Building Re-Tuning Training Guide: Zone Heating and Cooling Control

Summary

The purpose of the zone heating and cooling control guide is to show, through use of examples of good and bad operations, how the heating and cooling at the zone level can be efficiently controlled.

Zone set points drive the system and have a ripple effect all the way to the meter. For example, if the air-handler discharge-air set point in cooling mode is too low, excessive reheat can occur at the zone level. Also, if the zone set point is too high, energy will be wasted providing additional heat to the zones that is not needed. Also, if the minimum air flow setting in the terminal box is set high, it may result in significant simultaneous heating and cooling, extra fan power consumption, and higher energy consumption for most of the year.

Improper controls design or operator overrides can also lead to excessive reheat at the zone level. All of these situations can be corrected, if detected, resulting in significant savings in both thermal energy and electricity consumption. In most cases, however, it is difficult to detect excessive reheat because it does not impact zone comfort. Failure to investigate or correct/mitigate this situation, in all likelihood, will lead to increased fan, cooling and heating energy consumption.

Data needed to verify the zone heating and cooling control

To analyze and detect zone heating and cooling control problems, for single-duct variable-air-volume (SDVAV) air-handling units (AHU), the following parameters must be monitored using the trending capabilities of the building automation system (BAS):

- Zone temperature (for all zones)
- Zone reheat valve signal (for all zones)
- Outdoor-air temperature (OAT)
- Zone occupancy mode (for all zones).

The recommended frequency of data collection is between 5- and 30-minutes. When analyzing the zone heating and cooling operations, the trends to look for include:

- Is there night-time set back/unoccupied mode at the zone level?

- Is there significant reheat occurring at the zones, especially interior zones?

Is there night-time set back/unoccupied mode at the zone level?

To determine if night-time set back/unoccupied mode is enabled, review the plot of zone occupancy command, zone reheat valve signal (when available or staging for electric reheat) and zone temperature vs. time. Figure 1 shows a 3-day period in which the zone never enters unoccupied mode and the reheat valve is modulating at night. In contrast, Figure 2 shows a zone that has an unoccupied mode, and has a night-time set back in place. Here, the reheat valve modulates during occupied hours, and then shuts off during unoccupied hours.

