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Design Guide Chapter 4 Points List Explanations

Supplementary Material to Control System Points List.xls, referenced in the yellow column to the right of the points lists.

1 Because this is a 100% outdoor air unit, there is a preheat load and the preheat coil leaving air temperature is required to safely control the preheat coil. If the unit was a recirculating system that only brought in outdoor air for ventilation purposes or on an economizer cycle, the preheat coil leaving air temperature may be optional if there was not operating condition that caused the preheat coil to see subfreezing air. Even if the point is not required for control purposes, it provides valuable O&M and commissioning information that can help ensure that the system runs efficiently. For example, the point can be used to detect a leaking preheat coil control valve or simultaneous use of the preheat coil and cooling coil.

2 On single zone systems, designers are often tempted to use space temperature to control the heating and cooling elements. This strategy may work in some situations, making the air temperature sensors after the heating and cooling elements optional. But this approach should be used with caution since it can lead to operational problems due to transportation delays from the unit to the space. For example, if a unit serves a space that is internally located and insulated from the outdoor environment, then when the system started on a cold day, the freezestat might trip before the zone temperature sensor could detect that the air being brought into the system was too cold. In addition, dehumidification problems may occur under some load conditions. Poor dehumidification may occur if the space only requires air a degree or two below the set point to meet a light load. For example, if the required set point for a lightly loaded space was 75°F and it was raining and 72°F outside, a 100% outside air unit controlled based on space temperature would introduce unconditioned air into the space with a dew point of 72°F. The moist air could cause condensation problems in adjacent zones if they were operating at a lower dewpoint, condensation in the room itself if equipment or structures were below the dewpoint, and moisture accumulating in the building materials and other elements in the space.

3 To prevent the freezestat and humidity problems, the unit should be controlled based on cooling coil discharge temperature with a reset based on space temperature. The reset schedule should be capped so that the coil discharge temperature does not go above what is required for humidity control in the space. Limiting the reset schedule for humidity control may result in overcooling if there is no reheat system is available, although the fan heat and duct temperature rise may provide the necessary reheat effect, especially if the fan motor is in the air stream.

4 If the unit is being controlled based on cooling coil discharge temperature as described in DG Note 2, then the zone space temperature point may be optional from a pure control standpoint unless it is being used to reset the coil discharge temperatures to minimize energy consumption. However, since the zone temperature is usually the final outcome of the HVAC process, it is wise to sense this temperature, even if it is not used to directly control the system.

5 The preheat coil leaving water temperature provides information about the load on the preheat coil and a cross-check on the status of the preheat control valve. A very low value tends to indicate that the valve has failed closed or that for some other reason, the source of heat is inadequate or unavailable. A low preheat coil leaving water temperature can be a faster precursor of a freezestat trip than the leaving air temperature. If the temperature is near the supply water temperature, the valve may be open when it should not be. For instance, the valve is open when the unit is off. This information is useful and informative in a diagnostics mode, but is not essential to control the system.

6 The valve and damper commands are required in some form to control the unit. Costs can be reduced slightly by using one output to control valves and dampers in sequence from a common output. The sequence is achieved by selecting spring ranges and setting positioning relays on the valves in a manner that yields the desired sequencing. However, the generally modest reduction in first cost realized by implementing coil control in this manner results in a loss in flexibility (flexibility is one of the selling points for DDC). This loss in flexibility could reduce the ability to solve a start-up problem, where the ability to control one valve independently of the other would be beneficial. The loss in flexibility could be felt in the future when a change in the load served by the system makes the ability to independently control the valves desirable.

7 Filter pressure drop can be automatically detected and compared to a set point to determine when the filter should be changed. This point is called filter status. This information can make filter maintenance easier on a constant volume system, but is not critical as long as some form of filter pressure drop indication is provided (most codes require filter pressure drop measurement either directly or by reference to ASHRAE which cites it as good practice). Installing a Photohelic® or equivalent device that combines pressure drop indication, set point indication, and a contact closure at set point meets code requirements. Since the flow in a constant volume system is constant, the pressure drop of the filters will not vary with load on any given day, and the pressure drop observed by the operators on rounds will be a good indication of the condition of the filters. Detection of filter status is required for VAV systems because the filter pressure drop will vary with load and flow. The peak load and flow condition, and therefore the peak pressure drop, may occur at a time when the operators are not observing the filter pressure drop indicator. Failure to realize that the filters are exceeding their rated pressure drop can lead to structural failure of the filter or blow-through of the filter media.

