GUIDELINE

ASHRAE Guideline 36-2018

High-Performance Sequences of Operation for HVAC Systems

Approved by ASHRAE on June 4, 2018.

 ISSN 1049-894X

SPECIAL NOTE

This Guideline was developed under the auspices of ASHRAE. ASHRAE Guidelines are developed under a review process, identifying a Guideline for the design, testing, application, or evaluation of a specific product, concept, or practice. As a Guideline it is not definitive but encompasses areas where there may be a variety of approaches, none of which must be precisely correct. ASHRAE Guidelines are written to assist professionals in the area of concern and expertise of ASHRAE's Technical Committees and Task Groups.

ASHRAE Guidelines are prepared by Project Committees appointed specifically for the purpose of writing Guidelines. The Project Committee Chair and Vice-Chair must be members of ASHRAE; while other committee members may or may not be ASHRAE members, all must be technically qualified in the subject area of the Guideline.

Development of ASHRAE Guidelines follows procedures similar to those for ASHRAE Standards except that (a) committee balance is desired but not required, (b) an effort is made to achieve consensus but consensus is not required, (c) Guidelines are not appealable, and (d) Guidelines are not submitted to ANSI for approval.

The Senior Manager of Standards of ASHRAE should be contacted for

a. interpretation of the contents of this Guideline,
b. participation in the next review of the Guideline,
c. offering constructive criticism for improving the Guideline, or
d. permission to reprint portions of the Guideline.

CONTENTS

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NOTE

Approved addenda, errata, or interpretations for this guideline can be downloaded free of charge from the ASHRAE website at www.ashrae.org/technology.

(This foreword is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline. It has not been processed according to the ANSI requirements for a guideline and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

FOREWORD

This guideline establishes a set of standardized advanced sequences of operation for common HVAC systems. Standardized advanced control sequences provide the following benefits:

- *Reduced engineering time. Rather than develop sequences themselves, design engineers can adapt existing standard sequences that have been proven to perform.*
- *Reduced programming and commissioning time for contractors.*
- *Reduced energy consumption by making systems less dependent on proper implementation and commissioning of control sequences.*
- *Reduced energy consumption by ensuring that proven, cost-effective strategies, including those required by ASHRAE standards and building codes, are fully implemented.*
- *Improved indoor air quality by ensuring control sequences are in compliance with IAQ standards and codes such as ASHRAE Standard 62.1.*
- *Reduced energy consumption and reduced system downtime by including diagnostic software to detect and diagnose system faults and make operators aware of them before they cause performance problems.*
- *A common set of terms to facilitate communication between specifiers, contractors, and operators.*

The intended audience for the guideline includes HVAC designers, control contractors, commissioning agents, and building owners, operators, and maintenance technicians.

This initial version of the guideline is limited to variable-air-volume (VAV) systems, but it is expected that sequences for other HVAC systems will be added over time. It is also expected that the sequences herein will be adjusted, augmented, and possibly replaced over time, based on feedback from users.

This document falls under ASHRAE's continuous maintenance process. For more information, visit ASHRAE's website, or refer to the forms at the end of the guideline.

Note on Format

This guideline includes two kinds of informative notes:

Notes in bold between thick lines provide direction to the editor of these sequences so that they are properly implemented (e.g., identifying mutually exclusive options).

Notes in italics between thin lines provide guidance or additional information about specific sequences.

These notes are not a part of this guideline. They are merely informative and do not contain requirements necessary for conformance to the guideline.

1. PURPOSE

The purpose of this guideline is to provide uniform sequences of operation for heating, ventilating, and air-conditioning (HVAC) systems that are intended to maximize HVAC system energy efficiency and performance, provide control stability, and allow for real-time fault detection and diagnostics.

2. SCOPE

2.1 This guideline provides detailed sequences of operation for HVAC systems.

2.2 This guideline describes functional tests that, when performed, will confirm implementation of the sequences of operation.

3. SET POINTS, DESIGN, AND FIELD DETERMINED

3.1 Information Provided by Designer

The design set points listed in this section must be scheduled in design documents for each zone and air handler by the design engineer.

3.1.1 General Zone Information

3.1.1.1 Zone Temperature Set Points

Zone temperature initial set points can be specified by the designer in a number of ways. The most flexible way is to include them for each zone in variable-air-volume (VAV) box and single-zone VAV (SZVAV) air-handling unit (AHU) equipment schedules. They can also be generically listed by zone type, such as the example in (a) below.