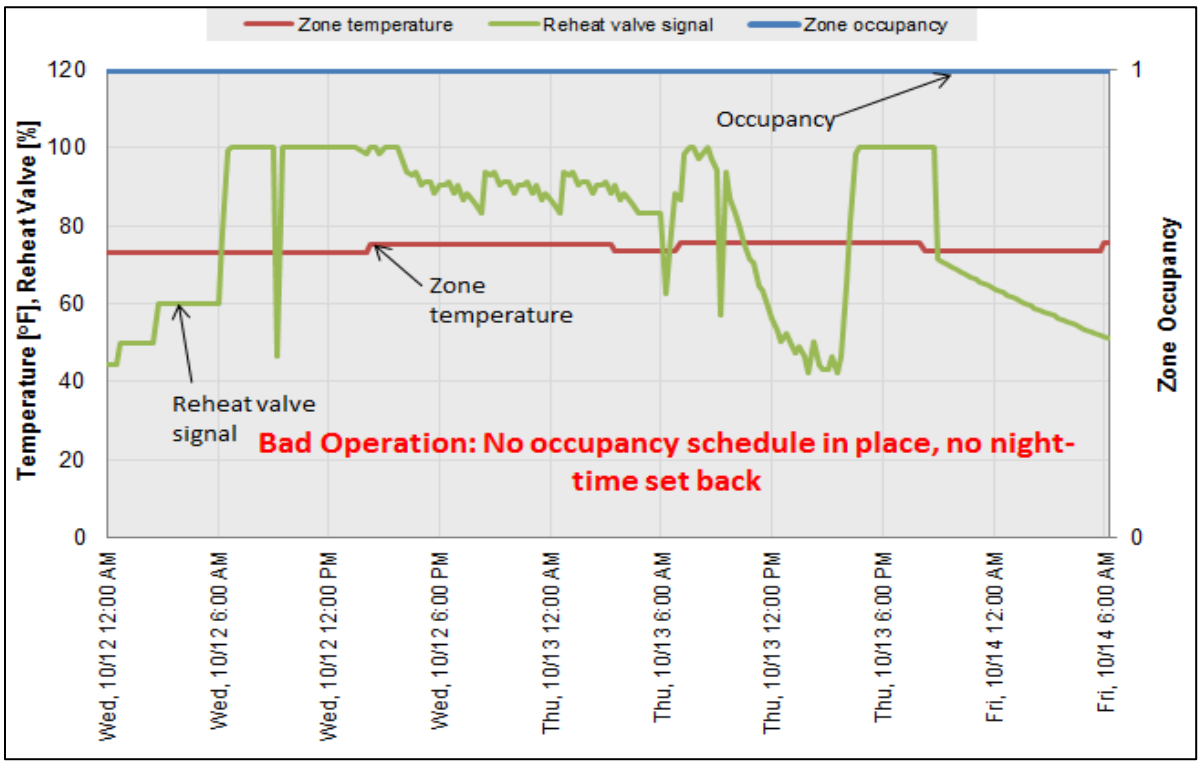

Figure 1: Zone with no unoccupied mode or night-time set back.

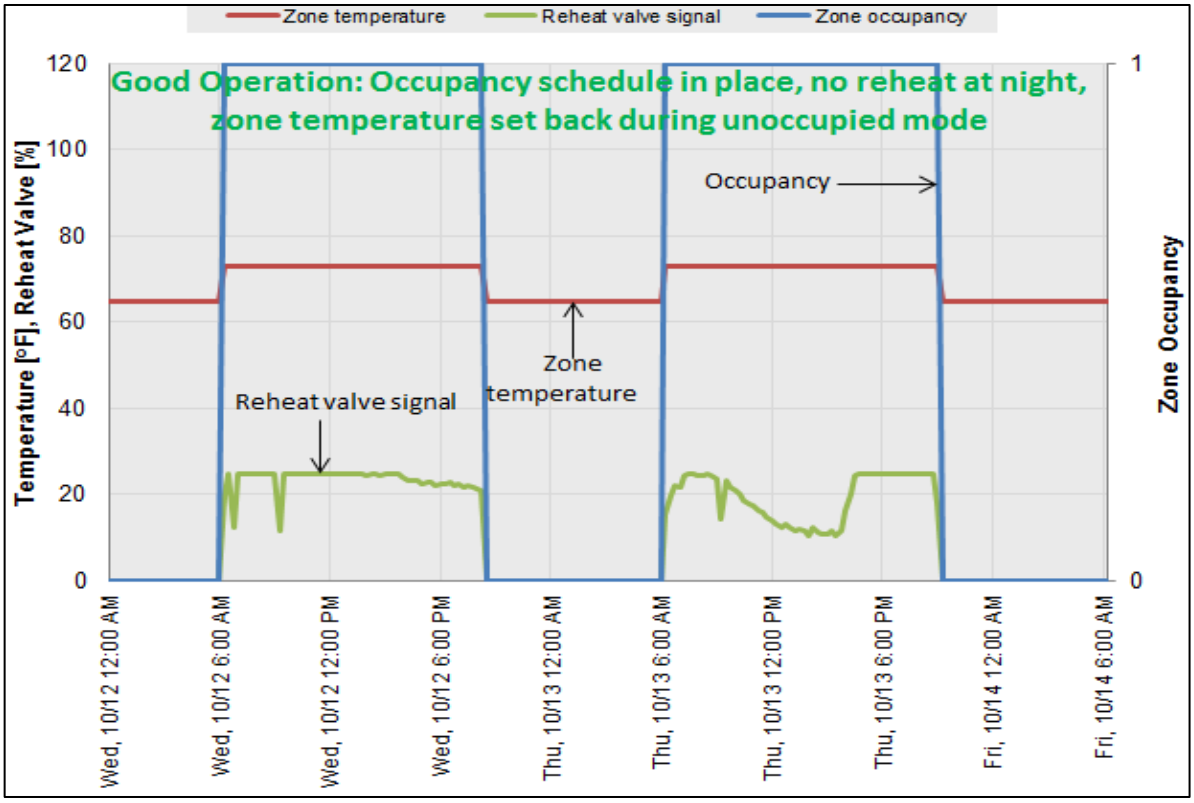

Figure 2: Zone with night-time set back in place.

