



**Addendum j to  
ASHRAE Guideline 36-2021**

**Public Review Draft**

**Proposed Addendum j to Guideline  
36-2021, High-Performance  
Sequences of Operation for HVAC  
Systems**

**First Public Review (November 2023)  
(Draft shows Proposed Changes to Current Guideline)**

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**(This foreword is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)**

## FOREWORD

*Note: In this addendum, changes to the current guideline are indicated in the text by underlining (for additions) and strikethrough (for deletions) unless the instructions specifically mention some other means of indicating the changes. Only these changes are open for review and comment at this time. Additional material is provided for context only and is not open for comment except as it relates to the proposed substantive changes.*

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The purpose of this addendum is to separate the ventilation logic for the Single Zone VAV Air Handling Units (SZVAV AHU) and VAV terminal units in the generic ventilation zones section. As currently written, variables such as  $V_{min}$ , unrelated to SZVAV AHU ventilation logic, remain in the generic ventilation sections whether or not they are used.

### **Addendum j to Guideline 36-2021**

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*(IP and SI Units)*

Revise Section 5.2.1 as follows:

5.2.1. Zone Minimum Outdoor Air and Minimum Airflow Setpoints

5.2.1.1. 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.

5.2.1.2. For VAV Terminal units, see Section 3.1.2 for zone minimum airflow setpoint  $V_{min}$ .

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**The engineer must select between ventilation logic options:**

**If the project is to comply with ASHRAE Standard 62.1 ventilation requirements, use Section 5.2.1.3 and delete Section 5.2.1.4.**

**If the project is to comply with California Title 24 ventilation requirements, use Section 5.2.1.4 and delete Section 5.2.1.3.**

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5.2.1.3. For compliance with the Ventilation Rate Procedure of ASHRAE Standard 62.1-2016, outdoor air and zone minimum setpoints shall be calculated as follows:

- a. See Section 3.1.1.2 for zone ventilation setpoints.
- b. VAV Terminal Units
  1. Determine zone air distribution effectiveness  $E_z$ .
    - i. If the DAT at the terminal unit is less than or equal to zone space temperature,  $E_z$  shall be equal to  $E_{zC}$  (default to 1.0 if no value is scheduled).
    - ii. If the DAT at the terminal unit is greater than zone space temperature,  $E_z$  shall be equal to  $E_{zH}$  (default to 0.8 if no value is scheduled).
  2.  $V_{bz-P^*}$  is the population component of the required breathing zone outdoor airflow. The normal value of  $V_{bz-P^*}$  shall be  $V_{bz-P}$ .  $V_{bz-A^*}$  is the area component of the required breathing zone outdoor airflow. The normal value of  $V_{bz-A^*}$  shall be  $V_{bz-A}$ .
  3.  $V_{min}$ 
    - i. Shall be equal to  $V_{oz}$  as calculated in Section 5.2.1.3.b.5 below if  $V_{min}$  in Section 3.1.2 is "AUTO" and the associated air handler has been supplying 100% outdoor air (outdoor air damper fully open; return air damper fully closed) for 10 minutes;
    - ii. Else shall be equal to  $1.5 * V_{oz}$  as calculated in Section 5.2.1.3.b.5 below if  $V_{min}$  in Section 3.1.2 is "AUTO" and the associated air handler is not supplying 100% outdoor air;
    - iii. Else shall be equal  $V_{min}$  as entered in Section 3.1.2.

4. The occupied minimum airflow  $V_{min}^*$  shall be equal to  $V_{min}$  except as noted in Section 5.2.1.3.b.5.
5. The required zone outdoor airflow  $V_{oz}$  shall be calculated as  $V_{oz} = (V_{bz-A^*} + V_{bz-P^*})/E_z$ , where the normal values of  $V_{bz-A^*}$  and  $V_{bz-P^*}$  are modified if any of the following conditions are met, in order from higher to lower priority:
  - i. If the zone is in any mode other than Occupied Mode, and for zones that have window switches and the window is open:  $V_{bz-P^*} = 0$ ,  $V_{bz-A^*} = 0$ , and  $V_{min}^* = 0$ .
  - ii. If the zone has an occupancy sensor, is unpopulated, and occupied-standby mode is permitted:  $V_{bz-P^*} = 0$ ,  $V_{bz-A^*} = 0$ , and  $V_{min}^* = 0$ .
  - iii. Else, if the zone has an occupancy sensor, is unpopulated, but occupied-standby mode is not permitted:  $V_{bz-P^*} = 0$  and  $V_{min}^* = V_{min}$ .