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

3.1.1.2 Outdoor Air Ventilation Set Points

Ventilation set points can be specified by the designer in a number of ways. The most flexible is to include them for each zone in VAV box and single-zone (SZ) equipment schedules.

The engineer must select between ventilation logic options:

- **If the project is to comply with ASHRAE Standard 62.1 ventilation requirements, keep subsection (a) and delete subsection (b).**
- **If the project is to comply with California Title 24 ventilation requirements, keep subsection (b) and delete subsection (a).**

a. For projects complying with the Ventilation Rate Procedure of ASHRAE Standard 62.1-2016:

Table 3.1.1.1 Default Set Points

	Occupied		Unoccupied	
Zone Type	**Heating**	**Cooling**	**Heating**	**Cooling**
VAV	21°C (70°F)	24°C (75°F)	16°C (60°F)	32°C (90°F)
Mechanical/electrical rooms	18°C (65°F)	29°C (85°F)	18°C (65°F)	29°C (85°F)
Networking/computer	18°C (65°F)	24°C (75°F)	18°C (65°F)	24°C (75°F)

1. The area component of the breathing zone outdoor airflow Vbz-A

*This is the zone floor area times the outdoor airflow rate per unit area, as given in Standard 62.1-2016, Table 6.2.2.1; i.e., Vbz-A = Az*Ra.*

2. The population component of the breathing zone outdoor airflow Vbz-P

*This is the zone design population (without diversity) times the outdoor airflow rate per occupant, as given in Standard 62.1-2016, Table 6.2.2.1; i.e.; Vbz-P = Pz*Rp.*

3. Zone air distribution effectiveness EzH in heating
4. Zone air distribution effectiveness EzC in cooling

Zone air distribution effectiveness depends on the relative locations of supply and return in the space, per ASHRAE Standard 62.1-2016, Table 6.2.2.2.

5. Indicate where occupied-standby mode is allowed, based on the zone occupancy category per Standard 62.1-2016, Table 6.2.2.1.

Occupied-standby mode applies to individual zones, is considered a zonal subset of occupied mode and is not considered a zone-group operating mode. See Section 5.4.6 for zone-group operating modes.

b. For projects complying with California Title 24 ventilation standards:
   1. ***Vocc-min.*** Zone minimum outdoor airflow for occupants, per California Title 24 prescribed airflow-per-occupant requirements.
   2. ***Varea-min.*** Zone minimum outdoor airflow for building area, per California Title 24 prescribed airflow-per-area requirements.

3.1.1.3 CO_2 Set Points

Space CO_2 set points are used for demand-controlled ventilation (DCV) and monitoring/alarming as required by LEED and other green building standards.

It is the designer's responsibility to determine CO_2 set points. The maximum set point varies by ventilation standard. Some guidance is provided below for Standard 62.1 and Title 24. The designer may also decide to set lower, more conservative set points for improved indoor air quality but at the expense of higher energy use.

Standard 62.1 CO_2 Set Point Guidance†

Recommended maximum CO_2 is 90% of the steady state concentration:

$$CO_2 setpoint = 0.9\left[C_{OA} + \frac{8400 Ezm}{Rp + (RaAz/Pz)}\right]$$

where C_{OA} is the outdoor air CO_2 concentration in ppm, E_z is the zone ventilation effectiveness, m is the metabolic rate of occupants, R_p is the people-based component of the ventilation rate, Ra is the area-based component of the ventilation rate, A_z is the zone floor area, and P_z is the number of occupants.

The CO_2 set points in Informative Table 3.1.1.3 assume an ambient concentration of 400 ppm in lieu of using an ambient CO_2 sensor. These sequences are based on not having an ambient sensor. This will be conservative in areas with high ambient CO_2 concentrations; few areas have lower concentrations.

Set points vary by occupancy type, so the easiest way to include this info is by including a column in VAV box and SZ unit schedules and entering the set point individually for each zone.

Demand controlled ventilation (DCV) is an active area of research under ASHRAE RP-1747, "Implementation of RP-1547 CO_2-Based Demand Controlled Ventilation for Multiple Zone HVAC Systems in Direct Digital Control Systems."

California Title 24 CO_2 Set Point Guidance

Title 24 stipulates the set point for all occupancies must be 600 ppm above ambient. Ambient concentration may be assumed to be 400 ppm, or an ambient sensor may be provided. These sequences are currently based on not having an ambient sensor, so the CO_2 set point for all occupancy types is 1000 ppm.

