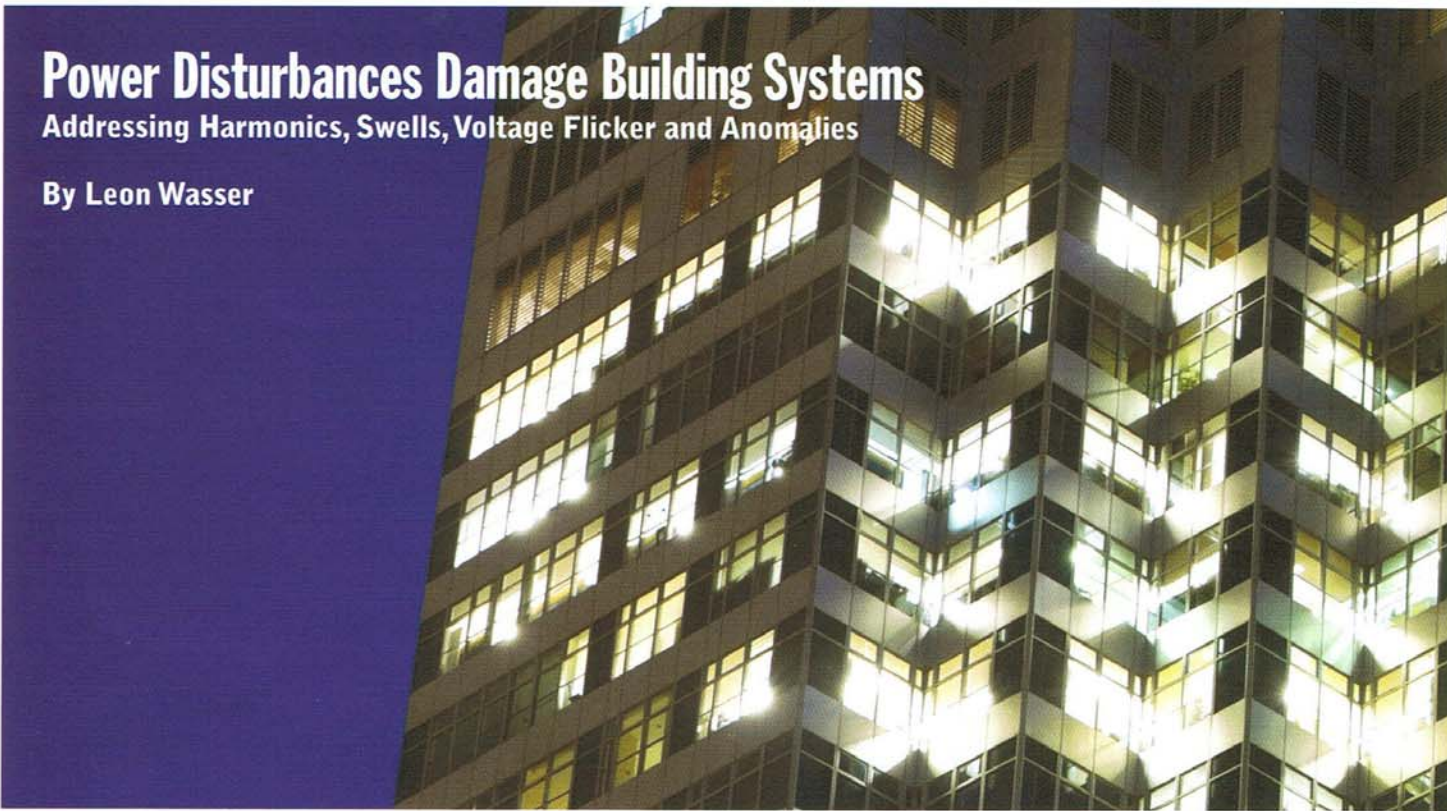


Power Disturbances Damage Building Systems

Addressing Harmonics, Swells, Voltage Flicker and Anomalies

By Leon Wasser



Historically, relatively few facility managers have given much thought to the quality of the power in their buildings. Instead, most managers, wearing their technical hats, are concerned about whether their facilities have a sufficient power supply, and, wearing their financial hat, are interested in opportunities for energy cost savings.