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*Occupied-standby mode applies to individual zones, is considered a zonal subset of Occupied Mode, and is not considered a zone-group operating mode.*

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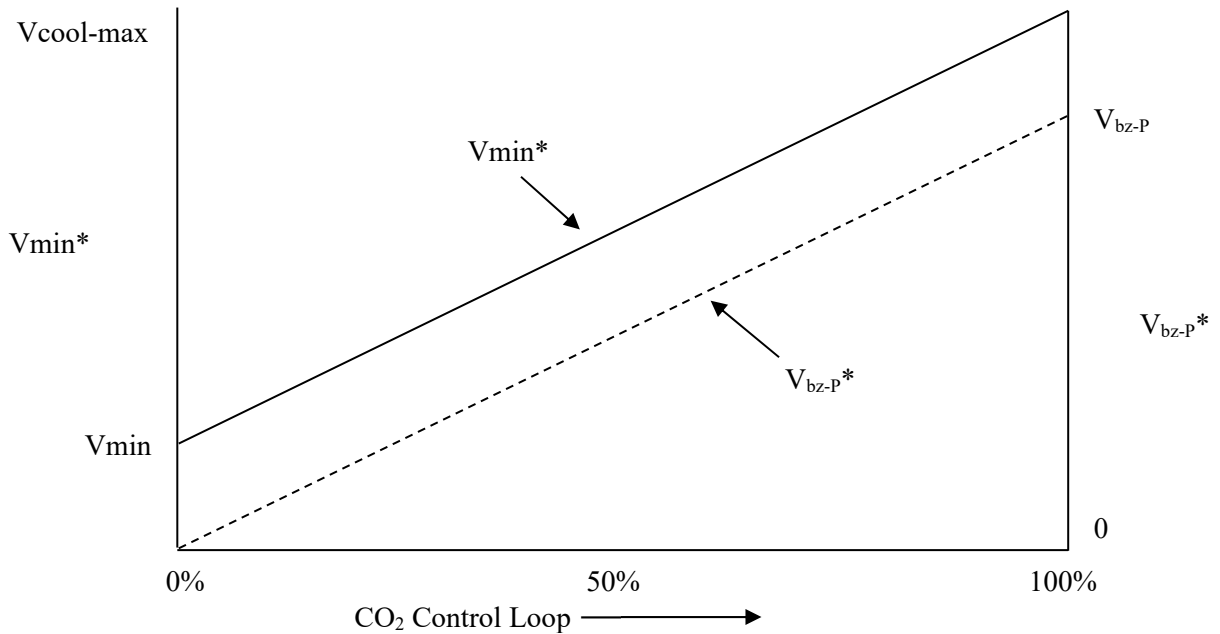
- iv. If the zone has a CO<sub>2</sub> sensor:
  - (a) See Section ~~3.1.1.33-1.1.2.b.3~~ for CO<sub>2</sub> setpoints.
  - (b) During Occupied Mode, a P-only loop shall maintain CO<sub>2</sub> concentration at setpoint; reset from 0% at setpoint minus 200 PPM and to 100% at setpoint.
  - (c) Loop is disabled and output set to zero when the zone is not in Occupied Mode.

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*CO<sub>2</sub> DCV is not yet well defined for Standard 62.1. RP-1747 is under way and should provide a detailed procedure. In the meantime, sequences have been included at the zone level, matching California's DCV approach as a first step. Because outdoor air rates at the AHU level dynamically calculate outdoor air rates using the Standard 62.1 multiple-spaces procedure, compliance with the standard is assured. Doing no DCV at all is not an option, because it is required by Standard 90.1-2016.*

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- (d) For cooling-only VAV terminal units, reheat VAV terminal units, constant-volume series fan-powered terminal units, dual-duct VAV terminal units with mixing control and inlet airflow sensors, dual-duct VAV terminal units with mixing control and a discharge airflow sensor, or dual-duct VAV terminal units with cold-duct minimum control:
  - (1) The CO<sub>2</sub> control loop output shall reset both the occupied minimum airflow setpoint ( $V_{min}^*$ ) and the population component of the required breathing zone outdoor airflow ( $V_{bz-P^*}$ ) in parallel.  $V_{min}^*$  shall be reset from the zone minimum airflow setpoint  $V_{min}$  at 0% loop output up to maximum cooling airflow setpoint  $V_{cool-max}$  at 100% loop output.  $V_{bz-P^*}$  shall be reset from 0 L/s (0 cfm) at 0% loop output up to the  $V_{bz-P}$  at 100% loop output. See Figure 5.2.1.3-1.