3.1.2 VAV Box Design Information

For the terminal unit sequences, the engineer must provide the set point information in the following subsections, typically on VAV box schedules on drawings.

3.1.2.1 VAV Cooling-Only Terminal Unit

a. Zone maximum cooling airflow set point (Vcool-max)
b. Zone minimum airflow set point (Vmin)

† **Source:** Lawrence, T. 2008. Selecting CO_2 criteria for outdoor air monitoring. *ASHRAE Journal* 50(12).

Informative Table 3.1.1.3 Default CO_2 Set Points per ASHRAE Standard 62.1

Occupancy Category	CO_2 Set Point, ppm	Occupancy Category	CO_2 Set Point, ppm
Correctional Facilities		**Office Buildings**	
Cell	965	Office space	894
Dayroom	1656	Reception areas	1656
Guard stations	1200	Telephone/data entry	1872
Booking/waiting	1200	Main entry/lobbies	1391
Educational Facilities		**Miscellaneous Spaces**	
Day care (through age 4)	1027	Bank vaults/safe deposit	805
Day care sickroom	716	Computer (not printing)	738
Classrooms (ages 5 to 8)	864	Pharmacy (preparation area)	820
Classrooms (ages 9+)	942	Photo studios	983
Lecture classroom	1305	Transportation waiting	1305
Lecture hall (fixed seats)	1305	**Public Assembly Spaces**	
Art classroom	837	Auditorium seating area	1872
Science laboratories	894	Place of religious worship	1872
University/college lab	894	Courtrooms	1872
Wood/metal shop	1156	Legislative chambers	1872
Computer lab	965	Libraries	805
Media center	965	Lobbies	2628
Music/theater/dance	1620	Museums (children’s)	1391
Multiuse assembly	1778	Museum/galleries	1620
Food and Beverage Service		**Retail**	
Restaurant dining rooms	1418	Sales (except below)	1069
Cafeteria/fast-food dining	1536	Mall common areas	1620
Bars, cocktail lounges	1536	Barbershop	1267
General		Beauty and nail salons	723
Break rooms	1267	Pet shops (animal areas)	709
Coffee stations	1185	Supermarket	1116
Conference/meeting	1620	Coin-operated laundries	1322
Hotels, Motels, Resorts, Dormitories		**Sports and Entertainment**	
Bedroom/living area	910	Spectator areas	1778
Barracks sleeping areas	1116	Disco/dance floors	1440
Laundry rooms, central	1249	Health clubs/aerobics room	1735
Laundry within dwelling	983	Health clubs/weight room	1232
Lobbies/prefunction	1494	Bowling alley (seating)	1232
Multipurpose assembly	2250	Gambling casinos	1368
		Game arcades	894
		Stages, studios	1391

For ASHRAE Standard 62.1 ventilation, select Vmin to prevent creating critical zones. Critical zones are zones with the highest zone primary outdoor air fraction Zpz, which results in lower system ventilation efficiency Ev and higher effective minimum outdoor air set point MinOAsp. For calculation of MinOAsp for Standard 62.1 ventilation, see Section 5.16.3.1. This will lead to Vmin being higher than code minimum ventilation for all zones that require outdoor air. For California Title 24 ventilation, Vmin should be selected as the larger of Varea-min and Vocc-min, except for zones that have CO_2 DCV, for which Vmin should be equal to Varea-min. When selecting Vmin, do not consider the limitations of the VAV box controller to measure and control airflow; that is addressed by the control sequences themselves (see Section 5.1.16).

3.1.2.2 VAV Reheat Terminal Unit

a. Zone maximum cooling airflow set point (Vcool-max)
b. Zone minimum airflow set point (Vmin)

For ASHRAE Standard 62.1 ventilation, select Vmin to prevent creating critical zones. Critical zones are zones with the highest zone primary outdoor air fraction Zpz, which results in lower system ventilation efficiency Ev and higher effective minimum outdoor air set point MinOAsp. For calculation of MinOAsp for Standard 62.1 ventilation, see Section 5.16.3.1. This will lead to Vmin being higher than code minimum ventilation for all zones that require outdoor air. For California Title 24 ventilation, Vmin should be selected as the larger of Varea-min and Vocc-min, except for zones that have CO_2 DCV, for which Vmin should be equal to Varea-min. When selecting Vmin, do not consider the limitations of the VAV box controller to measure and control airflow; that is addressed by the control sequences themselves (see Section 5.1.16).

