2021 WSEC Commercial

KEY CHANGES TO THE MECHANICAL PROVISIONS

PART 1

WSEC Commercial Technical Support Team:
Duane Lewellen – Lewellen Associates, LLC
Lisa Rosenow - Evergreen Technology Consulting (ETC)
(360) 539-5300 | com.techsupport@waenergycodes.com

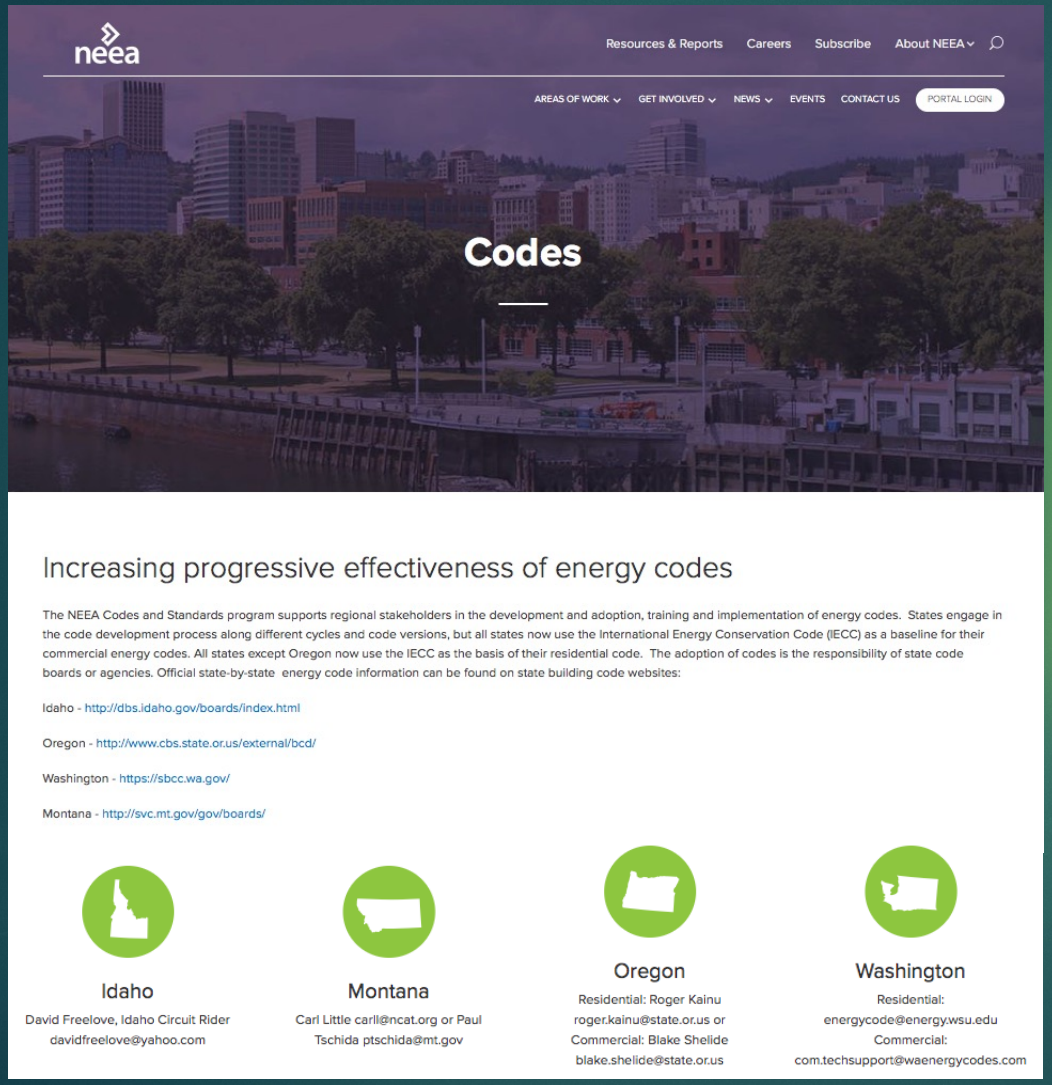
WSEC Commercial Technical Support

- On-call technical support thru 3 avenues
  - Telephone hot line – **360-539-5300**
  - Online form – **https://www.waenergycodes.com**
  - Email inquiries – **com.techsupport@waenergycodes.com**
- Classroom and webinar training
- We administer the technical support and compliance documentation webtool

Duane Lewellen

Chris Haas, PE

Lisa Rosenow



WSEC technical support services are made possible thanks to the generous support of the Northwest Energy Efficiency Alliance

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Today's Presentation

- This presentation represents ETC's ***unofficial*** interpretation of code intent.
- Our technical support team is not an affiliate, nor do we speak for the Washington State Building Code Council (SBCC).
- The WSEC commercial technical support we provide is advisory only and non-binding.

