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FEATURE

A simple solution for delta T trouble

Precision control valves help Atlanta buildings boost chilled-water system efficiency.

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When reflecting on factors that have the biggest impact on worker productivity, one might first think of flashy items such as computers, cell phones and the Internet. It might be surprising, then, to hear that creating uniform year-round comfort for building tenants can be just as important. While the heating, ventilation and air-conditioning system may not be the most notable feature of a productive office space, there is a strong correlation between office temperatures and worker productivity and performance.

After a Cornell University study corroborated this point, news outlets devoted more attention to this association, noting that when temperatures drop or cannot be properly controlled, workers tend to make more mistakes. According to a FastCompany.com article on the Cornell research, "Want More Productive Workers? Adjust Your Thermostat" (Sept. 7, 2012), "When temperatures were low (68 degrees F, to be precise), employees committed 44 percent more errors and were less than half as productive as when temperatures were warm (a cozy 77 F). Cold employees weren't just uncomfortable, they were distracted. The drop in performance was costing employers 10 percent more per hour, per employee."

While HVAC designers and operators continue to make occupant comfort a priority for large buildings, that comfort is often delivered at the expense of energy efficiency. With increasing awareness of the negative environmental impacts the planet faces from energy consumption, there is a growing expectation for energy to be treated as a precious resource. This presents those in the HVAC industry with a number of challenges to face:

- Building owners want to reduce costs and increase efficiency.
- Sustainability advocates want to meet their carbon reduction goals.
- Facilities teams want to focus less on comfort complaints and more on preventive maintenance.

What all these stakeholders need is a building HVAC system that delivers efficient, consistent and reliable performance.

While minor improvements in HVAC efficiencies and control technologies have been made in the past, many of the system types, designs and, more importantly, expectations have remained unchanged. The difficulty is that HVAC engineers tasked with crafting more efficient systems are often pressured by time constraints and have limited exposure to new tools and technology, leading to a reliance on existing design standards. Unfortunately, innovation is hindered by these same design standards and regulations, further reinforcing the status quo. We cannot expect higher performance from a new system modeled on an old one that was "good enough."

So how do we break out of this routine?

A new perspective is required. Historically, HVAC efficiency efforts have focused on chilled- and heating water generation or production equipment. They have not often borrowed a strategy from the electricity industry – minimizing the system demand first to reduce the required generation capacity and provide concurrent gains in efficiency. Translated to HVAC, this means addressing how chilled and heating water is utilized prior to how it is generated.

CASE STUDY: ATLANTIC STATION

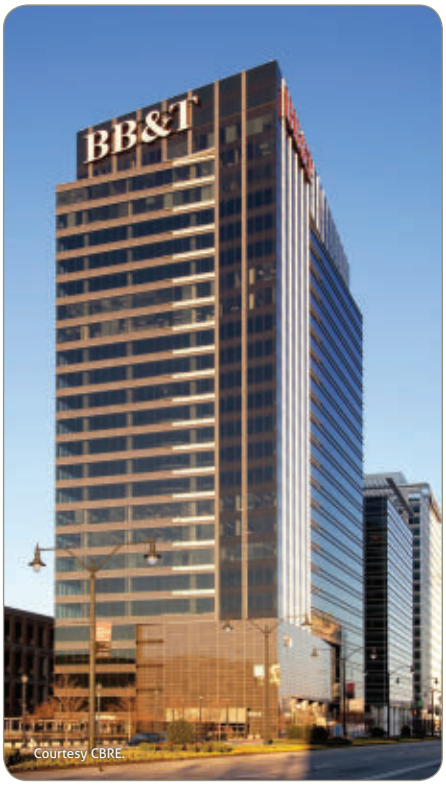
Let's take a look at this methodology as it was applied at Atlantic Station, a mixed-use neighborhood in Atlanta, Ga. This development,

built on the site of a former steel mill, allows residents to live and work within walking distance of everything they need each day – retailers, restaurants, theaters, parks, etc. In the planning phases of the project, careful attention was given to mitigating urban sprawl and reducing air pollution. To complement this environmental focus, a new chilled-water facility was constructed to provide district cooling to each building in the 138-acre development. The chilled-water plant can provide 7,500 tons of cooling to 3 million sq ft of conditioned space, with room to expand and eventually serve 12 million sq ft.

The contract negotiated between the district cooling provider and the building owners required chilled-water performance targets, including a maximum cooling load for each building and a minimum chilled-water temperature differential. Despite being designed for peak efficiency and less than five years old, the high-rise at 271 17th St. at Atlantic Station was unable to meet these delta T targets and therefore faced higher rates and stiff penalties from the district cooling provider. This resulted in the owner paying fines of up to $10,000 per month for a single building due to poor chilled-water delta T performance. Because the utility costs typically pass through to occupants, it became increasingly difficult for the building to acquire and retain tenants.

The building owner struggled to find a solution that would enable the 271 building HVAC system to achieve the required delta T performance without sacrificing tenant comfort. Typical first steps were taken, including checking the coils and strainers for clogs, investigating sensors and setpoints, and performing other routine maintenance. However, this was a relatively new facility, and no specific issues were found with the equipment. The system simply was not capable of properly managing chilled-water flow throughout the operating range of cooling loads.

