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Nicholas O'Neil, Energy 350 - Modulating DOAS Requirements Opposition

Additional submitted attachment is included below.

July 17th, 2026
California Energy Commission
Docket: 25-BSTD-03
Project Title: 2028 Energy Code Pre-Rulemaking.
From: Nicholas O'Neil, Energy 350

Feedback Request from the Public – Modulating DOAS Questions

I offer feedback below as requested by the CEC at the June 24th meeting soliciting public input. I am a mechanical engineer working in the utility energy efficiency industry for the past 18+ years, and have worked as a mechanical HVAC designer, controls designer, and worked on code proposals for the Washington State Energy Code, Oregon Energy Efficiency Specialty Code, Title 24, and IECC.

Modulating DOAS – Current Code Interpretation

1. How are DCV and occupied standby requirements currently being interpreted in design, plan review, and acceptance testing of DOAS systems?

   Response: We interpret this as DCV being required for DOAS, just as it is for combined space conditioning and ventilation systems when the *system* meets the requirements of 120.1(d)3 or 160.2(c)5A.

2. Please share any project examples where DOAS systems were treated differently than mixed-air systems.

   Response: There are multiple PG&E ETCC reports and projects out of the Northwest that demonstrate how DOAS functions differently than mixed-air systems. In those projects, DOAS would still be subjected to DCV requirements if it met the thresholds noted in the question above was exceeded. That said, DCV is typically done at the unit level and not the zone level for two key reasons.

   First, implementing DCV at the unit level is easily controlled by the DOAS or mixed-air unit. Duct mounted CO2 sensor costs are well defined and routinely installed in the industry and unit level DCV ensures that during highly unoccupied periods, the unit is able to ramp down ventilation airflow to save energy. Energy savings due to reduction in ventilation airflow on a DOAS, which is what DCV is targeting, are small in this case but the small incremental cost of a duct CO2 sensor is still outweighed by the small energy savings benefit.

   Second, as noted in several responses below, the costs to add zone level control are significantly more than the energy savings realized by the tighter control of ventilation airflow. In a traditional VAV or mixed air system, modulating airflow during periods of low occupancy is imperative to reducing energy due to the space conditioning and ventilation loads that are always mixed. But in DOAS, the only loads being reduced are ventilation based, which is a much smaller percentage of overall load to the space. Furthermore, most if not all DOAS have efficient fans (typically ECMs) that can modulate flow as necessary based on

CO2 inputs, meaning the incremental fan power being reduced through DCV is very small. When compared to the cost of zone level control, it is not a cost-effective strategy particularly in New Construction where you are dealing with more efficient baseline systems and better design.

As an example, a recent PG&E code readiness study (**Code Readiness Case Study: Energy Recovery Dedicated Outdoor Air System with Heat Recovery VRF: Office/Classroom Building in Santa Rosa, CA | ETCC**) showed that even if using a low utility cost of $0.20/kWh for zone level DCV, the payback was shown to be 18-yrs, and it was not cost-effective.

Modulating DOAS – Clarification vs. New Requirement

3. Please suggest edits to clarify that DCV and occupied standby requirements apply to DOAS systems.

   Response: I recommend leaving the DCV section unchanged to keep the threshold defined at the *system* level and not at the zone level as per the CASE study proposed code change language. DCV by system type works for DOAS currently and ensures they are held to the same requirements as other system types when occupant density dictates its use. Moving DCV to a building level calculation is difficult to enforce, especially in situations with core+shell permitting happening separate from tenant improvement which may increase or decrease building outside air requirements.

Modulating DOAS – Per-Zone Airflow Modulation

4. What considerations do you foresee in trying to modulate outside air at each zone for DOAS systems serving multiple space-conditioning zones?

   Response: If you link ventilation to conditioning zones, you are unnecessarily increasing cost and complexity to achieve little if any energy savings. There are usually many more space conditioning zones than ventilation zones in a typical office, school, lodging environment and by tying the DOAS to the conditioning zones, you have effectively turned it into a mixed air system that negates many of the energy saving benefits a DOAS can provide.

   DCV has failed in current practice because designers often link together zones with different ventilation rates on a single system, thereby avoiding triggering the threshold. But the solution to getting more energy savings through ventilation isn't by tying ventilation air to space conditioning zones, it's by using market-ready, higher efficiency DOAS to deliver that air in the first place. DOAS can still do DCV at the unit level and provide modest savings from doing so. You just don't need to do it at every ventilation zone, and certainly not if you are trying to link ventilation and space conditioning zones 1-to-1.

   Finally, the CASE team modeled various scenarios for a multi-zone DOAS serving office and school buildings. My read is that Title 24 requires in Section 140.4(3) that office and school buildings that are modeled with DOAS need to

use heat recovery (see section 140.4(a)3E) which means that the baseline case is DOAS + heat recovery. Once you have heat recovery and efficient fans, additional savings attributed to per-zone modulation are relatively small and it is unclear if this is what the savings in the model are actually based off of.

Modulating DOAS – Alternative Design Pathways

5. Are there alternative design approaches that could provide similar ventilation reduction during low-occupancy periods? If so, what code language would make those approaches clear?

