memo

TO	2018 WSEC TAG	**DATE**	July 27, 2018
ATTN.	Duane Jonlin, FAIA	**REGARDING**	EM083-2018
FROM	Hargis Engineers		

The purpose of this memo is to provide a rationale based on analyzed results against approving change proposal EM083-2018 in its current form. As currently written, this change proposal will limit the use of Section C403.6.10 (High Efficiency VAV Systems) to systems that serve a minimum of 3000 square feet and have a minimum of five VAV zones (per C403.6.10.1). With the anticipated adoption of EM061-2018 (approved by the TAG in the 7/20/18 meeting), most assembly spaces within A-1, A-2, and A-3 occupancy categories will be required to utilize a DOAS per Section C403.3.5. The HVAC systems for assembly spaces, such as gyms, multipurpose rooms, and community halls, are traditionally designed as a single-zone system. As a result, DOAS will become the only system option available if EM083-2018 is approved in its current form. Hargis argues that DOAS is NOT the most cost-effective and energy efficient option, nor does it result in the most attractive life-cycle cost, for most single-zone spaces with high occupant density.

Hargis Proposal:

A) Eliminate C403.6.10.1 altogether, or
B) Replace C403.6.10.1 with the following: "System shall include energy recovery ventilation that complies with the minimum energy recovery efficiency and energy recovery bypass requirements, where applicable, of Section C403.7.7.1."
C) Eliminate energy recovery as an exception to demand controlled ventilation (i.e. Exception #1 of Section C403.7.1). Note: this change may have unintended consequences, such as requiring DOAS units serving spaces requiring DCV to be variable air volume as opposed to constant volume (increased first cost).

Potential Outcomes:

1) Approve EM083-2018 as-currently written:
DOAS will become the only system option for occupancy types that require DOAS and are served by single-zone HVAC systems. As a result, annual energy consumption, energy costs, first costs, maintenance costs, and 50-year life cycle costs will likely **INCREASE**. Additionally, this leaves HVAC designers with limited design options.
2) Revise EM083-2018 per Option A above:
HE-VAV systems can still be utilized for occupancy types that require DOAS, regardless of the size and number of zones within the system. As a result, energy consumption and all costs will remain **UNCHANGED**.
3) Revise EM08-2018 per Option B above:
HE-VAV systems (with energy recovery) can still be utilized for occupancy types that require DOAS. As a result, energy consumption and costs will **DECREASE**.
4) Revise Section C403.7.1 per Option C above:
Requires DCV in spaces if they meet existing parameters (>500 square feet and occupant load >/= 25 people per 1000 square feet), regardless of whether energy recovery is installed. Although this particular situation was not analyzed within this study, energy

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consumption will likely **DECREASE**. However, first costs for some system types may **INCREASE**. The impact on life cycle costs would require further evaluation.

Analysis:

The analysis below of a large volume high occupancy multipurpose room supports Hargis' concern regarding this proposal. This analysis was conducted using a specific set of conditions and assumptions, but is emblematic of what is seen in current designs. Hargis understands that the results may differ for each unique space and system type; however, this analysis should at minimum encourage the TAG to thoroughly evaluate the potential impacts of this proposal prior to approval in its current form.

Hargis believes that this proposal, in combination with other proposals that have been approved in recent TAG meetings, will **INCREASE** energy consumption and thus defy the intended purpose of the TAG and future energy codes. In addition, this proposal will lead to an **INCREASE** in first and life cycle costs. Although it is important to thoroughly evaluate change proposals on an individual basis, it is of even greater importance to evaluate the interactive effects of ALL proposals to ensure unintended consequences do not result.

Results:

The analysis studied the comparison between energy consumption (EUI), operating costs (energy, annual maintenance, and repair), first costs, and life cycle costs of (3) HVAC system types serving a large volume high occupancy multipurpose room. The three systems types analyzed are listed below. Note that Options 2 & 3 utilize Exception 2 of Section C403.3.5 (i.e. HE-VAV exception), since DOAS is now required for assembly spaces per the passage of EM061-2018.