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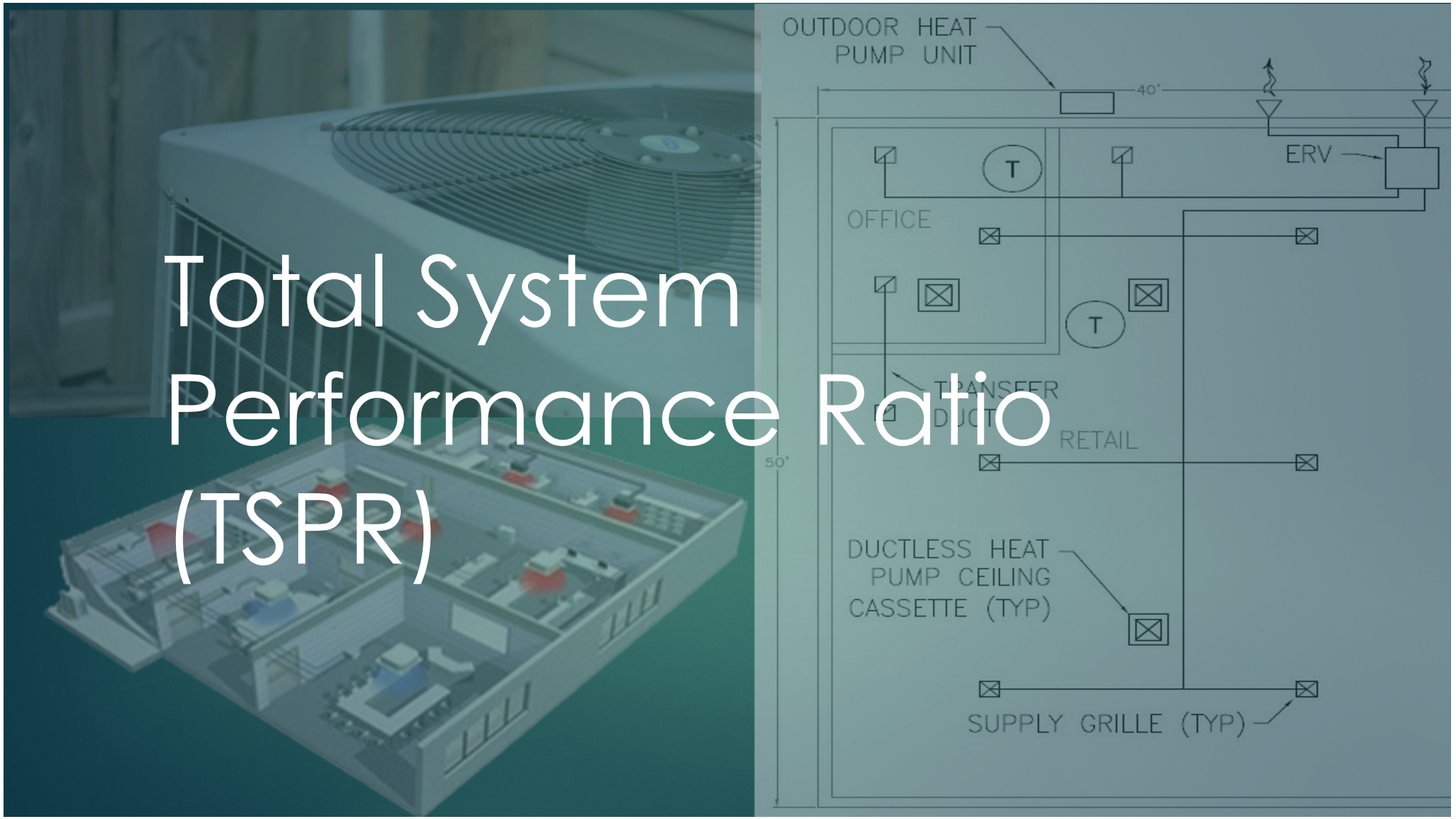
Topics we'll discuss today ~

1. Total system performance ratio (TSPR)
2. HVAC equipment efficiency
3. Dedicated outdoor air systems (DOAS)
4. Package terminal heat pumps and vertical package terminal heat pumps
5. HVAC fan power allowance
6. Data centers
7. Group R-2 multi-family building definition
8. Q&A

Current Status of the 2021 WSEC-C

- **Effective date of the 2021 WSEC has been delayed until October 29th, 2023**
- The Energy Code Technical Advisory Group (TAG) is being reconvened to address legal uncertainty stemming from the decision in California Restaurant Association v. City of Berkeley recently issued by the Ninth Circuit Court of Appeals.
- This presentation covers changes between the 2018 and 2021 WSEC-C that are not likely to be affected by this process.
- Follow the Washington State Building Council **https://www.sbcc.wa.gov/** for the latest news or to participate in the code development process.

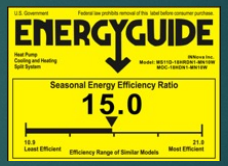
Total System Performance Ratio (TSPR)



What is TSPR?

$$TSPR\ Score = \frac{Annual\ HVAC\ Loads}{Annual\ HVAC\ Carbon\ Emissions}$$

The TSPR analysis tool compares the score of the proposed building to a reference building as defined in 2021 WSEC-C Appendix D

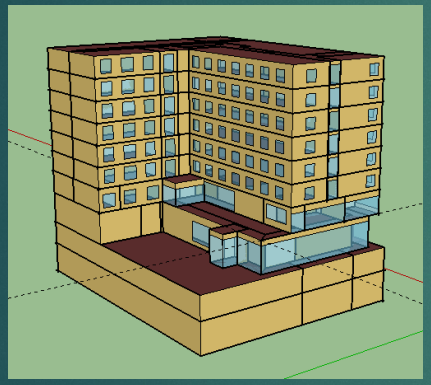


Whole building seasonal HVAC efficiency rating

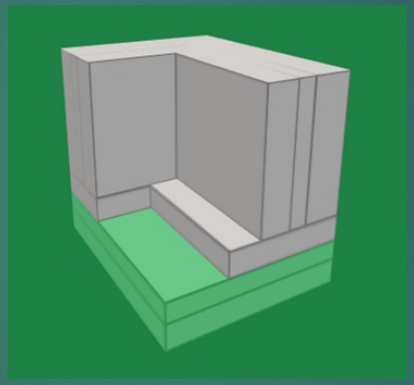
C403.1.1

TSPR Compliance Calculation Tool

- New module on top of DOE's (free) Asset Scope Tool
- Simplified tool to assess building energy efficiency



Typical C407 Energy Model



Asset Score Simplified Model

- Uses default loads and schedules
- Lighting and envelope loads are the same as the baseline loads
- ~10% of the time as a full customized energy model

C403.1.1

TSPR Score Verification

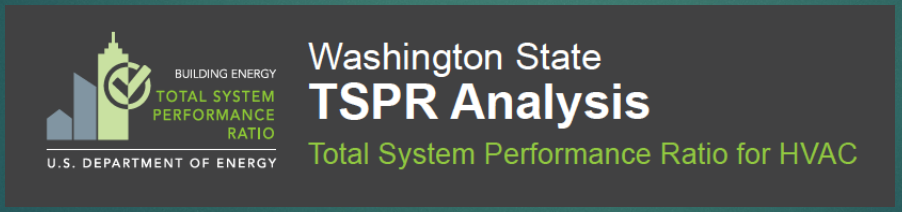
Whole Building Total System Performance Ratio

Proposed Building TSPR:	16.9
Baseline Building TSPR:	12

Larger number = Better score

The Total System Performance Ratio complies with the 2018 Washington State Energy Code.

Total System Performance Ratio (TSPR) is the ratio of the sum of a building's annual heating and cooling load in thousands of BTUs to the sum of the annual carbon emissions in pounds from energy consumption of the building HVAC systems.



