Comparison of Very High Efficiency DOAS with Washington State Energy Code (WSEC) DOAS Requirement

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The following table details the key elements that differentiate very high efficiency dedicated outside air system (DOAS) from the more typical DOAS with heat recovery required by Washington State Energy Code (WSEC 2021). To learn more about very high efficiency DOAS design and qualifying heat and energy recovery ventilator (HRV/ERV) systems, visit: betterbricks.com/resources/very-high-efficiency-doas-system-requirements.

	Very High Efficiency DOAS	Washington State Energy Code—2021 for DOAS	Key Takeaway
Definition	An alternative HVAC system for commercial buildings that use a very high efficiency heating/cooling system and a very high efficiency HRV/ERV to deliver heating and cooling air separately from ventilation air so that the control and energy impacts of each can be managed optimally, resulting in significantly reduced whole-building energy consumption.	A ventilation system that delivers 100% outside air primarily for the purposes of ventilation without requiring operation of a space conditioning system fans for outdoor air delivery.	Very high efficiency DOAS has more stringent requirements that lead to deepened energy efficiency as compared to WSEC-minimum installations.
Applications	New construction and HVAC system replacement (especially ideal in replacing existing RTUs in spaces with open layouts and exposed interior ductwork).	New construction and major renovations where the HVAC system is replaced.	Similar applications.
Applicable Building Types	Generally, for commercial buildings 50,000 sq. ft. or less.	WSEC requires DOAS in a wide range of commercial building types including but not limited to offices, schools (through 12th grade), retail & department stores, theaters and general assembly, banks, casinos, libraries, places of religious worship, and many more listed in Table C403.3.5.	WSEC requires DOAS in many commercial buildings, and very high efficiency DOAS is an excellent solution in many small-to-medium commercial building applications.
Heat Recovery at Rated Conditions	Minimum Sensible Effectiveness of HRV/ERV: 82% sensible effectiveness at 75% of nominal full airflow (HRV/ERV can either be selected from a compliant product list or meet the 82% sensible effectiveness using AHRI 1060-2018 certified software at design conditions).	Section C403.3.5.1 requires minimum energy (enthalpy) recovery effectiveness of 60% or sensible recovery effectiveness of 68%. Section C406.2.2.6 (High Performance DOAS Option) requires minimum sensible heat recovery effectiveness of 80%.	Very high efficiency DOAS requires higher sensible effectiveness than WSEC and slightly higher than the high-performance DOAS option. Very high efficiency DOAS also provides a prescriptive or design condition path while WSEC is more open for interpretation in what outdoor airflow the effectiveness corresponds to.