Option 1 - DOAS + RTU: required system type if EM083 is passed (see Outcome #1 above)
Option 2 - VAV-RTU: permitted system type if Option A is passed (see Outcome #2 above)
Option 3 - VAV-RTU w/ energy recovery: permitted system type if Option B is passed (see Outcome #3 above)

The table is color-coordinated for visual purposes. For each metric, **green** indicates the best performing system, whereas **red** indicates the worst performing system.

Metric	Option 1	Option 2	Option 3
	DOAS + RTU	VAV-RTU	VAV-RTU w/ Energy Recovery
EUI (kBTU/SF/Yr)	**49.9**	40.3	**37.0**
First Cost	**$64,750**	**$46,200**	$59,350
Energy Cost (year 1)	**$4,290**	$3,442	**$3,244**
Maintenance Cost (year 1)	**$1,741**	**$1,102**	**$1,102**
Life Cycle Cost (50-year)	**$410,271**	**$304,034**	$329,096

The large EUI delta between the two system types is primarily attributed to the fact that DOAS units with energy recovery do NOT require demand controlled ventilation (DCV) per Exception 1 of Section C403.7.1. As the results indicate, eliminating DCV within space types that are

frequently loaded at occupancy rates well below peak conditions, such as gyms, multipurpose rooms, auditoriums and large meeting spaces, significantly increases energy consumption even when the DOAS unit contains energy recovery. Outcome #4 above would mitigate this issue by requiring DCV regardless of whether energy recovery is installed.

Space Information:

Type: Multipurpose room (within a school)
Occupancy: A-3
Size: 6,000 square feet
Height: 30 feet
People: 600 max (100 people per 1000 square feet)
Lighting: 0.98 W/SF
Envelope: prescriptive per Table C402.1.3
Schedule: M-F 8AM-6PM, year-round (except for standard holidays)
Occupancy: assumes 10% (60 people), with 100% occupancy for 1 hour each day

HVAC System Options:

System Features	Option 1	Option 2	Option 3
	DOAS + RTU	VAV-RTU	VAV-RTU w/ Energy Recovery
Compliance method	Required if EM083 is passed (Outcome #1 above)	Only permitted if Option A above is passed (Outcome #2 above)	Only permitted if Option B above is passed (Outcome #3 above)
Cooling	DX Efficiency per Table C403.2.3(1)A	Same as Option 1	Same as Option 1
Heating	80% efficient gas-fired furnace per Table C403.2.3(4)	Heating water coil, served by 90% efficient gas-fired boiler per Section C403.7.15.1	Same as Option 2
Fan Power	RTU & DOAS calculated per Table C403.2.11.1(1) Note: EM094-2018 now requires separate fan power allowance calculations for DOAS	RTU calculated per Table C403.2.11.1(1)	Same as Option 2
Supply Airflow	9,000 CFM (assumes 1.5 CFM/SF)	Same as Option 1	Same as Option 1
Economizer	No	Yes	Yes
Ventilation (Max)	4,860 CFM (7.5 CFM/person, 0.06 CFM/SF)	Same as Option 1	Same as Option 1
Ventilation (Min)	Same as Max	810 CFM (assumes only 60 people)	Same as Option 2
Energy Recovery	Yes (per C403.6.1)	No	Yes
Demand Controlled Ventilation	No (not required per C403.2.6.2 exception 1)	Yes	Yes
Airflow Control	DOAS: constant volume RTU: 2-speed, 50% turndown per C403.2.11.5	VAV (20% minimum turndown)	Same as Option 2
Temperature Setpoints	Heating: 70/60 Cooling: 75/85 (occupied/unoccupied)	Same as Option 1	Same as Option 1

Note: all code references within the table above are based on the 2015 WSEC

Cost Opinion:

2018 RSMeans Mechanical was utilized as the basis for all cost opinions. Cost estimates include rooftop equipment and do not account for ductwork, controls, insulation, commissioning, etc.

