Addendum k to
ASHRAE Guideline 36-2024

Public Review Draft

Proposed Addendum k to Guideline 36-2024, High-Performance Sequences of Operation for HVAC Systems

First Public Review (May 2025)
(Draft shows Proposed Changes to Current Guideline)

This draft has been recommended for public review by the responsible project committee. To submit a comment on this proposed standard, go to the ASHRAE website at www.ashrae.org/standards-research--technology/public-review-drafts and access the online comment database. The draft is subject to modification until it is approved for publication by the Board of Directors and ANSI. Until this time, the current edition of the standard (as modified by any published addenda on the ASHRAE website) remains in effect. The current edition of any standard may be purchased from the ASHRAE Online Store at www.ashrae.org/bookstore or by calling 404-636-8400 or 1-800-727-4723 (for orders in the U.S. or Canada).

This standard is under continuous maintenance. To propose a change to the current standard, use the change submittal form available on the ASHRAE website, www.ashrae.org.

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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. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE.)

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 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.

This addendum adds sequences of operation (SOOs) for VAV laboratory controls for 4-pipe VAV systems and 2-pipe VAV systems (more commonly called VAV Reheat systems).

The control schematics and points tables show two hardware design scenarios for supply air and general exhaust airflow control:

- Manufactured air valves. Each air valve includes on-board controllers to measure and control airflow to maintain a setpoint that is determined by a separate room level controller.
- Field constructed air valves, such as VAV boxes. Each air valve (VAV box) includes damper and velocity pressure sensor, but the PID control to maintain airflow at setpoint resides in the room level controller.

The sequences are the same for both design scenarios except for how the airflow control of air valve is performed.

In both design scenarios, the air valves for hoods are assumed to be manufactured air valves. This is the most common approach because the air valve materials are designed for the caustic exhaust from hoods and, for VAV hoods, their on-board controllers are proven to address very fast response to rapid sash position changes, and they generally include integrated fume hood monitors which are required by code in most applications.

The room level control sequences are not tied to any of the many hardware options available to designers. For instance, the logic could reside in a so-called Lab Control Systems (LCS) which includes proprietary controllers networked together within a lab and networked to the BAS via BACnet, or the BAS itself could execute the control logic, optionally including direct control of air valve dampers. Some designers prefer LCSs because the products are specialized for labs and the installing technicians are very experienced with installing and commissioning them, while others prefer the BAS approach to ensure all controllers, control programming, and control system human interface are the same throughout the building, programming is transparent and usually editable, and all control systems have a single source of responsibility. This addendum includes both approaches and leaves it to designers to choose among them.

Addendum k to Guideline 36-2024

(IP and SI Units)

Revise Section 3.1.3 as follows:

3.1.3. Zone Group Assignments

Zones and miscellaneous associated equipment 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

1. *Each zone served by a single-zone air handler shall be its own Zone Group.*
2. *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.*
3. *A Zone Group shall not span floors (per Section 6.4.3.3.4 of ASHRAE 90.1).*
4. *A Zone Group shall not exceed 2,300 m2 (25,000 ft2) (per Section 6.4.3.3.4 of ASHRAE 90.1).*
5. *If future occupancy patterns are known, a single Zone Group shall not include spaces belonging to more than one tenant.*
6. *A zone shall not be a member of more than one Zone Group.*
7. *Miscellaneous equipment, such as exhaust fans, serving spaces within a Zone Group shall be included in the Zone Group.*
8. *Miscellaneous equipment may be included in multiple Zone Group if it serves spaces in multiple Zone Groups.*
9. *Laboratory zones typically are ventilated 24/7 but if they are intermittently occupied, they should be assigned to Zone Groups with occupancy schedules like offices and any other building occupancy. This is to allow for temperature and ventilation setpoint setback.*

Add Section 3.1.10 as follows. Note that all text in this section is new but not underlined for ease of review:

3.1.10. Laboratory Zone Design Information

The engineer must provide the setpoint information in the following subsections, typically on lab room/air valve schedules on drawings.

3.1.10.1. Pressurization Control

Pressurization control sequences herein use volumetric flow tracking control logic with a fixed pressurization airflow offset setpoint. Other control options, including direct room pressure control and cascade control (volumetric flow tracking where the differential airflow setpoint is reset dynamically by room pressure), are also used but less common. See ASHRAE Applications Handbook Chapter 17, Section 3.4 for a discussion of the pluses and minuses of each option.

Pressurization airflow offset, Voffset, is entered as a positive value for positively pressurized labs and negative for negatively pressurized labs. Some operators find it less confusing to use two variables, one to indicate whether the lab is positive or negative, and another indicating the absolute value of the airflow offset. This can be implemented in the user interface where the operator enters these two values, then the value Voffset is calculated in software as the absolute value of the airflow offset times +1 for positively pressurized labs and times -1 for negatively pressurized labs.

a. Pressurization airflow offset, Voffset. Setpoints are positive for positively pressurized labs and negative for negatively pressurized labs.

Pressurization airflow offsets to achieve desired room pressurization must be estimated during the design phase, e.g., based on the number of entry doors and wall area. For many projects, that estimate is considered sufficient, and these offsets are used for control. But offsets may also be determined empirically to achieve a specific differential pressure, for example at BSL3 or other critical lab rooms. If so, TAB specifications must include this added scope.

b. Tracking preference shall be either:

1. Supply tracks exhaust (STE)

For STE logic, the general exhaust airflow setpoint is first determined based on room load, ventilation, and pressurization needs, then the supply airflow setpoint is calculated based on actual exhaust airflow, not exhaust airflow setpoints. This logic ensures lab pressurization offset is maintained even when actual exhaust rates do not meet setpoint due to a design or operational error. However, if the actual supply airflow rate fails to meet setpoint due to a design or operational error, the lab becomes more negative. This logic can result in excessively negative pressure in the case where supply airflow rates are way below setpoint; this might impact the ability of occupants to safely exit when exit doors open outward, as they generally do, but other logic is provided herein to mitigate that problem. STE logic is generally preferred for negatively pressurized labs because this logic ensures that minor mechanical system failures do not cause the lab to become less negatively or even positively pressurized.

2. Exhaust tracks supply (ETS)

For ETS logic, the supply airflow setpoint is first determined based on room load, ventilation, and pressurization needs, then the general exhaust airflow setpoint is calculated based on actual supply airflow, not supply airflow setpoints. This logic ensures lab pressurization offset is maintained even when actual supply rates do not meet setpoint due to a design or operational error. However, if the actual exhaust airflow rate fails to meet setpoint due to a design or operational error, the lab becomes less negative, possibly even positive. This logic can result in excessively positive pressure in the case where exhaust airflow rates are way below setpoint, but this should not impact the ability of occupants to safely exit when exit doors open outward, as they generally do. ETS logic is generally preferred for positively pressurized labs because this logic ensures that minor mechanical system failures do not cause the lab to become less positively or even negatively pressurized.

Summary:

Tracking preference	*Failure Scenario*	
	Supply falls below setpoint	*Exhaust falls below setpoint*
STE	*Room goes more negative*	*Room pressure offset maintained*
ETS	*Room pressure offset maintained*	*Room goes less negative or even positive*

3.1.10.2. Minimum Ventilation

a. Minimum occupied ventilation rate (Vvent-min-occ)

Vvent-min-occ is the minimum ventilation rate when the lab is occupied. This is typically calculated as air changes per hour (e.g., 6 ACH) times room volume, or airflow per unit area (e.g., 5 $L/s/m^2$ [1 cfm/ft^2])times room area, often determined based on a hazard evaluation and risk assessment per ANSI Z9.5. In the control sequences, this minimum rate is maintained when the lab is occupied using supply air for positively pressurized labs, or exhaust air for negatively pressurized labs.

b. Minimum unoccupied ventilation rate (Vvent-min-unocc)

Vvent-min-unocc is the minimum ventilation rate when the lab is unoccupied. This is typically calculated as air changes per hour (e.g., 3 ACH) times room volume, or airflow per unit area (e.g., 2.5 L/s/m^2 [0.5 cfm/ft^2]) times room area. In the control sequences, this minimum rate is maintained when the lab is unoccupied using supply air for positively pressurized labs, or exhaust air for negatively pressurized labs.