**Figure 5.2.1.3-1 Vmin\* and Vbz-P\* reset with CO2 loop.**

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*The CO<sub>2</sub> control loop graph in Figure 5.2.1.3-1 is provided as a visual representation of the reset logic and is not representative of magnitude of Vbz-P\* in relation to Vbz-A or Vmin\*.*

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(e) For parallel fan-powered terminal units:

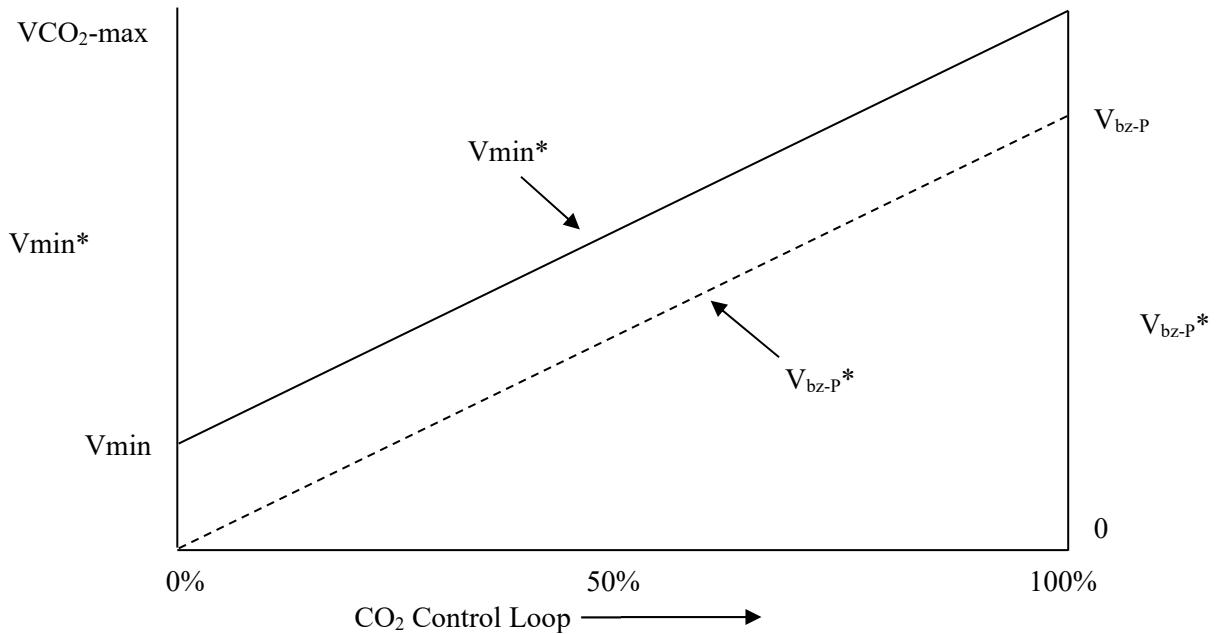
- (1) Determine VCO<sub>2</sub>-max as follows:
- (2) When the Zone State is cooling, VCO<sub>2</sub>-max is equal to the maximum cooling airflow setpoint Vcool-max.
- (3) When the Zone State is heating or deadband, VCO<sub>2</sub>-max is equal to Vcool-max minus the parallel fan airflow

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*This logic prevents the total supply airflow from exceeding Vcool-max, which could create diffuser noise problems.*

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- (4) The CO<sub>2</sub> control loop output shall reset both the occupied minimum airflow setpoint Vmin\* and the population component of the required breathing zone outdoor airflow Vbz-P\* in parallel. Vmin\* shall be reset from the zone minimum airflow setpoint Vmin at 0% loop output up to maximum cooling airflow setpoint VCO<sub>2</sub>-max at 100% loop output. Vbz-P\* shall be reset from 0 L/s (0 cfm) at 0% loop output up to the Vbz-P at 100% loop output. See Figure 5.2.1.3-2.