Recently, a number of factors have conspired to demand far more interest in the quality of power. That's both for technical reasons, because it may be affecting a building's system performance, and because improving the quality of a building's power supply can lead to major energy cost savings.

The electrical utility sector, which includes both producers and local distributors, is highly aware of and sensitive to power quality issues, and works hard to ensure that the power transmitted to consumers is high quality. In recent years, however, the electrical network has come under increasing stress as demand has soared and transmission capability and distribution has stagnated.

Toronto and Ontario as a whole have faced multiple outages and brownout conditions as the utilities strain to meet the power demand. What makes this problem even worse is that just as systems are working hardest to meet the demand for sheer power volume, their clients' needs for cleaner power are increasing exponentially.

For example, the power requirement for office data centres is becoming a major factor

for many property owners. Not only do these facilities consume enormous quantities of power themselves, but, by generating enormous quantities of heat, they also place increasing strain on the building's air conditioning system.

Simultaneously, as buildings become increasingly "intelligent" through the introduction of more solid-state controls for building systems ranging from elevators to security systems, they become more vulnerable to subtle variations in power supply. Increasing numbers of building managers responsible for technology packed facilities ranging from hospitals to high-tech manufacturing plants are concerned about power supply vulnerabilities that could cause unexpected shutdowns and/or malfunctions in critically important and sensitive operations.

INTERNAL FACTORS CAUSE VULNERABILITIES

The vast majority of power quality problems are caused by factors internal to a building itself. Usually, these power quality problems are the unintended and almost unavoidable consequence of the power loads in the building. Different forms of power consumption result in a variety of effects on the building's power supply, and different types of loading result in a variety of forms of degradation of the institution's power supply.

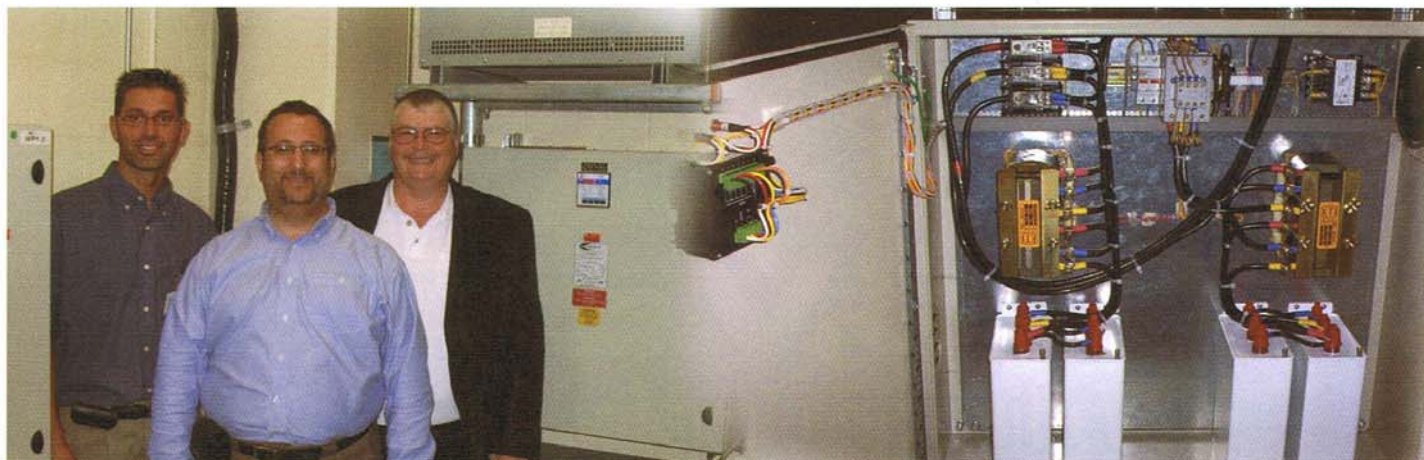
All electrical devices are classified as either resistive loads or inductive loads. Resistive

loads, such as incandescent lighting and baseboard heating, use power in a simple but inefficient manner – i.e. through the generation of heat and light through a filament or other resistive medium. These inefficient devices have become quite scarce in commercial buildings.

