Building Automation

Optimize HVAC Controls And Energy Management Systems

Building Automation Systems' (BAS) technology has evolved from pneumatic and mechanical devices to microprocessor-based direct digital controls (DDC) to internet web-based information systems. **BY GERRY CELLUCCI**

The improvements to BAS technology over the past four decades offer the opportunity for building operators and mechanical service contractors to optimize the operation of these systems to enhance comfort and increase energy savings.

Studies have shown that most BAS are not operating to their maximum potential. Most systems employ standard functions, such as scheduling equipment and basic setpoint changes during unoccupied periods, but few BAS built-in advanced sequences, such as load shedding, night-purge (pre-cooling a building before occupancy) or temperature reset routines, are enabled.

Additional studies have shown that control system maintenance is important to ensure optimum performance after the initial installation and commissioning. In fact, if control systems are not maintained, operation deteriorates and energy costs increase to levels greater than those before the implementation of a BAS/DCF system.

Figure 1 shows a CUSUM chart of cumulative gas energy savings used to normalize energy consumption against weather data. The data shows gas consumption (savings) since the installation of a BOILERzone DDC system. The controls sequenced boilers and valves typically found in many apartment and condominium heating systems. Although the system was originally commissioned properly, by year three the savings began to reverse.

After additional trending and operator interviews, factors that caused reduced control system performance were shown to include:

- Override of automatic control by operator staff or service contractors – generally driven by comfort complaints.
- Temporary changes to control strategy and schedules became permanent for various reasons.
- Mechanical override of equipment including valves left in bypass (full heat for the heating season).
- Failure of mechanical equipment.
- Control sensor failure or drift.

These factors are found in many BAS installed over the years. As a result, organizations such as the Green Building Council’s LEED program, point to proper, original, commissioning procedures, including retro-commissioning and system optimization (re-commissioning).

**LOW COST, HIGH RETURN MEASURES**

Scheduling and Setback-Setup

Contractors should review occupancy schedules and monitor BAS trends to effectively optimize the operation of the equipment. Run the equipment when it is needed at appropriate temperatures. Nothing saves more energy than turning equipment off when it does not need to run. Adjusting building temperatures up or down during unoccupied periods is not a new system strategy but often needs review. In addition, using real people occupancy, such as people counters, occupancy sensors or CO₂ sensors to adjust temperatures or turn off equipment when there is low occupancy, significantly adds to savings.

Variable Speed Drives

Most HVAC/R systems were designed for the worst degree
day (coldest or hottest day of the year) and are therefore oversized for the majority of the year. Variable speed drives (VSD) installed on air handler fans, pumps and exhaust fans reduce energy consumption because the fans are not always running at full speed. The system’s demand is designed to match the building’s actual cooling or heating loads. In the case of make-up air units, the volume of air in a building is reduced during known low occupancy periods. On systems with existing VSDs, mechanical service contractors should review existing control strategies since improper pressure control sequences or setpoints often lead to performance problems.

Make-Up Air Discharge Air Temperatures
In buildings with make-up air equipment, energy is wasted by bringing in cool air and then re-heating it. Discharge air temperatures can be changed or reset based on the need for cooling. In other words, if the cooling setpoint is raised when the demand for cooling is reduced, energy consumption for re-heating the air is reduced.

Variable Air Volume
In variable air volume systems (VAV) the amount of airflow delivered by the main air handler can be optimized to reflect the actual demand (occupancy) of the VAV boxes. The flow of air can be reset to deliver less air when there is low demand from the majority of the VAV boxes, while still maintaining comfort and indoor air quality. Employing this strategy when an existing automated control system exists can yield large savings at relatively low cost. It involves no capital outlay and the expense is usually a day of BAS re-programming time.

Economizer Systems for Packaged Systems
When the condition of the outside air is suitable, economizer systems allow cool outside air to enter the building before mechanical cooling is energized.

Several studies have found that economizers do not perform or have failed 50 per cent of the time. When they do fail, the system consumes more energy. Common failures include, malfunctioning sensors and dampers resulting in comfort, energy and building pressurization issues. Significant energy savings can be realized by optimizing, retrofitting or installing new economizer systems. When carbon dioxide sensors are installed and calibrated in conjunction with the existing sensors, savings of 20 per cent or greater can be achieved.

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