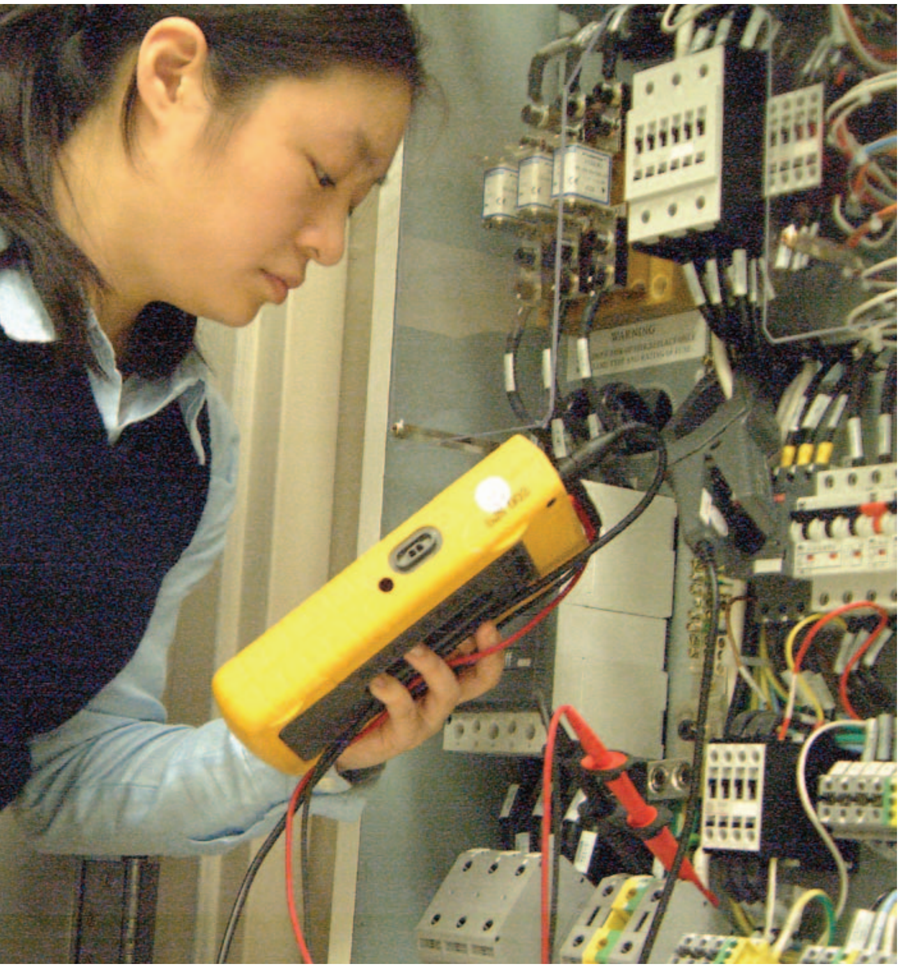
When power quality is life and death

Technology at Work

Power quality and reliability can be a matter of life and death in the medical field. Diagnostic machines such as X-rays, CT Scans and MRIs feature extremely fine calibration tolerances and specific power ranges. Yet they have to be up and running with complete reliability at all times in order to properly diagnose and treat patients.



Selina Chang using the Fluke 43B Power Quality Analyzer to collect voltage and current data at the PDU (Power Distribution Unit) of a CT Scanner.

Power Quality (PQ) covers a wide range of issues, from voltage disturbances like sags, swells, outages and transients, to current harmonics, to performance wiring and grounding. The symptoms of poor PQ include intermittent lock-ups and resets, corrupted data, premature equipment failure, overheating of components for no apparent cause, etc. The ultimate cost is in downtime, decreased productivity and frustrated personnel.

But some PQ problems in hospitals can show symptoms that are downright creepy. One onsite field engineer at a hospital reports getting a call from a very concerned nurse in the ER: one of their patients had died. But as upsetting as that was, it wasn't the main source of concern. What was really unusual was that this particular corpse had a heartbeat.