**Figure 5.2.1.3-2  $V_{min}^*$  and  $V_{bz-P}^*$  reset with CO<sub>2</sub> loop (parallel fan-powered).**

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*The CO<sub>2</sub> control loop graph in Figure 5.1.2.1.3-2 is provided as a visual representation of the reset logic and is not representative of magnitude of  $V_{bz-P}^*$  in relation to  $V_{bz-A}$  or  $V_{min}^*$ .*

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c. Single-Zone VAV Air-Handlers

1. Determine zone air distribution effectiveness  $E_z$ .
  - i. If the SAT at the air handling unit is less than or equal to zone space temperature,  $E_z$  shall be equal to  $E_zC$  (default to 1.0 if no value is scheduled).
  - ii. If the SAT at the air handling unit is greater than zone space temperature,  $E_z$  shall be equal to  $E_zH$  (default to 0.8 if no value is scheduled).
2.  $V_{bz-P}^*$  is the population component of the required breathing zone outdoor airflow. The normal value of  $V_{bz-P}^*$  shall be  $V_{bz-P}$ .  $V_{bz-A}^*$  is the area component of the required breathing zone outdoor airflow. The normal value of  $V_{bz-A}^*$  shall be  $V_{bz-A}$ .
3. The minimum outdoor air setpoint  $MinOAsp$  shall be equal to  $V_{oz}$ .
4. The required zone outdoor airflow  $V_{oz}$  shall be calculated as  $V_{oz} = (V_{bz-A}^* + V_{bz-P}^*)/E_z$ , where the normal values of  $V_{bz-A}^*$  and  $V_{bz-P}^*$  are modified if any of the following conditions are met, in order from higher to lower priority:
  - i. If the zone is in any mode other than Occupied Mode, and for zones that have window switches and the window is open:  $V_{bz-P}^* = 0$  and  $V_{bz-A}^* = 0$ .
  - ii. If the zone has an occupancy sensor, is unpopulated, and occupied-standby mode is permitted per Section 3.1.1.2.a.5:  $V_{bz-P}^* = 0$  and  $V_{bz-A}^* = 0$ .
  - iii. Else, if the zone has an occupancy sensor, is unpopulated, but occupied-standby mode is not permitted per Section 3.1.1.2.a.5:  $V_{bz-P}^* = 0$ .

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Occupied-standby mode applies to individual zones, is considered a zonal subset of Occupied Mode, and is not considered a zone-group operating mode.

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- iv. If the zone has a CO<sub>2</sub> sensor:
- (a) See Section 3.1.1.3 for CO<sub>2</sub> setpoints.
  - (b) During Occupied Mode, a P-only loop shall maintain CO<sub>2</sub> 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.

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CO<sub>2</sub> DCV is not yet well defined for Standard 62.1. RP-1747 is under way and should provide a detailed procedure. In the meantime, sequences have been included at the zone level, matching California's DCV approach as a first step. Because outdoor air rates at the AHU level dynamically calculate outdoor air rates using the Standard 62.1 multiple-spaces procedure, compliance with the standard is assured. Doing no DCV at all is not an option because it is required by Standard 90.1-2016.

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v. For SZVAV AHUs:

- (a) The minimum outdoor air setpoint MinOAsp is equal to V<sub>oz</sub>. The CO<sub>2</sub> control loop output shall reset the population component of the required breathing zone outdoor airflow V<sub>bz-P\*</sub> from 0 L/s (0 cfm) at 0% loop output up to V<sub>bz-P</sub> at 100% loop output. See Figure 5.2.1.3-3.

