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# RELIABLE

## Large industrial plant identifies repairs, avoids damage

United States
Industrial plant quickly finds loose connections, identifies and completes repairs.

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# Large industrial plant avoids disruption: identifies loose connection and repairs before damage caused

A large industrial operation is situated in a campus setting within a mix of industrial and office buildings. The office building is served by an overhead 12 kV circuit owned and maintained by the local utility. This feeder serves the office building and other commercial and small industrial customers located beyond the plant.

After fluorescent lighting in one of the office buildings began to flicker and computers started rebooting unexpectedly, the facility engineer suspected there were power quality disturbances coming from the utility, so he checked the campus power monitoring and control system.

## Isolating the source of the problem

The Facilities Team had recently installed a Schneider Electric power management system – with PowerLogic™ power meters at key locations across the campus – capable of capturing voltage and current waveforms. One meter was installed at the service entrance of the building that was experiencing the intermittent reboots; and, using the power management software, the engineer saw that an alarm was indicated on this meter. It also showed multiple voltage fluctuations on phase A-to-neutral, which had dropped intermittently below the 88% threshold over the past hour (see figures 1 and 2). Further, thanks to the disturbance direction detection feature, the meter indicated these voltage sags had occurred upstream of the meter, meaning the likely source of the problem was the electrical utility.

With information from the power monitoring system in hand, which indicated the high probability that the voltage sags resulted from problems on the utility system, the facility engineer called the local utility. Then an employee at the office building reported seeing a “welding light” at the top of the utility pole just outside the building. This came from one phase of a 3-pole knife-blade switch mounted just upstream of the feeder serving the building. By this time, the arcing problem had escalated to the point that personal computers were rebooting, lights were flickering constantly, and the local area network server was malfunctioning. The facility engineer placed another call to the utility to report the arcing.

## Goal

To quickly isolate and resolve — and ultimately prevent — loose connections and associated downtime and equipment damage.

## Solution

Power management system that includes power meters and software, capable of capturing and alarming on concerning voltage and current waveform fluctuations.

## Story

A large industrial operation experienced issues within its office buildings. The power management system indicated below-threshold voltage fluctuations, and was able to determine the likely source of the disturbance.

## Results

Once the source was identified, the company was able to resolve the issue, saving downtime and possible extensive equipment damage. Monitoring is key to reliability.

## Resolving the problem

The utility company sent a line crew to the scene to investigate the report. By the time the crew arrived, molten metal dripping from the switch had ignited dry grass at the base of the pole. The switch had deteriorated to the point that it could not be closed.

After notifying customers along the circuit, the crew de-energized the 12 kV feeder to install a temporary jumper around the faulty switch.

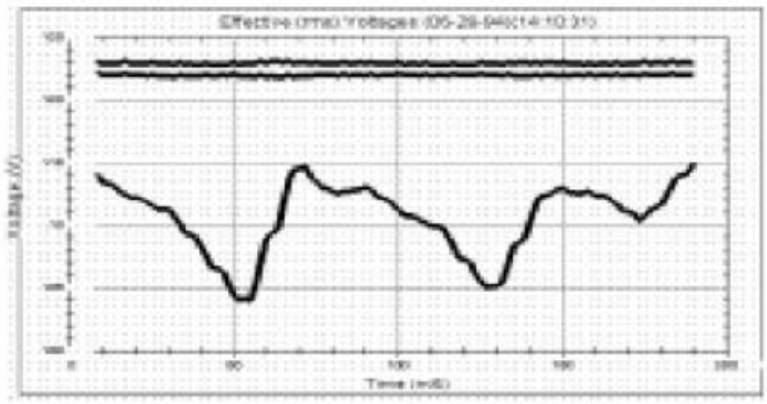
The next day, the line crew replaced the faulty switch and removed the jumper, all without power interruption to the customers on the circuit.

## The risk of not monitoring power

For the industrial complex in this case study, the solution to a loose connection problem was to call the local utility. The industrial customer's power management system quickly identified the problem before it caused more serious production delays.

One manufacturer of time clock controllers was less fortunate. This plant suffered a fire and shutdown due to a faulty connection inside the facility. The cause was traced to a twisted piece of busbar to which large cables were attached. The cable lugs had been correctly selected and installed, but the plant never again checked the integrity of the connections (and it did not have a power management system). One phase connection began arcing during third shift, cascaded to a three-phase fault, and initiated a fire that closed the plant for a week.

