What You Don’t Know May Hurt You

(Start logging your problems, advises this specialist)

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Familiarity may breed acceptance: a grudging willingness to live with the glitch in your PC, the temperamental robot on your shop floor, and the perceived lack of robustness in new electronic equipment. But you Don’t have to live with these goblins. What we need is a clearer understanding of the equipment we use and the electrical environment they operate in.

How do you know you have a power quality problem? Not all equipment breakdowns and malfunctions are caused by poor power quality. If a good preventive maintenance program is in place and the equipment is well maintained, it will be easier to identify true power quality problems. Start keeping a log of breakdowns, if you are not already doing so. Record what broke down, when and why. When you get too many unanswered “whys” you may have a power quality problem to be addressed.

Power quality problems can stem from a variety of causes: improper grounding, wiring errors, loose connections, electro-magnetic incompatibility, radio frequency interference, power factor correction, static electricity…. Along with the person responsible for the area of concern, study the impact of the problem encountered. If it is of serious significance – loss of equipment or major disruption of production – find a qualified consultant to carry out a power quality analysis.

Self-help first

Before calling in a consultant, there are some checks that can be done by yourself/your staff, starting at the service entry of the distribution system and extending to the point of the affected area:

- Check the grounding for illegal bonds in the distribution panels.
- Check principal grounding point.
- Check transformers for overheating.
- Check for possible damage to the electrical system from moisture or humidity.
- Perform instantaneous measurements to check ground-to neutral voltage, polarities and ground loops.

If the above checks fail to point to the cause of your problems, it is time to consider more sophisticated monitoring equipment such as a power analyser. In the absence of such detailed preliminary checks, no power conditioner will, by itself, solve your problem. The following example is drawn from my own field experience.

The client had purchased brand new graphic art stations (to replace an older system) and had them professionally installed by the supplier. To his dismay, the images on the new CRT (cathode ray tube) screens were floating"! Sounds familiar? The supplier's efforts to cure this with power conditioning devices as well as by changing the work stations were unsuccessful, which is when I was called in.

During the preliminary walk-through, I noticed over-head power lines (feeding industry in the neighbourhood) running parallel to the building and close to the area where the work stations were located. The building also had metalclad siding which was bonded to the principal ground point. Immediately, a suspicion of radio frequency interference (RFI) entered my mind.

To check this out, I put the work station on a 150 foot extension cord, placed it on a cart, and proceeded to push it away from the proximity of the power lines and the metal-sided wall. As I moved it away from the area, the "floating" gradually diminished and the problem was solved. This was an instance where the new equipment was more susceptible to poor power quality. Updating with new equipment frequently causes this kind of occurrence, because the faster, smaller, more efficient technology is also more sensitive and more dependent on a good electrical environment. All power quality problems are not this easily or inexpensively overcome, but none are impossible to resolve.

Working with a consultant

Power quality is a very specialized and fast-changing area. When looking for a consultant, seek out a qualified specialist. Research the consulting firm's background, experience in industry, and training in power quality. Enquire what measuring equipment they use and what performance guarantee they offer. Make sure the consultant will explain his findings, stating the causes of the problem and the solutions thereto. Request specifications and sources for corrective devices recommended. Ascertain if the consultant will perform follow-up checks and measurements after installation of the corrective devices, to confirm proper operation.

The first step is to familiarize yourself and the consultant with the physical environment of the problem area. Check out the possibility of work-in progress on the electrical distribution system – in house, outside, by the utilities, by the phone company, or by neighbouring industry. Review the latest changes or alterations to the system. List any additional equipment installed in your facility in the affected area and elsewhere. You and the consultant should make a list of sites to be monitored, starting with the problem area. This list may include equipment upstream in the distribution system, such as transformers, breakers and splitters, distribution panels etc. A walk through the facility or an updated single line diagram will enable the preparation of the list.

Make sure to define beforehand the required measurements and thresholds for each of the sites to be monitored. Also, determine the time duration for taking measurements. These depend on the load cycles of the business; usually one week, this may change with the nature of the problem or the purpose of the survey. Most monitoring equipment will have the following capabilities: power consumption, current, current sequence, voltage, kVAR, kVA, power factor, voltage and current disturbances, harmonics and harmonics spectrum.

Keep in mind that most power problems originate within your building, the exemptions being lightning and power factor impulses caused by the utilities which rarely enter the building's electrical distribution.

Check the recorded disturbances for coincidence against your log of occurrences. The characteristics of the measurements may offer clues to the cause of the problem, be it upstream or downstream of the monitoring point. You may need to check harmonic content against guidelines recommended in IEEE-519 or IEEE standard 1100-92, the “Emerald Book”. Your consultant should be Familiar with these.

Talking of harmonics….

Of all the power quality problems encountered in a facility, some 50% are the result of harmonics. What are harmonics?

They are distortions of the sinusoidal shape of the voltage and current waveforms. Not to be confused with other types of power disturbances such as transients and sags, they are a steady state distortion that can create unforeseen problems. On the other hand, because they are of a relatively steady state, they are predictable and hence preventable.

What causes harmonics? Solid state devices and non-linear loads cause them in varying degrees. If the following types of equipment are installed in your facility, you could have harmonics in the system with minor or major effects; rectifiers, variable speed/variable frequency drives, high efficiency lighting, arc equipment, induction heaters, and switch mode power supplies. Power factor correction capacitors are not in themselves the cause of harmonics. They do however, amplify the existing harmonics in the system.

You may want to compare some of the effects of harmonics listed below against your problem log:

- Motors and transformers running hotter.
- Torque pulsations in motors, causing mechanical vibration and noise.
- Disruption in the operation of electronic equipment such as computers.
- Non-reliability of control signals, causing roots, NC machines and motor controllers to malfunction.
- Inaccurate reading on meters.
- Incorrect operating of protective equipment.
- Capacitors over-heating, blowing fuses, short-circuiting or exploding.

The order of harmonics encountered in a commercial (i.e. office) complex is usually different from the harmonics generated in an industrial facility. The increased use of PCs, networks, laser printers, copiers and other electronic equipment in office complexes causes a very real concern about harmonics as a power disturbance. The equipment is usually installed on a three phase, four wire system. The problem here is the third harmonic current distortion caused by the characteristic operation of switch mode power supply on these types of electronic equipment. Overheated neutrals are a common symptom of third harmonic problems. In turn, these cause distribution transformers to overheat and, in extreme cases to short circuit.

In industry, the harmonics are usually of higher orders – 5th, 7th, 11th 13th – caused by industrial equipment. The methods of resolving these problems are very different from the means appropriate to a commercial environment.

In power quality, there are as many solutions as there are problems. Puzzling as these problems may seem to be, they do obey the laws of physics and can be remedied. There are, however, no “off the shelf” solutions. Having the appropriate monitoring equipment and a good understanding of electrical distribution systems/electrical equipment is the first necessity.

Educated, step-by-step problem-solving techniques, applied with good rational thinking, will lead you to the right solution for your specific problems.

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