Option 1: DOAS+ RTU

Component	Cost	Reference
DOAS	$14,800 $13,150	Page 392: 12.5 ton single-zone RTU w/ DX & gas heat (assumes 400 CFM/ton) Page 390: Air-to-air heat wheel, 5000 CFM
RTU	$36,800	Page 392: 20 ton single-zone RTU w/ DX & gas heat (assumes 400 CFM/ton)
Total	**$64,750**	

Option 2: VAV-RTU

Component	Cost	Reference
DOAS	-	
RTU	$46,200	Page 393: 25 ton single-zone RTU w/ DX, gas heat, & VAV (assumes 400 CFM/ton)
Total	**$46,200**	

Option 3: VAV-RTU w/ Energy Recovery

Component	Cost	Reference
DOAS	-	
RTU	$46,200 $13,150	Page 393: 25 ton single-zone RTU w/ DX, gas heat, & VAV (assumes 400 CFM/ton) Page 390: Air-to-air heat wheel, 5000 CFM
Total	**$59,350**	

Maintenance Estimates:

The Whitestone Building Maintenance and Repair Cost Reference was utilized as the basis for all maintenance estimates.

Option 1: DOAS+ RTU

Component	Annual Maintenance	Repair Costs	Repair Frequency	Annualized Cost
DOAS	$392	$2,994	10 years	$691
RTU	$725	$3,252	10 years	$1,050
			Total	**$1,741**

Option 2: VAV-RTU

Component	Annual Maintenance	Repair Costs	Repair Frequency	Annualized Cost
DOAS	-	-	-	-
RTU	$761	$3,414	10 years	$1,102
			Total	**$1,102**

Option 3: VAV-RTU w/ Energy Recovery

Component	Annual Maintenance	Repair Costs	Repair Frequency	Annualized Cost
DOAS	-	-	-	-
RTU	$761	$3,414	10 years	$1,102
			Total	**$1,102**

Energy Modeling:
A simple shoe-box model was developed for each HVAC option based on the inputs described above. 2018 IES-VE was utilized as the energy modeling software.

Appendix:

1) 50-year ELCCA
2) DOAS+RTU One-Line Diagram
3) Single-zone RTU One-Line Diagram
4) EM083-2018 change proposal

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Office of Financial Management
Olympia, Washington - Version: 2015-B
Evaluation Life Cycle Cost Analysis Tool

ELCCAT Inputs & Report

ELCCA Results Table	PV of Capital Cost	PV of Maint. Costs	PV of Utility Costs	Total Life Cycle Cost	Net Present Savings	NPS w/SCC	EUI	SIR
Baseline: DOAS + RTU	$170,422	$61,300	$178,550	$410,271	N/A	N/A	49.9	N/A
Single-Zone VAV	$121,598	$38,801	$143,635	$304,034	$106,236	$122,486	40.3	No Cost
Single-Zone VAV with Energy Recovery	$156,209	$38,801	$134,087	$329,096	$81,174	$101,692	37.0	No Cost
0	$0	$0	$0	$0	$410,271	$493,128	0.0	No Cost
0	$0	$0	$0	$0	$410,271	$493,128	0.0	No Cost
0	$0	$0	$0	$0	$410,271	$493,128	0.0	No Cost
0	$0	$0	$0	$0	$410,271	$493,128	0.0	No Cost
0	$0	$0	$0	$0	$410,271	$493,128	0.0	No Cost
0	$0	$0	$0	$0	$410,271	$493,128	0.0	No Cost
0	$0	$0	$0	$0	$410,271	$493,128	0.0	No Cost

