SECTION 259000

BUILDING AUTOMATION SEQUENCES OF OPERATION

PART 1 GENERAL

1.1 SUMMARY

A. Program and commission the Building Automation System (BAS) to execute the Sequences of Operation specified herein.

B. See Section 250000 Building Automation Systems for general requirements.

C. These control sequences include references to ASHRAE Guideline 36 and approved addenda. Where sequences are verbatim from Guideline 36, they are shown in green text. Not all informative text has been included. Sequences have been customized to include only Title 24 options where they take precedence over ASHRAE 90.1 and 62.1 requirements.

D. Guideline 36 sequences shall be programmed to exactly match the specified sequences verbatim. The Contractor may use "equivalent" alternative sequences only with formal approval by the Engineer. Proposed changes in sequences shall be clearly identified and included as a part of Submittal Package 2.

E. This file shall be maintained by the Contractor to include all approved changes to sequences made during testing and commissioning and shall become the final as-built sequences of operation installed on the CSS per Section 250000 Building Automation Systems.

1.2 INFORMATION PROVIDED BY DESIGNER

A. See equipment schedules on drawings for all setpoints unless otherwise noted below.

B. General Zone Information

1. Zone Temperature Setpoints

a. Default setpoints shall be based on zone type as shown in Table 3.1.1.1.

Table 3.1.1.1 Default Setpoints

	Occupied		Unoccupied	
Zone Type	Heating	Cooling	Heating	Cooling
Electrical Room	–	78ºF	–	78ºF

2. Outdoor Air Ventilation Setpoints

a. All zone minimum outdoor air setpoints.

1) Contractor to take pre-demolition air flow readings with the economizer dampers at the minimum outside air position. See also AC unit schedule.

2) Varea-min. Zone minimum outdoor airflow for building area = 0.15 CFM x area.

3. CO2 Setpoints

a. The CO2 setpoint for all occupancy types is 800 ppm.

C. VAV Box Design Information

1. All VAV box setpoints are scheduled on Drawings except as indicated below.

2. VVT Terminal Unit

a. Zone maximum cooling airflow setpoint (Vcool-max)

b. Zone maximum heating airflow setpoint (Vheat-max) = Vcool-max

c. Zone minimum airflow setpoint (Vmin). This is an optional entry. If no value is scheduled, or a value of "AUTO" is scheduled, Vmin will be calculated automatically and dynamically to meet ventilation requirements.

D. Zone Group Assignments

1. Unless otherwise specified by Owner, the following Zone Groups shall be created:

Zone Group Name	AH Tag	Terminal Unit Tags	Miscellaneous Equipment Tags	Default Schedule
All AC Units	AC-1 to AC-7	All VVT	All interlocked exhaust fans	WD: 6 am to 8 pm WE: 8 am to 10 pm HOL: off

E. Packaged AC Unit Design Information

1. Temperature Setpoints

a. Min_ClgSAT, lowest cooling supply air temperature setpoint: 55°F.

b. Max_ClgSAT, highest cooling supply air temperature setpoint: 70°F.

c. Min HtgSAT, lowest heating supply air temperature setpoint: 70°F

d. Max HtgSAT, highest heating supply air temperature setpoint: 85°

e. OAT_Min, the lower value of the OAT reset range: 50°F.

f. OAT_Max, the higher value of the OAT reset range: 70°F.

2. Ventilation Setpoints

a. AbsMinOA: the design outdoor airflow rate when all zones with CO2 sensors or occupancy sensors are unpopulated: per AC unit schedule

b. DesMinOA: the design minimum outdoor airflow with areas served by the system are occupied at their design population: per AC unit schedule

3. Economizer High Limit

a. California Title 24 economizer high limit

1) California climate zone = ***3***

2) High limit option:

a) Fixed dry bulb + differential dry bulb

1.3 INFORMATION PROVIDED BY (OR IN CONJUNCTION WITH) THE TESTING, ADJUSTING, AND BALANCING CONTRACTOR

A. Coordinate with Testing, Adjusting and Balancing for setpoint determination. Any work not specifically listed shall be provided under this Section.

B. Packaged AC Unit Information

1. Duct Design Maximum Static Pressure, Max_DSP (for VVT system)

2. Minimum Outside Air

3. Space Static Pressure

1.4 INFORMATION DETERMINED BY CONTROL CONTRACTOR

A. VAV Box Controllable Minimum (Applicable to all existing VVT Terminals)

1. This section is used to determine the lowest possible VAV box airflow setpoint (other than zero) allowed by the controls (Vm) used in VAV box control sequences. The minimums shall be stored as software points that may be adjusted by the user but need not be adjustable via the graphical user interface.

2. The minimum setpoint *Vm* shall be determined from the table below for the VAV box manufacturer from approved submittals:

Inlet	Titus	Krueger	Price	MetalAire High Gain	ETI	Greenheck
4	15	15	20	15	15	18
6	30	35	30	30	30	35
8	55	60	55	50	55	63
10	90	90	95	85	90	105
12	120	130	135	110	130	149
14	190	175	195	155	180	206
16	245	230	260	210	235	259
24x16	455	445	490	N/A	415	N/A

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

3.1 GENERAL

A. Contractor shall review sequences prior to programming and suggest modifications where required to achieve the design intent. Contractor may also suggest modifications to improve performance and stability or to simplify or reorganize logic in a manner that provides equal or better performance. Proposed changes in sequences shall be clearly identified and included as a part of Submittal Package 2.

B. Include costs for minor program modifications if required to provide proper performance of the system.

C. Unless otherwise indicated, control loops shall be enabled and disabled based on the status of the system being controlled to prevent windup.

D. When a control loop is enabled or reenabled, it and all its constituents (such as the proportional and integral terms) shall be set initially to a neutral value.

E. A control loop in neutral shall correspond to a condition that applies the minimum control effect, i.e., valves/dampers closed, VFDs at minimum speed, etc.

F. When there are multiple outdoor air temperature sensors, the system shall use the valid sensor that most accurately represents the outdoor air conditions at the equipment being controlled.

1. Outdoor air temperature sensors at air-handler outdoor air intakes shall be considered valid only when the supply fan is proven on and the unit is in Occupied Mode or in any other mode with the economizer enabled.

2. The outdoor air temperature used for optimum start, plant lockout, and other global sequences shall be the average of all valid sensor readings. If there are four or more valid outdoor air temperature sensors, discard the highest and lowest temperature readings.

G. The term “proven” (i.e., “proven on”/“proven off”) shall mean that the equipment’s DI status point (where provided, e.g., current switch, DP switch, or VFD status) matches the state set by the equipment’s DO command point.

H. The term “software point” shall mean an analog variable, and “software switch” shall mean a digital (binary) variable, that are not associated with real I/O points. They shall be read/write capable (e.g., BACnet analog variable and binary variable).

I. The term “control loop” or “loop” is used generically for all control loops. These will typically be PID loops, but proportional plus integral plus derivative gains are not required on all loops. Unless specifically indicated otherwise, the guidelines in the following subsections shall be followed.

1. Use proportional only (P-only) loops for limiting loops (such as zone CO2 control loops, etc.).

2. Do not use the derivative term on any loops unless field tuning is not possible without it.

J. To avoid abrupt changes in equipment operation, the output of every control loop shall be capable of being limited by a user adjustable maximum rate of change, with a default of 25% per minute.

K. All setpoints, timers, deadbands, PID gains, etc. listed in sequences shall be adjustable by the user with appropriate access level whether indicated as adjustable in sequences or not. Software points shall be used for these variables. Fixed scalar numbers shall not be embedded in programs except for physical constants and conversion factors.

L. Values for all points, including real (hardware) points used in control sequences shall be capable of being overridden by the user with appropriate access level (e.g., for testing and commissioning). If hardware design prevents this for hardware points, they shall be equated to a software point, and the software point shall be used in all sequences. Exceptions shall be made for machine or life safety.