Suggested Actions

Enable unoccupied mode and night-time set back control, and develop a schedule for each zone. For unoccupied mode, set the cooling minimum air flow requirement to 0 if the zone is an interior zone. For perimeter zones, or zones with reheat, reset the heating maximum air flow requirement to match that of the heating minimum air flow requirement. This will allow the variable-air-volume (VAV) box dampers to open at night and ensure that air is getting to zones that need it. This will also allow air to get to zones that need it during warm up reheat operations. Turning off systems too early in the evening or turning them on too late in the morning may cause comfort problems.

Is there significant reheat occurring at the interior zones?

To determine if reheat is occurring at the interior zones, review the plot of the zone reheat valve signal, zone temperature, and outdoor-air temperature vs. time during occupied summer hours. Figure 3 shows an interior zone that has the reheat valve open roughly 40% during occupied hours in June. During the summer months (OAT >70^{o}F), interior zones should not be calling for heat, indicating that the minimum air flow setting is too high, or the AHU discharge-air temperature is too low. Figure 4 shows an interior zone operation during the similar

conditions in which the reheat valve is not open. For this case, the air flow and discharge-air temperature are correctly set.

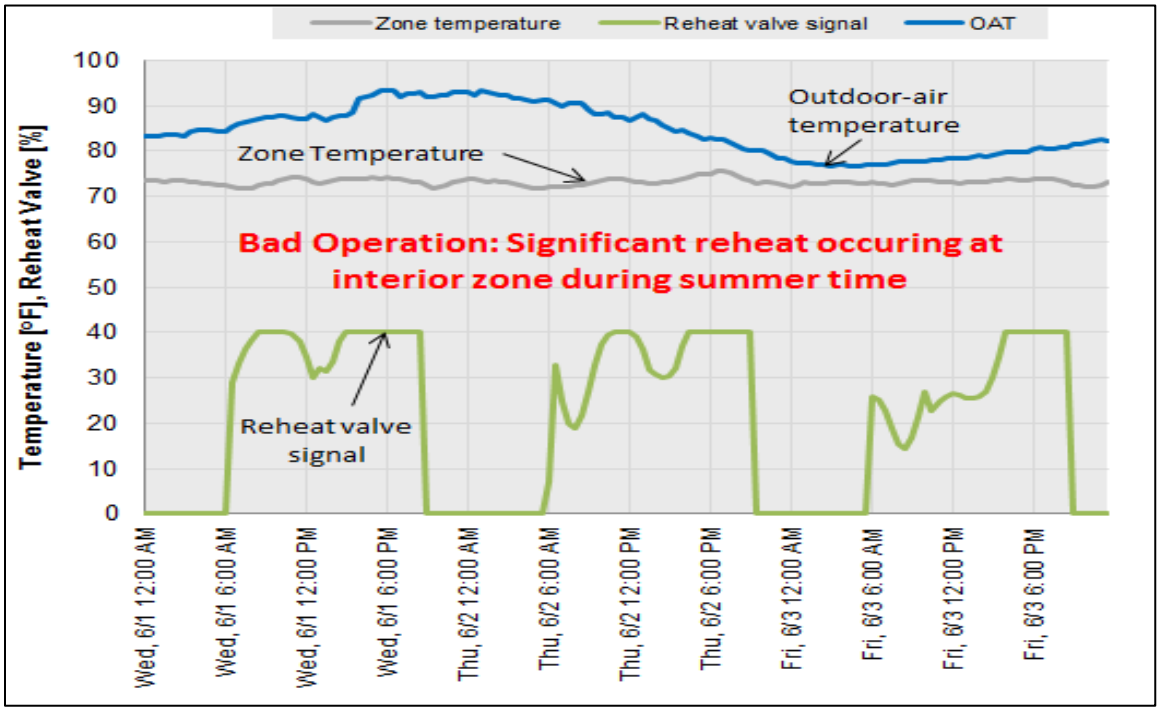

Figure 3: Significant reheat occurring at interior zone during summer months.

