STATE OF WASHINGTON

STATE BUILDING CODE COUNCIL

2015 Washington State Energy Code Development

Standard Energy Code Proposal Form

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

Code Section #	C403.2.6.1	Dedicated Outdoor Air Systems (DOAS)
	C403.3	Economizers (Prescriptive)
	C406.6	Dedicated outdoor air system
	C503.4	Mechanical systems
	C402.4.1	Maximum area

Brief Description:

Requires the use of Dedicated Outdoor Air Systems (DOAS) in most commercial building HVAC systems.

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.)

C403.2.6.1 Dedicated Outdoor Air Systems (DOAS). Outdoor air shall be provided to each zone by a Dedicated Outdoor Air System (DOAS) which delivers 100% outside air without requiring operation of the heating and cooling system fans for ventilation air delivery. The DOAS shall include either *Energy Recovery Ventilation* and/or D*emand Control Ventilation*. Equipment and controls shall be configured to cycle off zone heating and cooling equipment fans and/or pumps when there is no call for heating or cooling in the zone. If the DOAS includes heating or cooling coils, supply air shall be delivered within 5 degrees F of the space conditioning setpoint.

Exception:

1. Multiple zone systems in buildings other than office, education, libraries, police, or fire stations meeting all requirements of C403.3 and C403.4.
2. Group R occupancies.
3. Zones with year-round cooling loads from lights and equipment of greater than 5 Watts per square foot and complying with economizer Section C403.3.
4. Fans used for heating and cooling using less than 0.1 Watts per CFM may operate when space temperatures are within the setpoint deadband (Section 403.2.4.1.2) to provide destratification and air mixing in the space.

C403.2.6.1.1 Impracticality. In cases where full compliance with all the requirements of Section C403.2.6.1 is impractical, the applicant is permitted to arrange a pre-design conference with the design team and the *code official* to seek modifications. The applicant shall identify specific requirements that are impractical, and shall identify design solutions and modifications that achieve a comparable level of energy efficiency.

The *code official* is authorized to waive specific requirements in this code to the extent that the *code official* determines those requirements to be impractical.

C403.3 Economizers (Prescriptive). Air economizers shall be provided on all new systems including those serving computer server rooms, electronic equipment, radio equipment, and telephone switchgear. Economizers shall comply with Sections C403.4.1.1 through C403.4.1.4.

Exceptions:

1. Systems complying with C403.2.6.1 Dedicated Outdoor Air Systems (DOAS) with year-round cooling loads from lights and equipment of less than 5 Watts per square foot.

~~**C406.6 Dedicated outdoor air system.** Buildings covered by Section C403.4 shall be equipped with an independent ventilation system designed to provide not less than the minimum 100-percent outdoor air to each individual occupied space, as specified by the *International Mechanical Code*. The ventilation system shall be capable of total energy recovery. The HVAC system shall include supply-air temperature controls that automatically reset the supply-air temperature in response to representative building loads, or to outdoor air temperatures. The controls shall reset the supply-air temperature at least 25 percent of the difference between the design supply-air temperature and the design room-air temperature.~~

C503.4 Mechanical systems. Those parts of systems which are altered or replaced shall comply with Section C403. Additions or alterations shall not be made to an existing mechanical system that will cause the existing mechanical system to become out of compliance.

All new systems in existing buildings, including packaged unitary equipment and packaged split systems, shall comply with Section C403.

Where mechanical cooling is added to a space that was not previously cooled, the mechanical ~~cooling~~ system shall comply with either Section C403.2.6.1 Dedicated Outdoor Air Systems (DOAS) or C403.3 Economizers ~~economizer requirements in Section C403.3.~~

Exception: Alternate designs that are not in full compliance with this code may be approved when the building official determines that existing building or occupancy constraints make full compliance impractical or where full compliance would be economically impractical.

Alterations to existing mechanical cooling systems shall not decrease economizer capacity unless the system complies with Section C403.2.6 or C403.3. In addition, for existing mechanical cooling systems that do not comply with Sections C403.2.6 or C403.3, including both the individual unit size limits and the total building capacity limits on units without economizer, other alterations shall comply with Table ~~C~~C503.4.

When space cooling equipment is replaced, controls shall comply with all requirements under Section C403.2.6 and related subsections or be in accordance economizer operation, Section C403.3.1.