Another plant without a power management solution spent weeks trying to determine the cause of operating problems with a new electric glue-curing machine. The problem was finally traced to poor connections inside an outdoor, overhead junction box at which cables were attached to bus duct. The voltage fluctuations disrupted the equipment, but the additional heating losses in the junction box went unnoticed due to its outdoor location and the problem occurring in the winter.



Waveform capture translated into effective (rms) values shows voltage fluctuations on Phase A-N due to faulty utility switch.

## Preventing loose connection issues

Facilities can avoid disruptions caused by loose connections. A power management system can detect them early, before trouble arises. As demonstrated in this case history, power meters can detect voltage fluctuations caused by loose connections. Monitors placed at key points in new or existing switchgear can trigger waveform captures and initiate alarms when loose connections cause fluctuations.

Some industrial facilities rely solely on thermographic surveys of electric switchgear to identify loose connections. These surveys are often called infrared scans because the detection scheme records infrared light variations. Loose connections show up as lighter-colored areas (hot spots) on thermographic prints. Some devices indicate the actual temperature of the metal components.

While periodic infrared scans are strongly recommended, their benefit in preventing loose connections problems is limited. Many companies complete the surveys on an annual or biannual basis. The problem may continue for months, intermittently disrupting sensitive production equipment or reducing employee effectiveness, before the periodic scan discovers it. The scan also relies on the secondary effect of loose connections: excessive heating. The heat is caused by unusual voltage drops across circuit components not intended to be high impedance connections.

Power management systems continuously monitor for the voltage fluctuations that are the cause of heating and equipment problems. The systems capture a variety of other power-related problems as well, but they can easily pay for themselves by preventing a single loose-connection incident like those described earlier.

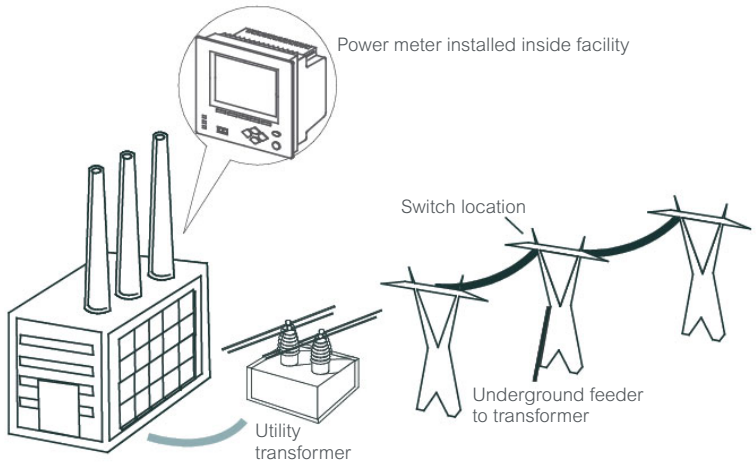
Power meter captures voltage fluctuations on utility feed.

## Monitoring is key to reliability

Some experts claim that most power quality problems can be solved with a screwdriver. What they mean is that wiring and grounding problems like loose connections cause the great majority of operating problems experienced by sensitive equipment.

Ensuring that loose connections do not disrupt your facility is more complicated than just tightening lugs with a screwdriver; and, of course, repairing loose connections needs to be more safely done. One important way to ensure that voltage fluctuations from any source do not disrupt production, or cause catastrophic faults, is to continuously monitor your electrical circuits.