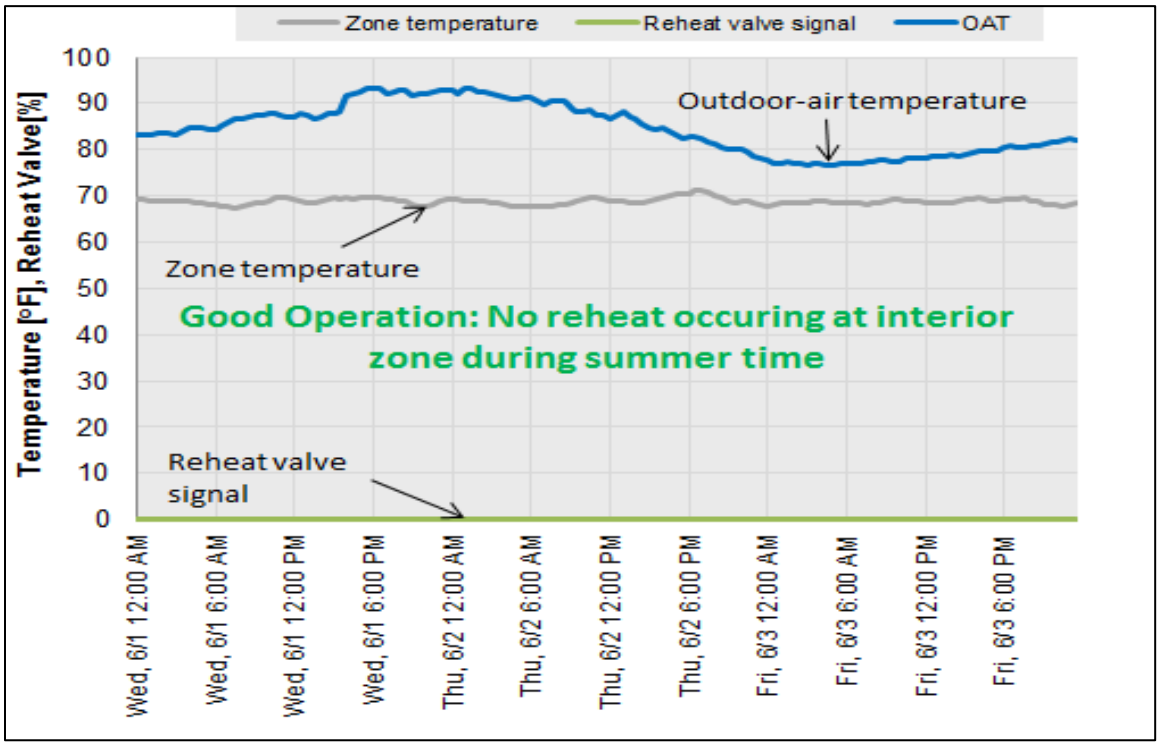

Figure 4: No reheat occurring at interior zone during summer months.

Suggested Actions

Reduce the interior zone terminal box heating minimum air flow setting by 5 to 10 percent of the heating maximum air flow set point and trend new data. Additionally, disable heating for interior zones in summer months (OAT> 70^{o}F, for example) to eliminate heating leakage. If multiple zones are calling for reheat, increase the AHU discharge-air temperature by a few degrees and trend new data. Even after making these changes, if there is significant reheat at the zones, additional adjustments should be made to both the minimum air flow setting and the AHU discharge-air temperature.