While considering the installation of a standalone in-building chilled-water plant, the owner turned to the district cooling provider as a respected expert for guidance and other solutions. FlowEnergy was also consulted for support on the building system. An on-site survey was conducted to assess the air-handling units, evaluate coil selections and expected performance, and develop a hydraulic model of the initial building hydronic distribution system. With this insight, it was confirmed by both FlowEnergy and the building owner that the existing HVAC system was severely underperforming. There were issues with overflowing, subcooling, and reheating to maintain building comfort. Further discussions led to a turnkey solution – precision control valves – to correct the unstable operation and guarantee delta T performance, without sacrificing tenant comfort.



The 271 building was the first Atlantic Station high-rise to boost HVAC system performance with precision control valves.

Owners of the 271 building replaced each air-handling unit chilled-water control valve with a precision control valve.

BACK ON TRACK

Precise and effective control brings all of the system components together into their expected operating ranges. Flow Control, sister company of FlowEnergy, pioneered a precision control system that delivers stability behind the scenes and comfort to the front lines by eliminating the leaving air temperature fluctuations. Whereas the ASHRAE guideline for leaving air temperature stability is within ±1.5 degrees F setpoint, Flow Control's DeltaPValve® system targets within ±0.1 F of setpoint, or 15 times better control than a standard system. These precision control valves regulate chilled water and heating water with a high degree of accuracy, enabled by an instantaneous response that eliminates the impact of system pressure fluctuations. Many other control valves, conventional or pressure-independent, lack the stability, turndown or quick response required to maintain precise control, resulting in higher flow rates and low delta T. This new level of precision necessitates the use of temperature sensors that are accurate to this degree of control – a small investment for a dramatic improvement.

The first phase of the Atlantic Station project, which addressed the 271 building's daytime HVAC operation, included replacing each air-handling unit chilled-water control valve with a DeltaPValve, integrating each new valve into the existing building automation system, confirming the desired performance at every unit and modifying the building pump control strategy

to address the significant reduction in chilled-water flow. The second phase of the project addressed nighttime performance and included replacing fan coil unit control valves, correcting equipment operating schedules, and locating and eliminating small flushing bypasses. The final phase addressed outliers, such as differential pressure setpoints based on the operating profile and hydraulically remote locations and a lobby unit impacted by a temperature sensor bathed in afternoon sun. The entire project, including a validation of system performance, was completed in two weekends to minimize system downtime to the occupied floors.

AFTER THE RETROFIT, THE AVERAGE MONTHLY DELTA T WENT FROM 6 F TO 18 F AND EVEN EXCEEDS 24 F DURING DAYTIME OPERATION.

Prior to the project, the 271 building recorded an average monthly delta T of 6 F, well below the contract target. After the retrofit was completed, the new average monthly delta T is 18 F and exceeds 24 F during daytime operation. District chilled water to the building heat exchanger dropped so low during nighttime operation that the flow meter calibration was called into question and had to be confirmed. (It was correct but operating at the very low end of velocity limits.) Total building electricity consumption dropped 17 percent, due to both pump energy savings and stable fan operation, and all delta T penalties were eliminated. After installation of the precision control system, the building owner saved $150,000 in energy costs in the first three summer months alone. The total project savings delivered an outstanding project simple payback in only six months, and with the reduced utility bills, the building became easier to lease. Despite occupancy nearly doubling in one building alone, there was no increase in chilled-water usage.

Due to the dramatic savings and improved performance seen in the 271 building after the retrofit, the owner installed the precision control system in another Atlantic Station property, the 201 building. In 2014, both these Atlantic Station buildings were designated as Building Owners and Managers Association 360 Performance Buildings, and the owner received two of the association's TOBY (The Outstanding Building of the Year) Awards. The buildings also earned LEED (Leadership in Energy and Environmental Design) for Existing Buildings Gold certification.

These results inspired yet another building within the development to implement a precision control system solution the following year. The combined efficiency improvement and cooling load reduction of the three buildings with precision control valves enhanced the district cooling provider's distribution infrastructure to allow delivery of an additional 1,000-plus tons of cooling capacity throughout the development. Taking control of the chilled water benefited both the distribution facility and the end users, setting the development back on track to lead the way in energy efficiency and environmental design.

SYSTEM STABILITY, COMFORT CONTROL

When a system is designed and operated using precision control valves at the air-handling unit coils, system stability and comfort control are achieved. With HVAC systems taking up as much as 40 percent of total building energy consumption, accepting instability and low system delta T is accepting a failed system and, thus, a failed building. Responsibility dictates and science proves that actual system performance should be much better than most HVAC designers and system operators believe. Keeping building occupants comfortable while minimizing energy use is a balancing act that is gaining urgency and importance and will force us to think outside the box with high-performance precision control.

A precision control valve system has the ability to upset the status quo with its progressive flow control and delivery of peak performance at all load conditions. These systems are more efficient, deliver full system capacity, improve comfort and are easier to operate and maintain. This not only keeps operating costs at their lowest while providing efficient and effective comfort but also minimizes the need for the additional capacity often required to accommodate poorly performing systems. Precision control valve systems are a "win-win" in terms of energy and capital conservation as well as comfort control – key to maintaining worker productivity.

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