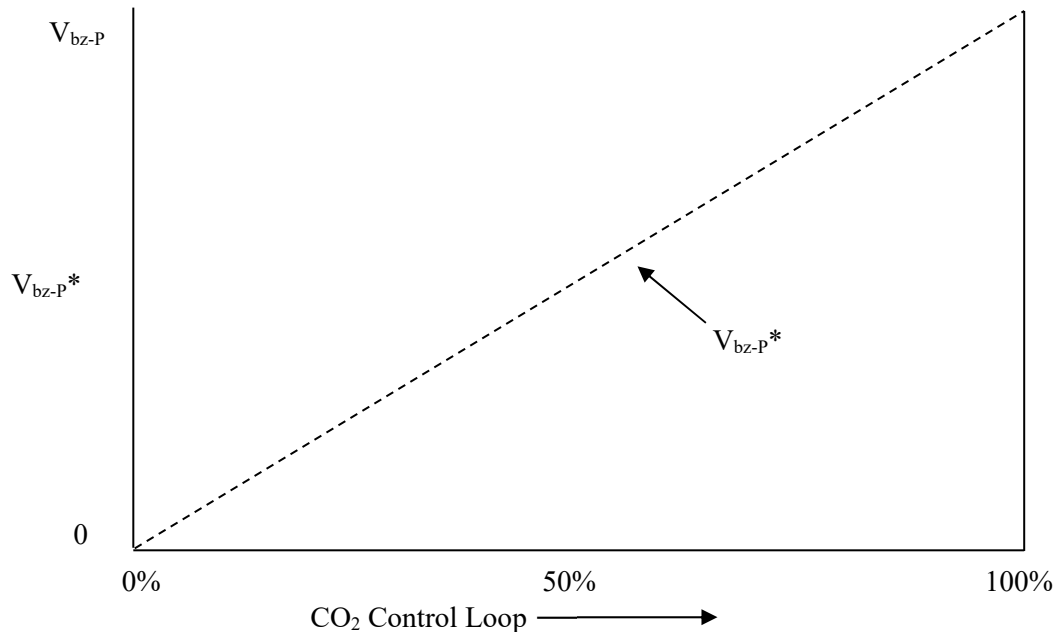


Figure 5.2.1.3-3 V<sub>bz-P\*</sub> reset with CO<sub>2</sub> loop (SZVAV).

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**The engineer must select between ventilation logic options:**

**If the project is to comply with ASHRAE Standard 62.1 ventilation requirements, use Section 5.2.1.3 and delete Section 5.2.1.4.**

**If the project is to comply with California Title 24 ventilation requirements, use Section 5.2.1.4 and delete Section 5.2.1.3.**

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

- a. See Section 3.1.1.2 for zone ventilation setpoints.
- b. VAV Terminal Units
  1. Determine the zone minimum outdoor air setpoints Zone-Abs-OA-min and Zone-Des-OA-min.

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*Zone-Abs-OA-min is used in terminal-unit sequences and air-handler sequences. Zone-Des-OA-min is used in air-handler sequences only.*

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- i. 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 3.1.1.2.b.3.

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*The term “populated” is used instead of “occupied” to mean that a zone occupancy sensor senses the presence of people, because the term “occupied” is used elsewhere to mean “scheduled to be occupied.”*

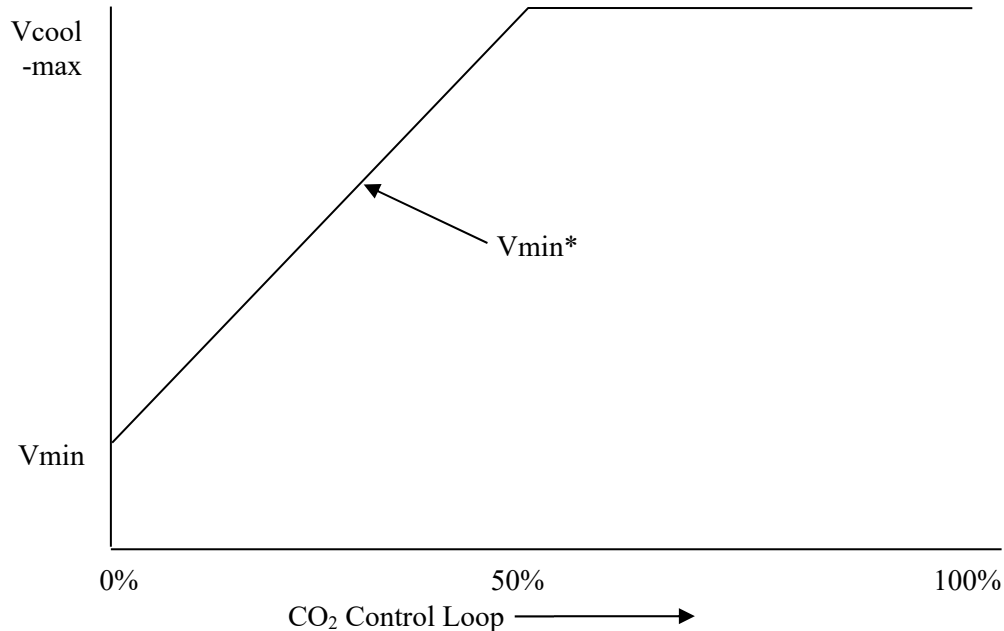
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- (c) Varea-min if the zone has a CO<sub>2</sub> sensor.
  - (d) Zone-Des-OA-min otherwise.
- ii. Zone-Des-OA-min is equal to the following, in order from highest to lowest priority:
    - (a) Zero if the zone has a window switch and the window is open.
    - (b) Zero if the zone has an occupancy sensor, is unpopulated, and is permitted to be in occupied-standby mode per Section 3.1.1.2.b.3.
    - (c) The larger of Varea-min and Vocc-min otherwise.
2. Vmin
    - i. Shall be equal to Zone-Abs-OA-min if Vmin in Section 3.1.2 is “AUTO”;
    - ii. Else shall be equal to Vmin as entered in Section 3.1.2.
  3. The occupied minimum airflow Vmin\* shall be equal to Vmin except as noted below, in order from highest to lowest priority:
    - i. If the zone has an occupancy sensor and is permitted to be in occupied-standby mode per Section 3.1.1.2.b.3, Vmin\* shall be equal to zero when the room is unpopulated.
    - ii. If the zone has a window switch, Vmin\* shall be zero when the window is open.
    - iii. If the zone has a CO<sub>2</sub> sensor:
      - (a) See Section ~~3.1.1.3~~~~3.1.1.2.b.3~~ for CO<sub>2</sub> setpoints.
      - (b) During Occupied Mode, a P-only loop shall maintain CO<sub>2</sub> 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 cooling-only VAV terminal units, reheat VAV terminal units, constant-volume series fan-powered terminal units, dual-duct VAV terminal units with mixing control and inlet airflow sensors, dual-duct VAV terminal units with mixing control and a



