

Response to Minority Report on Proposed State Amendment 15-E070 to the International Energy Conservation Code Section 403.2.6.1 Dedicated Outdoor Air Systems (DOAS)

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“Limited Data”

The authors of the Minority Report claim that this proposal is based on limited research on an anecdotal collection of small buildings in the Seattle area and that research sponsored by a large national organization such as ASHRAE is necessary to support such a proposal.

In fact ASHRAE has been publishing research about DOAS for at least 20 years showing the advantages of this approach of separating the ventilation air from the heating and cooling system. A technical feature article in the July 2014 ASHRAE Journal¹ provided a literature review of DOAS research mostly sponsored by ASHRAE showing the benefits of diverse DOAS designs compared to basic VAV systems including:

- Easier to provide proper ventilation
- Decreased energy use and demand
- Enhanced indoor air quality

The May 2014 ASHRAE Journal² included a very detailed analysis of two identical side-by-side buildings in India; each about 125,000SF. One building included a VAV system and the other a DOAS with radiant ceilings. This analysis found that the DOAS radiant building was less expensive, used 33% less HVAC energy, and that the occupants were more satisfied with the comfort conditions.

A look through ASHRAE’s High Performance Buildings Magazine shows that almost every building highlighted by that publication as a “High Performance Building” includes some type of DOAS. The table below shows highlighted buildings from the 2014 and 2015 ASHRAE High Performance Buildings Magazines; excluding residential, healthcare and lab facilities. They include only two buildings that do not have DOAS systems and they are the highest energy users in this group. DOAS buildings include three examples over 200,000SF and a variety of climate zones including several in Washington State on both sides of the cascades.

¹ Shihan Deng, Lau, J., and Jeong, J. “Do All DOAS Configurations Provide the Same Benefits?”. ASHRAE Journal. July 2014.

² Guruprakash Sastry and Peter Rumsey. “VAV vs. Radiant: Side-by-Side Comparison”. ASHRAE Journal. May 2014.

Building	Location	System Type	Site EUI (KBtu/SF/yr)	SF
Gates Foundation	Seattle, WA	VAV w/ UFAD	64	660,000
Oak Forest Library	Houston, TX	Multizone Airhandler	70	12,000
Packard Foundation	Los Altos, CA	DOAS with Chilled Beams	24	49,000
Shenzhen Inst. of Building Research	Shenzhen, China	DOAS with Radiant and fan coils	21	200,000
Federal Center South	Seattle, WA	DOAS with Chilled beams	33	209,000
School of Engineering	Lacey, WA	DOAS with zonal geo heat pumps	18	25,300
McKinstry Station Retrofit	Spokane, WA	DOAS with Radiant	56	70,000
Exploratorium	San Fran, CA	DOAS with radiant and fan coils	45	190,000
Iowa Utilities Board	Des Moines, IA	DOAS with zonal geo heat pumps	22	44,000
Zero Net Energy Center	San Leandro, CA	DOAS with VRF	15	43,000
Edith Wyatt Federal Building	Portland, OR	DOAS with radiant	36	512,000

“Cost Impacts”

The minority report asserts, but provides no evidence, that DOAS systems are more expensive to renovate in later years if the occupancy of the space changes. There is no data to suggest that this is true and indeed it is possible to construct the same scenarios for almost any complex building HVAC system.

“Reduced Room Air Circulation”

The minority report warns that cycling of the heating and cooling system fans could lead to comfort problems associated with reduced room air circulation. This is a design issue that has many potential solutions. Using the heating and cooling fans to provide air circulation is highly energy intensive as these fans are designed to move conditioning throughout the building not just circulate air within a single zone. DOAS systems can provide indoor environments that are as comfortable or more comfortable than a VAV system and do not require the main HVAC airhandler to operate to provide minimum mixing in the space.

“Reduced Annual Ventilation”

The minority report claims that elimination of economizers could increase the risk of sick building syndrome. In fact, the ASHRAE research previously cited indicates improved indoor air quality³.

“Acoustic Issues”

The minority report mentions acoustical issues associated with cycling of heating and cooling equipment. This again is a design issue. Designs can be provided which achieve superior acoustical quality due to much smaller required fan systems. Careful fan selection in areas with acoustical concerns is always a good design practice.

“Scaling Issues”

We have not experienced any problems balancing low airflows in our DOAS designs. With modern air flow measuring equipment (available to almost any TAB consultant) air flow much lower than expected in a DOAS system can be measured and managed.

“Limits Flexibility and Creativity”

Most energy code requirements targeting higher levels of energy savings limit flexibility of the building community to some extent; they disallow inefficient equipment and methods in favor of more efficient equipment and methods. The DOAS proposal places relatively minor constraints on the selection of HVAC equipment. The proposal does not proscribe any specific heating or cooling system or any specific distribution system. Rather it places some limits on the operation of heating and cooling fans (they must cycle with load) and the ventilation air must be delivered directly to each space with heat recovery.

“Code Enforcement and Impracticality Clause”

As with any new code requirement some degree of training will be required for code officials. NEEA and NEEC have indicated that they will provide this training for code officials and the design community. The impracticality clause was added to provide a little more leeway for code officials in their enforcement of this particular proposal.

³ Shihan Deng, Lau, J., and Jeong, J. “Do All DOAS Configurations Provide the Same Benefits?”. ASHRAE Journal. July 2014.