Existing equipment currently in use may be relocated within the same floor or same tenant space if removed and reinstalled within the same permit.

C402.4.1.4 Increased vertical fenestration area with high-performance mechanical systems. The vertical fenestration area (not including opaque doors and opaque spandrel panels) is permitted to exceed 30% but shall not exceed 40% of the gross above grade wall area, for the

purpose of prescriptive compliance with Section C402.1.4 or for the component performance alternative in Section C402.1.5, provided that the mechanical system complies with all requirements of Section C403.2.6.1 Dedicated Outdoor Air Systems (DOAS). This increased glazing fraction is not permitted to be used to establish the reference case for the Total Building Performance compliance path in Section C407.

Purpose of code change:

The majority of commercial HVAC systems are based around a central air handling delivery system. This system typically provides heating, cooling and ventilation air from a single source. Since cooling is typically the largest instantaneous load, the fans must be sized large enough to deliver enough air to meet the peak cooling requirements. When the ventilation is integrated, these large fans must operate during all occupied hours to deliver ventilation effectively to the space. This leads to very high fan energy use. With ventilation separated from the heating and cooling delivery, the large heating/cooling fans can be shut off unless there is a call for heating or cooling and the much smaller ventilation-only fans can operate to deliver fresh air to the space. Furthermore, when the ventilation air is delivered using either Energy Recovery Ventilation (ERV) or Demand Control Ventilation (DCV) the heating energy requirements associated with tempering the ventilation air are significantly reduced or eliminated. Compliance with this proposed code amendments requires the following:

- **A.** 100% ventilation air delivered directly to each zone separate from the heating/cooling system.
- **B.** Ventilation air delivered using either ERV or DCV.
- **C.** Run heating and cooling equipment (fans and pumps) only when there is a call for conditioning in the zone.

This proposal allows an exception for multiple zones systems in buildings that may have specialized HVAC needs (buildings other than office, school, library, police, or fire stations) to use the currently allowed prescriptive paths for HVAC system compliance. Note that this proposal also adds an "Impracticality Clause." This clause allows for ultimate flexibility for the design team if they feel that for whatever reason compliance with the DOAS requirement is impractical for their application. They are allowed to submit a case that convinces the code official of the impracticality of these provisions and propose a solution which achieves a similar level of energy efficiency.

To allow design flexibility this proposal allows the heating/cooling fans to be used to provide air mixing and circulation if they are sufficiently efficient (<0.1W/CFM). For example, a typical wall-mount ductless heat pump fan coil meets this level of energy efficiency. The optimal method for providing for air movement, mixing, and destratification in spaces is through the use of ceiling fans.

Note that by removing the ventilation air from the main heating and cooling delivery it makes possible the use of very efficient heating and cooling distribution systems such as radiant systems, ductless fan coils, chilled beams, and other small zonal equipment with no outside air connections and minimal or no ducts. This in turn makes economizers difficult or impossible to integrate. Therefore, this proposal exempts these DOAS systems from the economizer requirements of Section C403.3 except for internal gains-dominated spaces that would benefit more from economizer cooling.

This proposal deletes a competing DOAS section that was included in Section 406.6. It also clarifies the requirements for renovation of mechanical systems in existing buildings and allows for either compliance with Section C403.3 Economizers or the new proposed Section C403.2.6.1 Dedicated Outdoor Air Systems (DOAS).

As an incentive for multiple zone systems to follow a DOAS path this proposal allows an increase in the maximum glazing allowance for buildings with systems meeting all requirements of the new DOAS section. The increased energy use associated with the increase in allowable glazing area is more than made up for by the reduction in HVAC energy use associated with the DOAS system.

Note that designs based around a DOAS is not new and it has long been established that this design direction leads to more energy efficient buildings. The General Services Administration has required DOAS as the baseline design for all new GSA buildings unless otherwise directed by design programming since 1998.[1] The specifications require perimeter and interior systems have 100 percent outside air ventilation systems which are completely independent of any other air distribution system. Enthalpy heat recovery must be included if the outside air required or equipment capacity exceeds a stated amount.[2]

[1] Mumma, Stanley A. "Designing Dedicated Outdoor Air Systems." *ASHRAE Journal* (May 2001) 28-31.
[2] General Services Administration. GSA 2003 Facilities Standards (P100), 5.5 HVAC Baseline Systems. Accessed September 27, 2014. http://www.gbci.org/Files/References/GSA-2003-facilities-standards.pdf

Your amendment must meet one of the following criteria. Select at least one:

☐ Addresses a critical life/safety need.