M. Alarms

1. There shall be 4 levels of alarm

a. Level 1: Life-safety message

b. Level 2: Critical equipment message

c. Level 3: Urgent message

d. Level 4: Normal message

2. Maintenance Mode. Operators shall have the ability to put any device (e.g., AHU) in/out of maintenance mode.

a. All alarms associated with a device in maintenance mode will be suppressed. Exception: Life safety alarms shall not be suppressed.

b. If a device is in maintenance mode, issue a Level 3 alarm at a scheduled date and time indicating that the device is still in maintenance mode.

3. Exit Hysteresis

a. Each alarm shall have an adjustable time-based hysteresis (default: 5 seconds) to exit the alarm. Once set, the alarm does not return to normal until the alarm conditions have ceased for the duration of the hysteresis.

b. Each analog alarm shall have an adjustable percent-of-limit-based hysteresis (default: 0% of the alarm threshold, i.e., no hysteresis; alarm exits at the same value as the alarm threshold) the alarmed variable required to exit the alarm. Alarm conditions have ceased when the alarmed variable is below the triggering threshold by the amount of the hysteresis.

4. Latching. A latching alarm requires acknowledgment from the operators before it can return to normal, even if the exit deadband has been met. A nonlatching alarm does not require acknowledgment. Default latching status is as follows:

    a. Level 1 alarms: latching

    b. Level 2 alarms: latching

    c. Level 3 alarms: nonlatching

    d. Level 4 alarms: nonlatching

5. Post-exit Suppression Period. To limit alarms, any alarm may have an adjustable suppression period such that once the alarm is exited, its post-exit suppression timer is triggered and the alarm may not trigger again until the post-exit suppression timer has expired. Default suppression periods are as follows:

    a. Level 1 alarms: 0 minutes

    b. Level 2 alarms: 5 minutes

    c. Level 3 alarms: 24 hours

    d. Level 4 alarms: 7 days

N. Trim & Respond Set-Point Reset Logic

1. T&R set-point reset logic and zone/system reset requests, where referenced in sequences, shall be implemented as described below.

2. A “request” is a call to reset a static pressure or temperature setpoint generated by downstream zones or air-handling systems. These requests are sent upstream to the plant or system that serves the zone or air handler that generated the request.

    a. For each downstream zone or system, and for each type of set-point reset request listed for the zone/system, provide the following software points:

        1) Importance-Multiplier (default = 1)

        2) Request-Hours Accumulator. Provided SystemOK (see Section 3.1P) is true for the zone/system, every x minutes (default 5 minutes), add x divided by 60 times the current number of requests to this request-hours accumulator point.

        3) System Run-Hours Total. This is the number of hours the zone/system has been operating in any mode other than Unoccupied Mode.

        4) Cumulative%-Request-Hours. This is the zone/system Request-Hours divided by the zone/system run-hours (the hours in any mode other than Unoccupied Mode) since the last reset, expressed as a percentage.

        5) The Request-Hours Accumulator and System Run-Hours Total are reset to zero as follows:

a) Reset automatically for an individual zone/system when the System Run-Hours Total exceeds 400 hours.

b) Reset manually by a global operator command. This command will simultaneously reset the Request-Hours point for all zones served by the system.

6) A Level 4 alarm is generated if the zone Importance-Multiplier is greater than zero, the zone/system Cumulative% Request Hours exceeds 70%, and the total number of zone/system run hours exceeds 40.

b. See zone and air-handling system control sequences for logic to generate requests.

c. Multiply the number of requests determined from zone/system logic times the Importance-Multiplier and send to the system/plant that serves the zone/system. See system/plant logic to see how requests are used in T&R logic.

3. For each upstream system or plant setpoint being controlled by a T&R loop, define the following variables. Initial values are defined in system/plant sequences below. Values for trim, respond, time step, etc. shall be tuned to provide stable control. See Table 5.1.14.3.

Table 5.1.14.3 Trim & Respond Variables

Variable	Definition
Device	Associated device (e.g., fan, pump)
SP0	Initial setpoint
SPmin	Minimum setpoint
SPmax	Maximum setpoint
Td	Delay timer
T	Time step
I	Number of ignored requests
R	Number of requests from zones/systems
SPtrim	Trim amount
SPres	Respond amount (must be opposite in sign to SPtrim)
SPres-max	Maximum response per time interval (must be same sign as SPres)

Informative Note: The number of ignored requests (I) should be set to zero for critical zones or air handlers.

4. Trim & Respond logic shall reset the setpoint within the range SPmin to SPmax. When the associated device is off, the setpoint shall be SP0. The reset logic shall be active while the associated device is proven on, starting Td after initial device start command. When active, every time step T, if R≤I, trim the setpoint by SPtrim. If there are more than I

requests, respond by changing the setpoint by SPres*(R – I), (i.e., the number of requests minus the number of ignored requests) but no more than SPres-max. In other words, every time step T.

If R≤I, change Setpoint by SPtrim
If R > I, change setpoint by (R – I)*SPres but no larger than SPres-max

O. Air Economizer High Limits

1. Economizer shall be disabled whenever the outdoor air conditions exceed the economizer high-limit setpoint as specified. Setpoints shall be automatically determined by the control sequences (to ensure they are correct and meet code) based on energy standard, climate zone, and economizer high-limit-control device type selected by the design engineer in Section 1.1A.1. Setpoints listed below are for current California Energy Standards.

2. Title 24-2019

Device Type	California Climate Zones	Required High Limit (Economizer off when)
Fixed dry bulb	1, 3, 5, 11 to 16	TOA > 24°C (75°F)
Differential dry bulb	1, 3, 5, 11 to 16	TOA > TRA

P. Hierarchical Alarm Suppression

1. For each piece of equipment or space controlled by the BAS, define its relationship (if any) to other equipment in terms of “source,” “load,” or “system.”

   a. A component is a “source” if it provides resources to a downstream component, such as a chiller providing chilled water (CHW) to an AHU.

   b. A component is a “load” if it receives resources from an upstream component, such as an AHU that receives CHW from a chiller.

   c. The same component may be both a load (receiving resources from an upstream source) and a source (providing resources to a downstream load).

d. A set of components is a "system" if they share a load in common (i.e., collectively act as a source to downstream equipment, such as a set of chillers in a lead/lag relationship serving air handlers).

1) If a single component acts as a source for downstream loads (e.g., an AHU as a source for its VAV boxes), then that single-source component shall be defined as a "system" of one element.

2) For equipment with associated pumps (chillers, boilers, cooling towers):

a) If the pumps are in a one-to-one relationship with equipment they serve, the pumps shall be treated as part of the system to which they are associated (i.e., they are not considered loads), as a pump failure will necessarily disable its associated equipment.

b) If the pumps are headered to the equipment they serve, then the pumps may be treated as a system, which is a load relative to the upstream equipment (e.g., chillers) and a source relative to downstream equipment (e.g., air handlers).

2. For each system as defined in Section 3.1P.1.d, there shall be a SystemOK flag, which is either true or false.

3. SystemOK shall be true when all of the following are true:

a. The system is proven on.

b. The system is achieving its temperature and/or pressure setpoint(s) for at least 5 minutes

c. The system is ready and able to serve its load

4. SystemOK shall be false while the system is starting up (i.e., before reaching setpoint) or when enough of the system's components are unavailable (in alarm, disabled, or turned off) to disrupt the ability of the system to serve its load. This threshold shall be defined by the design engineer for each system.

a. By default, Level 1 through Level 3 component alarms (indicating equipment failure) shall inhibit SystemOK. Level 4 component alarms (maintenance and energy efficiency alarms) shall not affect SystemOK.

b. The operator shall have the ability to individually determine which component alarms may or may not inhibit SystemOK.

5. The BAS shall selectively suppress (i.e., fail to announce; alarms may still be logged to a database) alarms for load components if SystemOK is false for the source system that serves that load.

a. If SystemOK is false for a cooling water system (i.e., chiller, cooling tower, or associated pump), then only high-temperature alarms from the loads shall be suppressed.

b. If SystemOK is false for a heating water system (i.e., boiler or associated pump), then only low temperature alarms from the loads shall be suppressed.

c. If SystemOK is false for an air-side system (air handler, fan coil, VAV box, etc.), then all alarms from the loads shall be suppressed.