3.1.10.3. Supply air valve(s)

If there is more than one supply air valve, they are assumed in these sequences to operate proportionally in parallel.

a. Maximum airflow setpoint (Vmax)

Vmax is the larger of:

- the required cooling airflow rate (Vcool-max);

- the heating airflow rate (Vheat-max);

- that needed for minimum occupied ventilation rate (Vmin-occ = Vvent-min-occ + Voffset, only if Voffset < 0);

- that needed for hood and other exhaust makeup with hood sashes open (Vmu-max = sum Vhex-max for all hoods + Vother-exh + Voffset)

- If any of the cooling maximum (Vcool-max), heating maximum (Vheat-max), or minimum ventilation (Vmin-occ) is between the minimum hood makeup air rate (Vmu-min = sum Vhex-min for all hoods + Vother-exh if always ON + Voffset) and maximum hood makeup air rate (Vmu-max), there will come a point where the hood exhaust makeup air rate, assuming it is continuous between these minimum and maximum endpoints, will just be below these rates when they reach their peaks, requiring the general exhaust valve to open, and once it does, it cannot operate below its controllable minimum (Vgex-ctrl-min) which therefore requires the supply rate Vmax to be at least these rates plus the general exhaust controllable minimum (Vgex-ctrl-min). These three rates, cooling maximum (Vcool-max), heating maximum (Vheat-max), or minimum ventilation (Vmin-occ), need to be tested individually for this condition.

- If any of the cooling maximum (Vcool-max), heating maximum (Vheat-max), or minimum ventilation (Vmin-occ) is greater than or equal to the maximum hood makeup rate (Vmu-max), there will come a point where the hood exhaust makeup air rate is just below these rates, requiring the general exhaust valve to open, and once it does, it cannot operate below its controllable minimum (Vgex-ctrl-min) which therefore requires the supply rate Vmax to be at least the maximum hood exhaust makeup rate (Vmu-max) plus the general exhaust controllable minimum (Vgex-ctrl-min). This test can be combined into one by just looking at the largest of the three rates.

Vmax = MAX(Vcool-max, Vheat-max, Vmin-occ, Vmu-max, (Vcool-max + Vgex-ctrl-min only if Vcool-max < Vmu-max and > Vmu-min), (Vheat-max + Vgex-ctrl-min only if Vheat-max < Vmu-max and > Vmu-min), (Vmin-occ + Vgex-ctrl-min only if Vmin-occ < Vmu-max and > Vmu-min), (Vmu-max + Vgex-ctrl-min only if MAX(Vcool-max, Vheat-max, Vmin-occ)≥ Vmu-max).

This setpoint could be automatically calculated by the sequences so the scheduled value of Vmax is not needed for control, but it is needed for supply air valve sizing, which in turn affects the controllable minimum, Vctrl-min, so it needs to also be scheduled on drawings. The sequences do a check of Vmax to be sure it was calculated and scheduled correctly, and an alarm is generated if not.

b. Maximum cooling airflow setpoint (Vcool-max)

Vcool-max is the rate required to meet lab cooling loads at design conditions with zone cooling coil discharge air temperature equal to DATmin (for 4-pipe systems) or to the AHU design cooling supply air temperature (for 2-pipe VAV reheat systems).

c. Maximum heating airflow setpoint (Vheat-max)

Vheat-max is the rate required to meet lab heating loads at design conditions with heating coil discharge air temperature equal to DATmax.

d. Design heating coil leaving air temperature (DATmax)

DATmax is the design zone heating coil discharge air temperature. This should be less than 11°C [20°F] above the heating setpoint to meet Standard 90.1 overhead heating limitations.

Include the following line for 4-pipe Lab zones. Delete for 2-pipe VAV reheat systems.

e. Design cooling coil leaving air temperature (DATmin)

DATmin is the design zone cooling coil discharge air temperature, e.g., 13°C [55°F].

Delete the next section if there are no mechanically pressure independent venturi type supply air valves whose controllers do not have feedback of damper position and use DP sensors across the air valve instead.

f. Minimum DP required for proper air valve performance (MinSAvalveDP)

MinSAvalveDP is used for static pressure setpoint reset for air valves that do not have knowledge of damper position.

3.1.10.4. Hood exhaust air valve(s)

Hood exhaust is assumed to be controlled by a manufactured air valve with an on-board controller that adjusts exhaust rates based on sash opening and desired face velocity. A fume hood monitor is also provided for user feedback and alarms. None of the control logic resides in the room BAS controller, other than monitoring alarms and commissioning overrides. The following minimum and maximum setpoints must be configured in, or written to, the exhaust air valve controller. They are not used in the lab control sequences.

a. Maximum airflow setpoint (Vhex-max)

Vhex-max is the required hood exhaust with sash open to design opening. This value should also be the setpoint for a hood "purge" if the hood monitor/controller has this feature.

b. Minimum airflow setpoint (Vhex-min)

Vhex-min is the required hood exhaust with sash fully closed. This value is typically determined based on a hazard evaluation and risk assessment per ANSI Z9.5.

Delete the next section if there are no mechanically pressure independent venturi type hood exhaust air valves whose controllers do not have feedback of damper position and use DP sensors across the air valve instead.

c. Minimum DP required for proper air valve performance (MinHEvalveDP)

MinHEvalveDP is used for static pressure setpoint reset for air valves that do not have knowledge of damper position.

3.1.10.5. General exhaust air valve

If there is more than one general exhaust air valve, they are assumed in these sequences to operate proportionally in parallel.

a. Maximum airflow setpoint (Vgex-max)

Vgex-max is the larger of: the required cooling airflow rate (Vcool-max); heating airflow rate (Vheat-max); that needed for minimum occupied ventilation rate (Vvent-min-occ + Voffset, only if Voffset < 0) and the supply air valve controllable minimum (Vctrl-min); <u>minus</u>: hood exhaust with hood sashes closed (sum Vhex-min for all hoods), other exhaust (Vother-exh), and pressurization airflow offset (Voffset).

Vgex-max = MAX (Vcool-max, Vheat-max, (Vvent-min-occ + (Voffset only if Voffset < 0), Vctrl-min)) minus (∑Vhex-min + Vother-exh + Voffset)

If Vgex-max is calculated to be less than or equal to zero, no general exhaust is needed, and Vgex-ctrl-min is also equal to zero. If Vgex-max is greater than zero but less than the controllable minimum Vgex-ctrl-min of the smallest general exhaust air valve available, then Vgex-max is equal to Vgex-ctrl-min.

This setpoint could be automatically calculated by the sequences so the scheduled value of Vgex-max is not needed for control, but it is needed for general exhaust air valve sizing, which in turn affects the controllable minimum, Vgex-ctrl-min, so it needs to also be scheduled by the designer on drawings. The sequences do a check of Vgex-max to be sure it was calculated and scheduled correctly, and an alarm is generated if not.

a. Enable general exhaust air valve to fully shut (GEXshutoff = ENABLED or DISABLED)

This is a software switch indicating the general exhaust air valve is capable of and enabled to fully shut off (near zero flow) when general exhaust is not needed. Some air valves are only capable of operating down to their controllable minimum, but others (where so specified by the designer) are capable of fully shutting off airflow when general exhaust is not needed, i.e., when hood exhaust airflow is higher than both the airflow required for ventilation and the airflow required to meet heating and cooling loads. Shutting off the GEX air valve in this case reduces the required supply airflow rate to the lab, reducing energy use.

Delete the next section if there are no mechanically pressure independent venturi type general exhaust air valves whose controllers do not have feedback of damper position and use DP sensors across the air valve instead.

b. Minimum DP required for proper air valve performance (MinGEXvalveDP)

MinGEXvalveDP is used for static pressure setpoint reset for air valves that do not have knowledge of damper position.

3.1.10.6. Other exhaust

a. Other exhaust airflow rate, (Vother-exh)

Vother-exh is the sum of all other continuous and constant volume exhaust airflow rates, such as for storage cabinets, snorkels, etc., if applicable.

Vother-exh is sometimes controlled by a separate on/off fan or switch, Vother-exh-status, as indicated in points list. If not, Vother-exh-status should be a software point locked to ON.

Add 3.3.2 as follows. Note that all text in this section is new but not underlined for ease of review:

3.3.2. Laboratory VAV Air Valve Controllable Minimum.

3.3.2.1. The controllable minimum for air valves using velocity pressure sensors shall be determined in accordance with Section 3.3.1.

3.3.2.2. The controllable minimum for air valves using other airflow sensing and control devices, including mechanically pressure independent venturi type valves, shall be per the manufacturer.

