LEADING TECHNICAL INSTITUTE UPGRADES CURRENT-LIMITING REACTORS TO ENSURE SMOOTH FLOW OF POWER TO GROWING CAMPUS

Located in metropolitan Boston, one of the world's leading scientific universities conducts research funded by both government and private organizations. To handle future electrical demand, the university has undertaken an ambitious program to upgrade every facet of its power distribution system.

"We're in Phase Three of a six- or seven-phase upgrade," explains the growing university's senior electrical engineer, who is supervising the upgrade. "Only about 25% of our overall demand is met through utility hookups. For the rest, we've had our own generating plant and switchgear since 1994. Because the losses from a significant power surge or short circuit could be incalculable, we are determined to head off any problems. Everyone here counts on a smooth flow of power."

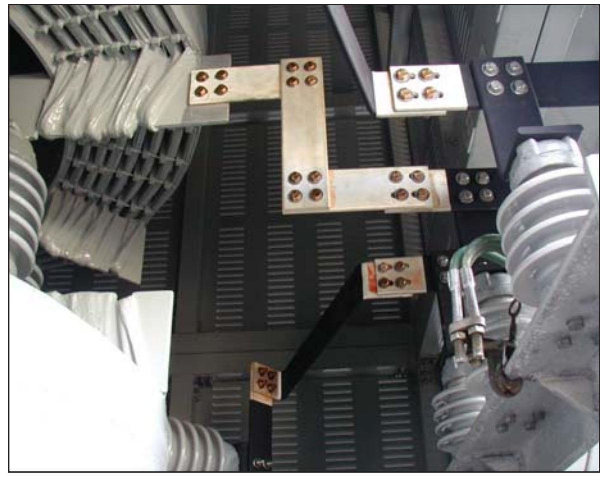
While classrooms, dormitories, and offices on the urban campus in Cambridge, Massachusetts, could lose lighting temporarily and perhaps suffer a few "fried" PCs or laptops, an unchecked power surge could wreak havoc on a multitude of ongoing research projects.

While a power anomaly is a mere inconvenience in the classroom, it can be a major setback in the laboratory. At the university's biomedical engineering center, for example, professors and students study cell responses to molecular stimuli, protein-DNA interactions, molecular dynamics, macromolecular binding/folding kinetics, etc. The center's new 2-photon microscopy imaging facility, funded in part by a grant from the National Science Foundation, includes a climate-controlled cell-culture room and two state-of-the-art microscopes that use a tunable titanium-sapphire laser as their light source. Other valuable instruments at the center include a scanning probe microscope, fluorescence microscopes, a surface plasmon resonance device, a radiolabeling hood and gamma counter, a steady-state spectrofluorometer, a real-time microphysiometer (to measure changes in extracellular ion levels), a cytosensor (to measure extracellular pH changes in response to soluble stimuli), and a peptide synthesizer. Typical of the university's many research nodes, the center also has more than its share of high-performance computer equipment that models, analyzes, displays, and stores images and other data.

Installed in 1994, the school's gas-turbine generators have an output of approximately 22 MW. Their total load demand is around 25 MW on a typical day and even higher on hot summer days that require air conditioning. To make up the shortfall, the system draws from the nearest utility substation.

Serving as a buffer between the university and utility systems are two custom-made, dry-type, air-core, current-limiting reactors built by Phoenix Electric Corporation of Boston. Brand new and installed side by side in May 2004, they are designed to limit the effects of short circuits, thus reducing the stress on buses, insulators, circuit breakers, and other high-voltage devices. All day every day, the reactors serve as a buffer between incoming current surges and campus facilities. This keeps the feed constant and predictable, even when there is a fault that would have damaged the university's generating equipment and other devices down the line.

A crane lowered the six five-ton reactor coils into place. Each reactor is a stack of three coils rated at 2000 amps each.



Phoenix Electric also manufactured the internal copper buswork for the two reactors. Each reactor is wired separately to the university's generator bus, providing redundancy.

