By RON WILKINSON, PE, LEED AP, e4 inc., and DAVID K. ROBERTS, Cypress Envirosystems

DDC Gain Without the Pain

With noninvasive analog-to-digital system, upgrade proceeds without disruption and needless expense

For Class A office buildings, which compete for the most prestigious tenants and command the highest rents, expectations are considerable. No one makes allowances for, say, a Class A building's age or the types of systems installed. And so it is for 345 California Center, a 48-story, mixed-use property in San Francisco's financial district. Looking to keep down costs while improving the tenant experience and making a statement about how technology is being applied to make the building work smarter and better, Chief Engineer Tim Danz sought to upgrade from pneumatic controls dating from the facility's mid-1980s completion to direct digital control (DDC).

Retrofitting Pneumatic Thermostats

Traditional pneumatic-to-DDC retrofits are neither practical nor cost-effective while spaces are leased and occupied, the most opportune time being when a floor is being gutted for renovation. Indeed, it took several years to convert six of 345 California Center's 33 office floors from pneumatic controls to DDC. In 2008, Danz discovered the wireless pneumatic thermostat (WPT) and decided to try it.

A Cushman & Wakefield Inc. property, 345 California Center holds LEED (Leadership in Energy and Environmental Design) Gold certification and a 94 Energy Star rating.

WPTs offer much of the functionality of hard-wired DDC thermostats, but can be installed without disrupting occupants. WPTs also offer the flexibility to retrofit only selected zones, rather than an entire floor or building. The cost is approximately $600 per thermostat, compared with the $2,000-to-$3,000-per-thermostat cost of a conventional hard-wired DDC conversion.

Implementation of the new analog-to-digital control technology at 345 California Center began in 2009 with a trial in the property-management suite. The operations-and-maintenance (O&M) staff tested WPT performance in six zones on a daily basis, working closely with the office staff to collect feedback. Following the success of the pilot project, the technology was installed on two floors in 2010 and two more in 2011, with an average of 25 to 30 zones per floor.

Danz was concerned a WPT's batteries would fail and leave a space without control. This concern was alleviated

A longtime member of HPAC Engineering*'s Editorial Advisory Board, Ron Wilkinson, PE, LEED AP, is chief engineer for e4 inc., a sustainable-buildings consultancy in New York. He is the author of the first commissioning training program for the Leadership in Energy and Environmental Design for New Construction and Major Renovations Green Building Rating System, the chair of the commissioning advisory committee of The American Institute of Architects (AIA) Committee on the Environment, and the recording secretary for ASHRAE Guideline Project Committee 0.2/1.2, The Commissioning Process for Existing Building Systems and Assemblies/The Commissioning Process for Existing HVAC&R Systems. An ASHRAE Distinguished Lecturer and an AIA Continuing Education Lecturer, he has spoken on commissioning practices internationally. David K. Roberts is vice president, marketing, for Cypress Envirosystems, manufacturer of noninvasive retrofit technologies for facilities intended to improve energy efficiency, auto-demand response, and asset utilization and lower maintenance costs. He has worked in the field of energy for more than 10 years, the last five focused on energy efficiency and auto-demand response and their enabling technologies.*

when he learned branch pressure is controlled with a bimetal strip not dependent on battery power. This means batteries last approximately five years and, if they were to fail, the last occupied temperature would be held. Skeptical, Danz removed the batteries from a thermostat. The thermostat held the setpoint; when the batteries were replaced, the thermostat automatically reconnected with the building-management system (BMS) and continued operating as normal.

To date, five full floors have been converted from legacy thermostats to WPTs. Two-floor conversions essentially were completed in a day. Today, 140 WPTs are installed on the property.

Installation was simple: A legacy thermostat would be removed and replaced with a WPT, which then would be addressed, tied into the building's Ethernet trunk, and integrated with the building automation system (BAS). The WPTs required about as much labor to install as traditional pneumatic thermostats would have. O&M savings come in part because recalibration of WPTs is faster and easier, accomplished with a few keystrokes at a remote monitoring station, saving hours of labor and drastically reducing legwork.

"I can address one, two, or five full floors of WPTs and change setpoints," Danz said. "... This is a key capability that just isn't possible with legacy pneumatic thermostats."

The new monitoring and control system uses the BACnet open protocol and is designed to integrate with almost all existing BAS.

"Integration from the WPTs to the BMS was no problem at all," Danz said. "It is plug-and-play."

Bringing all of the new wireless points into the existing BMS was straightforward. Data travel over the same local-area network, with no need for a black-box integrator.