Add 4.14 to 4.17 as follows. Note that all text in these sections is new but not underlined for ease of review:

4.14 Laboratory Four-Pipe VAV Zone with Supply Air and General Exhaust Air VAV Boxes

This design uses supply air and general exhaust air VAV boxes that include a damper and velocity pressure sensor with airflow controlled by the lab room controller. This design is generally used for labs without variable volume hoods – the lab either has no hoods or constant volume hoods. Constant volume hoods are commonly used when lab minimum ventilation requirements or minimum cooling airflow requirements exceed the hood maximum exhaust rate. (The control schematic and *points list for this design assume there is a constant volume hood.) This design can also be used for labs with variable volume fume hoods if fast-actuators are specified for all VAV boxes and the installer has experience with tuning very fast control loops.*

Where hoods are used, the points list and sequences assume hoods have manufactured air valves, which are specialty devices that include its own self-contained pressure independent controller; the air valve is not directly controlled by the BAS, although the BAS will require I/O points as indicated in the points table.

Air valves with controllers that have knowledge of damper position may indicate Duct Static Pressure Requests by the usual means using damper position. Mechanically pressure independent venturi type air valves can also be used, but if damper position is not known, they must be provided with a differential pressure sensor which is used for fan static pressure reset required by Standard 90.1 for supply air systems and recommended for lab exhaust systems by Labs21.

Only one controller, the lab room controller, should be used per lab so that network operation does not affect lab performance. Even for labs without VAV fume hoods, while airflow rates change slowly, reliability is improved if airflow setpoints do not have to be transferred over the BAS network. This can be done using a standard VAV box controller on the supply air VAV box with an auxiliary controller on the exhaust VAV box. Alternatively, standard VAV box controllers can be provided on both supply and exhaust air VAV boxes with exhaust setpoint hardwired from the supply air box controller to the exhaust controller and all setpoint logic residing in the supply air box controller.

Hot water and chilled water are shown to be controlled by a 6-way valve serving a single changeover coil. Two 2-way valves serving separate hot water and chilled water coils may also be used.

Occupancy sensors are listed as an optional hardwired point. This point is also commonly a software point mapped from a networked lighting control system or security system.

Re-quired?	Description	Type	Device
R	Supply VAV Box Damper Position	AO ***OR*** two DOs	Modulating actuator ***OR*** Floating actuator
R	Exhaust VAV Box Damper Position	AO ***OR*** two DOs	Modulating actuator ***OR*** Floating actuator
R	CHW/HW valve position	AO	Modulating actuator, 6-way valve
R	Supply Airflow	AI	Differential pressure transducer connected to flow sensor
R	General Exhaust Airflow	AI	Differential pressure transducer connected to flow sensor
R	Hood Exhaust Airflow (each hood)	AI	Air valve airflow feedback
R	Hood Exhaust Damper position or DP across air valve (each hood)	AI	Air valve feedback or DP sensor
R	Discharge Air Temperature	AI	Duct temperature sensor (probe or averaging at designer’s discretion)
R	Zone Temperature	AI	Room temperature sensor

Re-quired?	Description	Type	Device
O	Hood alarm (any hood)	DI	Connect to hood monitor alarm contact, in parallel if more than one hood
A	Occupancy Sensor	DI	Occupancy sensor
A	Zone Temperature Setpoint Adjustment	AI	Zone thermostat adjustment
A	Other exhaust status	DI	On/off status contact from a switch or exhaust fan current switch for other constant volume exhaust

4.15 Laboratory Four-Pipe VAV Zone with Manufactured Air Valves

This design is commonly used for labs that have variable volume fume hoods. It assumes that supply air, general exhaust, and fume hoods are all controlled by manufactured air valves, which are specialty devices that include their own self-contained pressure independent controller; the air valves are not directly controlled by the lab room controller, although the lab room controller will require I/O points as indicated in the points table.

Air valves with controllers that have knowledge of damper position may indicate Duct Static Pressure Requests by the usual means using damper position. Mechanically pressure independent venturi type air valves can also be used, but if damper position is not known, they must be provided with a differential pressure sensor which is used for fan static pressure reset required by Standard 90.1 for supply air systems and recommended for lab exhaust systems by Labs21.

Only one controller, the lab room controller, should be used per lab so that BAS network operation does not affect lab performance. The lab room controller should execute all room control functions and control logic. It typically transmits setpoints to the air valve controllers via hardwired I/O as indicated in the points list below. Alternately, multiple air valve flow controllers communicate with the room controller by a network that isolates communication of information required for room pressurization from BAS traffic unrelated to the room control system, from non-BAS traffic on the building network, and from network hardware faults outside the room control system.

Hot water and chilled water are shown to be controlled by a 6-way valve serving a single changeover coil. Two 2-way valves serving separate hot water and chilled water coils may also be used.

Occupancy sensors are listed as an optional hardwired point. This point is also commonly a software point mapped from a networked lighting control system or security system.

Re-quired?	Description	Type	Device
R	Supply airflow setpoint	AO	To air valve controller
R	General exhaust airflow setpoint	AO	To air valve controller
R	CHW/HW valve position	AO	Modulating actuator, 6-way valve
R	Supply Airflow	AI	Air valve airflow feedback
R	General Exhaust Airflow	AI	Air valve airflow feedback

Re-quired?	Description	Type	Device
R	Hood Exhaust Airflow (each hood)	AI	Air valve airflow feedback
R	Supply Damper position or DP across air valve	AI	Air valve feedback or DP sensor
R	General Exhaust Damper position or DP across air valve	AI	Air valve feedback or DP sensor
R	Hood Exhaust Damper position or DP across air valve (each hood)	AI	Air valve feedback or DP sensor
R	Discharge Air Temperature	AI	Duct temperature sensor (probe or averaging at designer's discretion)
R	Zone Temperature	AI	Room temperature sensor
O	Hood alarm (any hood)	DI	Connect to hood monitor alarm contact, in parallel if more than one hood
A	Occupancy Sensor	DI	Occupancy sensor
A	Zone Temperature Setpoint Adjustment	AI	Zone thermostat adjustment
A	Close sash (all hoods)	DO	Wire to sash closer controller emergency close contact; include multi-pole relay if more than one hood
A	Open emergency lab pressure relief dampers	DO	Two-position normally-closed actuator(s) on lab pressure relief damper (for safe exiting upon loss of makeup air)
A	Other exhaust status	DI	On/off status contact from a switch or exhaust fan current switch for other constant volume exhaust

4.16 Laboratory VAV Reheat Zone with Supply Air and General Exhaust Air VAV Boxes

This design uses supply air and general exhaust air VAV boxes that include a damper and velocity pressure sensor with airflow controlled by the lab room controller. This design is generally used for labs without variable volume hoods – the lab either has no hoods or constant volume hoods. Constant volume hoods are commonly used when lab minimum ventilation requirements or minimum cooling airflow requirements exceed the hood maximum exhaust rate. (The control schematic and points list for this design assume there is a constant volume hood.) This design can also be used for labs with variable *volume fume hoods if fast-actuators are specified for all VAV boxes and the installer has experience with tuning very fast control loops.*

Where hoods are used, the points list and sequences assume hoods have manufactured air valves, which are specialty devices that include its own self-contained pressure independent controller; the air valve is not directly controlled by the BAS, although the BAS will require I/O points as indicated in the points table.

Air valves with controllers that have knowledge of damper position may indicate Duct Static Pressure Requests by the usual means using damper position. Mechanically pressure independent venturi type air valves can also be used, but if damper position is not known, they must be provided with a differential pressure sensor which is used for fan static pressure reset required by Standard 90.1 for supply air systems and recommended for lab exhaust systems by Labs21.

Only one controller, the lab room controller, should be used per lab so that network operation does not affect lab performance. Even for labs without VAV fume hoods, while airflow rates change slowly, reliability is improved if airflow setpoints do not have to be transferred over the BAS network. This can be done using a standard VAV box controller on the supply air VAV box with an auxiliary controller on the exhaust VAV box. Alternatively, standard VAV box controllers can be provided on both supply and exhaust air VAV boxes with exhaust setpoint hardwired from the supply air box controller to the exhaust controller and all setpoint logic residing in the supply air box controller.

Occupancy sensors are listed as an optional hardwired point. This point is also commonly a software point mapped from a networked lighting control system or security system.