6. This hierarchical suppression shall cascade through multiple levels of load-source relationship such that alarms at downstream loads shall also be suppressed.

7. The following types of alarms will never be suppressed by this logic:

a. Life/safety and Level 1 alarms

b. Failure-to-start alarms (i.e., equipment is commanded on, but status point shows equipment to be off)

c. Failure-to-stop/hand alarms (i.e., equipment is commanded off, but status point shows equipment to be on)

Q. Time-Based Suppression

1. Calculate a time-delay period after any change in setpoint based on the difference between the controlled variable (e.g., zone temperature) at the time of the change and the new setpoint. The default time delay period shall be as follows:

a. For thermal zone temperature alarms: 18 minutes per °C (10 minutes per °F) of difference but no longer than 120 minutes

b. For thermal zone temperature cooling requests: 9 minutes per °C (5 minutes per °F) of difference but no longer than 30 minutes

c. For thermal zone temperature heating requests: 9 minutes per °C (5 minutes per °F) of difference but no longer than 30 minutes

R. Occupancy Sensor Status

1. Occupancy status of all spaces shall be via the Lighting Control BACnet interface.

2. Where a zone serves more than one room, “unoccupied” (or “unpopulated” per Guideline 36 terminology) means all rooms are unoccupied and “occupied” (populated) means any room is occupied.

3. In case of the network connection with the Lighting Controls is lost:

a. For lab zones, occupancy status shall default to “occupied” (for safety reasons)

b. For all other zones, occupancy status shall default to “occupied” if the Zone Group is in Occupied Mode and “unoccupied” for any other Zone Group Mode.

S. Pandemic Mode (Applicable for this project)

1. Provide a software switch on the Home Page graphic for Pandemic Mode on/off. The switch shall include a timer that can be manually set by the operator for a period of up to 60 weeks, after which the Mode shall be shut off and control logic and setpoints returned to normal.

2. When the Pandemic Mode timer is on:

   a. All CO2 DCV setpoints shall be set to 800 ppm.

   b. Occupancy sensors used for Occupied Standby logic shall be not reset zone ventilation rates; with respect to ventilation, the zone shall be considered "populated".

   c. All Zone Group time schedules shall indicate Occupied Mode one hour prior to the scheduled time. This earlier time shall be reflected in optimum start logic.

T. Wildfire Mode

1. Provide a 2-position software switch on the Home Page graphic for Wildfire Mode:

   a. Off. Locks Wildfire Mode off.

   b. On. Turns Wildfire Mode on for a preset period of time, after which the Mode shall be shut off. The preset time shall be operator adjustable for up to 1 week.

2. Provide a 3-position software switch on the Home Page graphic for Wildfire Mode:

   a. Off. Locks Wildfire Mode off.

   b. On. Turns Wildfire Mode on for a preset period of time, after which the Mode shall be shut off. The preset time shall be operator adjustable for up to 1 week.

   c. Auto. Turns Wildfire Mode on when PM2.5 as indicated by the APMS sensor is greater than a preset concentration limit for 15 minutes until it drops below that limit for 30 minutes, after which the Mode shall be shut off. The preset concentration limit shall default to 90 µg/m3 and be operator adjustable from 50 to 120 µg/m3.

3.2 ELECTRICITY DEMAND LIMITING

1. On home page, provide three software switches: Demand Limit Level 1 to 3.

   a. These switches shall have AUTO, ON, and OFF positions. AUTO position shall set the Demand Limit Level's status to enabled or disabled based on an OpenADR 2.0 signal from the utility (see Section 250000 Building Automation Systems) or the Owner Initiated Electricity Demand Limiting logic below with enabled taking precedence; ON shall manually enable the Demand Limit Level; and OFF shall disable and lockout the Demand Limit Level.

   b. The Highest Demand Limit Level signal currently enabled, either via an ON or AUTO command, shall be given priority.

c. These signals are used at the zone level (see Zone Control sequences) to adjust setpoints to reduce demand.

2. Include Demand Shed commands to the lighting control system via BACnet interface for each Demand Level. The response to each Demand Shed command shall be programmed into the lighting control system under Division 26.

3. When any Demand Limit Level is on, generate a Level 4 alarm.

3.3 GENERIC VENTILATION ZONES

A. Zone Minimum Outdoor Air and Minimum Airflow Setpoints

1. For every zone that requires mechanical ventilation, the zone minimum outdoor airflows and setpoints shall be calculated depending on the governing standard or code for outdoor air requirements.

2. See Section 1.2C for zone minimum airflow setpoint Vmin.

3. For compliance with California Title 24, outdoor air setpoints shall be calculated as follows:

a. See Section 1.2B.2 for zone ventilation setpoints.

b. Determine the zone minimum outdoor air setpoints Zone-Abs-OA-min and Zone-Des-OA-min.

1) Zone-Abs-OA-min shall be reset based on the following conditions in order from highest to lowest priority:

a) Zero if the zone has a window switch and the window is open.

b) Zero if the zone has an occupancy sensor and is unpopulated and is permitted to be in occupied-standby mode per Section 1.1A.1.a.1.

c) Varea-min if the zone has a CO2 sensor.

d) Zone-Des-OA-min otherwise.

2) Zone-Des-OA-min is equal to the following, in order from highest to lowest priority:

a) Zero if the zone has a window switch and the window is open.

b) Zero if the zone has an occupancy sensor, is unpopulated, and is permitted to be in occupied-standby mode per Section 1.1A.1.a.1.

c) The larger of Varea-min and Vocc-min otherwise.

c. Vmin

1) Shall be equal to Zone-Abs-OA-min if Vmin in Section 1.2C is “AUTO”;

2) Else shall be equal to Vmin as entered in Section 1.2C.

d. The occupied minimum airflow Vmin* shall be equal to Vmin except as noted below, in order from highest to lowest priority:

1) If the zone has an occupancy sensor and is permitted to be in occupied-standby mode per Section 1.1A.1.a.1, Vmin* shall be equal to zero when the room is unpopulated.

2) If the zone has a window switch, Vmin* shall be zero when the window is open.

3) If the zone has a CO2 sensor:

a) See Section 1.2B.3 for CO2 setpoints.

b) During Occupied Mode, a P-only loop shall maintain CO2 concentration at setpoint; reset from 0% at setpoint minus 200 PPM and to 100% at setpoint.

c) Loop is disabled and output set to zero when the zone is not in Occupied Mode.

d) For VVT terminal units:

1. The CO2 control loop output shall reset the occupied minimum airflow setpoint Vmin* from the zone minimum airflow setpoint Vmin at 0% up to maximum cooling airflow setpoint Vcool-max at 50%, as shown in Figure 5.2.1.4-1. The loop output from 50% to 100% will be used at the system level to reset outdoor air minimum; see AHU controls.