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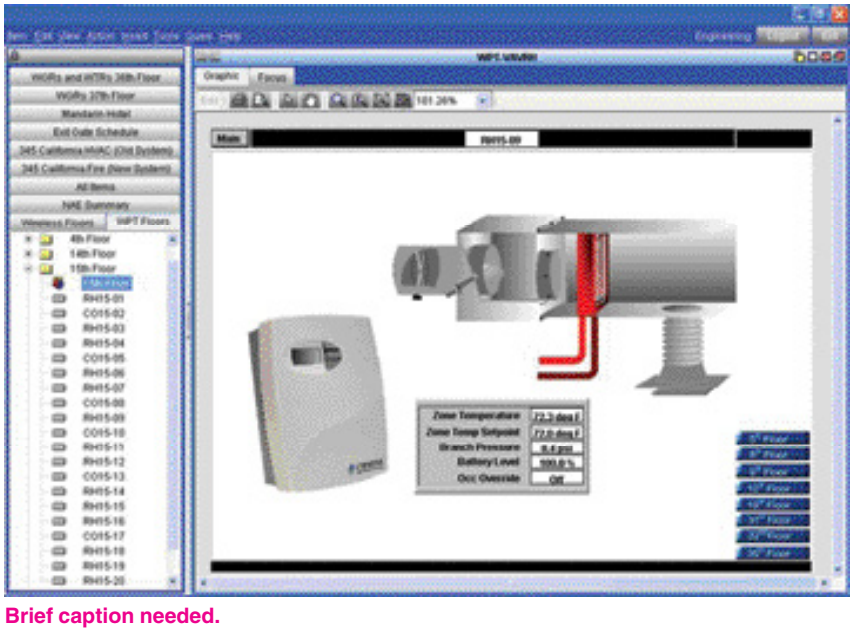
Benefits

Data points made visible via the WPTs include space temperature, setpoint adjustment, and pneumatic branch pressure, which are semi-automated fault-diagnosis tools providing the ability to identify issues within a variable-air-volume (VAV) box. While WPTs do not provide as many data points as hard-wired DDC room sensors, there is little identifiable difference between a DDC floor and a WPT-controlled floor when viewing thermostat location, space temperature, and the like in a BAS.

Danz achieves energy savings



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using many of the strategies DDC enables. He is able to maintain setpoints and program zone-level schedules while giving after-hours occupants the ability to override. He also is able to use zone data to reset supply-air temperature and take full advantage of variable-frequency drives by optimizing duct static pressure. And with California's aggressive time-of-use electricity rates, he can minimize costs by precooling the WPT floors.

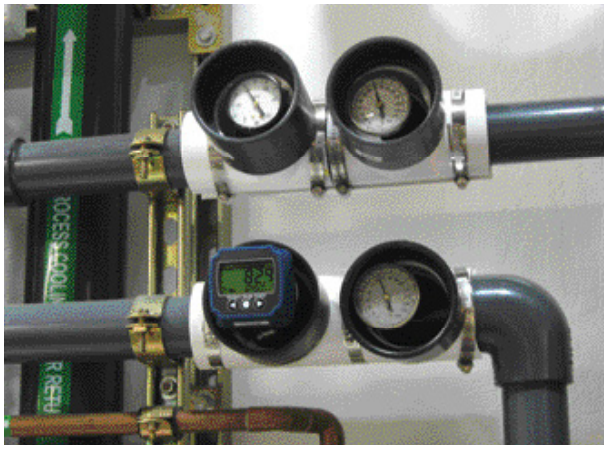


PHOTO A. Wireless gauge reader.

Enhanced visibility drives significant O&M improvements. Access to branch pressures, room temperatures, and setpoints allows an operator to diagnose jammed dampers and valves, malfunctioning actuators, and air leaks from anywhere. VAV diagnostics has made troubleshooting faster and, with the autocalibration feature, resulted in a 67-percent reduction in hot/cold calls.

Digitizing Data From Analog Gauges

Existing pump-suction and discharge, steam-pressure, domestic and sanitary water-pressure, and other gauges did not communicate or alarm excursions. Without an interface between the analog equipment and digital workstation, wire and conduit would have to be run and piping broken into for data to be brought into the BAS. The key to high performance was to digitize data so points could be monitored and managed through the automation system. Wireless gauge readers (WGRs) (Photo A) made this possible.

A WGR clamps onto the front of a gauge to capture and transmit readings to a BAS. It can be installed in minutes without the gauge being removed, pressure seals broken, leak checks performed, wires run, or the underlying process interrupted. To date, WGRs have been applied to 10 key pressures throughout the building.

Monitoring Steam Traps

Traditionally, steam-trap fault diagnosis has required manual observation. Typically, portable sensors are used to identify anomalous temperature differentials, indicators a trap is flooded or blowing through.

To avoid losses between manual inspections, Danz deployed wireless steam-trap monitors (WSTMs) (Photo B) on five large primary steam traps. The WSTMs, which continuously monitor delta-T, have improved maintenance operations substantially.

PHOTO B. Wireless steam-trap monitor.

By integrating the WSTMs and WGRs into the BMS and establishing alarm thresholds, Danz created a system that makes maintenance of the entire steam network easier. Trap-health and steam-pressure readings from remote parts of the building make it possible to ensure heat is being delivered to the most distant offices and residences. Gone are the days of travelling to the far corners of the high-rise to confirm a gauge reading or to check a steam trap. That is done from the central workstation now.