Re-quired?	Description	Type	Device
R	Supply VAV Box Damper Position	AO ***OR*** two DOs	Modulating actuator ***OR*** Floating actuator
R	Exhaust VAV Box Damper Position	AO ***OR*** two DOs	Modulating actuator ***OR*** Floating actuator
R	HW valve position	AO	Modulating actuator
R	Supply Airflow	AI	Differential pressure transducer connected to flow sensor
R	General Exhaust Airflow	AI	Differential pressure transducer connected to flow sensor
R	Hood Exhaust Airflow (each hood)	AI	Air valve airflow feedback
R	Hood Exhaust Damper position or DP across air valve (each hood)	AI	Air valve feedback or DP sensor
R	Discharge Air Temperature	AI	Duct temperature sensor (probe or averaging at designer’s discretion)
R	Zone Temperature	AI	Room temperature sensor

Re-quired?	Description	Type	Device
O	Hood alarm (any hood)	DI	Connect to hood monitor alarm contact, in parallel if more than one hood
A	Occupancy Sensor	DI	Occupancy sensor
A	Zone Temperature Setpoint Adjustment	AI	Zone thermostat adjustment
A	Other exhaust status	DI	On/off status contact from a switch or exhaust fan current switch for other constant volume exhaust

4.17 Laboratory VAV Reheat Zone with Manufactured Air Valves

This design is commonly used for labs that have variable volume fume hoods. It assumes that supply air, general exhaust, and fume hoods are all controlled by manufactured air valves, which are specialty devices that include their own self-contained pressure independent controller; the air valves are not directly controlled by the lab room controller, although the lab room controller will require I/O points as indicated in the points table.

Air valves with controllers that have knowledge of damper position may indicate Duct Static Pressure Requests by the usual means using damper position. Mechanically pressure independent venturi type air valves can also be used, but if damper position is not known, they must be provided with a differential pressure sensor which is used for fan static pressure reset required by Standard 90.1 for supply air systems and recommended for lab exhaust systems by Labs21.

Only one controller, the lab room controller, should be used per lab so that BAS network operation does not affect lab performance. The lab room controller should execute all room control functions and control logic. It typically transmits setpoints to the air valve controllers via hardwired I/O as indicated in the points list below. Alternately, multiple air valve flow controllers communicate with the room controller by a network that isolates communication of information required for room pressurization from BAS traffic unrelated to the room control system, from non-BAS traffic on the building network, and from network hardware faults outside the room control system.

Occupancy sensors are listed as an optional hardwired point. This point is also commonly a software point mapped from a networked lighting control system or security system.

Re-quired?	Description	Type	Device
R	Supply airflow setpoint	AO	To air valve controller
R	General exhaust airflow setpoint	AO	To air valve controller
R	HW valve position	AO	Modulating actuator
R	Supply Airflow	AI	Air valve airflow feedback
R	General Exhaust Airflow	AI	Air valve airflow feedback

Re-quired?	Description	Type	Device
R	Hood Exhaust Airflow (each hood)	AI	Air valve airflow feedback
R	Supply Damper position or DP across air valve	AI	Air valve feedback or DP sensor
R	General Exhaust Damper position or DP across air valve	AI	Air valve feedback or DP sensor
R	Hood Exhaust Damper position or DP across air valve (each hood)	AI	Air valve feedback or DP sensor
R	Discharge Air Temperature	AI	Duct temperature sensor (probe or averaging at designer's discretion)
R	Zone Temperature	AI	Room temperature sensor
O	Hood alarm (any hood)	DI	Connect to hood monitor alarm contact, in parallel if more than one hood
A	Occupancy Sensor	DI	Occupancy sensor
A	Zone Temperature Setpoint Adjustment	AI	Zone thermostat adjustment
A	Close sash (all hoods)	DO	Wire to sash closer controller emergency close contact; include multi-pole relay if more than one hood
A	Open emergency lab pressure relief dampers	DO	Two-position normally-closed actuator(s) on lab pressure relief damper (for safe exiting upon loss of makeup air)
A	Other exhaust status	DI	On/off status contact from a switch or exhaust fan current switch for other constant volume exhaust

Modify Section 5.15 as follows:

5.15 Air-Handling Unit System Modes

5.15.1. If there are no laboratory zones served by the air handling unit, AHU system modes are the same as the mode of the Zone Group served by the system. When Zone Group served by an air-handling system are in different modes, the following hierarchy applies (highest one sets AHU mode):

5.15.1.1. Occupied Mode

5.15.1.2. Cooldown Mode

5.15.1.3. Setup Mode

5.15.1.4. Warmup Mode

5.15.1.5. Setback Mode

5.15.1.6. Unoccupied Mode

5.15.2. If there are any laboratory zones served by the air handling unit, AHU system mode shall be Occupied Mode regardless of Zone Group modes.

For laboratory zones, zone controls will provide the desired zone temperature and airflow setpoints based on Zone Group Mode, but AHU operation is the same (Occupied Mode) regardless.

Add Section 5.23 as follows: Note: the section below is new, but additions are not underlined for ease of review.

5.23 Laboratory VAV Zone

5.23.1. See "Generic Thermal Zones" (Section 5.3) for setpoints, loops, control modes, alarms, etc.

5.23.2. See Section 3.1.10 for airflow and discharge air temperature setpoints.

5.23.3. Airflow setpoints

5.23.3.1. Where there is more than one valve of the same type, for control logic herein, measured rates from each shall be added together, and setpoints for each shall be divided proportional to air valve design maximum flow.

5.23.3.2. Ventilation minimum setpoints

a. Minimum occupied airflow setpoint, Vmin-occ = Vvent-min-occ + (Voffset only if Voffset < 0)

b. Minimum unoccupied airflow setpoint, Vmin-unocc = Vvent-min-unocc + (Voffset only if Voffset < 0)

5.23.3.3. Maximum setpoint check

a. Vmax-check = MAX (Vcool-max, Vheat-max, Vmin-occ, Vmu-max, (Vcool-max + Vgex-ctrl-min only if Vcool-max < Vmu-max and > Vmu-min), (Vheat-max + Vgex-ctrl-min only if Vheat-max < Vmu-max and > Vmu-min), (Vmin-occ + Vgex-ctrl-min only if Vmin-occ < Vmu-max and > Vmu-min), (Vmu-max + Vgex-ctrl-min only if MAX(Vcool-max, Vheat-max, Vmin-occ) ≥ Vmu-max))
where Vmu-max = (sum Vhex-max for all hoods + Vother-exh + Voffset)
and where Vmu-min = (sum Vhex-min for all hoods + Vother-exh + Voffset).

1. If Vmax-check is not equal to Vmax within 1%, generate a Level 4 alarm.

2. If Vmax-check is more than 5% above Vmax, generate a Level 2 alarm.

Vmax must be scheduled by the designer so that it can be used for air valve sizing, which in turn determines the controllable minimum Vctrl-min, but it also can be automatically calculated as indicated. If there is a mismatch, an alarm is generated so that Vmax setpoint, and perhaps air valve selection, can be corrected by the designer.

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b. Vgex-max-check = MAX(Vgex-ctrl-min, MAX (Vcool-max, Vheat-max, Vmin-occ, Vctrl-min) minus (∑Vhex-min + Vother-exh + Voffset)).

1. If Vgex-max-check is not equal to Vgex-max within 1%, generate a Level 4 alarm.

2. If Vgex-check is more than 5% above Vgex-max, generate a Level 2 alarm.

Vgex-max must be scheduled by the designer so that it can be used for air valve sizing, which in turn determines the controllable minimum Vgex-ctrl-min, but it also can be automatically calculated as indicated. If there is a mismatch, an alarm is generated so that Vgex-max setpoint, and perhaps air valve selection, can be corrected by the designer.

5.23.3.4. Lab air valve controllable minimum

a. Supply air valve controllable minimum (Vctrl-min) and general exhaust air valve controllable minimum (Vgex-ctrl-min) shall be determined in accordance with Section 3.3.2.

5.23.4. Pressurization airflow control

5.23.4.1. Sign conventions: All airflows have a positive sign, except for the room pressurization airflow offset Voffset which shall be positive for positively pressurized labs, and negative for negatively pressurized labs.

5.23.4.2. Vhex-flow shall be the sum of fume hood exhaust valve(s) airflow feedback.

5.23.4.3. Other exhaust

a. Vother-exh* is equal to Vother-exh if Vother-exh-status is ON and equal to zero otherwise.

5.23.4.4. Active minimum ventilation rate (Vvent) shall be equal to

a. If the zone is populated as indicated by its occupancy sensor <u>or</u> the lab is scheduled to be occupied, Vmin-occ;

Both the space occupancy sensor and the schedule are used to ensure that labs are unoccupied before rates are reduced to the unoccupied minimums.

---

b. Otherwise, Vmin-unocc

The following section allows the general exhaust valve to fully close when no general exhaust is needed for temperature control or ventilation. Otherwise, it must exhaust at least its controllable minimum.