Project:	Single Zone VAV vs. DOAS	
Analysts Firm:	Hargis Engineers	
Electric Rate ($/KWH):	$0.09	Sq.Ft. for EUI Calc
Natural Gas Rate ($/Therm):	$0.82	6,000

NPS = Net Present Savings, SCC = Social Cost of Carbon Doxide Pollution, EUI = Energy Use Intensity (kBtu/sq.ft), SIR = Savings to Investment Ratio (Net Present Savings/Incremental PV of Capital Costs)

DOAS + RTU

#	Weighted Average and Totals	15.0	$64,750	$1,741	Narrative
	Component Description	Useful Life	Installed Cost	Annual Maintenance	REF #
1	Non Re-Occuring Upfront Costs	50	$0.00	$1,741.00	
2	DOAS with Energy Recovery	15	$27,950.00		
3	RTU	15	$36,800.00		
4					
5					
6					
7					
8					
9					
10					
	Annual Elec Consumption (KWH)	31,896	Annual Electric Costs	$2,730	
	Annual N.G. Consumption (Therms)	1,907	Annual N.G. Costs	$1,560	

#	Weighted Average and Totals		$0	$0	Narrative
	Component Description	Useful Life	Installed Cost	Annual Maintenance	REF #
1	Non Re-Occuring Upfront Costs	50		$0.00	
2					
3					
4					
5					
6					
7					
8					
9					
10					
	Annual Elec Consumption (KWH)		Annual Electric Costs	$0	
	Annual N.G. Consumption (Therms)		Annual N.G. Costs	$0	

Single-Zone VAV

#	Weighted Average and Totals	15.0	$46,200	$1,102	Narrative
	Component Description	Useful Life	Installed Cost	Annual Maintenance	REF #
1	Non Re-Occuring Upfront Costs	50	$0.00	$1,102.00	
2	VAV-RTU	15	$46,200.00		
3					
4					
5					
6					
7					
8					
9					
10					
	Annual Elec Consumption (KWH)	25,344	Annual Electric Costs	$2,169	
	Annual N.G. Consumption (Therms)	1,556	Annual N.G. Costs	$1,273	

#	Weighted Average and Totals		$0	$0	Narrative
	Component Description	Useful Life	Installed Cost	Annual Maintenance	REF #
1	Non Re-Occuring Upfront Costs	50		$0.00	
2					
3					
4					
5	oeuo				
6					
7					
8					
9					
10					
	Annual Elec Consumption (KWH)		Annual Electric Costs	$0	
	Annual N.G. Consumption (Therms)		Annual N.G. Costs	$0	

Single-Zone VAV with Energy Recovery

#	Weighted Average and Totals	15.0	$59,350	$1,102	Narrative
	Component Description	Useful Life	Installed Cost	Annual Maintenance	REF #
1	Non Re-Occuring Upfront Costs	50	$0.00	$1,102.00	
2	VAV-RTU with Energy Recovery	15	$59,350.00		
3					
4					
5					
6					
7					
8					
9					
10					
	Annual Elec Consumption (KWH)	24,717	Annual Electric Costs	$2,116	
	Annual N.G. Consumption (Therms)	1,379	Annual N.G. Costs	$1,128	

#	Weighted Average and Totals		$0	$0	Narrative
	Component Description	Useful Life	Installed Cost	Annual Maintenance	REF #
1	Non Re-Occuring Upfront Costs	50		$0.00	
2					
3					
4					
5					
6					
7					
8					
9					
10					
	Annual Elec Consumption (KWH)		Annual Electric Costs	$0	
	Annual N.G. Consumption (Therms)		Annual N.G. Costs	$0	

H A R G I S

DOAS WITH ROOFTOP UNIT (RTU)

NOTES:

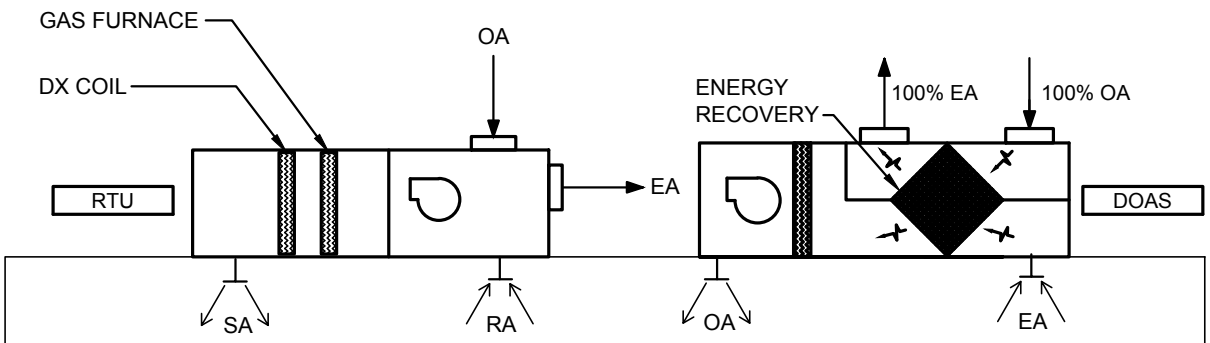
1) ALL CODE REFERENCES PER 2015 WSEC.
2) ASSUMES MULTIPURPOSE ROOM IS OPERATED YEAR-ROUND FROM 8AM-6PM WITH TYPICAL HOLIDAYS.
3) HEATING SETPOINT = 70°F (60°F). COOLING SETPOINT = 75°F (85°F).
4) ASSUMES 25% OCCUPIED ON AVERAGE (60 PEOPLE) WITH 100% OCCUPANCY FOR 1 HOUR EVERYDAY.
5) PUMP ENERGY IGNORED (RELATES TO SINGLE-ZONE VAV SYSTEM ONLY).

RTU INFO:

- 9,000 CFM SUPPLY (1.5 CFM/SF)
- 100% AIRSIDE ECONOMIZER PER EM080-2018
- 50% MIN TURNDOWN (4,500 CFM) PER C403.2.11.5
- DX COOLING EFFICIENCY PER TABLE C403.2.3(1)A
- ASSUMES 80% EFFICIENT GAS FURNACE PER TABLE C403.2.3(4)
- FAN POWER PER TABLE C403.2.11.1(1)

DOAS INFO:

- 4,860 CFM OA (7.5 CFM/PERSON, 0.06 CFM/SF)
- NO TURNDOWN (CONSTANT VOLUME)
- ENERGY RECOVERY PER C403.5
- FAN POWER PER TABLE C403.2.11.1(1) (PER EM094-2018)



MULTIPURPOSE ROOM (WITHIN A SCHOOL)
- 6,000 SF
- 30'-0" TALL
- 600 PEOPLE MAX (100 PEOPLE/1000 SF)
- 0.98 W/SF LIGHTING

CODE MIN ENVELOPE PER TABLE C402.1.3

S OS

PER C403.2.6.3

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SINGLE-ZONE HIGH EFFICIENCY VAV

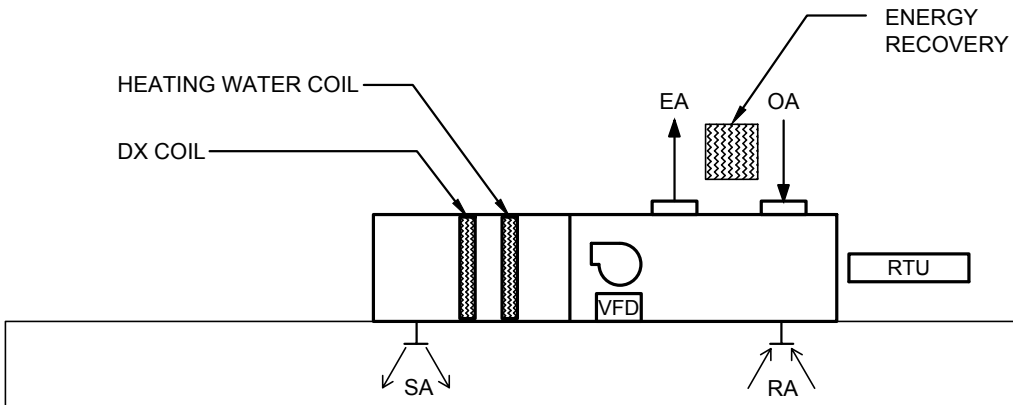
NOTES:

1) ALL CODE REFERENCES PER 2015 WSEC.
2) ASSUMES MULTIPURPOSE ROOM IS OPERATED YEAR-ROUND FROM 8AM-6PM WITH TYPICAL HOLIDAYS.
3) HEATING SETPOINT = 70°F (60°F). COOLING SETPOINT = 75°F (85°F).
4) ASSUMES 25% OCCUPIED ON AVERAGE (60 PEOPLE) WITH 100% OCCUPANCY FOR 1 HOUR EVERYDAY.
5) PUMP ENERGY IGNORED (RELATES TO SINGLE-ZONE VAV SYSTEM ONLY).

RTU INFO:

- 9,000 CFM SUPPLY (1.5 CFM/SF)
- 4,860 CFM OA (7.5 CFM/PERSON, 0.06 CFM/SF)
- 100% AIRSIDE ECONOMIZER
- 20% MIN TURNDOWN (1,800 CFM)
- DEMAND CONTROLLED VENTILATION
- DX COOLING EFFICIENCY PER TABLE C403.2.3(1)A
- UNIT SERVED BY 90% EFFICIENT GAS-FIRED BOILER PER SECTION C403.7.15.1
- FAN POWER PER TABLE C403.2.11.1(1)

ENERGY RECOVER PER C403.5



MULTIPURPOSE ROOM (WITHIN A SCHOOL)
- 6,000 SF
- 30'-0" TALL
- 600 PEOPLE MAX (100 PEOPLE/1000 SF)
- 0.98 W/SF LIGHTING

CODE MIN ENVELOPE PER TABLE C402.1.3

S CO2 OS

PER C403.7.13

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EM083-2018

STATE OF WASHINGTON

STATE BUILDING CODE COUNCIL

2015 Washington State Energy Code Development

Energy Code Proposal Short Form

For editorial **Coordination, Clarifications & Corrections** only,
without substantive energy or cost impacts

Code being amended: ☒ Commercial Provisions ☐ Residential Provisions
(A MS Word version of the code is linked to the name)

Code Section: **C403.6.10 High efficiency VAV Systems**

Brief Description:

Clarify requirements for HE VAV Systems as shown below.

Proposed code change text: (Copy the existing text from the Integrated Draft, linked above, and then use underline for new text and ~~strikeout~~ for text to be deleted.)

C403.6.10 High efficiency variable air volume (VAV) systems. For HVAC systems subject to the requirements of Section C403.3.5 but utilizing Exception 2 of that section, a high efficiency multiple-zone VAV system may be provided without a separate parallel DOAS when the system is designed, installed, and configured to comply with all of the following criteria (this exception shall not be used as a substitution for a DOAS per Section C406.6 or as a modification to the requirements for the Standard Reference Design per Section C407):

1. Each VAV system must serve a minimum of 3000 square feet and have a minimum of five VAV zones.

~~1.~~2. The VAV systems are provided with airside economizer per Section 403.3 without exceptions.

~~2.~~3. A direct-digital control (DDC) system is provided to control the VAV air handling units and associated terminal units per Section C403.4.11 regardless of sizing thresholds of Table C403.4.11.1.