c. Zone maximum heating airflow set point (Vheat-max)

The design engineer should set Vheat-max such that the design heating load is met by Vheat-max airflow at a discharge air temperature (DAT) equal to MaxΔT plus the heating set point. MaxΔT can be no higher than 11°C (20°F) above space temperature set point per ASHRAE/IES Standard 90.1-2016 (e.g., DAT no more than 32°C [90°F] at 21°C [70°F] space temperature set point) for systems supplying air greater than 1.8 m (6 ft) above floor, e.g., ceiling supply systems. Zone air distribution effectiveness EzH can be improved if MaxΔT is less than 8°C (15°F), provided that the 0.8 m/s (150 fpm) supply air jet reaches to within 1.4 m (4.5 ft) of floor level as indicated in ASHRAE Standard 62.1-2016, Table 6.2.2.2.

d. Zone maximum DAT above heating set point (MaxΔT)
e. The heating minimum airflow set point (Vheat-min)

Vheat-min is the minimum airflow required for reheat coil operation, as is often required of electric resistance coils. It should be as low as possible for best efficiency. For reheat coils with no minimum flow requirement, such as hot-water coils, Vheat-min should be zero.

3.1.2.3 Parallel Fan-Powered Terminal Unit, Constant-Volume Fan

a. Zone maximum cooling (primary) airflow set point (Vcool-max)
b. Zone minimum primary airflow set point (Vmin)

For ASHRAE Standard 62.1 ventilation, select Vmin to prevent creating critical zones. Critical zones are zones with the highest zone primary outdoor air fraction Zpz, which results in lower system ventilation efficiency Ev and higher effective minimum outdoor air set point MinOAsp. For calculation of MinOAsp for Standard 62.1 ventilation, see Section 5.16.3.1. This will lead to Vmin being higher than code minimum ventilation for all zones that require outdoor air. For California Title 24 ventilation, Vmin should be selected as the larger of Varea-min and Vocc-min, except for zones that have CO_2 DCV, for which Vmin should be equal to Varea-min. When selecting Vmin, do not consider the limitations of the VAV box controller to measure and control airflow; that is addressed by the control sequences themselves (see Section 5.1.16).

c. Zone maximum DAT above heating set point (MaxΔT)

3.1.2.4 Parallel Fan-Powered Terminal Unit, Variable-Volume Fan

Fans powered by electronically commutated motors (ECMs) must be programmed with the relationship between control signal and airflow. ECMs can be programmed to control either a specific airflow (with fan curve mapped into logic) or torque (pressure dependent airflow). For these sequences, the ECM fan should be configured for airflow control. This must be addressed by the design engineer in terminal-unit specifications.

a. Zone maximum cooling (primary) airflow set point (Vcool-max)
b. Zone minimum primary airflow set point (Vmin)

For ASHRAE Standard 62.1 ventilation, select Vmin to prevent creating critical zones. Critical zones are zones with the highest zone primary outdoor air fraction Zpz, which results in lower system ventilation efficiency Ev and higher effective minimum outdoor air set point MinOAsp. For calculation of MinOAsp for Standard 62.1 ventilation, see Section 5.16.3.1. This will lead to Vmin being higher than code minimum ventilation for all zones that require outdoor air. For California Title 24 ventilation, Vmin should be selected as the larger of Varea-min and Vocc-min, except for zones that have CO_2 DCV, for which Vmin should be equal to Varea-min. When selecting Vmin, do not consider the limitations of the VAV box controller to measure and control airflow; that is addressed by the control sequences themselves (see Section 5.1.16).

c. Parallel fan maximum heating airflow set point (Pfan-htgmax)

The design engineer should set Pfan-htgmax such that the design heating load is met by the sum of Pfan-htgmax and Vmin at a DAT equal to MaxΔT plus the heating set point. MaxΔT can be no higher than 11°C (20°F) above space temperature set point per ASHRAE/IES Standard 90.1-2016 (e.g., DAT no more than 32°C [90°F] at 21°C [70°F] space temperature set point) for systems supplying air greater than 1.8 m (6 ft) above floor, e.g., ceiling supply systems. Zone air distribution effectiveness EzH can be improved if MaxΔT is less than 8°C (15°F), provided that the 0.8 m/s (150 fpm) supply air jet reaches to within 1.4 m (4.5 ft) of floor level as indicated in ASHRAE Standard 62.1-2016, Table 6.2.2.2. This can be done in most zones by setting Pfan-htgmax to ensure these conditions are maintained.