Proposed building score must be equal to or higher than the Baseline building score

C403.1.1

Scope of TSPR provision has expanded to additional occupancy types

- HVAC systems serving office (**including medical office**), retail, library and education occupancies that are subject to the DOAS requirements, without exceptions
- **HVAC systems serving dwelling units and residential common areas within Group R-2 multi-family buildings**

BUILDING ENERGY
TOTAL SYSTEM PERFORMANCE RATIO
U.S. DEPARTMENT OF ENERGY

C403.1.1

Standard reference design HVAC system criteria added for multifamily buildings (Appendix D)

Table D602.11
Standard Reference Design HVAC Systems

Parameter	Building Type				
	Large Office[a]	Small Office and Libraries[a]	Retail	School	Multifamily
System Type	Water-source Heat Pump	Packaged air-source Heat Pump	Packaged air-source Heat Pump	Packaged air-source Heat Pump	Packaged air-source Heat Pump
Fan Control[b]	Cycle on Load	Cycle on Load	Cycle on Load	Cycle on Load	Cycle on Load
Space Condition Fan Power (W/cfm) Proposed < MERV 13	0.528	0.528	0.522	0.528	0.528
Space Condition Fan Power (W/cfm) Proposed ≥ MERV 13	0.634	0.634	0.634	0.634	0.634
Heating/Cooling Sizing Factor[c]	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15
Supplemental Heating Availability	NA	<40°F	<40°F	<40°F	<40°F
Modeled cooling COP (Net of Fan) [d]	4.46	3.83	4.25	3.83	3.83
Modeled heating COP (Net of Fan) [d]	4.61	3.81	3.57	3.81	3.86
Cooling Source	DX (Heat Pump)	DX (Heat Pump)	DX (Heat Pump)	DX (Heat Pump)	DX (Heat Pump)
Heat Source	Heat Pump	Heat Pump	Heat Pump	Heat Pump	Heat Pump
Number of Stages of Cooling	Single	Single	Two	Single	Single
OSA Economizer[e]	No	No	Yes	Yes	Yes
Occupied Ventilation Source[f]	DOAS	DOAS	DOAS	DOAS	DOAS
DOAS Fan Power (W/cfm of Outside Air)	0.819	0.819	0.730	0.742	0.780
DOAS Fan Power (W/cfm) Proposed ≥ MERV 13	1.042	1.042	0.928	0.944	0.944
DOAS Temperature Control[g, h]	Bypass	Wild	Bypass	Bypass	Wild
ERV Efficiency (Sensible Only)	70 percent	70 percent	70 percent	70 percent	70 percent
WSHP Loop Heat Rejection	Cooling Tower[i]	NA	NA	NA	NA
WSHP Loop Heat Source	Gas Boiler [j]	NA	NA	NA	NA
WSHP Loop Temperature Control[k]	50°F to 70°F	NA	NA	NA	NA
WSHP Circulation Pump W/gpm[l]	16	NA	NA	NA	NA
WSHP Loop Pumping Control[m]	HP Valves & Pump VSD	NA	NA	NA	NA

Reminder:

If an HVAC system is designed to meet or exceed the standard reference design requirements, the system is exempt from TSPR

Appendix D

New Exceptions to the TSPR Provisions

- **Buildings where the total SF area of all occupancy areas in the building that are required to comply with TSPR is less than 5,000 SF**
- HVAC systems connected to a *low-carbon district energy exchange system* (refer to Chapter 2 for definition)
- Mechanical system alterations to existing buildings that do not substantially replace the entire HVAC system
- Buildings or areas of medical office buildings that fully comply with ASHRAE Standard 170 including surgical centers, or other applicable codes or standards that require 24/7 air handling unit operation

C403.1.1

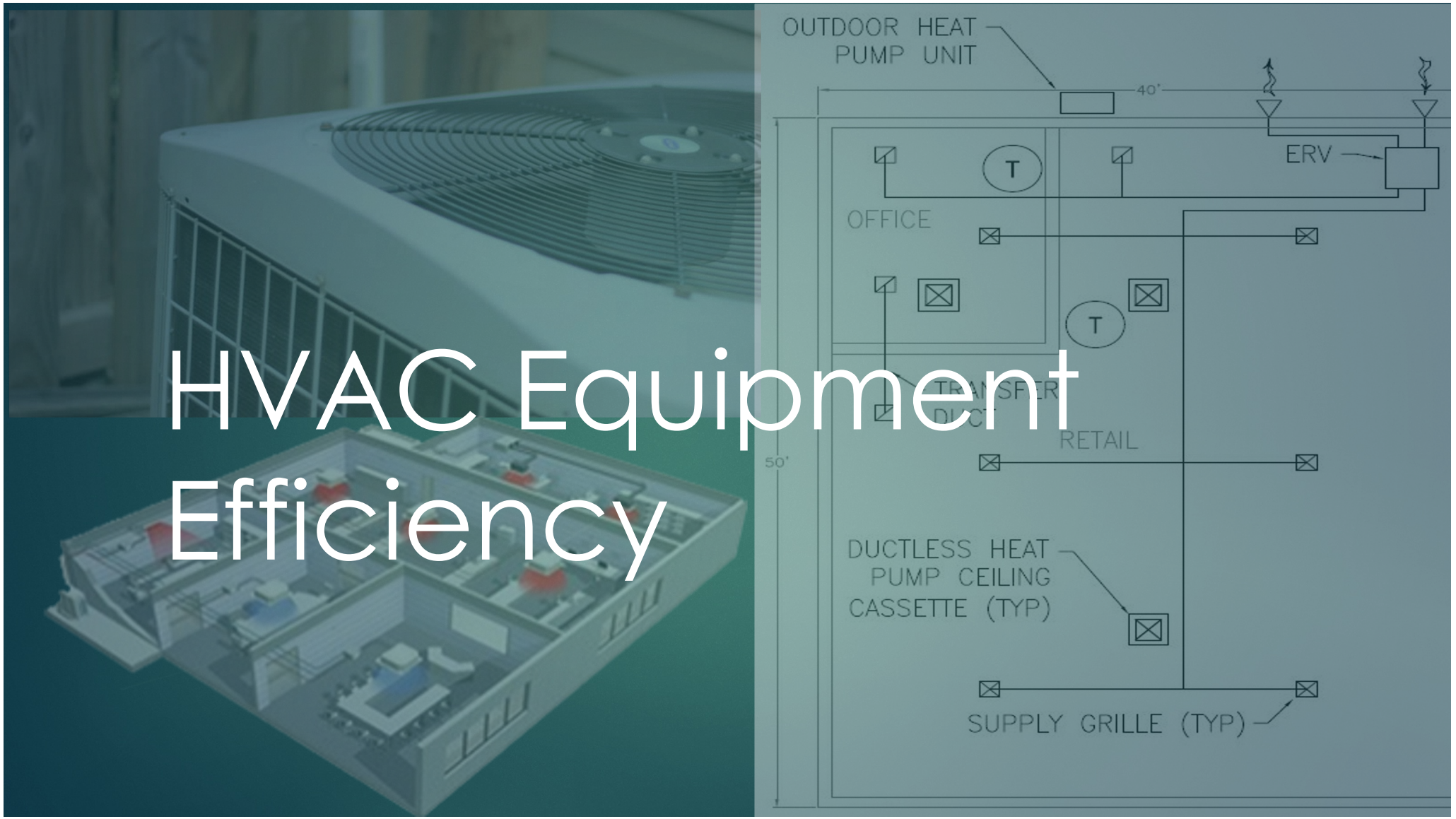
New Exceptions to the TSPR Provision

HVAC systems that exclusively serve the following areas and space types:

- Laundry rooms
- Elevator machine rooms
- Mechanical and electric rooms
- Data centers and computer rooms
- Laboratories with fume hoods
- Locker rooms
- Natatoriums and rooms with saunas
- Restaurants
- Commercial kitchens with cooking capacity > 100,000 btuh
- Areas with commercial refrigeration equipment with >100kW power input
- Cafeterias and dining rooms

C403.1.1

HVAC Equipment Efficiency



HVAC Equipment Efficiency Requirements

- Efficiencies updated to SEER2/HSPF2 where applicable
- EER/IEER requirements increased to match 2021 IEEC/ASHRAE 90.1 standards
- New equipment efficiency tables include:
  - Heat-pump and heat recovery chillers
  - Ceiling mounted computer-room air conditioners
  - Vapor-compression based indoor pool dehumidifiers

C403.3.2

High-Capacity Boiler Systems

- Applies to buildings with space heating boiler systems with input capacity >1,000,000 Btu/h, but not more than 10,000,000 Btu/h
- Gas-fired boilers shall have thermal efficiency of **at least 90%**
- For systems with multiple boilers, thermal efficiency shall be the weighted average efficiency based on total equipment input capacity

C403.3.4.5

High-Capacity Boiler Systems

- Exceptions to this provision:
  - Where 25% of the annual space heating requirement is provided by site-recovered energy, or heat recovery chillers
  - Space heating boilers installed in individual dwelling units
  - Where 50% or more of the design heating load is served using perimeter convective heating, radiant ceiling panels, or both
  - Individual gas boilers with input capacity less than 300,000 btu/h are not included in the tally of the total system capacity or weighted-average efficiency

C403.3.4.5

Electric packaged & split systems

- Updated provision applies to:
  - Packaged and **split systems** providing both electric heating and cooling
  - **Cooling-only equipment with electric heat in the main supply duct before VAV boxes**
- Must be a heat pump if cooling capacity **> 6,000 btu/h**
- Heat pump must be configured to operate in the heat pump mode whenever the outdoor temperature is above 25F

C403.3.2.6

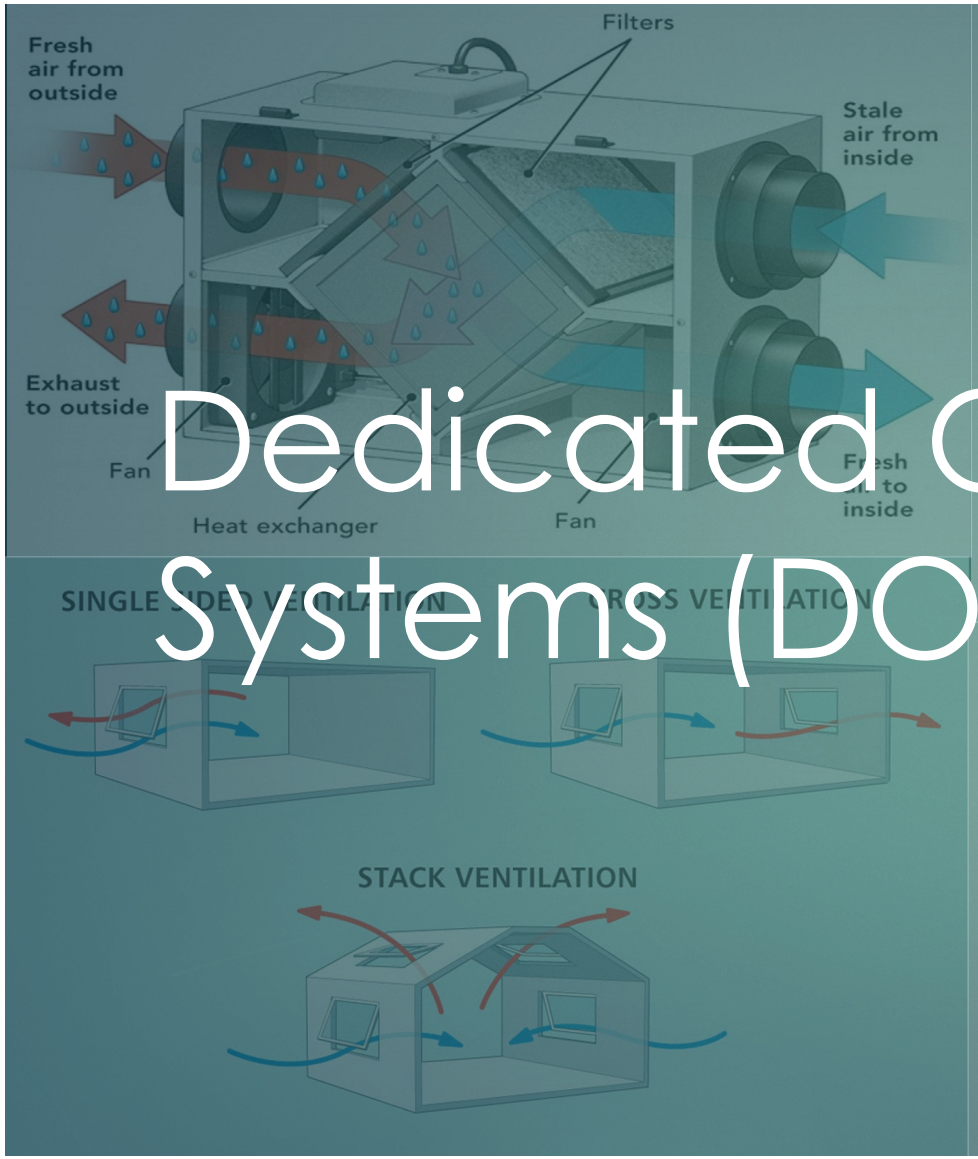
Stand-alone dehumidifiers

Stand-alone dehumidifiers in spaces for plant growth and maintenance shall meet one of the following:

- Minimum DOE efficiency: 2.41 L/kWh for spaces with volumes > 8 cu.ft.
- Integrated HVAC system using heat pump technology with dehumidification reheat
- Chilled water system with heat pump technology for dehumidification reheat
- Solid or liquid desiccant dehumidification for design that require a dewpoint of 50F or less

C403.3.2.7

Dedicated Outdoor Air Systems (DOAS)