A quick glance told the engineer that the dead had not come back to life. The problem lay elsewhere. The nurses pointed out what they had seen, a signal on the EKG indicating a heartbeat. But there was something unusual about this signal (above and beyond the fact that it seemed to be coming from a dead body). He noticed that the signal was a 60 Hz sine wave (slightly flat-topped). A further look at the signal wires told him that they had been laid parallel to the power cord. The coupling between signal and power wires caused the 60 Hz "heartbeat" on the EKG machine.

BDMCI-Med, the biomedical division of B&D Morningstar Consultants, troubleshoots and corrects power quality problems in Canada's medical facilities. When the power is poor, it can upset the system. The goal is to prevent damage to the sensitive electronic equipment and improve the power quality; often using universal power supplies (UPS) or power conditioners. Error logs generated by the medical diagnostic machines are a common problem and power quality analysis is needed to determine whether the error condition and a power event are related.

As an example, Selina Chang, Power and Grounding Specialist with BDMCI-Med, recalls a site suffering from poor system reliability that caused a lot of downtime and required a lot of troubleshooting. Many components were switched in and out trying to solve the problem. Chang and her team wanted to determine whether power quality was an issue.

"We set up our 3-phase Power Recorder and within about two weeks of monitoring we were able to determine that the specifications for the equipment were not being met, causing the system to be unable to function reliably."

Thanks to the data captured by the Power Recorder, Chang's team was able to pinpoint the problem: the transformer not providing its full capacity, which in turn meant the system was unreliable.

"We were able to analyze the site and identify power quality as the culprit," says Chang. "Corrective action was taken to alleviate the problems and eliminate downtime and reliability issues with this important diagnostic equipment."

Diagnostic approaches

One approach to PQ diagnostics is to start as close to the "victim load" as possible. The "victim load" is the sensitive load, typically electronic, that is somehow malfunctioning. An alternative is to start at the service entrance, using a three-phase monitor, and work back to the "victim load." This is most useful if the problems originate with the utility. However, the great majority of PQ problems originate in the facility. In fact, as a general rule, PQ is best at the service entrance (connection to utility) and deteriorates downstream through the distribution system. Remember that 75 percent of PQ issues are related to wiring and grounding problems.

It's tough to diagnose PQ problems without having a working knowledge of the site being investigated, so you should start by locating or reconstructing a one-line diagram of the site, which identifies the ac power sources and the loads they serve. Why go to this effort? Systems are dynamic; they change over time, often in unplanned and haphazard ways. Furthermore, while some problems are local in origin and effect, there are many problems that result from interactions between one part of the system and another. Be aware that often the sites that need the most help are the ones least likely to have a good record of what's going on in their system.

Sometimes a visual inspection will offer immediate clues, such as a transformer that's much too hot, wiring or connections discolored from heat, receptacles with extension strips daisy-chained to extension strips, signal wiring running in the same trays as power cables, extra neutral-ground bonds in sub-panels or grounding conductors connected to pipes that end in mid-air.

Interview the people operating the affected equipment. Get a description of the problem — it often turns up unexpected clues. It's also good practice, especially for intermittent problems, to keep a record of when problems happen and what the symptoms are. The goal is to find some pattern that helps correlate the occurrence of the problem in the "victim load" to a simultaneous event elsewhere.

Selina Chang verifying the setup for the RPM Portable Recorder at the main disconnect (circuit breaker) of an Angio system.

Use your PQ troubleshooting tools to measure the receptacle branch circuit, service panels, transformers, electrical noise and transients and lightning protection, motors, adjustable speed drives and commercial lighting loads.

Test tools used in PQ troubleshooting should be safety rated at CAT IV-600 V or CAT III-1000 V for measurements at the service entrance and on high energy power circuits. In addition, instruments with recording capability, waveform display and specialized measurements (such as harmonics, sags and swells, transient capture, high frequency noise, etc.) are needed.

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