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Fan Efficacy at Rated Conditions	Minimum fan efficacy: PHI certified, or 1.3 cfm/watt at 0.5" w.g. at 75% of nominal full airflow. Variable speed supply and exhaust fans are required.	Section C403.3.5.2 DOAS fan power requires that DOAS without at least one fan or fan array with fan electrical input power ≥1 kW have a total combined fan power that shall not exceed 1 watt per cfm of outdoor air. For a DOAS with at least one fan or fan array with fan electrical input power ≥1 kW, the DOAS shall comply with the fan power limitations of Section C403.8.1. Section C406.2.2.6 (High Performance DOAS Option) requires combined fan power less than 0.769 watt per cfm of outdoor air (1.3 cfm/watt), with no static pressure requirement, or 80% of the fan power allowance for a constant volume system when calculated in accordance with Section C406.8.1.	Very high efficiency DOAS fan efficacy requirement is slightly more stringent than the requirements of WSEC Section C403.3.5.2. The WSEC High Performance DOAS option (Section C406.2.2.6) for additional energy efficiency credit includes required fan efficacy equivalent to very high efficiency DOAS.
Heating/ Cooling System Efficiency	Heating and cooling equipment must use electric heat pump technology and meet the current ENERGY STAR® minimum efficiency requirements, or meet requirements in Appendix B. As an example, VRF and air-source heat pumps must meet the following minimum efficiencies[1]: • <65 kBtu/h: 16.0 SEER / 9.5 HSPF • >=65 & <135 kBtu/h: 18.9 IEER / 3.4 COP • >=135 & < 240 kBtu/h: 18.0 IEER / 3.25 COP • >= 240 kBtu/h: 17.0 IEER / 3.2 COP	Many different types of gas and electric space heating and cooling system equipment are allowed and must meet the minimum efficiency requirements in Section C403.3.2 VRF and air-source heat pumps must comply with the minimum efficiency requirements of Table C403.3.2(9)[2]: • <65 kBtu/h: 13.0 SEER / 7.7 HSPF • >=65 & <135 kBtu/h: 14.6 IEER/ 3.3 COP @ 47°F / 2.25 COP @ 17°F • >=135 & <240 kBtu/h: 13.9 IEER / 3.2 COP @47°F / 2.05 COP @ 17°F • >=240 kBtu/h: 12.7 IEER / 3.2 COP @ 47°F / 2.05 COP @ 17°F	Very high efficiency DOAS requires electric heat pump systems while WSEC allows a wider range of technologies. Additionally, the minimum efficiency requirements for very high efficiency DOAS are in general higher than what WSEC requires. WSEC includes low-temperature heating efficiency requirements for VRF systems, which very high efficiency DOAS will adopt with the ENERGY STAR Version 4 update January 1, 2023.
Decoupled System Design	Ventilation and heating/cooling fans must be controlled separately. Ventilation air from the HRV/ERV must be supplied to each occupied space, either directly through a dedicated supply outlet or through heating/cooling ductwork when the ventilation supply air is delivered downstream of the terminal heating/cooling coils.	Section C403.3.5.4 requires ventilation air to be "delivered directly to the occupied space or downstream of the terminal heating and/or cooling coil." Additionally, Section C403.3.5.3 requires the heating and cooling fans to "shut off when there is no call for heating or cooling in the zone."	Both have similar requirements around decoupled systems. WSEC is more specific with the operation of heating/cooling system fan cycling.

[1]VRF and heat pump efficiencies will be updated to ENERGY STAR V4 cold climate heat pump requirements (Table 4) as of 1/1/2023.
[2]Required cooling efficiency is 0.2 IEER lower for VRF equipment with refrigerant heat recovery capability.

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Peak Heating and Cooling Loads and Equipment Sizing	Very high efficiency DOAS requires that the capacity of the heating/cooling system is supported by load calculations with no more than a 20% safety factor. Suggests best practice is to use no more than a 10% safety factor.	Section C403.1.2 requires that design loads for HVAC systems must be calculated in accordance with ANSI/ASHRAE/ACCA Standard 183 or with an approved "computational procedure". Section C403.3.1 requires that the smallest available equipment size that exceeds the peak loads calculated must be selected.	Both very high efficiency DOAS and WSEC require systems are sized based on peak heating and cooling load calculations. Very high efficiency DOAS explicitly limits the amount of oversizing used. Over-sizing is common in DOAS systems as the impact of heat recovery is often overlooked in sizing heating/cooling systems. Over-sizing leads to higher overall HVAC energy usage and higher first cost.
HRV/ERV Defrost Control	Where climate conditions warrant, HRV/ERV heat recovery defrost is required. Recirculating return air is prohibited, and if electric resistance is used, it must be modulating.	Exception in Section C403.3.5.5 Supplemental heating and cooling requires that defrost control is locked out when outside air temperatures are above 35°F. Also, Supplemental heating for defrost shall modulate to 10 percent of the peak capacity, and shall be sized to prevent frost/damage to the unit at design temperatures and provide supply air less than or equal to 55°F (13°C).	To reduce unnecessary use of defrost and maintain indoor air quality, very high efficiency DOAS and the WSEC are in alignment. WSEC prescribes a lockout temperature, while very high efficiency DOAS does not. Both require modulating defrost heat.
Crossflow Leakage	Crossflow leakage: PHI certified or internal leakage less than 3% or AHRI 1060 EATR less than 3% when selected at 100% of nominal airflow at both 0 in w.g. and 0.5 in w.g.	No requirements for crossflow leakage.	Crossflow leakage limitation is a key difference in very high efficiency DOAS, which can be particularly impactful for enthalpy wheels.