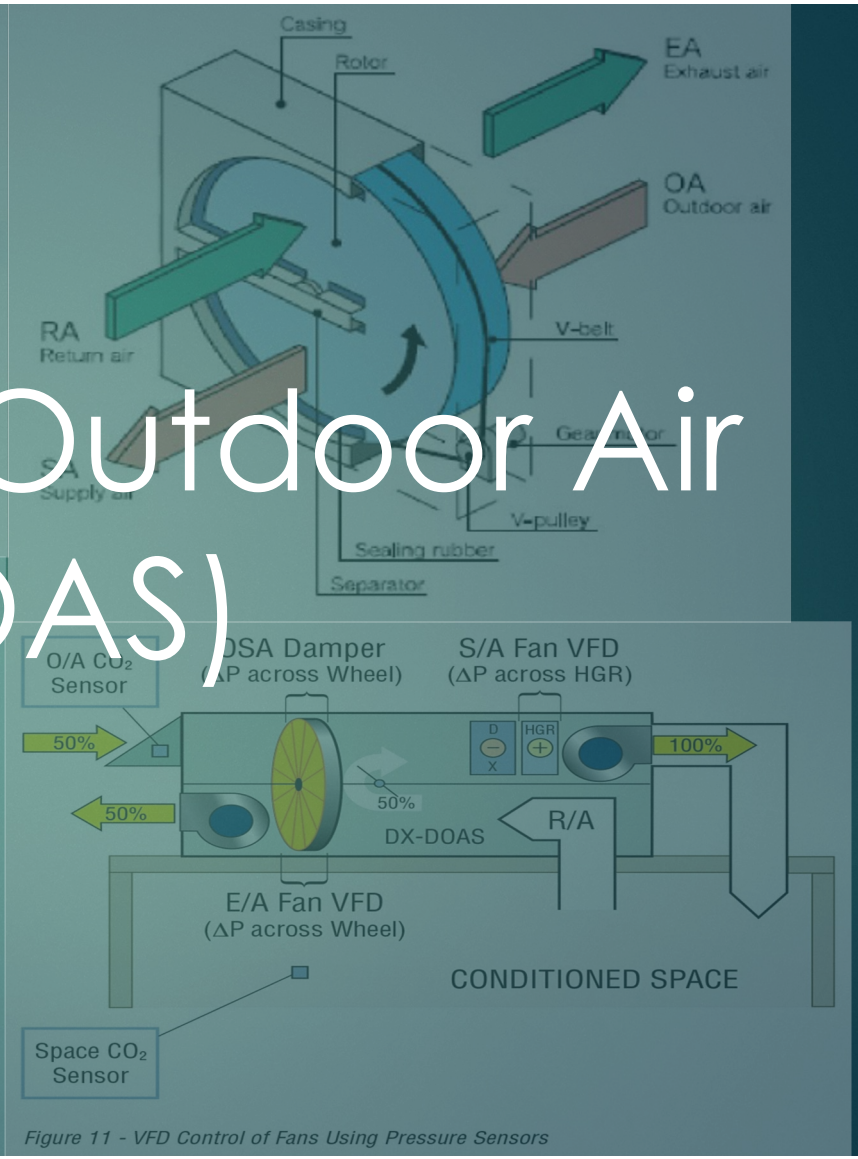


Figure 11 - VFD Control of Fans Using Pressure Sensors

Occupancies Requiring DOAS

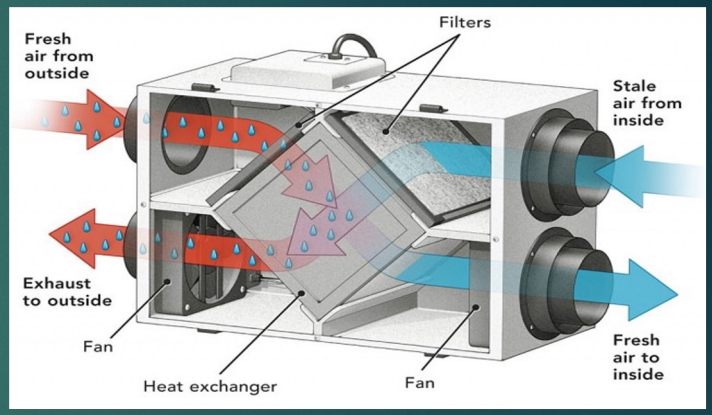
Table C403.3.5
Occupancy Classifications Requiring DOAS

Occupancy Classification[a]	Inclusions	Exempted
A-1	All occupancies not specifically exempted	Television and radio studios
A-2	Casinos (gaming area)	All other A-2 occupancies
A-3	Lecture halls, community halls, exhibition halls, gymnasiums, courtrooms, libraries, places of religious worship	All other A-3 occupancies
A-4, A-5		All occupancies excluded
B	All occupancies not specifically exempted	Food processing establishments including commercial kitchens, restaurants, cafeterias; laboratories for testing and research; data processing facilities and telephone exchanges; air traffic control towers; animal hospitals, kennels, pounds; ambulatory care facilities
F, H, I, R, S, U		All occupancies excluded
E, M	All occupancies included	

No scope changes in the 2021 WSEC-C

Dedicated Outdoor Air Systems

- Ventilation air shall be provided in each occupied space by a DOAS with energy recovery that delivers 100% outdoor air without requiring operation of the heating and cooling system fans
- DOAS shall be sized to meet the minimum ventilation requirements of the IMC with Washington State Amendments
- Exceptions to DOAS requirement:
  - Spaces that comply with the natural ventilation requirements of Section 402 of the IMC
  - High efficiency multiple zone variable air volume (VAV) systems that comply with C403.6.10
  - High efficiency single zone VAV systems serving Group A-1, A-2, A-3 that comply with C403.12



C403.3.5

Decoupled Supply Air Delivery

- The DOAS supply air shall be delivered directly into the occupied space or downstream of the terminal heating and/or cooling coils
- Exceptions
  - Active chilled beams
  - Sensible only cooling terminal units
  - Terminal heating/cooling units that comply with low fan power limit of < 0.12 watts/cfm