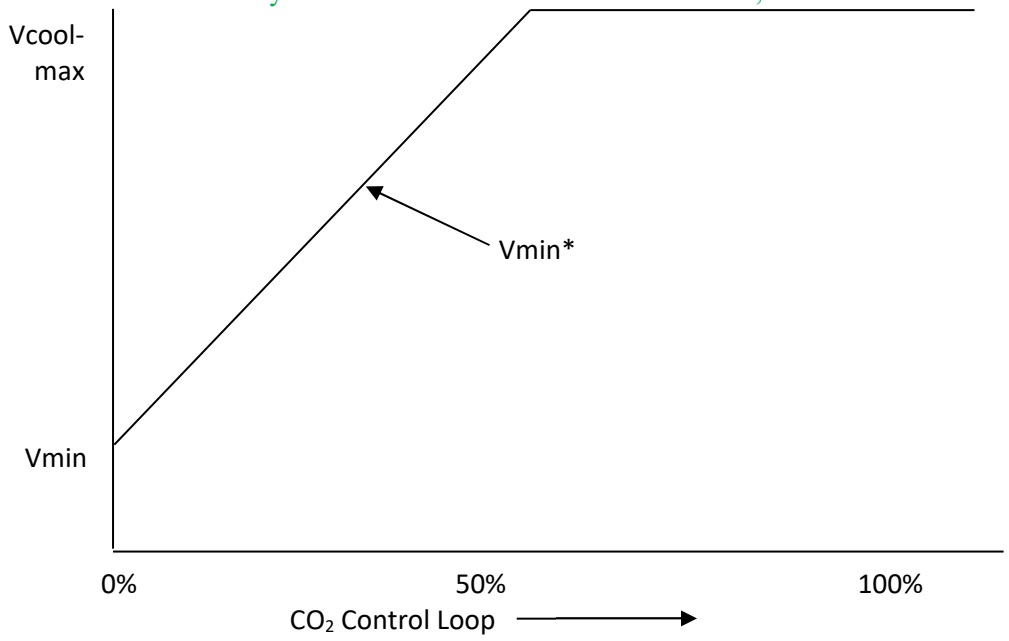


Figure 5.2.1.4-1 Vmin* reset with CO2 loop.

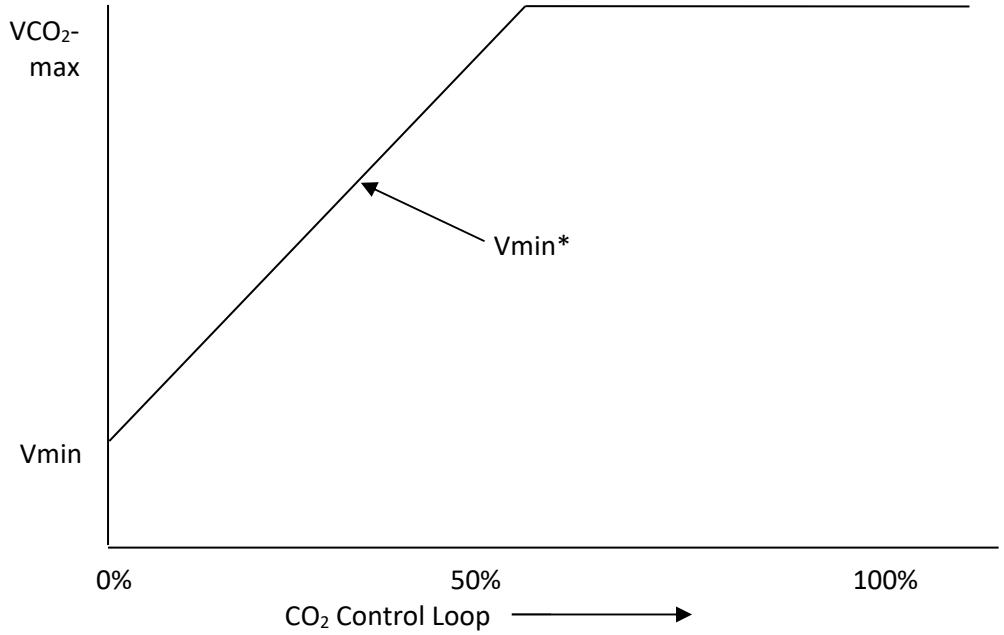


Figure 5.2.1.4-2 Vmin* reset with CO2 loop (parallel fan-powered).

e) For SZ AC UNIT:

1. The minimum outdoor air setpoint MinOAsp shall be reset based on the zone CO2 control-loop signal from MinOA at 0% signal to DesOA at 100% signal. See Figure 5.2.1.4-3.

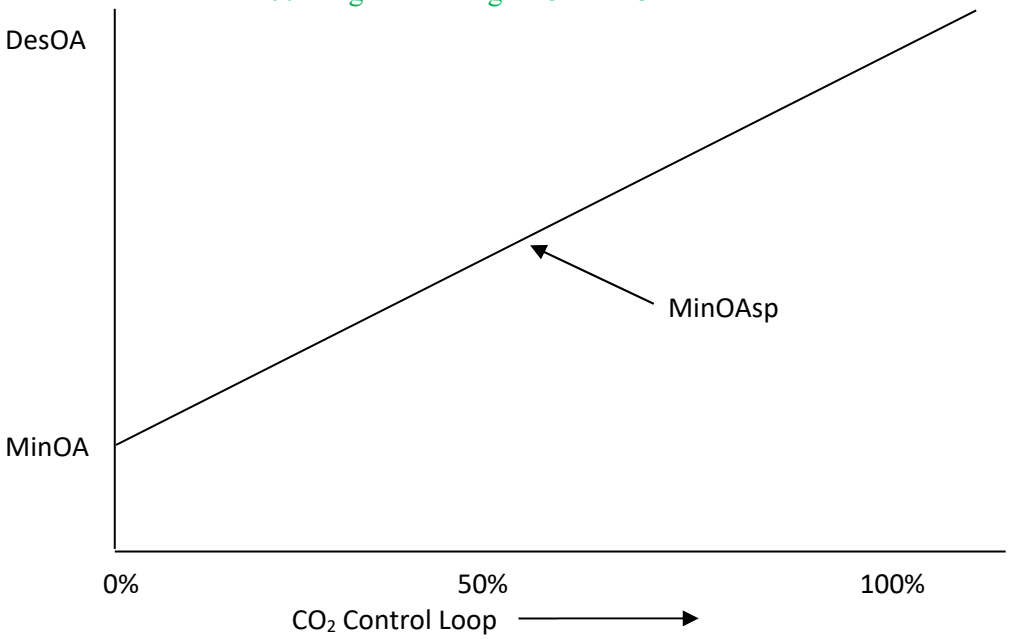


Figure 5.2.1.4-3 Vmin* reset with CO2 loop (SZ).

B. Time-Averaged Ventilation

1. When the active airflow setpoint Vspt is nonzero and is less than the lowest possible airflow setpoint allowed by the controls (Vm), the airflow setpoint shall be pulse width modulated as follows:

a. The time-averaged ventilation (TAV) ratio shall be determined as TAVratio = Vspt/Vm

b. The total cycle time (TCT) shall be 15 minutes (adjustable)

c. Open period. During the open period, the TAV airflow setpoint Vspt* shall be equal to Vm for a period of time OP, which is the larger of the following:

d. 1.5 minutes or

e. TCT multiplied by TAVratio

f. Closed period. During the closed period, Vspt* shall be set to 0 for a period of time CP, where CP = TCT – OP. The VAV damper control loop shall be disabled with output set equal to 0 during the closed period. At the end of each closed period, the VAV damper shall be commanded to the last position from the previous open period prior to reenabling the control loop.

g. During TAV mode, each cycle shall consist of an open and closed period that alternate until Vspt is greater than Vm.

h. When first entering TAV mode, start with an initial open period of duration RNDM*OP, where RNDM is a random number between 0.0 and 1.0.

2. When in TAV mode, the active airflow setpoint, Vspt, shall be overridden to Vspt*.

C. For zones with CO2 sensors:

1. If the CO2 concentration is less than 300 ppm, or the zone is in Unoccupied Mode for more than 2 hours and zone CO2 concentration exceeds 600 ppm, generate a Level 3 alarm. The alarm text shall identify the sensor and indicate that it may be out of calibration.

2. If the CO2 concentration exceeds setpoint plus 10% for more than 10 minutes, generate a Level 3 alarm.

3.4 GENERIC THERMAL ZONES

A. This section applies to all single-zone systems and subzones of air-handling systems, such as VAV boxes, fan-powered boxes, etc.

B. Setpoints

1. See Section 1.2B.1 for zone temperature setpoints.

2. Each zone shall have separate occupied and unoccupied heating and cooling setpoints.

3. The active setpoints shall be determined by the operating mode of the Zone Group (see Section 3.5F).

a. During occupied mode:

1) The cooling set point shall be the occupied cooling set point.