☒ Addresses a specific state policy or statute. (Note that energy conservation is a state policy)

☐ Consistency with state or federal regulations.

☐ Addresses a unique character of the state.

☐ Corrects errors and omissions.

Check the building types that would be impacted by your code change:

☐ Single family/duplex/townhome

☐ Multi-family 1 – 3 stories

☐ Multi-family 4 + stories

☒ Commercial / Retail

☐ Institutional

☐ Industrial

Your name Jonathan Heller, P.E.

Other contact name Poppy Storm

Your organization Ecotope, Inc. co-submitted with the Northwest Energy Efficiency Alliance (NEEA)

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Instructions: 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 360-407-9280.
Deadline for all 2015 code change proposals is March 1, 2015 at 11:59 PM.

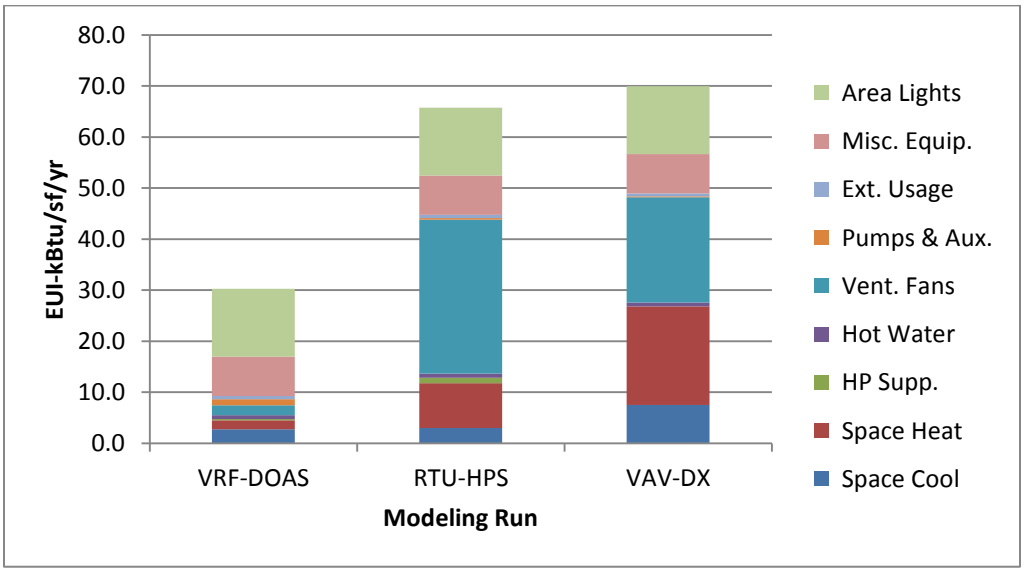
Economic Impact Data Sheet

Briefly summarize your proposal's primary economic impacts and benefits to building owners, tenants and businesses.

Energy savings associated with this proposal are large, varying from 30-60% for three case study buildings examined. Since this represents a different mechanical system design the calculation of savings and costs is somewhat difficult because it requires an assumption about what the base case system would have been.

The following graphic shows the modeled energy use for a case study building in Tukwila, WA. The building was built with a DOAS system as proposed by this code amendment. The actual building is using approximately 27kBtu/SF/year of site energy. The energy model was calibrated to within 10% of the actual bills (shown in the first column of the graphic below). The building was then modeled with two other possible code-compliant systems; a rooftop single-zone packaged heat pumps for the second column and with a central VAV system for the third column. Note the significant energy savings associated with the design change. This is particularly noticeable in the fan energy portion of the graph due to the cycling off of the main HVAC fans except during a call for heating or cooling. Large savings are also observable in the space heating energy portion of the graphic due to the presence of heat recovery ventilation and the elimination of reheating. Also of note is that this system was delivered for a cost of $14/SF for the HVAC system. This is on the low end of a typical commercial HVAC system bid.