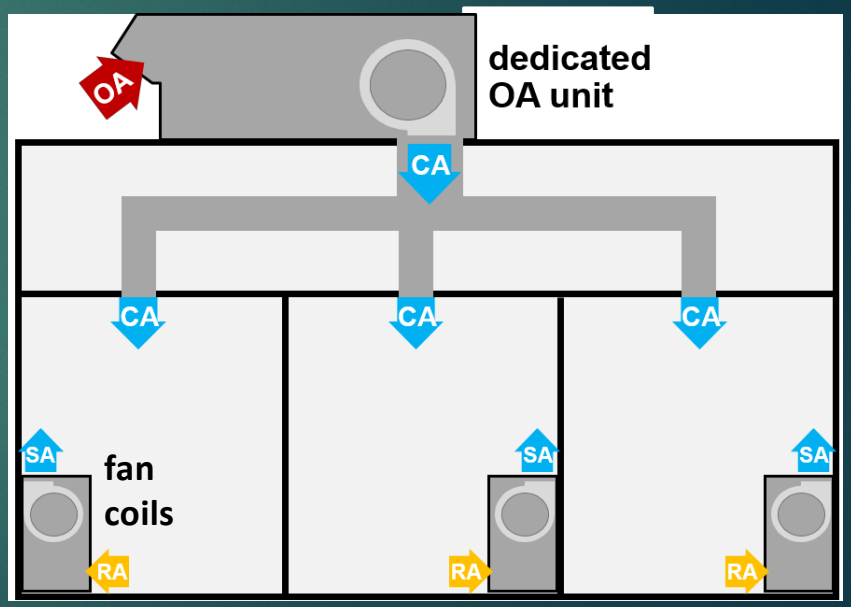


Diagram courtesy of Trane

C403.3.5.1

Energy Recovery Effectiveness

- DOAS equipment energy recovery performance shall be at least:
  - **68% sensible recovery effectiveness, calculated per Equation 4-9**

(Equation 4-9)

$$\text{Sensible Recovery Effectiveness} = \frac{T_{OA} - T_{SA}}{T_{OA} - T_{RA}}$$

Where:

T_{OA}	=	Design outdoor air dry bulb temperature entering the energy recovery device
T_{SA}	=	Supply air dry bulb temperature leaving the energy recovery device at design temperatures and airflow conditions, as selected for the proposed DOAS unit(s)
T_{RA}	=	Design return air dry bulb temperature

  - **60% enthalpy recovery ratio, calculated at design conditions**
- Exceptions
  - Systems exclusively used for makeup air for systems exhausting toxic air
  - Heat recovery and energy recovery ventilators (rated and listed in accordance with HVI 920) can demonstrate compliance using the adjusted sensible recovery effectiveness (ASRE) rating of the equipment at 32°F test conditions.

C403.3.5.1

Tempering of DOAS Supply Air

NEW Supplemental heating and cooling

- **Supplemental Heating**
  - **C403.7.3 Ventilation air heating control** – **Ventilation supply air supplemental heating** that operates in conjunction with zone heating & cooling systems **shall be limited to a supply air temperature of 55°F or less.**
  - EXCEPTION – Heating permitted for defrost control shall be locked out when outdoor air temperature is greater than 35°F
- **Supplemental Cooling**
  - **Ventilation supply air cooling is permitted only for the purpose of maintaining supply air relative humidity or zone relative humidity.**
  - Cooling coil shall be sized for peak dehumidification at design outdoor temperatures, and no larger

C403.3.5.5

DOAS Fan Power Allowance

- For DOAS that **does not** have at least one fan ≥1 kW (~1.5 Hp) ~
  - Fan power shall not exceed 1 watt/cfm, calculated per Equation 4-10

(Equation 4-10)

$$\text{DOAS Total Combined Fan Power } \left(\frac{Watts}{CFM}\right) = \sum\left(\frac{Fan\ bhp}{\eta_m}\right) \times \frac{746}{CFM_{supply}}$$

Where:

Fan bhp	=	Brake horsepower for each supply, exhaust and other fan in the system at design maximum airflow rate
η_m	=	Fan motor efficiency including all motor, drive and other losses for each fan in the system
CFM_{supply}	=	Design maximum airflow rate of outdoor (supply) air

- For DOAS **with** at least one fan ≥1 kW
  - DOAS shall comply with fan power limitations per C403.8.1

C403.3.5.2

Packaged Terminal Heat Pumps

PTHP Controls

Supplementary heat controls

- PTHPs are exempt from controls to minimize electric supplemental heating **only when** the PTHPs have reverse-cycle demand defrost **AND** are configured to operate in heat pump mode whenever the outdoor temperature is > 25°F and the unit is not in defrost.

Economizer Exceptions

- **1a & 1b** – Exempt from the economizer requirements when the PTHP is installed in conjunction with a DOAS that complies with C403.3.5, including the new required energy recovery performance minimums (68% sensible or 60% enthalpy).

C403.4.1.1
C403.5

PTHP Envelope Penetrations

- If total area of penetrations from through-wall mechanical equipment **exceeds 1%** of above-grade wall area ~
  - Total area of mechanical equipment penetrations shall be assigned a default U-factor of **U-0.5 (R-2)**
  - Mechanical equipment penetration area U-factor shall be area-weighted with the opaque above-grade wall area
  - Calculate the resulting overall effective wall U-factor for prescriptive or component performance compliance
- **NOTE** – This applies to **ALL** through-wall equipment listed in equipment efficiency Table C403.3.2(4)