2) The heating set point shall be the occupied heating set point.

b. During warm-up mode:

1) The cooling set point shall be the unoccupied cooling set point.

2) The heating set point shall be the unoccupied heating set point until the time remaining until the zone group's occupied start time is less than the zone's required warm-up time, tz-warmup, at which point the heating set point shall be the occupied heating set point.

c. During cool-down mode:

1) The cooling set point shall be the unoccupied cooling set point until the time remaining until the zone group's occupied start time is less than the zone's required cool-down time, tz-cooldown, at which point the cooling set point shall be the occupied cooling set point.

2) The heating set point shall be the unoccupied heating set point.

d. During setback mode:

1) The cooling set point shall be the unoccupied cooling set point.

2) The heating set point shall be 2°C (3°F) above the unoccupied heating set point.

e. During setup mode:

1) The cooling set point shall be 2°C (3°F) below the unoccupied cooling set point.

2) The heating set point shall be the unoccupied heating set point.

f. During unoccupied mode:

1) The cooling set point shall be the unoccupied cooling set point.

2) The heating set point shall be the unoccupied heating set point.

4. The software shall prevent the following:

a. The heating setpoint from exceeding the cooling setpoint minus 0.5°C (1°F) (i.e., the minimum difference between heating and cooling setpoints shall be 0.5°C [1°F]).

b. The unoccupied heating setpoint from exceeding the occupied heating setpoint.

c. The unoccupied cooling setpoint from being less than the occupied cooling setpoint.

5. Where the zone has a local setpoint adjustment knob/button:

a. The setpoint adjustment offsets established by the occupant shall be software points that are persistent (e.g., not reset daily), but the actual offset used in control logic shall be adjusted based on limits and modes as describe below.

b. The adjustment shall be capable of being limited in software.

1) As a default, the active occupied cooling setpoint shall be limited between 22°C (72°F) and 27°C (80°F).

2) As a default, the active occupied heating setpoint shall be limited between 18°C (65°F) and 22°C (72°F).

c. The active heating and cooling setpoints shall be independently adjustable, respecting the limits and anti-overlap logic described in Sections 3.4B.3.a and 3.4B.5.b. If zone thermostat provides only a single set-point adjustment, then the adjustment shall move both the active heating and cooling setpoints upward or downward by the same amount, within the limits described in Section 3.4B.5.b.

d. The adjustment shall only affect occupied setpoints in Occupied Mode, Warmup Mode, and Cooldown Mode and shall have no impact on setpoints in all other modes.

e. At the onset of demand limiting, the local set-point adjustment value shall be frozen. Further adjustment of the setpoint by local controls shall be suspended for the duration of the demand-limit event.

6. Cooling Demand Limit Set-Point Adjustment. The active cooling setpoints for all zones shall be increased when a demand limit is imposed on the associated Zone Group. The operator shall have the ability to exempt individual zones from this adjustment through the normal BAS user interface. Changes due to demand limits are not cumulative.

a. At demand-limit Level 1, increase setpoint by 0.5°C (1°F).

b. At demand-limit Level 2, increase setpoint by 1°C (2°F).

c. At demand-limit Level 3, increase setpoint by 2°C (4°F).

7. Heating Demand-Limit Set-Point Adjustment. The active heating setpoints for all zones shall be decreased when a demand limit is imposed on the associated Zone Group. The operator shall have the ability to exempt individual zones from this adjustment through the normal BAS user interface. Changes due to demand limits are not cumulative.

a. At demand-limit Level 1, decrease setpoint by 0.5°C (1°F).

b. At demand-limit Level 2, decrease setpoint by 1°C (2°F).

c. At demand-limit Level 3, decrease setpoint by 2°C (4°F).

8. Occupancy Sensors. For zones that have an occupancy switch:

a. When the switch indicates that the space has been unpopulated for 5 minutes continuously during the Occupied Mode, the active heating setpoint shall be decreased by 0.5°C (1°F) and the cooling setpoint shall be increased by 0.5°C (1°F).

b. When the switch indicates that the space has been populated for 1 minute continuously, the active heating and cooling setpoints shall be restored to their previous values.

9. Hierarchy of Set-Point Adjustments. The following adjustment restrictions shall prevail in order from highest to lowest priority:

a. Setpoint overlap restriction (Section 3.4B.3.a)

b. Absolute limits on local setpoint adjustment (Section 3.4B.5.b)

c. Window switches

d. Demand limit

1) Occupancy sensors. Change of setpoint by occupancy sensor is added to change of setpoint by any demand limits in effect.

2) Local set-point adjustment. Any changes to setpoint by local adjustment are frozen at the onset of the demand limiting event and remain fixed for the duration of the event. Additional local adjustments are ignored for the duration of the demand limiting event.

e. Scheduled setpoints based on Zone Group mode

C. Local Override. When thermostat override buttons are depressed, the call for Occupied Mode operation shall be sent to the Zone Group control for 60 minutes. Local Override shall be capable of being enabled and disabled separately for each thermostat via the graphical user interface; default to disabled.

D. Control Loops

1. Two separate control loops, the Cooling Loop and the Heating Loop, shall operate to maintain space temperature at setpoint.

a. The Heating Loop shall be enabled whenever the space temperature is below the current zone heating set-point temperature and disabled when space temperature is above the current zone heating setpoint temperature and the loop output is zero for 30 seconds. The loop may remain active at all times if provisions are made to minimize integral windup.

b. The Cooling Loop shall be enabled whenever the space temperature is above the current zone cooling set-point temperature and disabled when space temperature is below the current zone cooling set-point temperature and the loop output is zero for 30 seconds. The loop may remain active at all times if provisions are made to minimize integral windup.

2. The Cooling Loop shall maintain the space temperature at the active cooling setpoint. The output of the loop shall be a software point ranging from 0% (no cooling) to 100% (full cooling).

3. The Heating Loop shall maintain the space temperature at the active heating setpoint. The output of the loop shall be a software point ranging from 0% (no heating) to 100% (full heating).

4. Loops shall use proportional + integral logic or other technology with similar performance. Proportional-only control is not acceptable, although the integral gain shall be small relative to the proportional gain. P and I gains shall be adjustable by the operator.

5. See other sections for how the outputs from these loops are used.

E. Zone State

1. Heating. When the output of the space Heating Loop is nonzero and the output of the Cooling Loop is equal to zero.

2. Cooling. When the output of the space Cooling Loop is nonzero and the output of the Heating Loop is equal to zero.

3. Deadband. When not in either heating or cooling.

F. Zone Alarms

1. Zone Temperature Alarms

a. High-temperature alarm

1) If the zone is 2°C (3°F) above cooling setpoint for 10 minutes, generate a Level 4 alarm.

2) If the zone is 3°C (5°F) above cooling setpoint for 10 minutes, generate a Level 3 alarm.

b. Low-temperature alarm

1) If the zone is 2°C (3°F) below heating setpoint for 10 minutes, generate a Level 4 alarm.

2) If the zone is 3°C (5°F) below heating setpoint for 10 minutes, generate a Level 3 alarm.

c. Suppress zone temperature alarms as follows:

1) After zone setpoint is changed per Section 3.1Q.

2) While Zone Group is in Warmup Mode or Cooldown Mode.

G. Zone Group Mode Requests

1. Zone Group Mode Requests shall be generated by the conditions in each zone and sent to the Zone Group of which the zone is a member.

2. Warm-up Mode Requests

    a. An algorithm provided with the BAS shall calculate the required zone warm-up time, tz-warmup, which shall be less than 3 hours, based on the zone's occupied heating set point, the current zone temperature, the outdoor air temperature, and a heating mass/capacity factor for each zone.

    b. The heating mass/capacity factor may be either manually adjusted or automatically self-tuned by the BAS. If automatic, the tuning process shall be turned ON or OFF by a software switch to allow tuning to be stopped after the system has been trained.

    c. If the zone group is in any mode other than occupied mode, zone window switch(es) indicate that all windows are closed, and the time remaining until the zone group's occupied start time is less than the zone's required warm-up time, tz-warmup, send 1 Warm-up Mode Request; else, send 0 Warm-up Mode Requests.

