SYSTEMSREPORT

AKF engineers

Solid-State Devices Endanger Electrical Systems

The increasing use of advanced, solid-state technology throughout modern office buildings is creating a major problem for building owners and managers.

The proliferation of solid-state devices — servers, personal computers, variable speed motor drives and electronic ballasts — can create serious hazards in building electrical systems that are not designed to accommodate their widespread use. These solid-state devices are non-linear electrical loads that result in the creation of harmonic currents in the distribution system.

Although engineers have been aware of the potential hazards created by harmonic currents in building distribution systems for some time, the extent of these problems is just now being recognized.

Pulse Problems

Solid-state devices draw current in pulses. The frequency with which the pulses occur and their waveshapes are referred to in terms of harmonics (multiples) of the fundamental frequency (60 hertz). Generally, the pulses appear in the third, fifth and seventh harmonics (180, 300, and 420 hertz). The third harmonic current is the predominant contributor to the overall system current waveform distortion. The fifth and seventh harmonics have a lesser impact, although they must still be considered.

The proliferation of solid-state devices can create serious hazards in building electrical systems.

Standard electrical systems found in virtually all buildings today are designed to handle only traditional linear loads. Linear loads (such as motors, electric heaters, incandescent lighting and fluorescent lighting with magnetic ballasts) consume current on a continuous (linear) sinusoidal basis. Since there are no pulses in the electrical system, there is no generation of harmonics. When this type of load is balanced across a typical 3-phase, 4-wire power source, the return currents of each phase cancel each other out in the neutral conductor and there is no risk of transformer overload or wires overheating due to harmonics.

Problems develop in the neutral conductor when non-linear current is drawn from a 3-phase, 4-wire power source. Because the non-linear currents do not cancel in the neutral conductor, the neutral can be subjected to extremely high currents – even in excess of phase leg currents – causing hazards such as transformer overload and overheating of neutral wires and bus bars. This type of operation places an excessive amount of stress on the electrical power systems, resulting in loss of efficiency, equipment failure and/or a decrease in the systems' life expectancy.

Solutions

Despite the severity of this problem, it can be remedied through a number of relatively simple solutions.

Installation of special transformers and branch wiring containing oversized neutrals will significantly reduce the chances of harmonically induced transformer overload.

Harmonic problems in the branch wiring can be remedied in one of two ways:

- Oversizing the common neutral in a 3-phase, 4-wire circuit.
- Adding a separate neutral from each branch circuit back to the source panel.

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AKF has found the common neutral method to be a more effective and economical way of reducing heating in circuits with small-to-moderate amounts of harmonic content. For areas where there is extensive PC use, installation of a system with separate neutrals for each circuit must be considered.

Adding or oversizing neutral wires to accommodate non-linear loads has a direct effect on the sizing of electrical raceway systems. Partition manufacturers must be alerted when high non-linear loads are anticipated so that additional separate or oversized neutral wires can be included in electrified partitions. This method mitigates the harmonic problem by acknowledging it and planning systems to safely handle the currents involved.

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Other solutions include harmonic filters, counter harmonic generators and phase shifting transformers which address the problem by channeling the harmonic current.

Before performing any upgrade of an existing system, a qualified engineer must use a harmonic analyzer to test and pinpoint the exact level of harmonics in the building's electrical system. The percentage of harmonics in a system can range from very little to 50 percent of the total load.

New buildings offer more options where harmonics can be addressed closer to their source and their creation reduced by careful equipment selection.

With PCs on virtually every office desk, and solid-state devices such as electronic ballasts, rectifiers and data processing equipment commonplace throughout most office buildings, it is essential that this problem be addressed.

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