Modeled Energy Use for King County Housing Authority Office in Tukwila WA



We have prepared a cost/benefit analysis based on three actual case study buildings which have implemented various versions of this DOAS design approach. Costs and savings for those three case studies are summarized below and more detailed memos explaining the analysis are attached as supplementary documentation.

Case Study	Building Type	SF	Real World System	Code System 1	Code System 2
King County Housing Authority	Office	36000	VRF Heat Pumps w/ DOAS (ERV)	Packaged Roof Top Heat Pump Units, modeled w/ System 9 (PSZHP) inputs from WSEC performance path	Packaged VAV RTU w/ Parallel Fan Powered Terminal Units and Electric Re-heat. Modeled w/ System 3 inputs from 2015 IECC.
Fire Station 72	Institution	12000	Ground Loop HX serving Water to Water Heat Pumps, radiant distribution with DOAS (ERV)	Ground Loop HX serving constant volume water to air heat pumps.	Water Source Heat Pumps w/ Fluid Cooler and Electric Boiler. Modeled with System 6 inputs from 2015 IECC
Westside School	School	55000	VRF Heat Pumps w/ DOAS (ERV)	Packaged Roof Top Heat Pump Units, modeled w/ System 9 (PSZHP) inputs from WSEC performance path	Single Zone Gas Unit Ventilators

Case Study	Code Proposal (as designed $/sq.ft.)	Code System 1 ($/sq.ft.)	Code System 2 ($/sq.ft.)	As Designed System EUI (kBtu/sf/yr)	Code System 1 EUI (kBtu/sf/yr)	Code System 2 EUI (kBtu/sf/yr)
King County Housing Authority	$16.00	$9.10	$14.80	30	66	70
Fire Station 72	$24.80	$30.50	$17.70	33	56	67
Westside School	$10.80	$8.80	$6.30	16	33	28

Another example of systems is a small office building of roughly 2000 SF. If the base case building is a packaged rooftop heat pump with economizer, one DOAS approach could be a heat recovery ventilator in conjunction with a ductless heat pump system for heating and cooling. Assuming a small 2000SF storefront, the cost for a 5-ton rooftop heat pump with distribution ductwork would be approximately $12,000.3 The alternate 2-head ductless 4-ton heat pump system is approximately $6000. The cost for the ERV with minimal distribution ductwork is also about $6000; for no incremental cost over the base case system. Savings in fan and heating energy would be similar to the office prototype mentioned above compared to the packaged rooftop heat pump system; ~30KBtu/SF/yr.

Provide your best estimate of the construction cost (or cost savings) of your code change proposal?

$Varies/square foot

Information collected from contractors bidding the buildings summarized in the memo suggest system costs for DOAS varies from $1.00/SF to about $4.00/SF average as summarized below.

Building	Proposed DOAS Cost ($/SF)	Code System 1 Cost ($/SF)	Code System 2 Cost ($/SF)	Average Incremental Cost
King County Housing Authority	$16	$9	$15	**$4**
Fire Station 72	$25	$30	$18	**$1**
Westside School	$11	$9	$6	**$3**

Show calculations here, and list sources for costs/savings, or attach backup data pages

Costs summarized in the attached cost memo. These costs reflect the overall cost of the systems designed with the DOAS as a part of the design strategy. For the overall system the impact is shown in the above table for the example buildings.

[3] RS Means Building Construction Cost Data. 68th Annual Edition. 2010.

Provide your best estimate of the annual energy savings (or additional energy use) for your code change proposal?

Up to 8 KWH/ square foot

Using the DOAS as a basis for a system design can save up to 8 kWh/ SF in annual energy use. This includes the impact of reduced heating and cooling system operation and reduced capacity in the heating and cooling system. The DOAS enables this level of design efficiency.

Show calculations here, and list sources for energy savings estimates, or attach backup data pages

Savings are summarized in the attached savings memo. These savings reflect the performance of the building including the DOAS. The overall savings presented in the savings memo include the effects of reduced system size, the impact of the DOAS system, and the efficiency of the installed equipment. The use of the DOAS system enabled these designs but the savings are the result of the entire design approach.

List any code enforcement time for additional plan review or inspections that your proposal will require, in hours per permit application:

The permit review and site inspection of the HVAC system for compliance would be unchanged under this proposal.