~~3.~~4. Multiple-zone VAV systems with a minimum outdoor air requirement of 2,500 cfm (1180 L/s) or greater shall be equipped with a device capable of measuring outdoor airflow intake under all load conditions. The system shall be capable of increasing or reducing the outdoor airflow intake based on feedback from the VAV terminal units as required by Section C403.6.5, without exceptions, and Section C403.7.1 demand controlled ventilation.

~~4.~~5. Multiple-zone VAV systems with a minimum outdoor air requirement of 2,500 cfm (1180 L/s) or greater shall be equipped with a device capable of measuring supply airflow to the VAV terminal units under all load conditions.

~~5.~~6. In addition to meeting the zone isolation requirements of C403.2.1 a single VAV air handling unit shall not serve more than 50,000 square feet (2323 m2) unless a single floor is greater than 50,000 square feet (2323 m2) in which case the air handler is permitted to serve the entire floor.

~~6.~~7. The primary maximum cooling air for the VAV terminal units serving interior cooling load driven zones shall be sized for a supply air temperature that is a minimum of 5°F greater than the supply air temperature for the exterior zones in cooling.

~~7.~~8. Air terminal units with a minimum primary airflow setpoint of 50% or greater of the maximum primary airflow setpoint shall be sized with an inlet velocity of no greater than 900 feet per minute.

~~8. DDC systems be designed and configured per the guidelines set by *High Performance Sequences of Operation for HVAC Systems* (ASHRAE GPC 36, RP-1455).~~

9. Allowable fan motor horsepower shall not exceed 90% of the allowable HVAC *fan system bhp* (Option 2) as defined by Section C403.8.1.1.

10. All fan powered VAV terminal units (series or parallel) shall be provided with electronically commutated motors. The DDC system shall be configured to vary the speed of the motor as a function of the heating and cooling load in the space. Minimum speed shall not be greater than 66 percent of design airflow required for the greater of heating or cooling operation. Minimum speed shall be used during periods of low heating and cooling operation and ventilation-only operation.

    Exception: For series fan powered terminal units where the volume of primary air required to deliver the ventilation requirements at minimum speed exceeds the air that would be delivered at the speed defined above, the minimum speed setpoint shall be configured to exceed the value required to provide the required ventilation air**.**

11. Fan-powered VAV terminal units shall only be permitted at perimeter zones with an envelope heating load requirement. All other VAV terminal units shall be single duct terminal units.

    Exception: Fan powered VAV terminal units are allowed at interior conference rooms with demand control ventilation per C403.7.1.

12. When in occupied heating or in occupied deadband between heating and cooling all fan powered VAV terminal units shall be configured to reset the primary air supply setpoint, based on the VAV air handling unit outdoor air vent fraction, to the minimum ventilation airflow required per *International Mechanical Code* without utilizing exceptions 2, 3, or 4 of Section C403.6.1.

13. Spaces that are larger than 150 square feet (14 m^2) and with an occupant load greater than or equal to 25 people per 1000 square feet (93 m^2) of floor area (as established in Table 403.3.1.1 of the *International Mechanical Code*) shall be provided with all of the following features:
    13.1. A dedicated VAV terminal unit capable of controlling the space temperature and minimum ventilation shall be provided.
    13.2. Demand control ventilation (DCV) shall be provided that utilizes a carbon dioxide sensor to reset the ventilation setpoint of the VAV terminal unit from the design minimum to design maximum ventilation rate as required by Chapter 4 of the *International Mechanical Code*.
    13.3. Occupancy sensors shall be provided that are configured to reduce the minimum ventilation rate to zero and setback room temperature setpoints by a minimum of 5°F, for both cooling and heating, when the space is unoccupied.

14. Dedicated server rooms, electronic equipment rooms, telecom rooms, or other similar spaces with cooling loads greater than 5 watts/ft^2 shall be provided with separate, independent HVAC systems to allow the VAV air handlers to turn off during unoccupied hours in the office space and to allow the supply air temperature reset to occur.