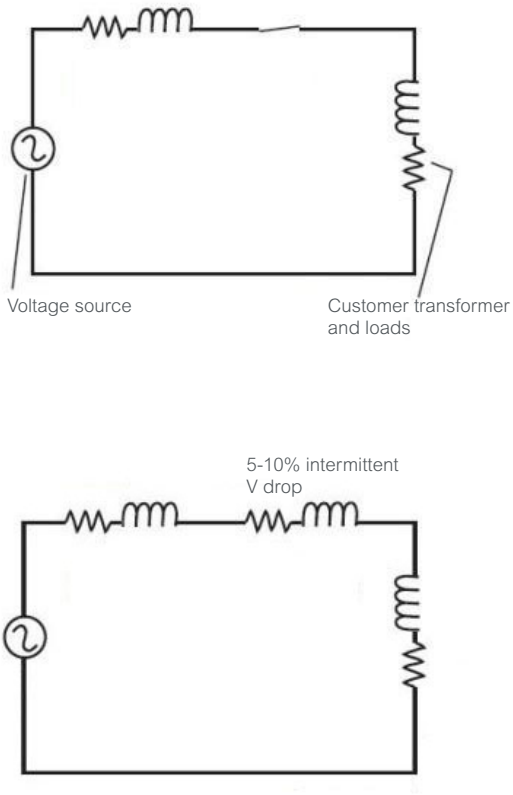
Power meters can capture voltage fluctuations, as well as other phenomena that disrupt or damage equipment. The power management system provides the plant engineer with the information needed to reduce downtime, ensure employee productivity, and reduce manufacturing costs.




The office building in this case history was served at 480 V from an overhead 12 kV utility distribution system.

## What are voltage fluctuations?

These are systematic, random, cycle-by-cycle changes in voltage that come from a variety of sources. Arc furnaces are one of the most common, affecting other customers served from the same utility circuit. Other common sources are loose connections, frequent motor starting, intermittent loading (as may occur with a chipper machine), and welding. Loose connections form high-impedance points in the electrical system, which in turn cause intermittent voltage drops. These fluctuations affect equipment on the load side of the loose connection. Inside a facility, loose connections can occur wherever conductors terminate or transition.




Top switch circuit diagram shows virtually no voltage drop across a properly seated knife blade switch. Most voltage drop occurs across customer loads. Bottom diagram shows that during switch arcing due to improper connection, there is an intermittent five to ten percent voltage drop across the switch. This arcing dissipated about 70 kVA – enough power to run a 100-hp motor – and caused the switch to begin melting.

## What is light flicker?

Flicker can be caused by voltage fluctuation magnitudes as low as 0.5%. Though people vary widely in light flicker, sensitivity, it is extremely irritating to many, resulting in decreased productivity and increased re-work. Studies show that sensitivity depends on the amount of illumination change (magnitude), how often it occurs (frequency), and the type of activity undertaken. It's worth noting that different lighting systems have different response characteristics to voltage changes.

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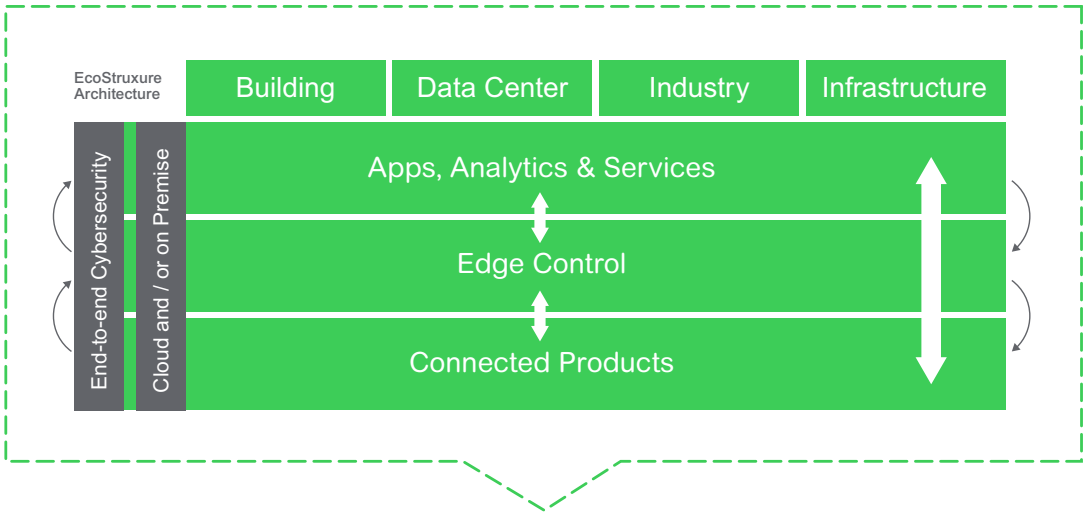


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