Additionally, an unacceptable loss of system capacity can lead to performance problems, IAQ issues, and loss of efficiency due to soiling of the heat transfer surfaces downstream of the filters.

8 The proof of operation digital input is necessary to prove the operating status of major energy-consuming equipment. These points are mandatory to verify that the start or stop command that was sent to the motor was effective, and that the drive train is intact. Monitoring the starter auxiliary contacts may cost slightly less, but this method will not detect the loss of a belt or coupling. The starter auxiliary contact simply proves that the motor starter engaged, but the motor could be spinning with no load on it due to a coupling or belt failure. Instead of using the starter contacts, proof of operation can be achieved through the use of current switches for little additional first cost. The current switches can be selected and adjusted to respond to the difference in current associated with a free spinning motor and a motor under load, in all but the smallest motor sizes.

9 Relay contacts that directly interrupt the motor current, such as a relay controlling the power circuit to a single phase motor, need to be rated for the motor's inrush current and also rated to open the circuit reliably under load. This rating is called "horsepower rated". Without this rating, a relay may not be able to break the circuit arc when disconnecting.

10 In some instances, the start/stop capability could be achieved at a lower first cost via a hard-wired interlock that occurs inside the motor control center. This strategy will only work for situations where the hardwired motors absolutely and always run at the same time as the motor they are interlocked with. Any variation from this, including the need for a time delay or the need to lock equipment out under certain conditions (like the preheat pump above a certain outside air temperature) usually means that providing an independent output will be more cost effective and provide better flexibility, as discussed in Design Guide Note 5.

11 Since the supply fan start/stop command interfaces with a motor starter, the relay contacts do not need to be horsepower rated. In fact, many systems can control smaller starters directly from their output contacts, however, providing an interface relay standardizes the installation and provides a measure of protection to the circuit board in the event of a fault in the starter control circuit. A motor control circuit fault may ruin the relay at a cost of $10-$25 instead of a circuit board serving multiple outputs, which could jeopardize other components in the controller at a cost of hundreds or even thousands of dollars.

12 Accumulated hours of operation points are useful for preventive maintenance and troubleshooting energy consumption problems. However, they are not essential to operating the system, since the information that they provide can be derived with a reasonable degree of accuracy from the operating schedule. These points are typically inexpensive because they require only a few program lines and database entries, and there is little hardware associated with them.

13 These hard-wired safety points are essential to protect the machinery and building occupants. On large systems, multiple freezestats and multiple mixed air sensors may be required to adequately cover the conditions in the mixed air plenums. Some guidelines recommend one foot of freezestat and mixed air sensing element per four square feet of coil face area.

14 The low mixed air plenum static pressure point is only necessary if the fan in the system can generate a static pressure in excess of the plenum's rated pressure and if there is a possibility that a failure could start the system when the outdoor air dampers were not completely open. Similar considerations apply to systems with some isolation dampers on the supply and return connections, and additional safeties at these locations may be required. Note that these switches will not protect the system from air hammer due to a rapid fire or smoke damper closure as is discussed in Section *18.5.3 Air Hammer* because the switch and the system can not respond quickly enough.

15 The control valve position signal feedback point is desirable but not mandatory since there are other fairly rapid but indirect indicators that the valves have positioned as commanded, such as the leaving condition from the coil. In most cases, these indicators will provide all of the feedback information that is required. The point has been included in this point list because some manufacturers build this feature into their output circuit boards, and on those systems, the information is available as standard at no additional first cost. Other manufacturers offer the point in an optional circuit board model at a slight increase in cost. If the feature is available at little or no additional cost, it is probably worth including. If the valve position feedback must be installed in the field, the point can be very expensive in relation to the benefit gained in all but the most critical applications.