discharge airflow sensor, or dual-duct VAV terminal units with cold-duct minimum control:

- (1) The CO<sub>2</sub> control loop output shall reset the occupied minimum airflow setpoint  $V_{min}^*$  from the zone minimum airflow setpoint  $V_{min}$  at 0% up to maximum cooling airflow setpoint  $V_{cool-max}$  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  $V_{min}^*$  reset with CO<sub>2</sub> loop.**

(e) For parallel fan-powered terminal units:

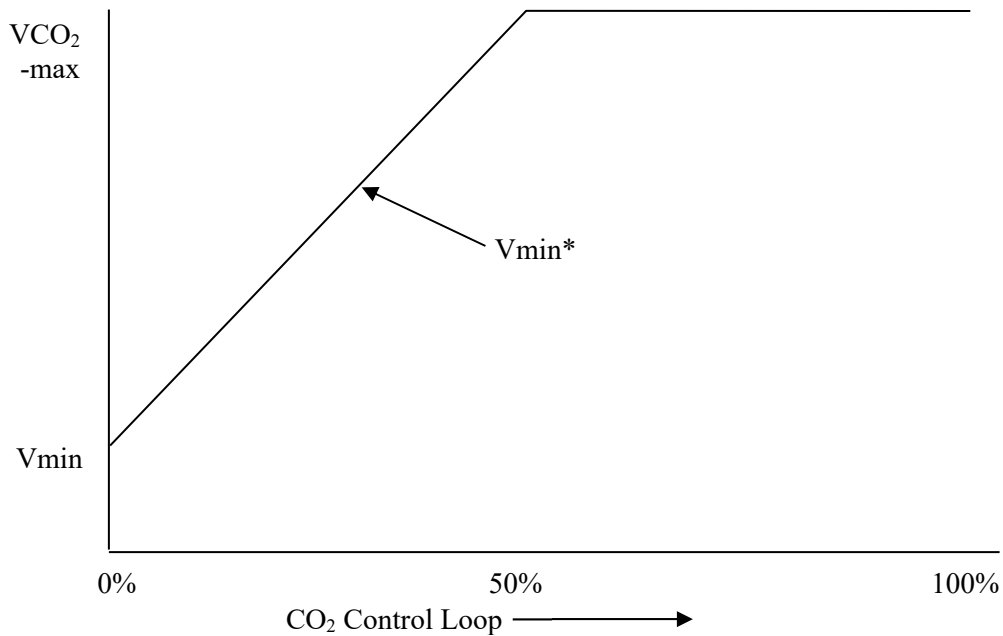
- (1) Determine  $V_{CO2-max}$  as follows:
- (2) When the Zone State is cooling,  $V_{CO2-max}$  is equal to the maximum cooling airflow setpoint  $V_{cool-max}$ .
- (3) When the Zone State is heating or deadband,  $V_{CO2-max}$  is equal to  $V_{cool-max}$  minus the parallel fan airflow

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*This logic prevents the total supply airflow from exceeding  $V_{cool-max}$ , which could create diffuser noise problems.*

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- (4) The CO<sub>2</sub> control loop output shall reset the occupied minimum airflow setpoint  $V_{min}^*$  from the zone minimum airflow setpoint  $V_{min}$  at 0% up to maximum cooling airflow setpoint  $V_{CO2-max}$  at 50%, as shown in Figure 5.2.1.4-2. The loop output from 50% to 100% will be used at the system level to reset outdoor air minimum; see AHU controls.