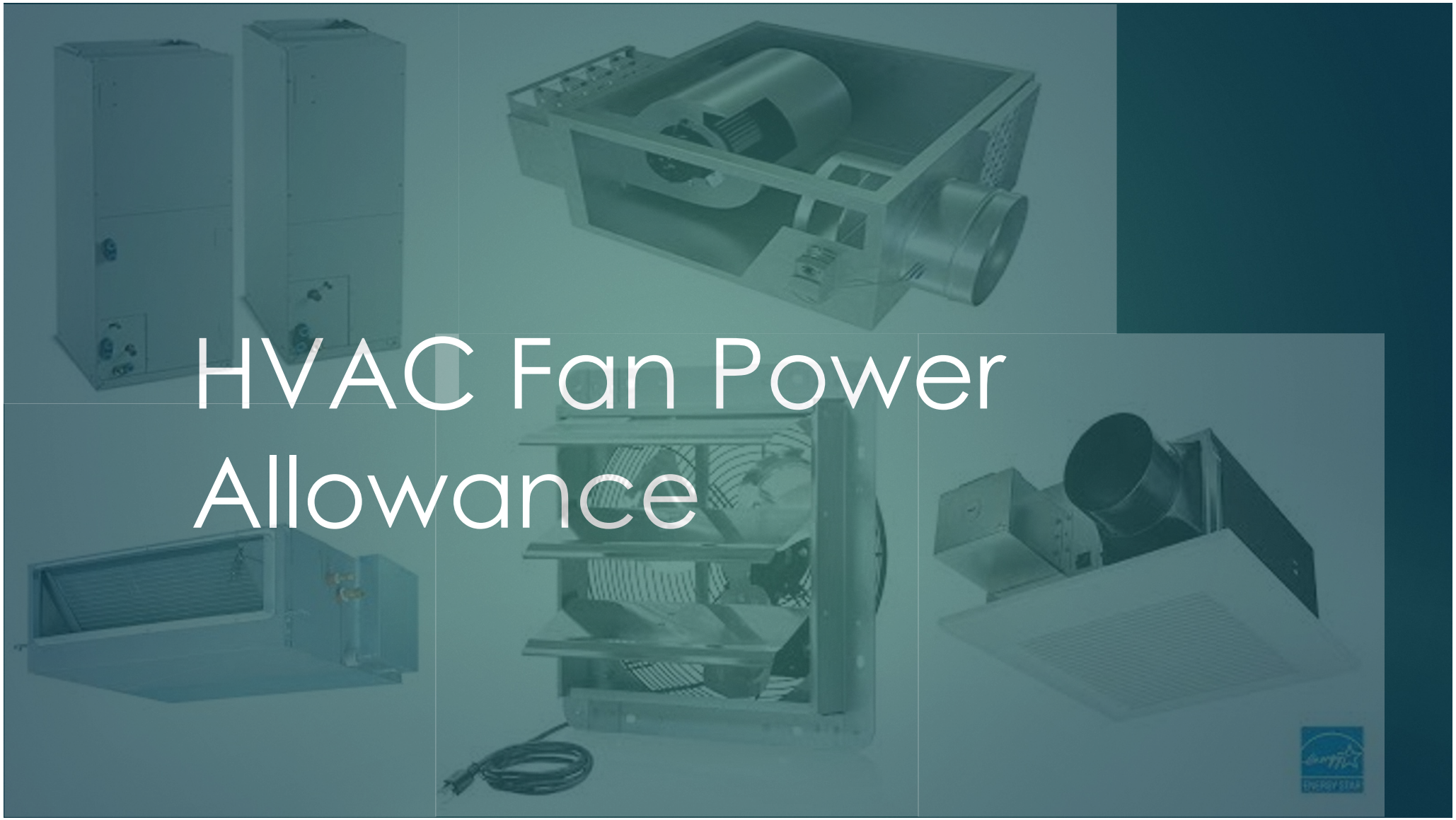
Table C402.1.4, Footnote k
C402.1.4.3

PTHP Penetrations

- Sample Area-Weighted Wall Assembly Calculation:
  - Percent area of mechanical equipment penetrations = 2%
  - Default U-factor for mechanical equipment penetrations = U-0.5
  - Sample maximum allowed opaque wall U-factor = **U-0.051**

Area-weighted U-factor = (0.5 * 0.02) + (0.051 * 0.98) = U-0.060

Table C402.1.4, Footnote k
C402.1.4.3



HVAC Fan Power Allowance

Fan Power Allowance

NEW Criteria – C403.8 Fan and Fan Controls

- Each fan system with **fan electrical input power ≥ 1kW** (~1.5 HP), the design input power (Fan kW_{design}) shall be less than or equal to the allowable fan power budget (Fan kW_{budget}).
- Table C403.8.1.1(1) – Supply fan power allowance budget
- Table C43.8.1.1(2) – Exhaust, relief, transfer fan power allowance budget
- Low-capacity fans with motors < 1/12 hp (62 watts) shall meet fan efficacy requirements per Table C403.8.4.
- *Large diameter ceiling fans* (commonly used for destratification, air mixing, etc) shall be labeled in accordance with AMCA 230

Step 1: Determine Fan Power Budget – Supply Fans

- Multiply the fan system airflow by the sum of the power allowances (W/CFM) for each fan system
- Base allowance plus allowances for filters, coils, heat recovery, dampers, etc
- Divide by 1,000 to convert to Fan kW_{budget}
- For building sites at elevation > 3,000 ft, multiply Fan kW_{budget} by 0.896

Table C403.8.1.1(1)
Supply Fan Power Allowances (W/CFM)

Airflow	Multi-Zone VAV Systems[a] ≤ 5,000 cfm	Multi-Zone VAV Systems[a] > 5,000 and ≤ 10,000 cfm	Multi-Zone VAV Systems[a] > 10,000 cfm	All Other *Fan Systems* ≤ 5,000 cfm	All Other *Fan Systems* > 5,000 and ≤ 10,000 cfm	All Other *Fan Systems* > 10,000 cfm
Supply system base allowance for AHU serving spaces ≤ 6 floors away	0.395	0.453	0.413	0.232	0.256	0.236
Supply system base allowance for AHU serving spaces > 6 floors away	0.508	0.548	0.501	0.349	0.356	0.325
MERV 13 to MERV 16 Filter upstream of thermal conditioning equipment (two-times the clean filter pressure drop)[b]	0.136	0.114	0.105	0.139	0.120	0.107

Step 1: Determine Fan Power Budget – Exhaust, Return, Relief

- Multiply the fan system airflow by the sum of the power allowances (W/CFM) for each fan system
- Base allowance plus allowances for filters, coils, heat recovery, dampers, etc
- Divide by 1,000 to convert to Fan kW_{budget}
- For building sites at elevation > 3,000 ft, multiply Fan kW_{budget} by 0.896

TABLE C403.8.1.1(2)
EXHAUST, RETURN, RELIEF, TRANSFER FAN POWER ALLOWANCES (W/CFM)

Airflow	Multi-Zone VAV Systems[a] ≤ 5,000 cfm	Multi-Zone VAV Systems[a] > 5,000 and ≤ 10,000 cfm	Multi-Zone VAV Systems[a] > 10,000 cfm	All Other *Fan Systems* ≤ 5,000 cfm	All Other *Fan Systems* > 5,000 and ≤ 10,000 cfm	All Other *Fan Systems* > 10,000 cfm
Exhaust system base allowance	0.221	0.246	0.236	0.186	0.184	0.190
Filter (any MERV value)[b]	0.046	0.041	0.036	0.046	0.041	0.035
Energy recovery allowance for 0.50 ≤ ERR <0.55[c]	0.139	0.120	0.107	0.139	0.123	0.109
Energy recovery allowance for 0.55 ≤ ERR <0.60[c]	0.165	0.142	0.126	0.165	0.144	0.128
Energy recovery allowance for 0.60 ≤ ERR <0.65[c]	0.190	0.163	0.146	0.191	0.166	0.148
Energy recovery allowance for 0.65 ≤ ERR <0.70[c]	0.215	0.184	0.165	0.216	0.188	0.167
Energy recovery allowance for 0.70 ≤ ERR <0.75[c]	0.240	0.206	0.184	0.241	0.209	0.186
Energy recovery allowance for 0.75 ≤ ERR <0.80[c]	0.265	0.227	0.203	0.266	0.231	0.205

Step 2: Determine The Design Fan Power

- **OPTION 1** – Use the default Fan kW_{design} in Table C403.8.1.2 based on motor nameplate horsepower. Cannot be used for complex systems.