16 The level of confidence required of the control valve position feedback is also a consideration. Feedback information based on a transducer that monitors the output signal (the typical approach associated with on-board indication) proves that the command is in fact being sent to the actuator. But, it does not prove that the actuator has moved. To obtain this level of confidence requires a transmitter on the field device. Usually this is a field-installed transducer but some manufacturers offer it as an option in their product line. Even at the field position, there are questions of degree of confidence to be addressed. The highest degree of confidence is achieved with a transducer that monitors actual valve stem or damper blade movement. Transducers that monitor actuator motion will not detect a linkage failure. In nearly all cases, monitoring for the highest degree of confidence will also be the most costly approach. If you ask for valve feedback points in a competitive bidding environment but only need a low degree of confidence; i.e. monitoring of the output signal at the output circuit board, it may be good to price the field-mounted feedback points as an alternate bid so that the cost differences between system with the function as a built-in feature and systems that require it to be field installed does not skew the bid results.

17 The selector switch status is desirable but not mandatory. However, the indirect indicators of a selector switch not being in the

fan runs 24 hours per day instead of on the programmed schedule, it may not be immediately obvious since the space is generally not occupied and comfort problems are not likely. Failure to operate on the programmed schedule can be one of the biggest reasons behind excessive energy consumption in a building. Similarly, if a VFD does not vary speed because someone has placed the speed control in ﷺHandﷺ and manually set the speed, it may not be immediately apparent unless exceeding set point causes a safety device to trip. Many manufacturers provide Hand-Off-Auto switches and their associated status as a standard or optional feature on their output circuit boards for little additional first cost. These features are highly desirable, but can be costly if not implemented during construction using onboard switches or if a retrofit is necessary in the future.

18 Since the function of the damper is to solve the building pressure control problem created by the operation of the economizer cycle, control is required for the relief air damper. Building pressure-based control is a good approach to this, and nearly mandatory on larger buildings, high rise buildings with significant stack effects, and variable volume systems. However, satisfactory operation for constant volume systems can usually be obtained by tracking the economizer signal with the relief dampers. If desired, the relief signal can be delayed or an offset can be provided to ensure positive pressurization of the building prior to the relief function. See Section *9.6.5 Building Pressure Control* for additional discussion of various relief damper control options. Section *9.8.3.4 Pressure Sensors and Switches* includes additional information on building pressure measurements.

19 Return air temperature is not absolutely essential but is a desirable diagnostic indicator and also a good indicator of the average conditions in the occupied zone.

20 In addition to providing an anticipatory alarm for a freezestat trip, the mixed air sensor is required for a mixed air low limit loop to minimize start-up problems in cold weather (In the Functional Testing Guide, see Section *5.5.3 Limit Control*). The mixed air temperature can also be used to control the preheat valve during the unoccupied cycle to protect the coils from freezing and at the same time, minimize the energy consumption associated with this process (In the Functional Testing Guide, see Section *5.4.4.1 Freezestat Control Sequences*).

21 Some position feedback signals may be deemed more desirable than others. In this example, the designer wanted to have positive indication that the minimum outdoor air damper command was actually being sent to the output, so they made feedback from that particular output a part of the base bid and price the other feedback outputs as an alternate.

22 The outdoor air damper limit switch point may be required depending on the characteristics of the fan and intake system. Systems with fans with low static pressure peaks on their fan curves and intake systems rated for pressures in excess of the peak would in all likelihood be protected from damage if the damper did not open and the fan started. However, this interlock may be desirable on a system where failure to supply flow when necessary constitutes a significant hazard. The interlock would ensure that the damper was open for the fan to start. Systems that can recirculate air probably do not need this point since the return damper are generally open when the outdoor air dampers are closed and would prevent the fan from operating with out an open inlet connection. The exception would be a system that closed both the return and outdoor air dampers when it was off for smoke isolation purposes. Section 9.7.3 Operational Interlocks in the Functional Test Guide discusses these issues.

23 CO2 sensors can be used in demand control ventilation strategies to set minimum outside air flow.

24 If the zone air flow and zone discharge air temperature were critical to the application, it would be necessary to understand how the manufacturer measures flow and temperature.