**Figure 5.2.1.4-2 Vmin\* reset with CO<sub>2</sub> loop (parallel fan-powered).**

- c. For SZVAV AHUs: Single-Zone VAV Air-Handlers
1. Determine the zone minimum outdoor airflow setpoint, MinOAsp.
    - i. MinOAsp shall be reset based on the following conditions in order from highest to lowest priority:
      - (a) Zero if the zone is in any mode other than Occupied Mode.
      - (b) Zero for zones that have window switches and the window is open.
      - (c) Zero if the zone has an occupancy sensor, is unpopulated, and is permitted to be in occupied-standby mode per Section 3.1.1.2.b.3.

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*The term “populated” is used instead of “occupied” to mean that a zone occupancy sensor senses the presence of people, because the term “occupied” is used elsewhere to mean “scheduled to be occupied.”*

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- (d) If the zone has a CO<sub>2</sub> sensor:
  - (1) See Section 3.1.1.3 for CO<sub>2</sub> setpoints.
  - (2) During Occupied Mode, a P-only loop shall maintain CO<sub>2</sub> concentration at setpoint; reset from 0% at setpoint minus 200 PPM and to 100% at setpoint.
  - (3) Loop is disabled and output set to zero when the zone is not in Occupied Mode.
  - (4) The minimum outdoor air setpoint MinOAsp shall be reset based on the zone CO<sub>2</sub> control-loop signal from MinOA at 0% signal to DesOA at 100% signal. See Figure 5.2.1.4-3.
- (e) DesOA otherwise.

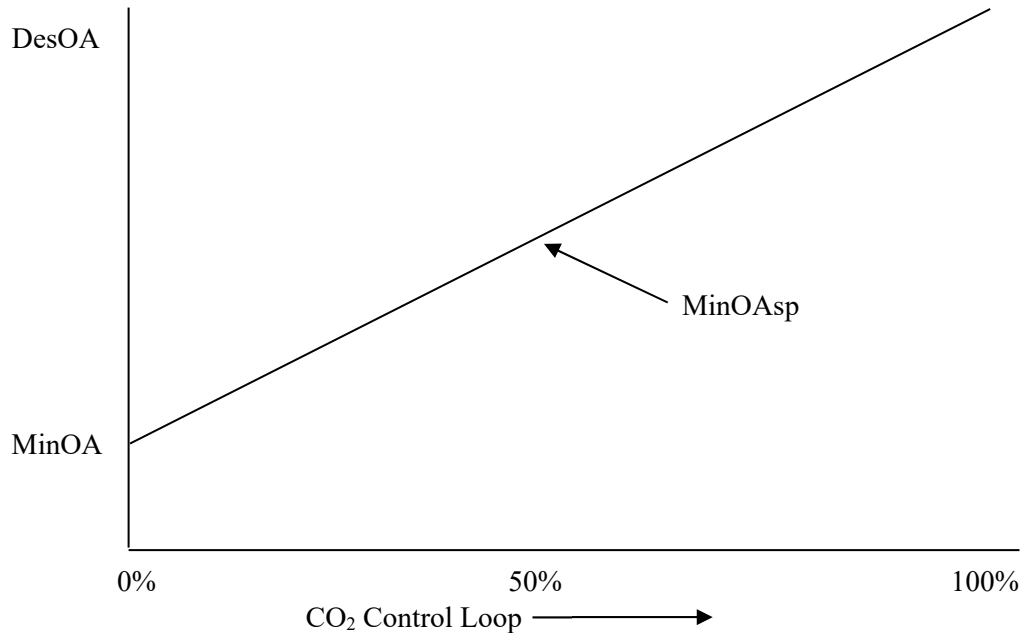


Figure 5.2.1.4-3  ~~$v_{min} = \text{MinOAsp}$~~  reset with CO2 loop (SZVAV).