5.23.4.5. Evaluate the following every 60 seconds: Vgex-min* shall be equal to Vgex-ctrl-min, except Vgex-min* shall be equal to 0 if:

1. GEXshutoff is ENABLED, and
2. The active supply airflow setpoint for temperature control, V-TC-spt is less than or equal to the following:

    i. Vhex-flow

    ii. Plus Vother-exh*

    iii. Plus Voffset

IF(V-TC-spt ≤ (Vhex-flow + Vother-exh + Voffset))*

5.23.4.6. The active minimum supply airflow setpoint, Vmin*, shall be equal to Vvent but no less than Vctrl-min.

Vmin = MAX(Vctrl-min, Vvent)*

5.23.4.7. The active cooling supply maximum Vcool-max* shall be the larger of Vcool-max and Vmin*.

Vcool-max = MAX(Vcool-max, Vmin*)*

5.23.4.8. The active heating supply maximum Vheat-max* shall be the larger of Vheat-max and Vmin*.

Vheat-max = MAX(Vheat-max, Vmin*)*

5.23.4.9. If tracking preference is Supply Tracks Exhaust (STE):

a. The active general exhaust valve setpoint, Vgex-spt, shall be equal to 0 when Vgex-min* is equal to 0; otherwise, it shall be equal to the following but no larger than Vgex-max and no less than Vgex-min*:

1. V-TC-spt
2. Minus Vhex-flow
3. Minus Vother-exh*
4. Minus Voffset

Vgex-spt = MIN(Vgex-max, MAX(Vgex-min, V-TC-spt - Vhex-flow - Vother-exh* - Voffset)*

b. The active supply air setpoint, Vspt, shall be equal to the following but no larger than Vmax and no less than Vctrl-min:

1. General exhaust feedback airflow, Vgex-flow
2. Plus Vhex-flow
3. Plus Vother-exh*
4. Plus Voffset

Vspt = MAX(Vctrl-min, MIN(Vmax, Vgex-flow + Vhex-flow + Vother-exh + Voffset))*

5.23.4.10. If tracking preference is Exhaust Tracks Supply (ETS):

a. The active supply airflow setpoint, Vspt, shall be equal to the following but no larger than Vmax and no less than V-TC-spt :

1. Vhex-flow
2. Plus Vother-exh*
3. Plus Vgex-min*
4. Plus Voffset

Vspt = MIN(Vmax, MAX(V-TC-spt, (Vhex-flow + Vother-exh + Vgex-min + Voffset)))*

b. The active general exhaust valve setpoint Vgex-spt shall be equal to 0 when Vgex-min* is equal to 0; otherwise, it shall be equal to the following but no larger than Vgex-max and no less than Vgex-min*:

1. Supply valve feedback airflow, Vflow
2. Minus Vhex-flow
3. Minus Vother-exh*
4. Minus Voffset

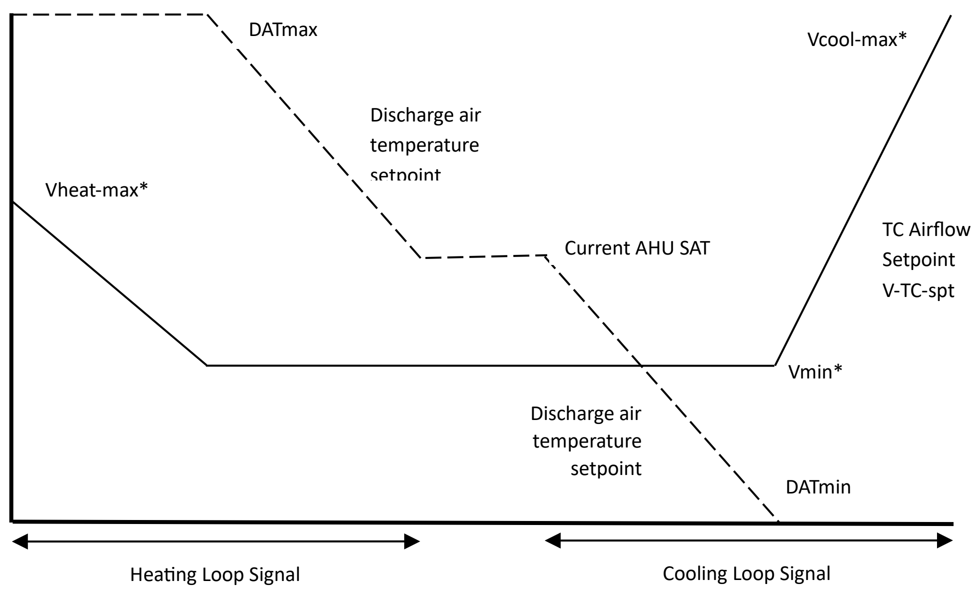
Vgex-spt = MIN(Vgex-max, MAX(Vgex-min, Vflow - Vhex-flow - Vother-exh* - Voffset)*

If there are no 4-pipe lab zone terminals, delete the following section:

5.23.5. Supply air control – 4-pipe terminals

5.23.5.1. Active endpoints used in the control logic depicted in the figure below shall not vary regardless of the Mode of the Zone Group the zone is a part of.

5.23.5.2. Control logic is depicted schematically in the figure below and described in the following sections.



5.23.5.3. When the Zone State is Cooling

a. From 0 to 50%, the Cooling Loop output shall reset the discharge temperature setpoint from the current AHU supply air temperature to DATmin. The temperature control airflow setpoint V-TC-spt shall be Vmin*.

b. From 51% to 100%, the Cooling Loop output shall reset the temperature control airflow setpoint V-TC-spt from Vmin* to Vcool-max*.

   1. Exception: If the zone discharge air temperature is greater than room temperature minus 1°C [2°F], the active airflow setpoint V-TC-spt shall be no higher than Vmin*.

The exception is provided in case zone cooling is disabled or unable to handle the cooling load; increasing airflow would then overheat the space.

c. The cooling coil shall be modulated to maintain the discharge temperature at setpoint.

d. The heating coil shall be disabled unless the discharge air temperature is below the minimum setpoint (see Section 5.23.6.6).

5.23.5.4. When the Zone State is Deadband

a. The temperature control airflow setpoint V-TC-spt shall be Vmin*.

b. The cooling coil shall be disabled.

c. The heating coil shall be disabled unless the discharge air temperature is below the minimum setpoint (see Section 5.23.6.6).

5.23.5.5. When the Zone State is Heating

a. From 0 to 50%, the Heating Loop output shall reset the discharge temperature setpoint from current AHU supply air temperature to DATmax. The temperature control airflow setpoint V-TC-spt shall be Vmin*.

b. From 51% to 100%, the Heating Loop output shall reset the temperature control airflow setpoint V-TC-spt from Vmin* to Vheat-max*.

1. Exception: If the discharge air temperature is less than room temperature plus 3°C [5°F], the active airflow setpoint V-TC-spt shall be no higher than Vmin*.

The exception is provided in case zone heating is disabled or unable to handle the heating load; increasing airflow would then overcool the space.

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c. The cooling coil shall be disabled.

d. The heating coil shall be modulated to maintain the discharge temperature at setpoint.

5.23.5.6. In Occupied Mode, the heating coil shall be modulated to maintain a DAT no lower than 10°C (50°F).

This prevents excessively cold DATs if the AHU does not have a heating coil.

5.23.5.7. Where drawings indicate supply air valves have on-board controllers, the airflow setpoint is sent to the controller and the controller modulates the air valve damper to maintain the measured airflow at setpoint.

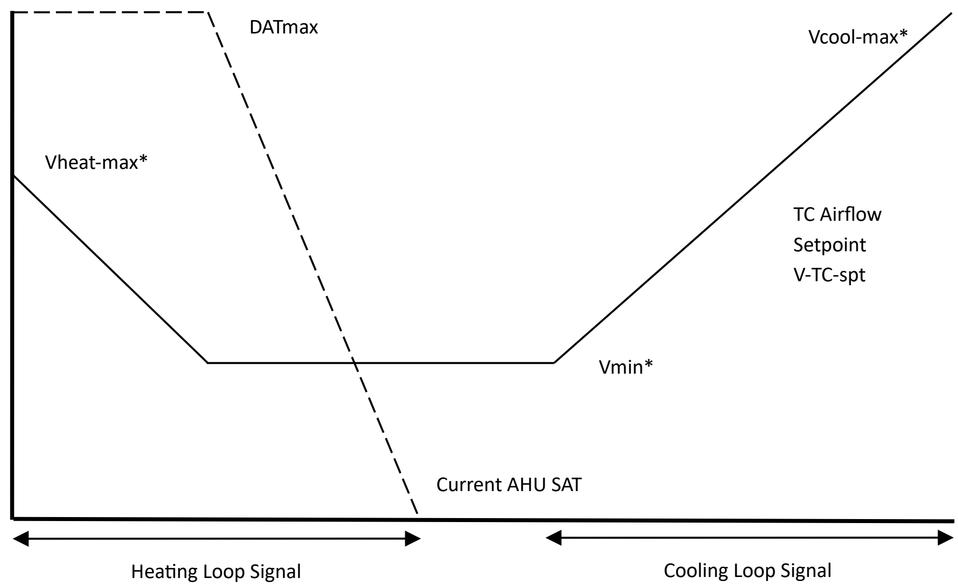
5.23.5.8. Where drawings indicate supply air valves are directly controlled by the BAS, the air valve damper shall be modulated with a PID loop to maintain the measured airflow at setpoint.

