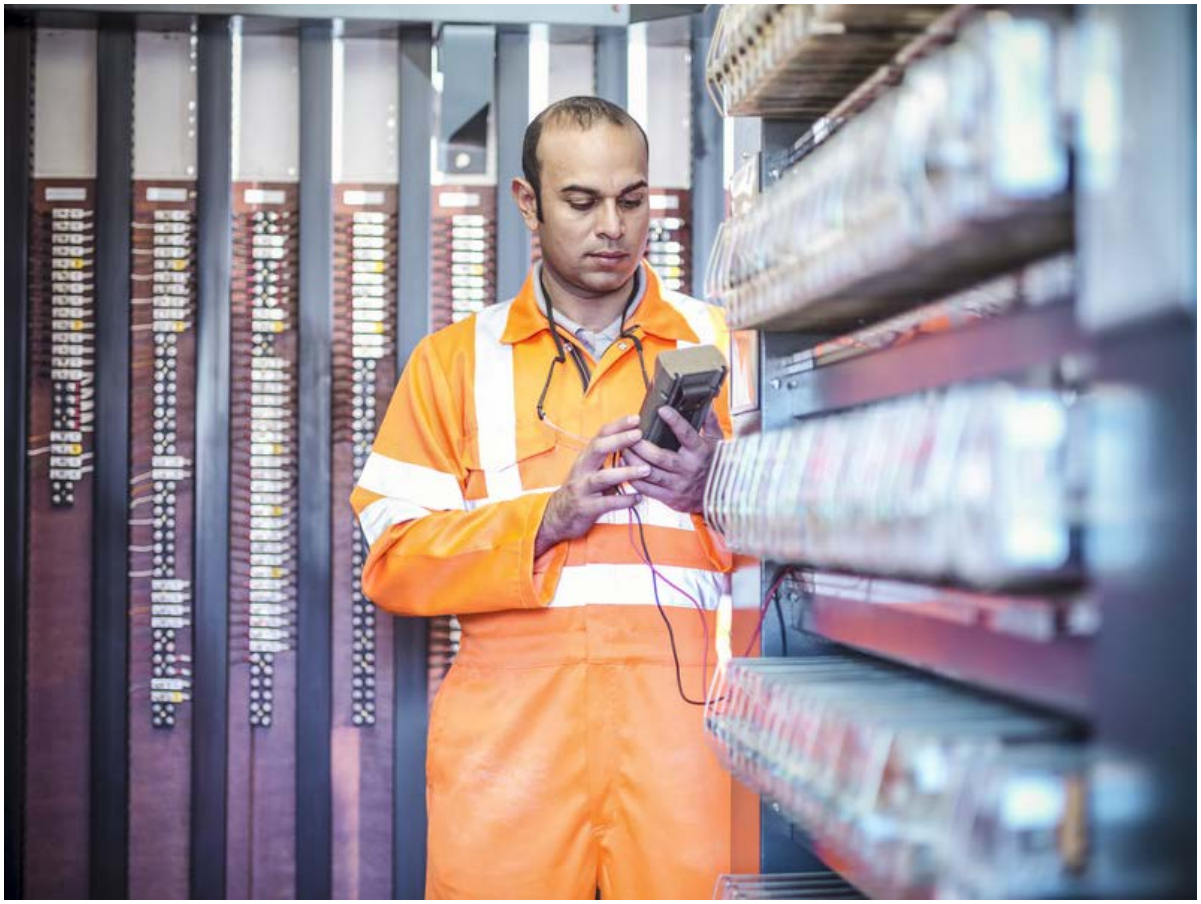
[Schneider Electric Case Study]

Large industrial complex

United States



Loose connections cause power quality problems

In Brief

Goal

To eliminate loose connections in AC power systems, thus reducing voltage fluctuations that cause power quality problems and equipment damage.

Solution

PowerLogic meters provide plant engineers with the information they need to reduce downtime, ensure employee productivity, and reduce manufacturing costs.

Results

- Loose connection identified quickly
- Utility connection point de-energized and repaired
- Facility avoided power disruption
- No serious production delays

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Background

It all began mysteriously.

One day the building's fluorescent lighting began to flicker, then computers unexpectedly rebooted. This went on for an hour before a frustrated employee finally reported it to the building's facility engineer. The engineer suspected power quality disturbances were coming from the utility, and immediately returned to his office to check the plant's power monitoring and control system.

The facility recently installed a Schneider Electric power management system – with meters installed at key locations within the complex – capable of capturing voltage and current waveforms. In fact, one PowerLogic ION7650 meter was installed at the service entrance of the same building suffering the intermittent reboots. The power monitoring software indicated an alarm on this meter; he also found 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). Plus, the ION7650 indicated these voltage sags had occurred upstream of the meter, meaning the likely source of the problem was the electrical utility.

The office building was served by an overhead 12 kV circuit owned and maintained by the local utility. This feeder served the office building and other commercial and small industrial customers located beyond the plant.