d. Zone maximum DAT above heating set point (MaxΔT)

3.1.2.5 Series Fan-Powered Terminal Unit, Constant-Volume Fan

a. Zone maximum cooling airflow set point (Vcool-max)
b. Zone minimum airflow set point (Vmin)

For ASHRAE Standard 62.1 ventilation, select Vmin to prevent creating critical zones. Critical zones are zones with the highest zone primary outdoor air fraction Zpz, which results in lower system ventilation efficiency Ev and higher effective minimum outdoor air set point MinOAsp. For calculation of MinOAsp for Standard 62.1 ventilation, see Section 5.16.3.1. This will lead to Vmin being higher than code minimum ventilation for all zones that require outdoor air. For California Title 24 ventilation, Vmin should be selected as the larger of Varea-min and Vocc-min, except for zones that have CO_2 DCV for which Vmin should be equal to Varea-min. When selecting Vmin, do not consider the limitations of the VAV box controller to measure and control airflow; that is addressed by the control sequences themselves (see Section 5.1.16).

Series fan airflow is not a design variable because it is not controlled. It must be designed and balanced to be equal to or greater than Vcool-max. Typically, the series fan airflow is equal to Vcool-max but may be higher if some blending is desired, such as on cold primary air systems. It may also be higher to improve zone air distribution effectiveness.

The design engineer should set the series fan airflow such that the design heating load is met with a DAT equal to MaxΔT plus the heating set point. MaxΔT can be no higher than 11°C (20°F) above space temperature set point per Standard 90.1-2016 (e.g., DAT no more than 32°C [90°F] at 21°C [70°F] space temperature set point) for systems supplying air greater than 1.8 m (6 ft) above floor, e.g., ceiling supply systems. Zone air distribution effectiveness EzH can be improved if MaxΔT is less than 8°C (15°F), provided that the 0.8 m/s (150 fpm) supply air jet reaches to within 1.4 m (4.5 ft) of floor level as indicated in ASHRAE Standard 62.1-2016, Table 6.2.2.2. This can be done in most zones by setting the series fan airflow to ensure these conditions are maintained.

c. Zone maximum DAT above heating set point (MaxΔT)

3.1.2.6 Series Fan-Powered Terminal Unit, Variable-Volume Fan

Fans powered by electronically commutated motors (ECMs) must be programmed with the relationship between control signal and airflow. ECMs can be programmed to control either a specific airflow (with fan curve mapped into logic) or torque (pressure dependent airflow). For these sequences, the ECM fan should be configured for airflow control. This must be addressed by the design engineer in terminal unit specifications.

a. Zone maximum cooling airflow set point (Vcool-max)
b. Zone minimum airflow set point (Vmin)

For ASHRAE Standard 62.1 ventilation, select Vmin to prevent creating critical zones. Critical zones are zones with the highest zone primary outdoor air fraction Zpz, which results in lower system ventilation efficiency Ev and higher effective minimum outdoor air set point MinOAsp. For calculation of MinOAsp for Standard 62.1 ventilation, see Section 5.16.3.1. This will lead to Vmin being higher than code minimum ventilation for all zones that require outdoor air. For California Title 24 ventilation, Vmin should be selected as the larger of Varea-min and Vocc-min, except for zones that have CO_2 DCV, for which Vmin should be equal to Varea-min. When selecting Vmin, do not consider the limitations of the VAV box controller to measure and control airflow; that is addressed by the control sequences themselves (see Section 5.1.16).

c. Series fan maximum heating airflow set point (Sfan-htgmax)

The design engineer should set Sfan-htgmax such that the design heating load is met by the sum of Sfan-htgmax and Vmin at a DAT equal to MaxΔT plus the heating set point. MaxΔT can be no higher than 11°C (20°F) above space temperature set point per Standard 90.1-2016 (e.g., DAT no more than 32°C [90°F] at 21°C [70°F] space temperature set point) for systems supplying air greater than 1.8 m (6 ft) above floor, e.g., ceiling supply systems. Zone air distribution effectiveness EzH can be improved if MaxΔT is less than 8°C (15°F), provided that the 0.8 m/s (150 fpm) supply air jet reaches to within 1.4 m (4.5 ft) of floor level as indicated in ASHRAE Standard 62.1-2016, Table 6.2.2.2. This can be done in most zones by setting Sfan-htgmax to ensure these conditions are maintained.

d. Zone maximum DAT above heating set point (MaxΔT)

3.1.2.7 Dual-Duct VAV Terminal Unit

a. Zone maximum cooling airflow set point (Vcool-max)

For ASHRAE Standard 62.1 ventilation, select Vmin to prevent creating critical zones. Critical zones are zones with the highest zone primary outdoor air fraction Zpz, which results in lower system ventilation efficiency Ev and higher effective minimum outdoor air set point MinOAsp. For calculation of MinOAsp for Standard 62.1 ventilation, see Section 5.16.3.1.