Inductive devices use power in far more complex and energy efficient ways. Nevertheless, one negative effect of the use of these devices is that they tend to disrupt the basic AC waveform, thus generating transients, harmonics and a variety of other disturbances to the basic three-phase structure of the power supply. In addition, they can unbalance the three phases of the power supply.

Since other devices require clean power, free of harmonics, phase imbalances and transients to operate efficiently, the more conflicting devices present in a building, the less efficient the overall power supply will be. This inefficiency translates into overheating of motors and compressors, and, in fact, the overheating of virtually all electrical devices as they attempt to shed the unusable power contained in the harmonics etc.

Most sophisticated devices require balanced loads, so the two higher phases will simply be ignored and the device will use only the power from the lowest phase, generating more losses and heat. In general, whenever a building has a large amount of power anomalies it will consequently also have a far lower power factor – the measure of the



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effective supplied (and paid for) power that a building actually uses.

Many building systems, as well as some major electrical systems, are designed to protect the system from these types of power problems, so power disturbances will trigger the automatic controls to shut off a system. Elevator contractors now report that an increasing number of power problems in the GTA, both from internal and external sources, is resulting in escalating/elevator system shutdowns that require service calls to perform manual system resets.

In some ways, the implementation of energy conservation technologies compounds these problems. Although the installation of compact fluorescent lights and variable speed drives dramatically reduces the overall power load of a building, these more sophisticated systems simultaneously introduce far more harmonics into a building's power supply, reducing its operating effectiveness. Over time, these power anomalies and the heat they generate can lead to permanent damage and

premature breakdown of a building's key operating systems.

POWER CONDITIONING

Low power factor has conventionally been addressed with a bank of capacitors located in proximity to large devices, or the power problems for a whole building could be partially remediated by larger capacitor banks located in the main electrical room. These capacitor banks address a symptom of the building's power supply problem while ignoring the cause of the problem, which is typically a combination of underlying power quality issues.

Computer controlled technology offers an effective alternative that can also be a cost effective conservation measure for a building. Power conditioning systems are designed to run in parallel with the primary electrical supply so that only a small proportion of the building's power runs through the power conditioning equipment in order to balance out or filter the power supply. This is also a safety measure if maintenance work is required for the system.

Because the system is designed to address fundamental power supply problems, static capacitors that some buildings have to locally stabilize power are removed since they tend to mask underlying power supply problems. Often, their presence results in the migration of power problems to elsewhere within a building, creating further and possibly more serious problems.

The design process begins with a complete diagnostic assessment of a building's power supply using sophisticated and highly precise meters and powerful power profile modeling software. These tests are systematically performed in each primary electrical room of a building starting at the entry point of the power supply and no power shutdowns are required.

Highly detailed results about the building's overall and local power characteristics and operating performance – including harmonics, transients, phase imbalances, voltage imbalances, current imbalances etc. – is combined with a full year's electrical data reflected in hydro invoices and the building's single line drawing to generate a design proposal. This includes projected reductions in kilowatt demand and kilowatt-hour consumption.

Savings could be understated because the generally non-quantifiable savings due to extended building equipment costs – as well as reduced maintenance and operational costs, and service disruption – can exceed the financial cost savings on the energy line of a company's ledger. **PMR**

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AVAILABLE INCENTIVES

Property owners can take advantage of energy incentive programs to improve the quality of power supply while conserving energy.

The Ontario Power Authority introduced the Electricity Retrofit Incentive Program (ERIP) in the summer of 2007. This incentive is administered through the numerous local distribution companies throughout the province. The attraction of this program is that it standardizes what had previously been a plethora of different local incentive programs, each with its own forms and measures (kW vs. kWh vs. power factor etc.). The details of this program can be found on the conservation web page at www.everykilowattcounts.com/erip.

The BOMA CDM program administered by BOMA Toronto offers generous grants of \$400 per kW or \$0.05 per kWh for commercial properties exceeding 25,000 square feet located in the City of Toronto. Smaller commercial buildings located in the City of Toronto still qualify for conservation grants from Toronto Hydro's PeakSaver Program.