If there are no 2-pipe lab zone terminals, delete the following section:

5.23.6. Supply air control – 2-pipe terminals

5.23.6.1. Active endpoints used in the control logic depicted in the figure below shall not vary regardless of the Mode of the Zone Group the zone is a part of.

5.23.6.2. Control logic is depicted schematically in the figure below and described in the following sections.



5.23.6.3. When the Zone State is Cooling

a. The Cooling Loop output shall be mapped to the temperature control airflow setpoint V-TC-spt from Vmin* to Vcool-max*.

1. Exception: If discharge air temperature is greater than room temperature minus 1°C [2°F], the active airflow setpoint V-TC-spt shall be no higher than Vmin*.

The exception is provided in case zone cooling is disabled or unable to handle the cooling load; increasing airflow would then overheat the space.

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a. The heating coil shall be disabled unless the DAT is below the minimum setpoint (see Section 5.23.6.6).

5.23.6.4. When the Zone State is Deadband

a. The temperature control airflow setpoint V-TC-spt shall be Vmin*.

b. The heating coil shall be disabled unless the DAT is below the minimum setpoint (see Section 5.23.6.6).

5.23.6.5. When the Zone State is Heating

a. From 0-50%, the Heating Loop output shall reset the discharge temperature setpoint from the current AHU supply air temperature to DATmax. The temperature control airflow setpoint V-TC-spt shall be Vmin*.

b. From 51%-100%, the Heating Loop output shall reset the temperature control airflow setpoint V-TC-spt from the Vmin* to Vheat-max*.

1. Exception: If the discharge air temperature is less than room temperature plus 3°C [5°F], the active airflow setpoint V-TC-spt shall be no higher than Vmin*.

The exception is provided in case zone heating is disabled or unable to handle the heating load; increasing airflow would then overcool the space.

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c. The heating coil shall be modulated to maintain the discharge temperature at setpoint. (Directly controlling heating off the zone temperature control loop is not acceptable).

5.23.6.6. In Occupied Mode, the heating coil shall be modulated to maintain a DAT no lower than 10°C (50°F).

This prevents excessively cold DATs if the AHU is providing high outdoor airflows and does not have a heating coil.

5.23.6.7. Where drawings indicate supply air valves have on-board controllers, the airflow setpoint is sent to the controller and the controller modulates the VAV damper to maintain the measured airflow at setpoint.

5.23.6.8. Where drawings indicate supply air valves are directly controlled by the BAS, the VAV damper shall be modulated to maintain the measured airflow at setpoint.

5.23.7. General Exhaust

5.23.7.1. Where drawings indicate general exhaust air valves have on-board controllers, the active airflow setpoint Vgex-spt is sent to the controller and the controller modulates the VAV damper to maintain the measured airflow at setpoint.

5.23.7.2. Where drawings indicate general exhaust air valves are directly controlled by the BAS, the VAV damper shall be modulated with a PID loop to maintain the measured airflow at the active airflow setpoint Vgex-spt.

5.23.8. Alarms

5.23.8.1. Airflow alarm (except hoods if setpoint is not known)

a. If the airflow feedback from any air valve is 15% above or below setpoint for 5 minutes, generate a Level 3 alarm.

b. If the airflow feedback from any air valve is 30% above or below setpoint for 5 minutes, generate a Level 2 alarm.

5.23.8.2. Room pressurization polarity alarm

a. Generate a Level 2 alarm if the actual airflow differential has incorrect polarity vs. Voffset for 5 minutes, with actual airflow differential calculated as the sum of supply airflow feedback signal minus sum of general and hood exhaust airflow feedback:

1. For a room with negative pressurization airflow offset Voffset, if actual airflow differential ≥ 0

2. For a room with positive pressurization airflow offset Voffset, if actual airflow differential ≤ 0

5.23.8.3. Room low supply rate alarm

a. If the sum of exhaust feedback signals exceeds the sum of supply feedback signal by more than 4 times the absolute value of Voffset for 1 minute:

1. Generate a Level 1 alarm (high level due to problems exiting)

Include the following paragraph if there is an audible and/or visual alarm, such as wall mounted horn/strobe in the lab with signage indicating that lab should be evacuated upon alarm. Delete otherwise.

2. Activate lab audible/visual alarm

ANSI Z9.5 section 6.2.3 requires that lab designs address loss/reduction of supply air (e.g., due to a AHU failure, FSD closure, supply air valve fail-close, etc.) in hood dominated labs to ensure occupant exiting can occur without excessive door pull pressure when exit doors open out of the lab. There are several designs that are possible, including two that are addressed herein because they require control logic:

** Automatic (motorized) sash closers that can be commanded closed to reduce exhaust rates to the hood minimum*

** Motorized dampers that open to the outdoors or other space to provide outdoor air or transfer air to relieve pressure.*

Other strategies include temporary reduction in lab exhaust rates, such as reducing hood setpoints below design or reducing exhaust fan duct pressure setpoints, but they are not addressed herein because they entail some exposure risk to occupants and approval from EH&S authorities.

Include the following paragraph if hoods have sash closers with close-overrides connected to the BAS used to equalize lab pressure to allow for safe exiting in case of a loss of supply air. Delete otherwise.

3. All fume hood sashes in room shall be commanded closed.

Sash closers are a cost-effective way to save energy and also to allow for safe exiting in case of a loss of supply air as described above. To be used for this purpose, the sash closer controller provided by the hood manufacturer requires a digital input that causes it to ignore the presence sensor and any delay-close timers so that it immediately closes the hood when this contact is closed. This is a standard feature of most major hood sash closer manufacturers. When the sashes close, exhaust rates drop to their minimum setpoints. Usually this is sufficient to allow for safe exiting. But occasionally, in labs with very high hood exhaust rates, room negative pressures can still be excessive. In that case, other means to reduce exhaust rate or increase supply air to equalize lab pressure must be provided by the design team.

Include the following paragraph if motorized relief dampers are used to equalize lab pressure to allow for safe exiting in case of a loss of supply air. Delete otherwise.

4. Open lab pressure relief dampers.

Another option to allow for safe exiting in case of a loss of supply air is to provide pressure relief dampers, e.g., in exterior walls or ducted from the lab to an exterior hood or louver. These dampers may be motorized, as assumed here, but also may be non-powered barometric type, in which case no control logic or devices are needed.

5.23.8.4. Low discharge air temperature

a. If heating hot water plant is proven on and the discharge air temperature is 8°C (15°F) less than setpoint for 10 minutes, generate a Level 3 alarm.

b. If heating hot water plant is proven on and the discharge air temperature is 17°C (30°F) less than setpoint for 10 minutes, generate a Level 2 alarm.

5.23.8.5. High discharge air temperature

a. If chiller plant is proven on and the discharge air temperature is 6°C (10°F) more than setpoint for 10 minutes, generate a Level 3 alarm.

b. If chiller plant is proven on and the discharge air temperature is 11°C (20°F) more than setpoint for 10 minutes, generate a Level 2 alarm.

5.23.8.6. Fume hood

a. Fume hood alarm: Level 2

b. If average sash height (interpolated based on average airflow feedback through the hood and design maximum and minimum setpoints) during the last 24 hours is greater than 50% (adjustable), generate a Level 4 alarm.

5.23.9. Testing/Commissioning Overrides: Provide software points that interlock to a system level point to

5.23.9.1. Force supply airflow setpoint to zero

5.23.9.2. Force supply airflow setpoint to Vmax

5.23.9.3. Force supply airflow setpoint to Vmin

5.23.9.4. Force supply damper full closed/open

5.23.9.5. Force heating valve to closed/open

If there are no 4-pipe lab zone terminals, delete the following paragraph:

5.23.9.6. Force cooling valve to closed/open

If there are no hardwired or networked hood exhaust setpoint override points, delete the following two paragraphs:

5.23.9.7. Force hood exhaust airflow setpoint to Vhex-max

5.23.9.8. Force hood exhaust airflow setpoint to Vhex-min

5.23.9.9. Force general exhaust airflow setpoint to Vgex-max

5.23.9.10. Force general exhaust airflow setpoint to Vgex-ctrl-min

5.23.9.11. Reset request-hours accumulator point to zero (provide one point for each reset type listed below)

5.23.10. System Requests

Delete the next section if there is no cooling coil in the AHU serving the lab supply air valves, as may be the case with 4-pipe VAV systems.