3. Cooldown Mode Requests

    a. An algorithm provided with the BAS shall calculate the required zone cool-down time, tz-cooldown, which shall be less than 3 hours, based on the zone's occupied heating set point, the current zone temperature, the outdoor air temperature, and a cooling mass/capacity factor for each zone.

    b. The cooling mass/capacity factor may be either manually adjusted or automatically self-tuned by the BAS. If automatic, the tuning process shall be turned ON or OFF by a software switch to allow tuning to be stopped after the system has been trained.

    c. If the zone group is in any mode other than occupied mode, zone window switch(es) indicate that all windows are closed, and the time remaining until the zone group's occupied start time is less than the zone's required cool-down time, t-cooldown, send 1 Cooldown Mode Request; else, send 0 Cooldown Mode Requests.

4. Setback Mode Requests

    a. If the zone group is in unoccupied or setback mode, zone window switch(es) indicate that all zone windows are closed, and zone temperature is less than the unoccupied heating setpoint for 5 minutes, send 1 Setback Mode Request; else, send 0 Setback Mode Requests.

5. Setup Mode Requests

    a. If the zone group is in unoccupied or setup mode, zone window switch(es) indicate that all zone windows are closed, and zone temperature is greater than the unoccupied cooling setpoint for 5 minutes, send 1 Setup Mode Requests; else, send 0 Setup Mode Requests.

3.5 ZONE GROUPS

A. Each system shall be broken into separate Zone Groups composed of a collection of one or more zones served by a single air handler. See Section 1.1A for Zone Group assignments.

B. Each Zone Group shall be capable of having separate occupancy schedules and operating modes from other Zone Groups.

C. All zones in each Zone Group shall be in the same zone-group operating mode as defined in Section 3.5F. If one zone in a Zone Group is placed in any zone-group operating mode other than Unoccupied Mode (due to override, sequence logic, or scheduled occupancy), all zones in that Zone Group shall enter that mode.

D. A Zone Group may be in only one mode at a given time.

E. For each Zone Group, provide a set of testing/commissioning software switches that override all zones served by the Zone Group. Provide a separate software switch for each of the zone-level override switches listed under “Testing and Commissioning Overrides” in terminal unit sequences. When the value of a Zone Group’s override switch is changed, the corresponding override switch for every zone in the Zone Group shall change to the same value. Subsequently, the zone-level override switch may be changed to a different value. The value of the zone-level switch has no effect on the value of the zone-group switch, and the value of the zone-group switch only affects the zone-level switches when the zone-group switch is changed.

F. Zone-Group Operating Modes. Each Zone Group shall have the modes shown in the following subsections.

1. Occupied Mode. A Zone Group is in the Occupied Mode when any of the following is true:

   a. The time of day is between the Zone Group’s scheduled occupied start and stop times.

   b. The schedules have been overridden by the occupant override system.

   c. Any zone local override timer (initiated by local override button) is nonzero.

2. Warm-Up Mode. Warm-up mode shall start when the number of Warm-Up Mode Requests > I (I = ignores, default = 5), and shall end at the zone group’s scheduled occupied start time or Warm-Up Mode Requests <MT (MT=minimum threshold, default = 1) after a minimum of 10 minutes in this mode.

3. Cool-down Mode. Cool-down mode shall start when the number of Cool-down Mode Requests > I (I = ignores, default to 5), and shall end at the zone group’s scheduled occupied start time or Cool-down Mode Requests <MT (MT=minimum threshold, default = 1) after a minimum of 10 minutes in this mode.

4. Setback Mode. Setback mode shall start when the number of Setback Mode Requests > I (I = ignores, default to 4), and shall end when Setback Mode Requests <MT (MT=minimum threshold, default = 1) after a minimum of 10 minutes in this mode.

5. Setup Mode. Setup mode shall start when the number of Setup Mode Requests > I (I = ignores, default to 4), and shall end when Setup Mode Requests <MT (MT=minimum threshold, default = 1) after a minimum of 10 minutes in this mode.

6. When zones in one Zone Group are generating requests for different modes, the hierarchy in Section 5.15.1 shall be used to determine Zone Group Operating Mode.

3.6 VVT TERMINAL UNIT

A. See “Generic Thermal Zones” (Section 3.3C) for setpoints, loops, control modes, alarms, etc.

B. See “Generic Ventilation Zones” (Section 3.3) for calculation of zone minimum outdoor airflow.

C. See Section 1.2C.1 for zone minimum airflow setpoint Vmin, zone maximum cooling airflow setpoint Vcool-max, and zone maximum heating airflow setpoint Vheat-max.

D. Active endpoints used in the control logic depicted in Figure 5.5.5 shall vary depending on the mode of the Zone Group the zone is a part of (see Table 5.5.4).

Table 5.5.4 Endpoints as a Function of Zone Group Mode

Endpoint	Occupied	Cooldown	Setup	Warmup	Setback	Unoccupied
Cooling maximum	Vcool-max	Vcool-max	Vcool-max	0	0	0
Minimum	Vmin*	0	0	0	0	0
Heating maximum	Vheat-max	0	0	Vcool-max	Vcool-max	0

E. Control logic is depicted schematically in Figure 5.5.5 and described in the following subsections.

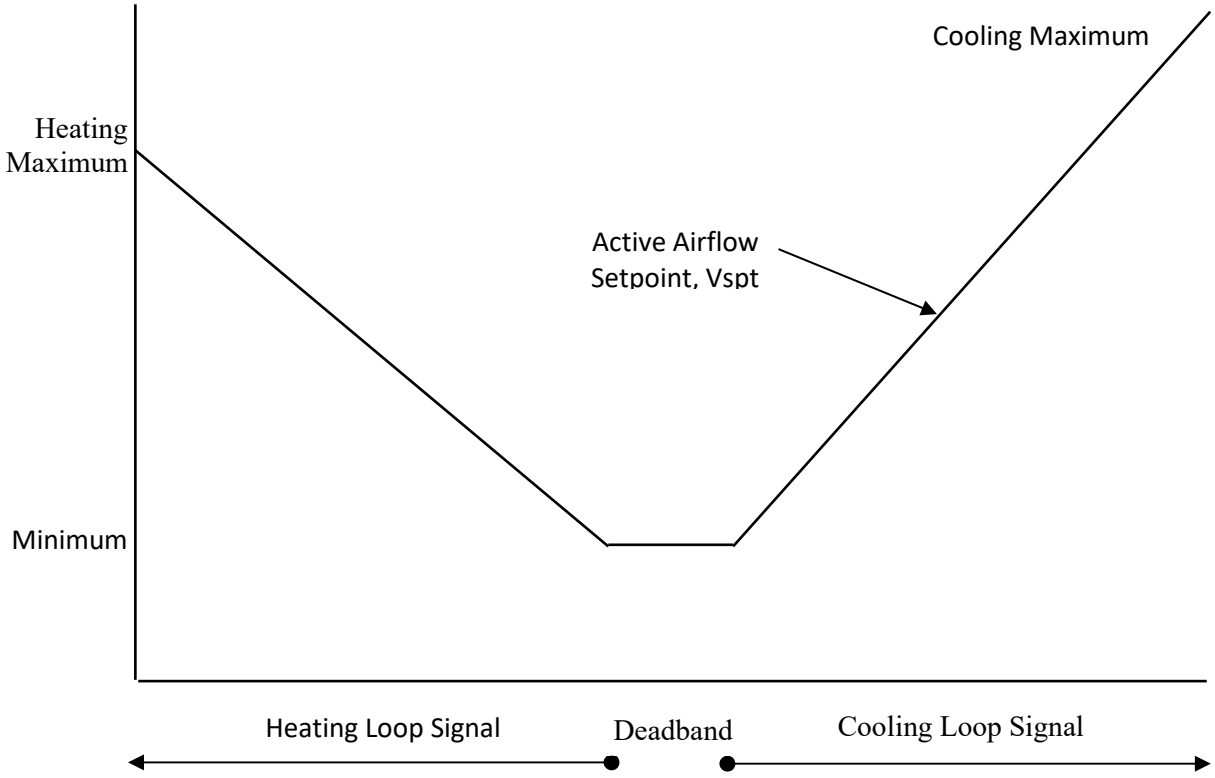


Figure 5.5.5 Control logic for cooling-only VAV zone.