"Reactors are sort of like giant surge suppressors," says the university's supervising engineer. "Without them, current spikes could disrupt or damage the utility's equipment as well as our own."

"Our old reactors could have lasted another 40 years, but we outgrew them," he continues. "Like our new ones, they were built by Phoenix Electric. They were rated for 28 MVA, but with the campus still growing, we think we're going to need a capacity of around 35 MVA in a few years. The new reactors are rated for 47 MVA, so they should be good for at least 15-20 years, depending on future growth."

Because incoming current has three phases, each reactor is a stack of three coils, weighing approximately 35,000 pounds and resting on a custom-designed aluminum support stand. The new units have an amperage rating of 6000 amps per three-phase reactor, or 2000 amps per coil. The reactors they replaced were each rated at 3600 amps, or 1200 amps per coil.

The challenge was to fit the new higher-capacity reactors into the same space, and to do it so quickly that the 20,000 people who work or study on campus would barely notice. Phoenix Electric engineers designed and supervised the entire retrofit, from conceptual diagrams to equipment installation. The project followed procedures that ensured optimum performance while minimizing service disruption and maximizing re-use of existing components. When the old units were removed, the university kept the four-sided aluminum enclosure towers. Although the new reactors have the same diameter as the old ones, they are taller, so the roofs were raised and another section was added at the top of each enclosure, for a height of approximately 24½ feet.

Noting the years of trouble-free performance from the old reactors, the school's engineer comments, "We saw value in sticking with Phoenix Electric. We have confidence in their products because we've had such success with their first set of reactors."

Based in the Boston suburb of Canton, Massachusetts, Phoenix Electric has been building reactors and specialty switchgear for more than 25 years for customers around the world, including major utilities and manufacturers, engineering and construction firms, and government agencies. All of the company's reactors are custom designed, taking into account voltage, current, inductance, available space, indoor/outdoor installation, loss characteristics, and other constraints.

Phoenix reactors are air-core, maintenance-free, cylindrically wound units that meet or exceed ANSI and IEC standards. Constructed on weather-resistant fiberglass epoxy tubes, they are encapsulated with epoxy-impregnated fiberglass roving and tape. The dielectric integrity of every coil is assured by pre-tested conductor insulation. Completed reactors undergo extensive testing, which varies according to customer needs but may include, for example, thermal current calculations, impulse tests, mechanical strength tests, impedance and loss tests, temperature-rise tests, and sound-level tests.

The new reactors stand side by side at the edge of the campus. Because the new units are taller than the lower-capacity reactors they replaced, the roofs were raised and another cubicle section was added at the top of each enclosure.

The university's two new reactors, the internal copper buswork, and all other equipment for the project were manufactured by Phoenix Electric. The reactors share a common bus with four incoming circuits (two per reactor), and each reactor system is connected to the main generator bus system separately. This provides redundancy if one of the utility systems is down.

The project drew on the expertise of a cast of Phoenix Electric professionals adept at disciplines such as civil, mechanical, and electrical engineering; seismic risk analysis; and computer science. For example, the design of the enclosures required sophisticated calculations on magnetic fields, to make sure the exterior panels would minimize loop and eddy currents. If allowed to circulate, such currents could cause overheating and could even shock someone touching the enclosure. Proper grounding is key to preventing such scenarios and was accomplished with specially designed straps that link each panel to the one below it. The spacing and shape of the panel louvers are also important design elements. These louvers not only provide ventilation but also break up magnetic fields, limiting their range and intensity.

"We visited the Phoenix Electric factory when the reactor upgrade was in the planning stage," recalls the school's supervising engineer. "We were impressed with their customer-service orientation. Their normal manufacturing window for these units was about six months, but we asked them to do it in only four. They met our schedule, and they were on site to help with the installation. Although Phoenix is always on call for technical support, their reactors require next to no maintenance. Every couple of years we check for dirt buildup on the insulators, but that's about it. Reliability is what it's all about – we aren't taking any chances."

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