5.23.10.1. Cooling SAT Reset Requests

a. If the Cooling Loop is greater than 95% and 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, send 3 Requests.

b. Else if the Cooling Loop is greater than 95% and 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, 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.

Delete the next section if there are no mechanically pressure independent venturi type supply air valves whose controllers do not have feedback of damper position and use DP sensors across the air valve instead.

Venturi valve controllers without knowledge of damper position must include differential pressure sensors across the valve for static pressure setpoint reset logic.

5.23.10.2. Supply Static Pressure Reset Requests (differential pressure feedback)

a. If the air valve differential pressure is less than MinSAvalveDP minus 25 Pa (0.1 in. of water) for 30 seconds, send 3 requests.

b. Else if the air valve differential pressure is less than MinSAvalveDP minus 12 Pa (0.05 in. of water) for 30 seconds, send 1 request.

c. Else if the air valve differential pressure is greater than MinSAvalveDP, send 0 requests.

Delete the next section if there are no mechanically pressure independent venturi type hood exhaust air valves whose controllers do not have feedback of damper position and use DP sensors across the air valve instead.

Venturi valve controllers without knowledge of damper position must include differential pressure sensors across the valve for static pressure setpoint reset logic.

Note that requests are conservatively generated to help ensure a sudden change in air valve demand can be met. This issue is also addressed in the Lab Exhaust Fan control sequences.

5.23.10.3. Hood Exhaust Static Pressure Reset Requests (differential pressure feedback)

a. If the air valve differential pressure is less than MinHEvalveDP minus 12 Pa (0.05 in. of water) for 15 seconds, send 3 requests.

b. Else if the air valve differential pressure is less than MinHEvalveDP for 15 seconds, send 1 request.

c. Else if the air valve differential pressure is greater than MinHEvalveDP plus 12 Pa (0.05 in. of water), send 0 requests.

Delete the next section if there are no mechanically pressure independent venturi type general exhaust air valves whose controllers do not have feedback of damper position and use DP sensors across the air valve instead.

Venturi valve controllers without knowledge of damper position must include differential pressure sensors across the valve for static pressure setpoint reset logic.

5.23.10.4. General Exhaust Static Pressure Reset Requests (differential pressure feedback)

a. If the air valve differential pressure is less than MinGEXvalveDP minus 25 Pa (0.1 in. of water) for 30 seconds, send 3 requests.

b. Else if the air valve differential pressure is less than MinGEXvalveDP minus 12 Pa (0.05 in. of water) for 30 seconds, send 1 request.

c. Else if the air valve differential pressure is greater than MinGEXvalveDP, send 0 requests.

Delete the next section if there are no supply air valves whose controllers have feedback of damper position, such as those that use closed loop airflow control or venturi type with damper position feedback transducers.

5.23.10.5. Supply Static Pressure Reset Requests (damper position feedback)

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.

Delete the next section if there are no hood exhaust air valves whose controllers have feedback of damper position, such as those that use closed loop airflow control or venturi type with damper position feedback transducers.

Note that requests are conservatively generated to help ensure a sudden change in air valve demand can be met. This issue is also addressed in the Lab Exhaust Fan control sequences.

5.23.10.6. Hood Exhaust Static Pressure Reset Requests (damper position feedback)

a. If the measured airflow is less than 90% of setpoint while setpoint is greater than zero and the damper position is greater than 90% for 10 seconds, send 3 requests.

b. Else if the damper position is greater than 90%, send 1 request until the damper position is less than 80%.

c. Else if the damper position is less than 90%, send 0 requests.

Delete the next section if there are no general exhaust air valves whose controllers have feedback of damper position, such as those that use closed loop airflow control or venturi type with damper position feedback transducers.

5.23.10.7. General Exhaust Static Pressure Reset Requests (damper position feedback)

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.

5.23.10.8. Hot Water Reset Requests

a. If the HW valve position is greater than 95% and the discharge air temperature is 17°C (30°F) less than setpoint for 5 minutes, send 3 Requests.

b. Else if the HW valve position is greater than 95% and the discharge air temperature is 8°C (15°F) less than setpoint for 5 minutes, send 2 Requests.

c. Else if HW valve position is greater than 95%, send 1 Request until the HW valve position is less than 85%,

d. Else if the HW valve position is less than 95%, send 0 Requests.

5.23.10.9. Heating Hot Water Plant Requests

a. If the HW valve position is greater than 95%, send 1 Request until the HW valve position is less than 10%

b. Else if the HW valve position is less than 95%, send 0 Requests.

If there are no 4-pipe lab zone terminals, delete the following two sections:

5.23.10.10. Chilled Water Reset Requests

a. If the CHW valve position is greater than 95% and the discharge air temperature is 6°C (10°F) greater than setpoint for 5 minutes, send 3 requests.

b. Else if the CHW valve position is greater than 95% and the discharge air temperature is 3°C (5°F) greater than setpoint for 5 minutes, send 2 requests.

c. Else if the CHW valve is greater than 95%, send 1 request.

d. Else if the CHW valve is less than 85%, send 0 requests.

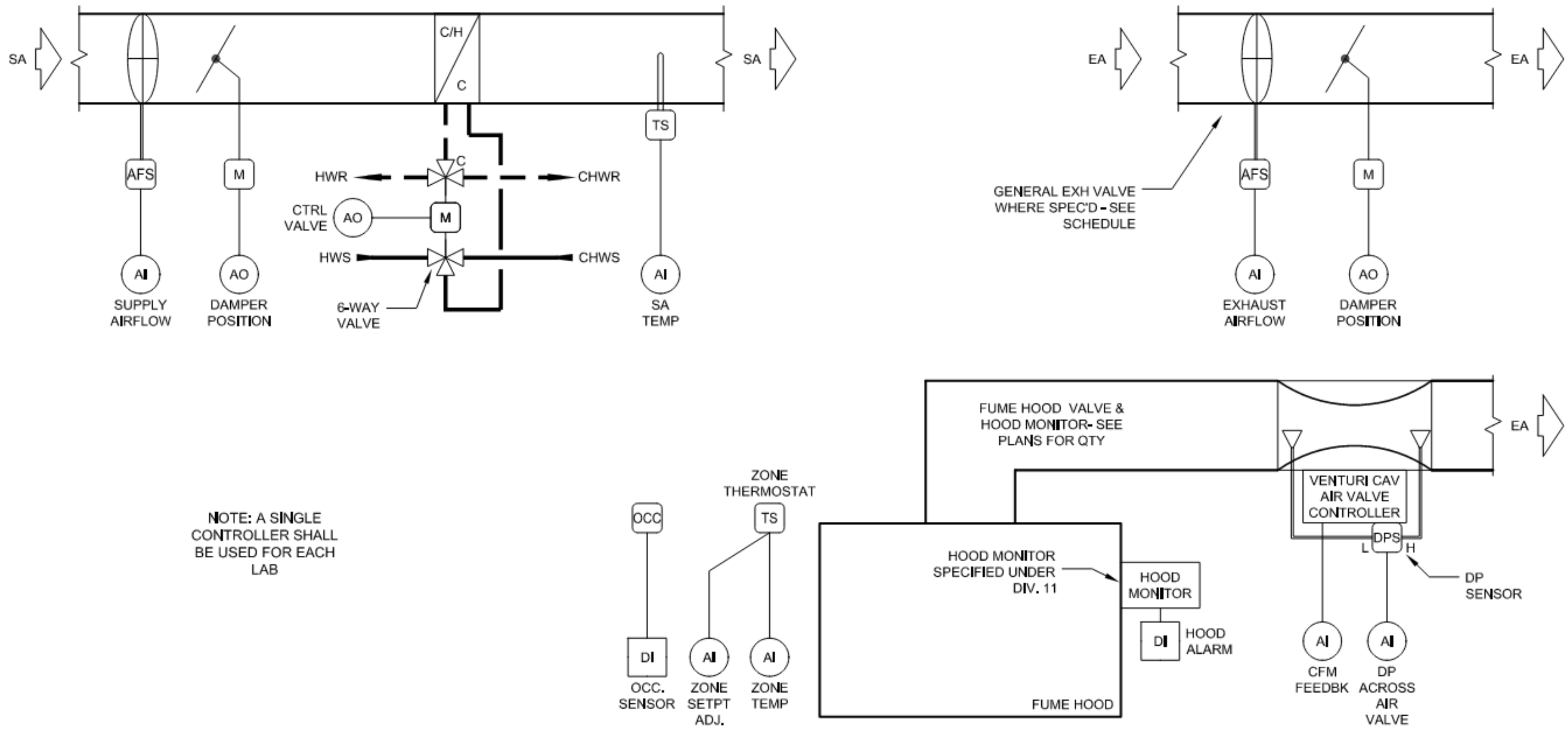
5.23.10.11. Chiller Plant Requests

a. If the CHW valve position is greater than 95%, send 1 Request until the CHW valve position is less than 10%.