1. When the Zone State is cooling, the cooling-loop output shall be mapped to the active airflow setpoint from the minimum endpoint to the cooling maximum endpoint.

    a. If supply air temperature from the air handler is greater than room temperature, the active airflow setpoint shall be no higher than the minimum endpoint.

2. When the Zone State is deadband, the active airflow setpoint shall be the minimum endpoint.

3. When the Zone State is heating, the Heating Loop output shall be mapped to the active airflow setpoint from the minimum endpoint to the heating maximum endpoint.

    a. If supply air temperature from the air handler is less than 3°C (5°F) above the room temperature, the active airflow setpoint shall be no higher than the minimum endpoint.

4. The VAV damper shall be modulated by a control loop to maintain the measured airflow at the active setpoint.

F. Alarms

1. Low Airflow

    a. If the measured airflow is less than 70% of setpoint for 10 minutes while setpoint is greater than zero, generate a Level 4 alarm.

b. If the measured airflow is less than 50% of setpoint for 10 minutes while setpoint is greater than zero, generate a Level 3 alarm.

c. If a zone has an importance multiplier of 0 (see Section 3.1N.2.a.1)) for its static pressure reset T&R control loop, low airflow alarms shall be suppressed for that zone.

2. Airflow Sensor Calibration. If the fan serving the zone is off and airflow sensor reading is above the larger of 10% of the cooling maximum airflow setpoint or 50 cfm for 30 minutes, generate a Level 3 alarm.

3. Leaking Damper. If the damper position is 0%, and airflow sensor reading is above the larger of 10% of the cooling maximum airflow setpoint or 50 cfm for 10 minutes while the fan serving the zone is proven on, generate a Level 4 alarm.

G. Testing/Commissioning Overrides. Provide software switches that interlock to a system-level point to

a. force zone airflow setpoint to zero,

b. force zone airflow setpoint to Vcool-max,

c. force zone airflow setpoint to Vmin,

d. force damper full closed/open, and

e. reset request-hours accumulator point to zero (provide one point for each reset type listed in the next section).

H. System Requests

1. Cooling SAT Reset Requests

a. If the zone temperature exceeds the zone's cooling setpoint by 3°C (5°F) for 2 minutes and after suppression period due to setpoint change per Section 3.1Q, send 3 requests.

b. Else if the zone temperature exceeds the zone's cooling setpoint by 2°C (3°F) for 2 minutes and after suppression period due to setpoint change per Section 3.1Q, send 2 requests.

c. Else if the Cooling Loop is greater than 95%, send 1 request until the Cooling Loop is less than 85%.

d. Else if the Cooling Loop is less than 95%, send 0 requests.

2. Static Pressure Reset Requests

a. If the measured airflow is less than 50% of setpoint while setpoint is greater than zero and the damper position is greater than 95% for 1 minute, send 3 requests.

b. Else if the measured airflow is less than 70% of setpoint while setpoint is greater than zero and the damper position is greater than 95% for 1 minute, send 2 requests.

c. Else if the damper position is greater than 95%, send 1 request until the damper position is less than 85%.

d. Else if the damper position is less than 95%, send 0 requests.

3.7 GENERAL CONSTANT SPEED EXHAUST FAN

A. Exhaust Fan Control

1. Exhaust Fan Start/Stop

a. Scheduled fans

1) Exhaust fan shall operate when any of the associated system supply fans is proven on and any associated Zone Group is in the Occupied Mode. See Section 1.1A for Zone Group assignments.

b. Fans controlled by space temperature

1) Exhaust fan shall run when zone temperature rises above the active cooling setpoint until zone temperature falls more than 1°C (2°F) below the active cooling setpoint for 2 minutes.

The room temperature control method should only be used in non-occupied spaces where ventilation is not required (e.g., equipment rooms).

B. Alarms

1. Maintenance interval alarm when fan has operated for more than 3,000 hours: Level 4. Reset interval counter when alarm is acknowledged.

2. Fan alarm is indicated by the status being different from the command for a period of 15 seconds.

a. Commanded on, status off: Level 2

b. Commanded off, status off: Level 4

3.8 PACKAGED SINGLE ZONE HEAT PUMP OR GAS/ELECTRIC AC UNIT WITH DDC (AC-1, 2, 5, 6, 7 AND 8)

A. See “Generic Thermal Zones” (Section 3.4) for setpoints, loops, control modes, alarms, etc.

B. Supply fan control

1. For occupied areas: The unit fan shall run when system is in any mode other than Unoccupied Mode.

C. Cooling control

1. Cooling is enabled when the zone is in Cooling State.

2. The zone Cooling Loop output shall be mapped to stage the two stages of cooling as follows. Each stage shall have a 5 minute minimum on time and a 5 minute minimum off-time:

    a. Stage 1 of cooling shall be enabled when the loop output is at 50 and staged off when the loop output is at 0. Note the economizer (where applicable) is enabled by the unit controls whenever the first stage of cooling is engaged.

    b. Stage 2 of cooling shall be enabled when the loop output is at 100 and staged off when the loop output is at 50.

    c. Each stage shall have a 2-minute (adjustable) minimum on time and a 2-minute (adjustable) minimum off-time

D. Heating control

1. Heating is enabled when the zone is in Heating Mode.

2. The zone Heating Loop output shall be mapped to stage the two stages of heating as follows. Each stage shall have a 5 minute minimum on time and a 5 minute minimum off-time:

    a. Stage 1 of heating shall be enabled when the loop output is at 40 and staged off when the loop output is at 0.

    b. Stage 2 of heating shall be enabled when the loop output is at 70 and staged off when the loop output is at 30.

    c.

E. Minimum Outdoor air control.

1. Outdoor Airflow Setpoint for California Title 24 Ventilation

    a. See zone CO2 control logic under terminal unit sequences.

    b. The minimum outdoor air setpoint MinOAsp shall be reset based on the highest zone CO2 control-loop signal from AbsMinOA* at 50% signal to DesMinOA* at 100% signal.

    c. The maximum/minimum outside air position shall be determined by the balancer.

    d. Minimum Outdoor Air Control Loop

        1) Minimum outdoor air control loop is enabled when the AC unit is in Occupied Mode and disabled and output set to zero otherwise.

F. Relief (Power Exhaust) Fan

1. Building pressure sensor shall be field installed in location indicated on Drawings.

2. Relief fans shall be controlled by AC unit internal controls to maintain building pressure at setpoint (0.05" adjustable).

G. Alarms

1. Maintenance interval alarm when fan has operated for more than 1500 hours: Level 4. Reset interval counter when alarm is acknowledged.

2. Fan alarm is indicated by the status input being different from the output command for 15 seconds.

a. Commanded on, status off: Level 2. Do not evaluate alarm until the device has been commanded on for 15 seconds.

b. Commanded off, status on: Level 4. Do not evaluate the alarm until the device has been commanded off for 60 seconds.

3. Generate a Level 3 alarm if:

a. Heating outputs are on and supply air fan is proven on and supply air temperature is below 80°F for more than 3 minutes indicating heating system failure.

b. Cooling outputs are on and supply air fan is proven on and supply air temperature is above 65°F for more than 3 minutes indicating cooling system failure.