"We have reduced steam consumption in this building by about 40 percent, and cost-effective monitoring technology is a big part of that," Danz said.

Results

With diagnostic data provided by the wireless steam-trap monitors, gauge readers, and thermostats, the facility team is able to be more proactive in addressing mechanical-system issues. Just by looking at the BAS, Danz can tell whether the terminal units are working properly and often can detect a problem before it is noticed by a tenant.

Before the installation of WGRs, Danz made rounds to check pressure and log gauge data daily. Now, this information is available via the BAS. Even better, alarm thresholds have been set in case pressures drop, allowing the system to evolve from a simple BAS to

an automated fault-diagnosis tool. No longer is there a need to take the elevator up 36 stories to get information; that time can be spent on other tasks.

Thanks to the improved controls and other upgrades at 345 California Center, not only are there fewer hot and cold calls from tenants, the time spent addressing complaints has decreased by two-thirds.

Three forty-five California Center is able to reduce costs further via demand curtailment.

"Demand response is a big byproduct of WPT installations," Danz said. "The fact that I can grab these WPT zones in high volume and change them all instantaneously in response to curtailment requirements is incredible. With two clicks of the mouse, I can change setpoints, reduce fan-system loads, and avoid extremely high peak-time utility rates."

Now that the building has either DDC or WPTs on 12 of its 33 office floors, Danz can curtail load during times when California's electric grid is at its peak. Being able to reset 12 full floors globally as part of a contracted response protocol has made a significant impact on energy bills.

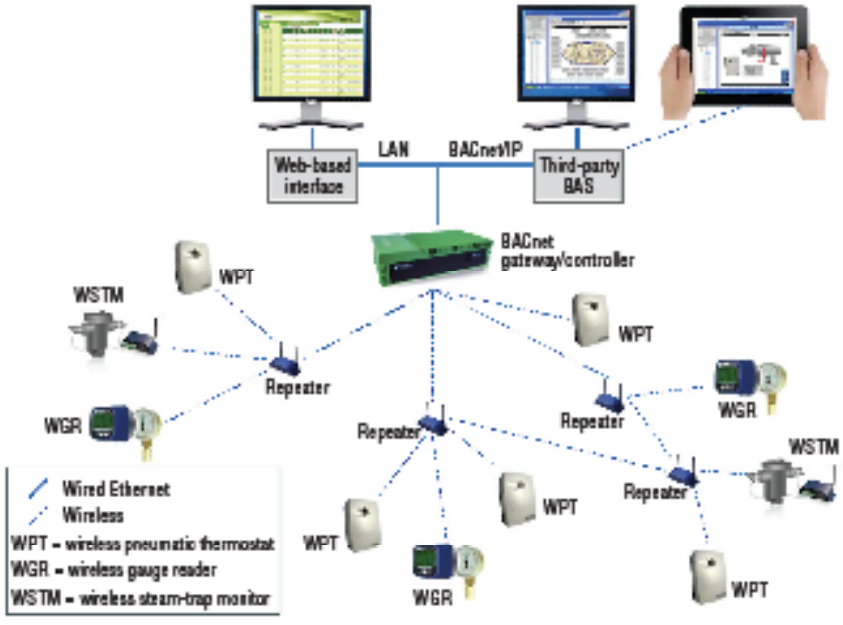
Conclusion

The application of newer, smarter wireless analog-to-digital control technology has meant immediate improvements for 345 California Center. WPTs easily can be installed on weekends, with no disruption to high-end tenants. WGRs and WSTMs also are budget-friendly solutions to making old technology smart. Installation is fast and simple, with a payback of about one year.

To Danz, the energy-saving and tenant-satisfaction benefits are two sides of the same coin.

"The technology definitely speeds up our troubleshooting and diagnostic efforts," Danz said. "Often, an operator can identify and address the problem prior to the tenant becoming aware of it. Our call logs document that we have fewer calls from WPT zones than with the legacy 'stats."

Danz's records show that from 2007 to 2011, 345 California Center saved nearly 3 million kwh of energy a year through a variety of control upgrades and load-reduction strategies.



Wireless analog-to-digital interface.

Thanks to innovative retrofit solutions, 345 California Center has improved operations and reduced energy use. More important, Danz's team now is fighting fewer fires, so to speak, and has been able to improve the tenant experience to better meet the expectations of a Class A office building.

Did you find this article useful? Send comments and suggestions to Executive Editor Scott Arnold at scott.arnold@penton.com.

Co-author to Present Seminar

On Nov. 13, the eve of the Greenbuild International Conference and Expo, in San Francisco, Ron Wilkinson, PE, LEED AP, will present "Green Building Commissioning: ASHRAE and LEED," a full-day seminar examining the quantitative benefits of commissioning, fundamental and enhanced LEED (Leadership in Energy and Environmental Design) new-building commissioning, ASHRAE existing-building commissioning, how commissioning prepares a building for success, and how the benefits of commissioning motivate design teams and contractors. For more information, go to *http://bit.ly/Cx_seminar*.