Written by MT Staff
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The blackout of August 14, 2003 was a sharp reminder of the essential nature of electricity and just how dependent we are on its very existence.

Much of the electrical equipment in an industrial facility requires high-quality electricity; it will not tolerate sags, swells, transients, or harmonics, and it certainly will not tolerate power outages, no matter how short-lived. Recognizing the limitations of grid-delivered power (99.9 percent reliable, which translates into about 9 hours of downtime a year) and the fact that 80 percent of all power quality and reliability problems occur inside end-user's facilities, it behooves all maintenance and reliability managers to understand the power quality susceptibilities within their facilities and of their key equipment.

Look inside the plant

The blackout aside, most power disturbances come from within the facility itself, such as large loads turning on simultaneously, improper wiring and grounding practices, the start-up of large motors, and "electronic" equipment that can be both a source and victim of power quality phenomena.

These disturbances can interrupt production lines, cause damage to products and equipment, result in lost orders or transactions, corrupt data communication and storage, and cause an overall decrease in productivity in today's global economy. Estimates put power-quality-related losses at $50 billion to $150 billion annually in the U.S.

Power monitoring can address these issues in a number of ways:
• Evaluation of incoming electric supply and distribution throughout the facility to determine if power quality disturbances or variations are impacting, or have the potential to impact, facility operations and/or manufacturing processes
• Identification of power quality trends to provide a baseline for establishing predictive maintenance activities and avoiding interruptions of critical business activities
• Optimization of power mitigation equipment using a reliability- or condition-based monitoring approach. Power parameters can be correlated with process performance and output to locate production defects caused by poor power quality.
• Reduction of energy expenses. In some industries, such as textiles or pulp and paper, electricity consumption of electric motors alone accounts for 90 percent of the total energy bill.
• Assessment of energy and electricity issues related to capital investments and new equipment. There are many examples of multi-million-dollar equipment that performed flawlessly at the vendor's test site, but did not operate as specified at the customer location

due to poor power quality.

Focus on motor reliability

Electric motor systems account for 65 percent of all electricity consumed by U.S. industries. Motors represent a significant capital expenditure, but more important, a sizeable ongoing expense as the average motor consumes 50-60 times its initial purchase in electricity during its life. Further, motors are sensitive to power quality problems such as unbalance and harmonics, and can produce sags (the power quality event that characterized the blackout) for other equipment on the circuit.

Improving the performance, reliability, and cost-effectiveness of these motors is an important goal for industrial maintenance specialists. When a motor is first energized, a large inrush of current results, typically 6-10 times the normal steady state current running levels. This large current change results in a significant voltage drop across the source wiring impedance and the resulting sag leaves less voltage remaining for the loads connected to the same circuit.

Power monitoring systems are used to manage these inrush conditions associated with start-up, as well as to provide critical information on voltage irregularities, one of the five factors attributed to most motor failures. Often overlooked, incoming power quality can have a direct impact on motor performance.

For example, undervoltage and overvoltage conditions can cause rapid heating in the windings, shortening their life. Transients can trigger failures in the winding insulation, while harmonics from nearby equipment can contribute to overheating of the windings. Unbalanced voltage conditions between phases will result in increased current flow and overheated windings as well.

Power monitors are used to baseline incoming power, identify any conditions that might contribute to motor failure, trend parameters that could lead to long-term degradation, and provide data to reduce energy consumption.

Beyond the blackout

While volumes will be written on the cause of the August blackout, the lessons learned about power vulnerabilities at the facility level should spur immediate action. Today’s power monitoring instrumentation is a predictive maintenance tool that can help facilities avoid power quality problems that lead to equipment malfunction, overheating of circuits, and system failure.