    Exception: The VAV air handling unit and VAV terminal units may be used for secondary backup cooling when there is a failure of the primary HVAC system.

    Additionally, server rooms, electronic equipment rooms, telecom rooms, or other similar spaces shall be provided with airside economizer per Section C403.5 without using the exceptions to Section C403.5.

    Exception: Heat recovery per exception 9 of Section C403.5 may be in lieu of airside economizer for the separate, independent HVAC system.

15. HVAC system central heating or cooling plant will include a minimum of one of the following options:
    15.1. VAV terminal units with hydronic heating coils connected to systems with hot water generation equipment limited to the following types of equipment: gas-fired hydronic boilers with a thermal efficiency, E_t, of not less than 9~~0~~92 percent, air-to-water heat pumps or heat recovery chillers. Hydronic heating coils shall be sized for a maximum entering hot water temperature of 120°F for peak anticipated heating load conditions.
    15.2. Chilled water VAV air handing units connected to systems with chilled water generation equipment with IPLV values more than 25 percent higher than the minimum part load efficiencies

listed in Table C403.3.2(7), in the appropriate size category, using the same test procedures. Equipment shall be listed in the appropriate certification program to qualify. The smallest chiller or compressor in the central plant shall not exceed 20% of the total central plant cooling capacity or the chilled water system shall include thermal storage sized for a minimum of 20% of the total central cooling plant capacity.

16. The DDC system shall include a fault detection and diagnostics (FDD) system complying with the following:
    16.1. The following temperature sensors shall be permanently installed to monitor system operation:
        16.1.1. Outside air.
        16.1.2. Supply air.
        16.1.3. Return air.
    16.2. Temperature sensors shall have an accuracy of ±2°F (1.1°C) over the range of 40°F to 80°F (4°C to 26.7°C).
    16.3. The VAV air handling unit controller shall be configured to provide system status by indicating the following:
        16.3.1. Free cooling available.
        16.3.2. Economizer enabled.
        16.3.3. Compressor enabled.
        16.3.4. Heating enabled.
        16.3.5. Mixed air low limit cycle active.
        16.3.6. The current value of each sensor.
    16.4. The VAV air handling unit controller shall be capable of manually initiating each operating mode so that the operation of compressors, economizers, fans and the heating system can be independently tested and verified.
    16.5. The VAV air handling unit shall be configured to report faults to a fault management application accessible by day-to-day operating or service personnel or annunciated locally on zone thermostats.
    16.6. The VAV terminal unit shall be configured to report if the VAV inlet valve has failed by performing the following diagnostic check at a maximum interval of once a month:
        16.6.1. Command VAV terminal unit primary air inlet valve closed and verify that primary airflow goes to zero.
        16.6.2. Command VAV thermal unit primary air inlet valve to design airflow and verify that unit is controlling to with 10% of design airflow.
    16.7. The VAV terminal unit shall be configured to report and trend when the zone is driving the following VAV air handling unit reset sequences. The building operator shall have the capability to exclude zones used in the reset sequences from the DDC control system graphical user interface:
        16.7.1. Supply air temperature setpoint reset to lowest supply air temperature setpoint for cooling operation.
        16.7.2. Supply air duct static pressure setpoint reset for the highest duct static pressure setpoint allowable.
    16.8. The FDD system shall be configured to detect the following faults:
        16.8.1. Air temperature sensor failure/fault.
        16.8.2. Not economizing when the unit should be economizing.
        16.8.3. Economizing when the unit should not be economizing.
        16.8.4. Outdoor air or return air damper not modulating.
        16.8.5. Excess outdoor air.
        16.8.6. VAV terminal unit primary air valve failure.

Purpose of code change:

Clarify requirements based on comments received.

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Instructions: For use with Coordination, Clarifications & Corrections **ONLY**. Send this form as an email attachment, along with any other documentation available, to: sbcc@ga.wa.gov. For further information, call the State Building Code Council at 360-407-9277.