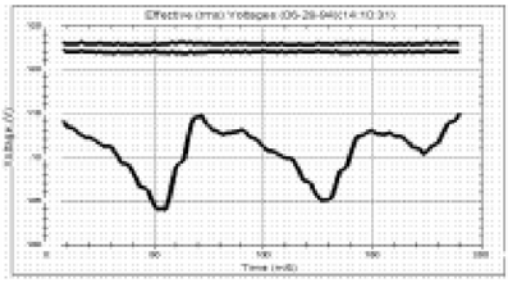

Figure 1: Waveform capture translated into effective (rms) values shows voltage fluctuations on Phase A-N due to faulty utility switch.

Suspecting 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. Figure 4 shows that the "welding light" 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 badly, and the local area network server was malfunctioning. The facility engineer placed another call to the utility to report the arcing.

Key Concepts and Terms

Voltage Fluctuations

Voltage fluctuations are defined as systematic or random variations of voltage. Fluctuations cause cycle-by-cycle changes in voltage which can come from a variety of sources – arc furnaces are one of the most common causes. These furnaces often affect other customers served from the same utility circuit. In commercial and industrial facilities, some other common sources of fluctuations are loose connections, frequent motor starting or 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.

Light flicker

Sensitive equipment disruption and power system component failures are only part of the problem. Voltage fluctuation magnitudes as low as 0.5% can cause a perceptible flicker in some lighting sources. Though individuals vary widely in their susceptibility to light flicker, it is extremely irritating to some workers, 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. The problem is further complicated by the fact that lighting systems have different response characteristics to voltage changes.

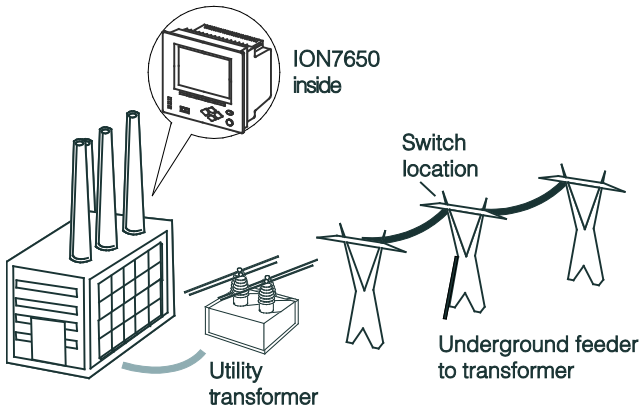

Figure 2: The office building in this case history was served at 480 V from an overhead 12 kV utility distribution system.

The solution

Figure 3: A three-pole knife blade switch began arcing due to improper seating.

For the industrial complex in this case study, the solution to a loose connection problem was to call the local utility. The 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 industrial customer's problem was identified quickly and effectively with its power monitoring and control system 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, as the plant engineer discovered, 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 PowerLogic 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 PowerLogic metering 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 occurred in the winter.

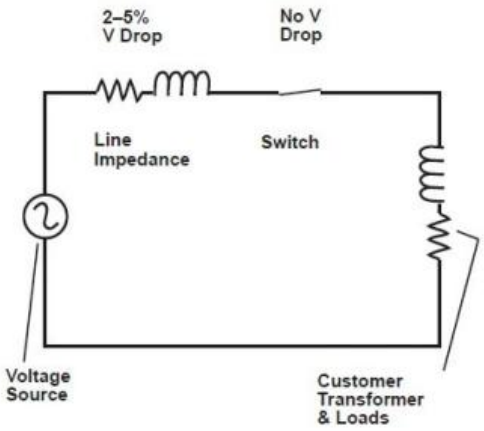

Figure 4: Circuit diagram of the switch circuit shows virtually no voltage drop across a properly seated knife blade switch. Most voltage drop occurs across customer loads.

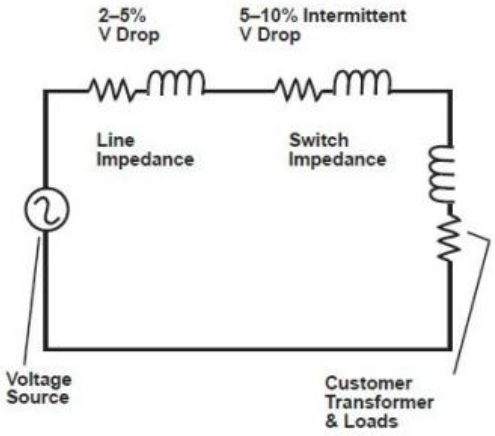

Figure 5: During switch arcing due to improper connection, there is an intermittent five- to ten-percent voltage drop across the switch. This arcing dissipated about 70 kVA – enough power to run a 100-hp motor – and caused the switch to begin melting.

Preventing loose connection problems

Loose connections in a facility need not be disruptive. They can be detected early with a PowerLogic monitoring and control system. As demonstrated in this case history, Schneider Electric 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 industrials 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.

PowerLogic 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 can easily pay for themselves by preventing a single loose-connection incident like those described earlier.

Schneider Electric offers complete power quality consulting services to ensure that power problems do not impact your operation. Contact our power management experts for information about the following:

- Power Quality Consulting
- Energy Management Consulting
- Harmonic Filters
- Power Factor Correction
- Power Management Training
- Technical Support
- Digital Simulation Studies
- Remote Monitoring Services
- Data Collection and Analysis

Conclusion

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 needs to be safer!). One important way to ensure that voltage fluctuations from any source do not disrupt production, or cause catastrophic faults, is to monitor your electrical circuits.

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