4. Filter pressure drop exceeds adjustable alarm limit. Level 4

3.9 PACKAGED GAS/ELECTRIC AC UNIT WITH DDC FOR VVT SYSTEM (AC-3 AND AC-4)

A. AC Unit shall be configured to disable any internal scheduling, start/stop, and mode control. All operating modes and setpoints shall be determined by the BAS as described herein. The AC unit shall be configured to operate only when enabled by BAS commands and to maintain the setpoints determined by the BAS below. All commands and setpoints shall be passed from the BAS to the to the AC unit's internal controls via the gateway.

B. AC System Modes. See Paragraph 1.1 for Modes which are generated by Zone Group Requests.

C. Supply Fan Control

1. Supply Fan Start/Stop

a. Supply fan shall run when system is Energized.

b. Totalize current airflow rate from VAV boxes to a software point Vps.

2. Static Pressure Set-Point Reset

a. Static pressure setpoint. Setpoint shall be reset using T&R logic (see Section 3.1N) using the parameters shown in Table 5.16.1.2.

Table 5.16.1.2 Trim & Respond Variables

Variable	Value
Device	Supply fan
SP0	120 Pa (0.5 in. of water)
SPmin	25 Pa (0.1 in. of water)
SPmax	Max_DSP (See Section 1.1A.1)
Td	10 minutes
T	2 minutes
I	2
R	Zone static pressure reset requests
SPtrim	–12 Pa (–0.05 in. of water)
SPres	15 Pa (+0.06 in. of water)
SPres-max	32 Pa (+0.13 in. of water)

3. Static Pressure Control

   a. Static pressure tip shall be extended in field to location shown on plans.

   b. The BAS shall modulate the supply duct by-pass damper to maintain supply duct static pressure setpoint.

   c. Send an alarm when the supply duct static pressure drops below 0.4 in w.c.

D. Supply Air Temperature Control

1. Control loop is enabled when the supply air fan is proven on, and disabled when supply fan is off.

2. Supply Air Temperature Setpoint

   a. Heat/Cool Mode:

      The BAS shall total the incoming heating and cooling request from the VVT terminals to determine the effective mode.

      1) The unit shall be in heating mode if the number of heating requests are greater than the cooling requests.

      2) The unit shall be in cooling mode if the number of cooling requests are greater than the heating request.

   b. Supply Air Temperature Control:

1) The BAS shall optimized the supply air temperature. Cooling set point based on incoming cooling request. Supply air temperature set point shall be initially set at the minimum supply air temperature and shall be reset based on the incoming cooling request. A cool request is generated by the zone that has a cooling demand greater than 90% (adjustable).

2) The BAS shall optimize the supply air temperature heating set point based on incoming heating request. Supply air temperature heating set point shall be initially set at the maximum heating supply air temperature, and shall be reset based on incoming heat request. A heat request will be generated by the zone with a heating demand greater than 90% (adjustable).

3) Cooling Mode

    a) Direct expansion cooling shall be enabled when outside air temperature is above 60°F (adjustable).

    b) Once enabled, the BAS shall sequence the economizer damper and the first and second Dx cooling to maintain the supply air temperature set point. Allow 2 minutes (adjustable) compressor “on” time and 2 minutes (adjustable) compressor “off” time to prevent the short cycling of the compressor.

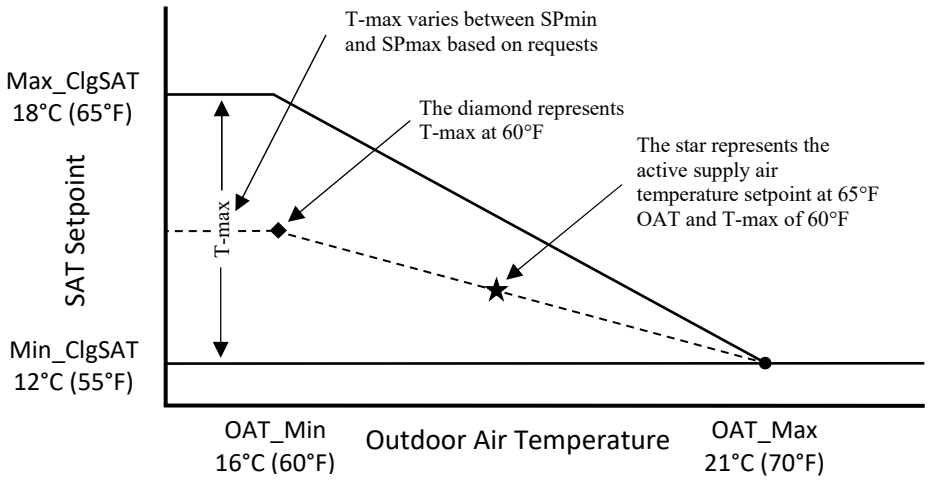
    c) When the outside air temperature is 3 deg F (adjustable) higher than the return air temperature, the economizer damper shall go the minimum outside air position. See also CO2 DCV.

4) Heating Mode

    a) Gas fired heating shall be enabled when outside air temperature is below 65°F (adjustable).

    b) Once enabled, the BAS shall sequence the economizer damper and the two stages of heating to maintain the supply air temperature set point.

    c) When the outside air temperature is 5 deg F (adjustable) below the return air temperature, the economizer damper shall go to its minimum outside air position. See also CO2 DCV.



Informative Figure 5.16.2.2 Example supply air temperature reset diagram.

E. Minimum Outdoor Air Control

1. Outdoor Airflow Setpoint for California Title 24 Ventilation

a. See Section 1.1A.1 for calculation of current setpoints AbsMinOA* and DesMinOA*.

b. See zone CO2 control logic under terminal unit sequences.

c. The minimum outdoor air setpoint MinOAsp shall be reset based on the highest zone CO2 control-loop signal from AbsMinOA* at 50% signal to DesMinOA* at 100% signal.

d. The maximum/minimum outside air position shall be determined by the balancer.

e. Minimum Outdoor Air Control Loop

1) Minimum outdoor air control loop is enabled when the AC unit is in Occupied Mode and disabled and output set to zero otherwise.

F. Relief (Power Exhaust) Fan

1. Building pressure sensor shall be field installed in location indicated on Drawings.

2. Relief fans shall be controlled by AC unit internal controls to maintain building pressure at setpoint (0.05” adjustable).

G. Alarms:

1. Maintenance interval alarm when fan has operated for more than 1500 hours: Level 4. Reset interval count when alarm is acknowledged.

2. Fan alarm is indicated by the status being different from the command for a period of 15 seconds.

a. Commanded on, status off: Level 2

b. Commanded off, status on: Level 4

3. Filter pressure drop exceeds the larger of the alarm limit or 12.5 Pa (0.05") for 10 minutes when airflow (expressed as a percentage of design airflow or design speed if total airflow is not known) exceeds 20%: Level 4. The alarm limit shall vary with total airflow (if available; use fan speed if total airflow is not known) as follows:

$$DP_x = DP_{100}(x)^{1.4}$$

where DP100 is the high-limit pressure drop at design airflow (determine limit from filter manufacturer) and DPx is the high limit at the current airflow rate x (expressed as a fraction). For instance, the setpoint at 50% of design airflow would be (0.5)1.4, or 38% of the design high-limit pressure drop. See Section 1.1A.1 for DP100.

4. High building pressure (more than 25 Pa [0.10 in. of water]) for 5 minutes: Level 3.

5. Low building pressure (less than 0 Pa [0.0 in. of water], i.e., negative) for 5 minutes: Level 4.

6. AC unit failure alarm: Level 2

7. Cooling compressors operate when the outdoor air is below 55°F. Level 4.

3.10 MISCELLANEOUS ALARMS

A. Fire alarm (via contact from Division 26 fire alarm system): Level 1

B. Fire alarm trouble (via contact from Division 26 fire alarm system): Level 2

C. Equipment alarm (for equipment with alarm contacts such as VFDs, AC units): Level 2

D. Panel or LAN failure: Level 2

E. Loss of communication with any device via Gateway (e.g. VFD) for more than 30 seconds: Level 2 (alarm shall indicate which specific device is not responding).

END OF SECTION 259000