Whether used to baseline power infrastructure, troubleshoot power quality problems, evaluate power availability prior to purchasing new manufacturing equipment, or bringing key processes on line, power monitoring instrumentation delivers a significant return on investment. **MT**

Information supplied by Dranetz-BMI , 1000 New Durham Rd., Edison, NJ 08818; (800) 372-6832

Monitoring the Blackout

Now considered the most significant blackout of modern times, statistics surrounding the August 14, 2003 event are worth considering:

- What started out as a “typical” summertime power plant trip at 2 p.m. in Ohio set off the cascade of massive outages across eight states and two countries.
- Over 100 power plants and transmission lines shut down during this period—most after 4:10 p.m. within a 9 second span.
- 50 million people experienced power loss, some for up to 72 hours.
- 61,800 MW of customer load was impacted.

Monitoring data was captured using Dranetz-BMI’s Signature System, a web-browser-based, continuous monitoring system, at numerous locations across the impacted area. This data proves useful in understanding the cascade of events across the region. In fact, system customers who recognized the unique “signature” created by the simultaneous 3-phase deep sag were able to affect an orderly transition to their UPS systems and backup generators.

The type of data generated by these monitoring systems enabled customers to implement and evaluate backup generation programs, assess the impact of power quality events on key process equipment, and bring that equipment successfully back on line without damaging product quality.

Fig. 1 shows the rms voltage recorded in New Jersey at the time of the unraveling. The voltage has a drop that showed the system was becoming overloaded as generation was going off-line and power flow reversed through parts of the grid. (The faulty current increased during this time as the monitored office building drew more amps to compensate for the reduced voltage.)

Fig. 2 shows a frequency rise in New Jersey that occurred when load was dropped and there was temporarily too much generation compared to load in the remaining system.

Fig. 3 shows the frequency jump in Knoxville, TN. This is because the grid is interconnected and the utility was feeding power north into the affected areas. When Ohio, Michigan, Pennsylvania, etc., were lost, then the same situation occurred: There was temporarily too much generation in the system.

Fig. 1

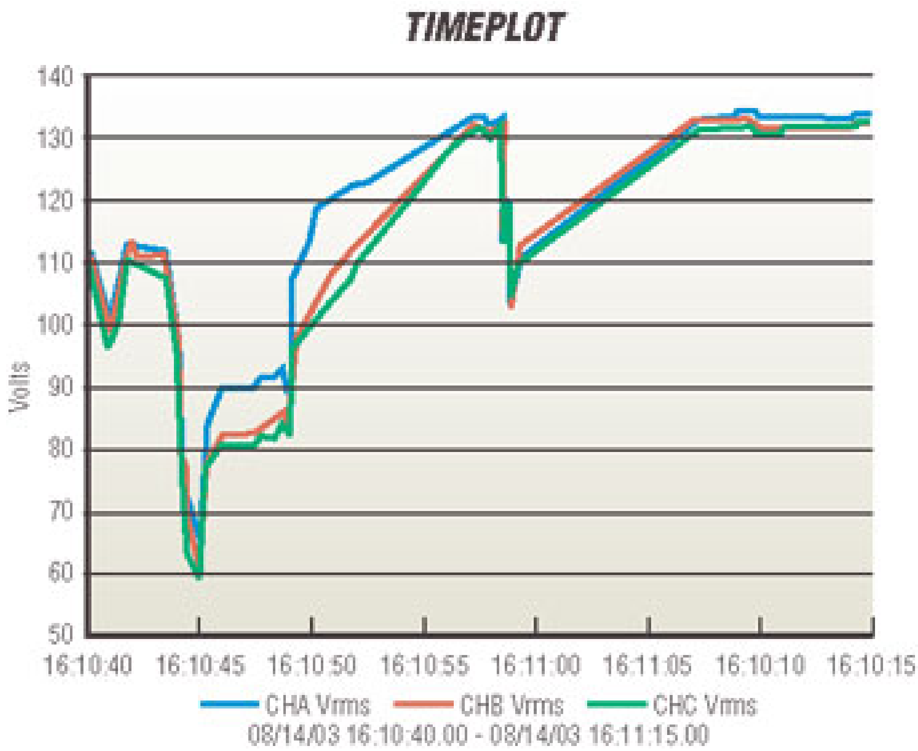

Fig. 2