Ideas that Work!

Retuning the Building Automation System

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ABSTRACT

A building automation system (BAS) can save considerable energy by effectively and efficiently operating building energy systems (fans, pumps, chillers, boilers, etc.), but only when the BAS is properly set up and operated. Tuning or retuning the BAS is a cost effective process worthy of your time and attention.

INTRODUCTION

Like today's smart phone with all its useful apps, a building automation system (BAS) has several useful apps to serve occupants' needs while minimizing energy consumption. In fact, you probably would not consider trying to own or operate a large building without a BAS. As critical as the BAS is to the efficient operation of building energy systems, my *Idea that Works* is to check and retune the BAS.

RETUNING THE BAS—AN IDEA THAT WORKS

You may think that because you have an extensive BAS, that your building is being well operated. Unfortunately, that may not be the case. Schedules, which may have been correct at one time, may no longer be current. Short-term overrides may still be active. Let's face it: buildings are dynamic, people get busy, things happen. We have found it is worth the effort to get into the BAS programming, optimize applications to improve operation, match schedules to true occupancy, and use conditional setpoints. The actions covered in this article do not require buying new equipment or repairing failed sensors or equipment—although you might still want to repair/replace those failed sensors. These actions do require knowledge of your HVAC equipment and knowledge of your BAS, but the actions are inexpensive.

To put some numbers to it, we grabbed 30 recent client retuning reports to find the most frequently cited recommended actions. This article assumes a fully functional BAS, and that schedules, setpoints, and setbacks have—at least at one point—been set. The range of energy savings estimates provided are based on building energy simulations, but our validation efforts tend to indicate that realized energy savings can be greater. The bottom line: Savings can result from retuning the BAS.

Supply-air Temperature Reset

This action was applicable 63% of the time (19 of 30 reports). Estimated energy savings reached as much as 10.1% of the annual building energy consumption. Your HVAC system may require 55-60°F supply air to cool the facility when it is 100°F outside, but when it is only 70°F outside, the supply-air temperature does not need to be as cold to meet the cooling load. Raising the supply-air temperature when the load allows might mean moving more air but it reduces the load on the chiller (as well as the reheat system). The net impact is energy savings.

Our team's general recommendation is to set the minimum supply-air setpoint to the design supply-air temperature (around 55-60°F) with a return-air temperature of around 75°F (this corresponds to a near peak cooling load) and to set the maximum supply-air temperature setpoint to around 70°F with a return-air temperature of around 72°F (this corresponds to near minimum cooling load). The supply-air temperature setpoint will linearly interpolate between the minimum and maximum return-air temperature conditions. Instead of setting the supply-air temperature setpoint as a function of the return-air temperature, it may also be possible to set the supply-air temperature setpoint as a function of the average cooling load. In this case, set the minimum supply-air temperature setpoint for an average cooling load of 60% and the maximum supply-air temperature setpoint for an average cooling load of 25%.

Static Pressure Reset—Variable-air Volume System

This action was applicable 57% of the time (17 of 30 reports). The estimate of energy savings ranged up to 5.7% of the annual building energy consumption. Variable-frequency drives (VFD) serving the variable air volume (VAV) ventilation systems are frequently regulated based on a static pressure sensor in the supply-air ductwork. The static pressure setpoint is typically set such that the ventilation system will move sufficient air when most of the cooling zones are calling for air (peak design load). During off-peak operation, when most VAV boxes are closing down, the fan generates more static pressure than is required to serve the load. Lowering the static pressure setpoint during periods of low demand will reduce the load on the fan motor and saving energy.

Our team's general recommendation is to provide a maximum static pressure setpoint, say 1.0 to 1.5 inches water column, to be associated with a 60% average VAV box damper position and to set a minimum static pressure setpoint, typically about 50% of the maximum, to be associated with a 30 to 40% average VAV box damper position. The static pressure setpoint will linearly interpolate between the minimum and maximum based on the average VAV box damper conditions.

Chilled-water Supply Temperature Reset

This action was applicable 43% of the time (13 of 30 reports). Estimated energy savings reached as much as 10.0% of the annual building energy consumption. Your HVAC system may require 42-44°F chilled water to cool the facility when it is 100°F outside; but, when it is only 70°F outside, the chilled-water supply temperature does not need to be as cold to meet the cooling load. Raising the chilled-water supply temperature when the cooling load allows will improve the operating efficiency of the chiller, thereby saving energy.

Our team's general recommendation is to set the minimum chilled-water temperature setpoint to its design temperature (around 42-44°F), when the average cooling load is greater than 60-80% (or when the outside-air temperature is greater than 80°F and the building is in occupied status) and to set the maximum chilled-water temperature setpoint to around 50-55°F, when the average cooling load is less than 20-40% (or when the outside air temperature is less than 60°F and the building is in occupied status). The extent to which you can further set back the chilled-water temperature during the building's unoccupied status depends on local concerns for humidity control. The chilled-water temperature setpoint will linearly interpolate between the minimum and maximum based on the average cooling load or outdoor air temperature conditions.

Optimal Start

This action was applicable 40% of the time (12 of 30 reports). Estimated energy savings reached as much as 3.0% of the annual building energy consumption. Programming schedules is a great way for your BAS to save energy. On a peak day, your AC system may need to reset from the unoccupied setpoint to the occupied setpoints at 4:00 AM to have the building ready for occupancy at 7:30 AM. But on off-peak days, you can save energy by delaying the time of the reset—this is the purpose of optimal start. The BAS determines the optimal time to bring the building back up to the occupied setpoints. Our team's general recommendation is to activate this application and to align the schedules with the normal scheduled occupancy of the building—not earlier.

Additional frequently cited recommended actions include:

- Hot water supply temperature reset (11 of 30 reports)—savings up to 3% of annual energy consumption.
- Condenser water temperature reset (7 of 30 reports)—savings up to 1.5% of annual energy consumption.
- Chilled water and hot water pump differential pressure reset (5 of 30 reports)—savings up to 2.9% of annual energy consumption.

CONCLUSION

A building equipped with a fully functional BAS can keep occupants comfortable while minimizing energy consumption. However, to ensure the BAS is doing all it can, our *Idea that Works* is to check and retune the BAS. Of course, there are more ways to improve the operation of your BAS and HVAC systems. For more information on retuning your BAS, we invite you to check out http://buildingretuning.pnnl.gov/ and http://retuningtraining.labworks.org.

ABOUT THE AUTHOR

Steven Parker, PE, CEM, is a chief engineer at the Pacific Northwest National Laboratory, operated by Battelle Memorial Institute for the US Department of Energy. He is also the associate editor of *Energy Engineering* and *Strategic Planning for Energy and the Environment*. Steven served as the president of the Association of Energy Engineers during 2002, was inducted into the AEE Energy Manager's Hall of Fame in 2004, and inducted as an AEE Fellow in 2013. Mr. Parker may be contacted at steven.99.parker@gmail.com.