Informative Table 3.1.3 Example Zone-Group Table

Zone Group Name	AH Tag	Terminal Unit Tags	Default Schedule
First-floor assembly	AH-1	VAV-1-1 through 11	WD: 6 am to 8pm WE: 8 am to 10pm HOL: OFF
Second-floor office	AH-1	VAV-2-1 through 15	WD: 7 am to 7 pm SAT: 9 am to 2 pm SUN: OFF HOL: OFF
IDF rooms	AH-1	VAV-1-12, VAV-2-16	ALL: 12 am to 12 am
First-floor lobby	AH-2		WD: 6 am to 8 pm WE: 8 am to 10 pm HOL: OFF

This will lead to Vmin being higher than code minimum ventilation for all zones that require outdoor air. For California Title 24 ventilation, Vmin should be selected as the larger of Varea-min and Vocc-min. When selecting Vmin, do not consider the limitations of the VAV box controller to measure and control airflow; that is addressed by the control sequences themselves (see Section 5.1.16).

b. Zone minimum airflow set point (Vmin)
c. Zone maximum heating airflow set point (Vheat-max)

3.1.3 Zone Group Assignments

Zones must be assigned to zone groups, such as by using a table (see example Informative Table 3.1.3) either on drawings or in Building Automation System (BAS) specifications. Other formats may be used if they convey the same information.

Guidance for Zone Group Assignments

- *Each zone served by a single-zone air handler shall be its own Zone Group.*
- *Rooms*
- *occupied 24/7, such as computer rooms, networking closets, mechanical, and electrical rooms served by the air handler shall be assigned to a single Zone Group. These rooms do not apply to the zone group restrictions below.*
- *A Zone Group shall not span floors (per*
- *Section 6.4.3.3.4 of ASHRAE 90.1 2016).*
- *A Zone Group shall not exceed 2,300 m^2 (25,000 ft^2) (per Section 6.4.3.3.4 of ASHRAE 90.1 2016).*
- *If future occupancy patterns are known, a single Zone Group shall not include spaces belonging to more than one tenant.*
- *A zone shall not be a member of more than one zone group.*

3.1.4 Multiple-Zone VAV Air-Handler Design Information

3.1.4.1 Temperature Set Points

AHU set points required by the designer are best conveyed in equipment schedules because the set points vary for each AHU.

a. Min_ClgSAT, lowest cooling supply air temperature set point

The Min_ClgSAT variable should be set no lower than the design coil leaving air temperature to prevent excessive CHW temperature reset requests, which will reduce chiller plant efficiency.

b. Max_ClgSAT, highest cooling supply air temperature set point

The Max_ClgSAT variable is typically 18°C (65°F) in mild and dry climates and 16°C (60°F) or lower in humid climates. It should not typically be greater than 18°C (65°F) because this may lead to excessive fan energy that can offset the mechanical cooling savings from economizer operation.

c. OAT_Min, the lower value of the OAT reset range
d. OAT_Max, the higher value of the OAT reset range

Occupied mode supply air temperature set-point reset logic uses a combination of reset by outdoor air temperature (intended to reduce fan energy during warm weather) and zone feedback (SAT needed to satisfy the zone requiring the coldest air to meet space temperature set point). OAT_Min and OAT_Max define the range of outdoor air temperatures used for the OAT reset logic. Typical values are OAT_Min = 16°C (60°F) and OAT_Max = 21°C (70°F), selected to maximize economizer operation and minimize reheat losses, offset partially by higher fan energy. A lower range, e.g., 18°C (65°F) and 13°C (55°F), respectively, may improve net energy performance for some applications:

- *The chiller plant operates continuously, so extended economizer operation does not reduce plant runtime.*
- *The system has very little reheat inherently, such as dual-fan dual-duct systems or fan-powered box systems with very low primary air minimums.*
- The climate is warm or humid, limiting available economizer hours.