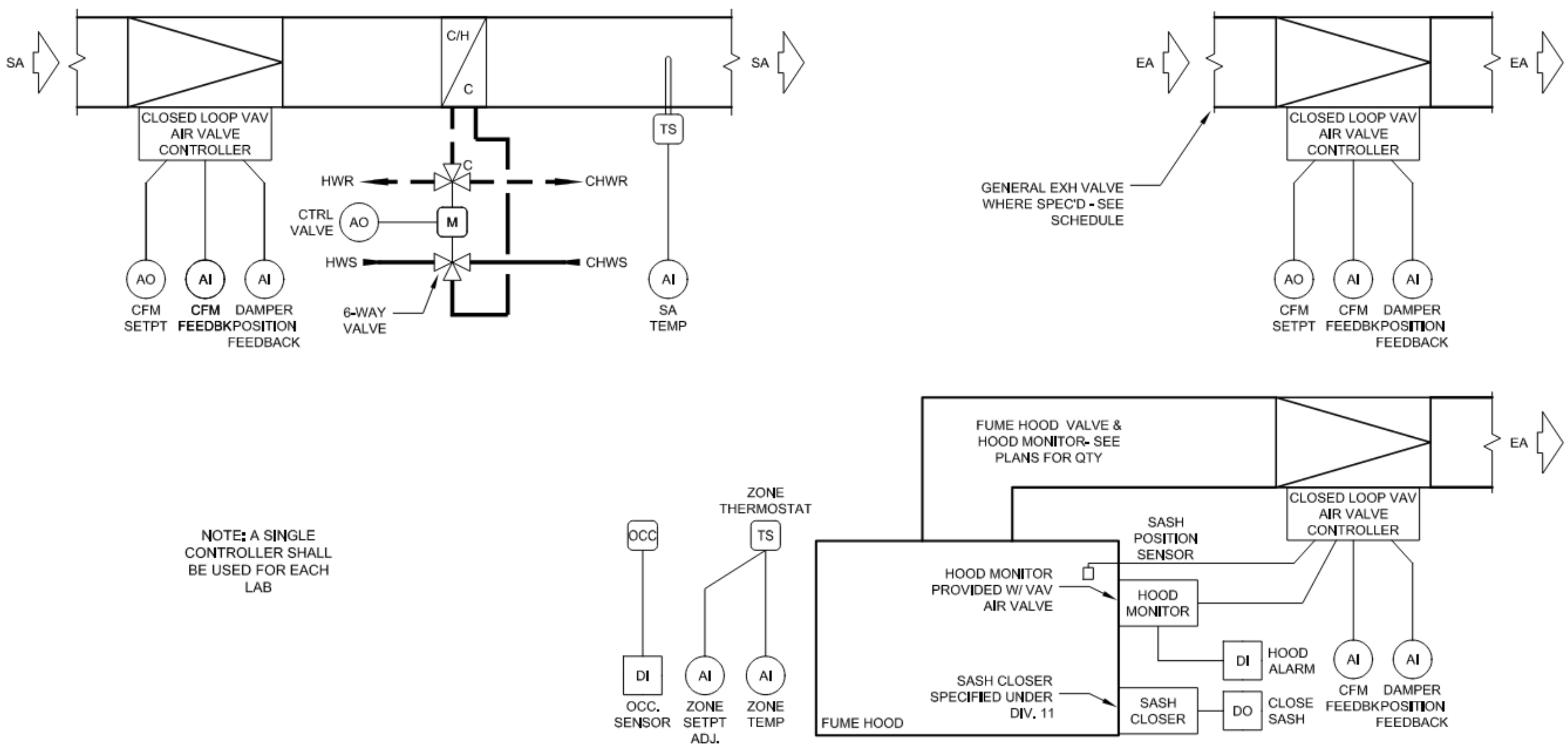
b. Else if the CHW valve position is less than 95%, send 0 Requests.

Add Informative Appendix A-13 to 16 as follows: Note: the figures below are new, but additions are not underlined for ease of review.

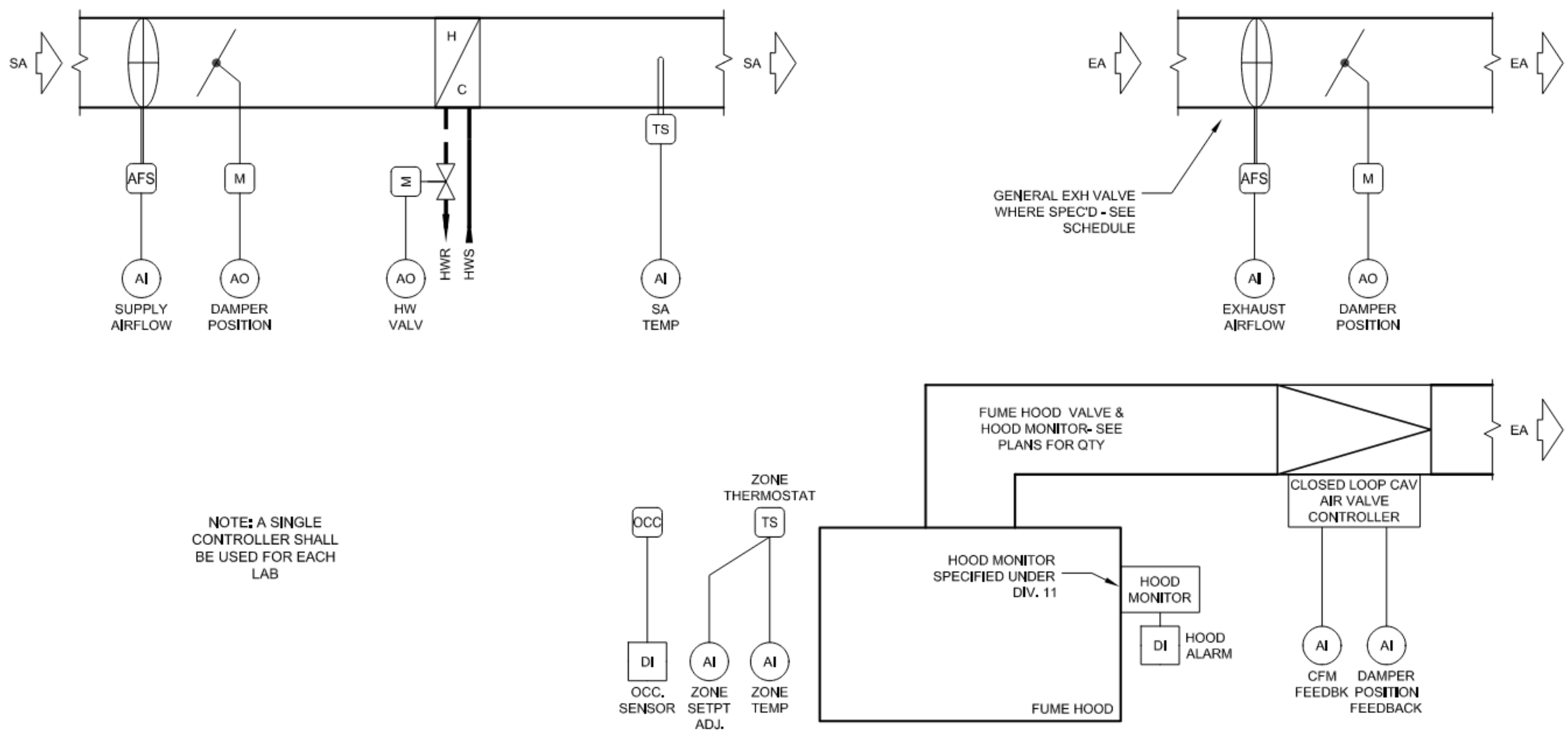
A-29. Laboratory Four-Pipe VAV Zone with Supply Air and General Exhaust Air VAV Boxes



A-30. Laboratory Four-Pipe VAV Zone with Manufactured Closed Loop Air Valves



A-31. Laboratory VAV Reheat Zone with Supply Air and General Exhaust Air VAV Boxes



A-32. Laboratory VAV Reheat Zone with Manufactured Venturi Air Valves