Table C403.8.1.2
Default Values for Fan kW_{design} Based on Motor Nameplate HP[a,b]

Motor Nameplate HP	Default *Fan* kW_{design} with variable speed drive (Fan kW_{design})	Default *Fan* kW_{design} without variable speed drive (Fan kW_{design})
<1	0.96	0.89
≥1 and <1.5	1.38	1.29
≥1.5 and <2	1.84	1.72
≥2 and <3	2.73	2.57
≥3 and <5	4.38	4.17
≥5 and <7.5	6.43	6.15
≥7.5 and <10	8.46	8.13
≥10 and <15	12.4	12.0
≥15 and <20	16.5	16.0
≥20 and <25	20.5	19.9
≥25 and <30	24.5	23.7

Step 2: Determine The Design Fan Power

- **OPTION 2** – Use the Fan kW_{design} at fan system design conditions provided by the manufacturer of the fan, fan array or equipment
- **OPTION 3** – Use the Fan kW_{design} provided by the manufacturer calculated at fan system design conditions per one of the methods listed in Section 5.3 of ANSI/AMCA 208
- **OPTION 4** – Determine the Fan kW_{design} by using the maximum electrical input power provided on the motor nameplate

C403.8.1.2

Fan Energy Index (FEI)

- Each fan and fan array shall have a **fan energy index (FEI) of not less than 1 (for constant volume) or not less than 0.95 (for variable volume)** at the design point of operation per AMCA 208 and labeled by the manufacturer.
- Exceptions
  - Fans that are NOT embedded fans < 1 hp (0.89 kW or less)
  - Embedded fans 5 hp or less (4.1 kW or less)
  - Multiple fan arrays with combined motor nameplate of 5 hp or less (3.7 kW)
  - Fans included in an equipment package certified for energy performance (SEER2, HSPF2, EER, COP, IPLV, IEER, etc.)
  - Ceiling fans, reversible tunnel ventilation fans, explosion proof fans
  - Emergency fans

C403.8.1.3


Data Centers

Requirements for Data Centers

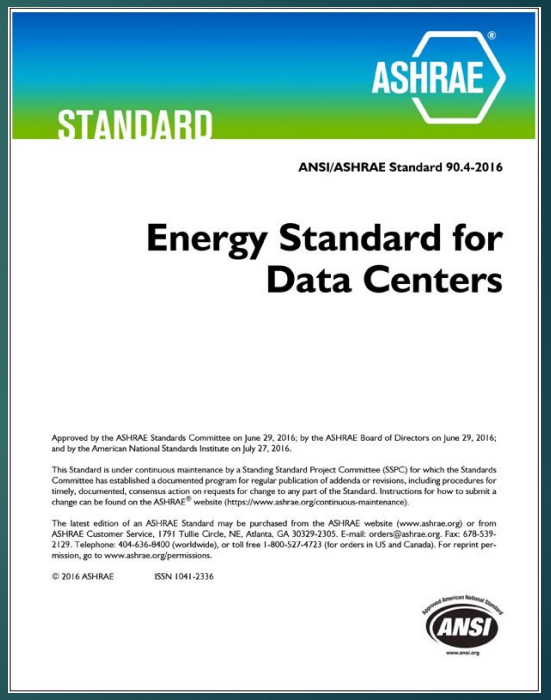
DEFINITIONS

- ***DATA CENTER.*** *A room or series of rooms that share Data Center Systems where, which has a design total information technology equipment (ITE) equipment* ***power density exceeding 20 watts per square foot of conditioned area and a total design ITE equipment load greater than 10 kW****.*
- ***COMPUTER ROOM.*** *A room whose primary function is to house equipment for the processing and storage of electronic data and that has a design total information technology equipment (ITE)* ***equipment less than or equal to 20 watts per square foot of conditioned area or a design ITE equipment load less than or equal to 10 kW.***

C403.1.3

Data Center Requirements

- Comply with Sections 6 and 8 of **ASHRAE Standard 90.4-2019** (with addenda a,b,c,d) for **either** the "Maximum Design Component (Design MLC) or "Maximum Annualized Mechanical Load" (Annual MLC) depending on climate zone
- Different requirements for small and large data centers
- Option to trade efficiencies between Section 6 (HVAC) and Section 8 (Power))
- Use the MLC values listed in the standard without modification



C403.1.3

Group R-2 Multi-family Residential Buildings

Residential Building Definition

2021 WSEC-R DEFINITION

- **RESIDENTIAL BUILDING.** *For this code, the following building types are residential buildings:*
  1. *Detached one- and two-family dwellings.*
  2. *Multiple single-family dwellings (townhouses).*
  3. *Group R-3 occupancy areas in buildings three stories or less in height above grade plane whose dwelling units are* ***accessed directly from the exterior.***
  4. *Group R-2 occupancy areas in buildings three stories or less in height above grade plane whose dwelling units are* ***accessed directly from the exterior.***
  5. *Accessory structures to residential buildings.*

All Group R-2 buildings with dwelling units accessed from interior corridors or other interior spaces are no longer within the scope of the 2021 WSEC-R.

Residential Building Definition

Bottom Line

All Group R-2 multi-family buildings less than 4 stories where dwelling units are accessed from interior corridors or other spaces (ie interior lobby) shall meet all applicable requirements of the WSEC-Commercial.

- PTHP mechanical penetrations
- Equipment efficiency requirements
- Economizer provided or economizer exception if cooling provided
- Balanced ventilation system with 60% sensible heat recovery effectiveness delivering outdoor air directly to each habitable space
- Additional energy efficiency and load management measures

Training Topics Review

- Equipment efficiency tables updated with new SEER2/HSPF2 metrics for single package and split system air conditioners and heat pumps
- Equipment efficiency tables expanded to include heat-pump and heat recovery chillers, refrigerated indoor pool dehumidifiers, ceiling-mounted computer room AC units and indoor plant growth dehumidifiers
- TSPR requirements expanded to include medical office and Group R-2 dwelling units and common areas
- TSPR exceptions list updated to include HVAC systems serving spot cooling, data centers and computer rooms, laboratories with fume hoods, locker rooms, natatoriums, restaurants, commercial kitchens and grocery stores

Training Topics Review

- Minimum heat and energy recovery effectiveness for DOAS increased to 68% sensible and 60% latent energy recovery
- Group R-2 building definition changed to apply the WSEC-Commercial to buildings less than 4 stories with internal corridors
- Mechanical penetrations from PTHP equipment that exceed 1% of the gross above grade wall area shall be included in the envelope compliance calculations
- New fan power allowance calculation criteria
- Sections 6 and 8 of ASHRAE 90.4-2019 adopted for Data Centers without amendment

Q&A

KEY CHANGES TO THE MECHANICAL PROVISIONS

PART 1

WSEC Commercial Technical Support Team:
Duane Lewellen – Lewellen Associates, LLC
Lisa Rosenow - Evergreen Technology Consulting (ETC)
(360) 539-5300 | com.techsupport@waenergycodes.com