   Response: You can achieve even greater energy savings at a much lower cost using a higher efficiency HRV and low power fans on the DOAS without introducing a complex system of zone dampers to cut flow during unoccupied periods. Additionally, the complexity of the proposed system will only lead to the need for retrocommissioning over time and cuts into the longevity of any energy savings using this approach.

   If the CEC wants to create an exception to costly zone level control that would save significantly more energy, consider language that requires multi-zone DOAS to meet higher efficiency standards in lieu of complex controls solutions. An example of an exception is below and is built off the past 10 years of projects in the Northwest supported by numerous case studies on the Advanced DOAS BetterBricks page.

   > **Exception: DOAS serving multiple zones with a minimum heat recovery sensible effectiveness at design conditions of 70% or a minimum enthalpy recovery ratio of 60%, a total combined fan power less than 0.77 W/cfm when using the design maximum airflow rate, and equipped with an economizer bypass, damper control, or wheel bypass control.**

   These few technology improvements go a long way to ensuring minimal tempering of ventilation air is needed, the unit operates in an efficient state regardless of occupancy, and the DOAS can effectively deliver air to ventilation zones instead of being linked to space conditioning zones which lowers cost.

Modulating DOAS – Controls and BAS/DDC Assumptions

6. For new buildings with BAS/DDC controls, what level of additional programming, coordination, and commissioning is typically needed to support DOAS modulation, DCV, and occupied standby? Are there scenarios where the controls effort may be higher or lower?

   Response: Additional controls are needed at each box to tie into a DDC system, routinely estimated in the industry at $1500/point. That includes the electrical and control wiring but doesn't include costs associated with testing and balancing (ex. setting min/max damper positions), potential additional access panels above

gypboard ceilings, and numerous CO2 sensors installed and commissioned around the space. This can be compared to a few points for the DOAS entered into the BMS (status, alarming, etc.) and a single duct mounted CO2 sensor if the unit is required to do DCV.

Costs for integrating and commissioning a DOAS if it included zone damper control can be compared to the higher costs of integrating and commissioning a VAV system. Each zone isolation box would need a similar level of effort to ensure it modulates correctly in response to CO2 and occupancy sensor readings and then correctly mapped in the BMS.

Occupied Standby Cleanup

7. Please suggest edits to clarify intent of the occupied standby cleanup language.

   Response: Similar to statements made above, occupied standby is important in systems where inefficient space conditioning equipment operates unnecessarily and can easily be turned off during periods of no occupancy. In a true DOAS design, the small amount of ventilation air delivered to a space wastes very little energy when the space is unoccupied, especially when paired with higher heat (or energy) recovery devices.

8. Are there space types, size thresholds, or lighting-control interactions situations where examples would help avoid confusion?

   Response: Many code officials do not look across disciplines to check if this is happening. If the requirement sits in the lighting section, it is often overlooked by the HVAC plans reviewer and vice versa. This measure is problematic from an enforcement perspective more so than a feasibility perspective. As stated above, on DOAS, especially those that have heat recovery, the added benefit from this measure is minimal and the cost to link this across disciplines is significant. Occupied standby makes sense from a space conditioning perspective since that is the majority of airflow and energy use, and should remain a requirement for comfort systems only.

FCU Return-Air-Inlet Delivery Option

9. For designs that deliver DOAS air to the fan coil return-air inlet, what design details should be considered to ensure ventilation air reaches the occupied zone when the fan coil cycles off or operates at low airflow?

   Response: You would need to ensure the DOAS is sized to push against the static of the unit and associated downstream ductwork, and that the FCU has necessary controls to modulate dampers open during times of no heating or cooling to minimize the static pressure imposed on the DOAS. This adds cost and complexity and is poor design practice when optimizing for efficiency.

   This is an inherent increase in energy use compared to the other methods of delivering ventilation air to the space that exist in Title 24 already. If the CEC decides to allow this type of ducting, as a designer I would strongly recommend

allowing this solely as a trade-off in the compliance software. Designers should demonstrate that other methods of their design offset the energy penalty from ducting into the back of an FCU.

10. Are there duct, plenum, return-path, or fan-minimum-flow conditions that should be clarified?

    Response: I do not recommend ducting into the back of an FCU as a viable design option without an energy tradeoff. If allowed, the FCU will need integrated controls to modulate any dampers open to allow the air to flow through the FCU with as little static as possible and that the return path back to the DOAS is unobstructed. In this way, plenum return systems may be problematic unless the DOAS is set up to pull from there throughout the building. This can be especially problematic when you have a correctly designed DOAS serving ventilation zones that may be separate from space conditioning zones.

DOAS Supply-Air Temperature Limits

11. What input should be considered on the proposed DOAS supply-air temperature limits, including the 55°F mechanical heating cap and 75°F mechanical cooling floor?

    Response: While the 2021 Washington State Energy Code (WSEC) has a provision to limit tempering of supply air from DOAS, this seems overly prescriptive and likely unnecessary. In the Northwest we are concerned about heating air unnecessarily and have the following code provision in the 2021 WSEC.

> **C403.7.3. Ventilation air heating control.** For ventilation air units with supplemental heating capacity that operate in conjunction with zone heating and cooling systems, supplemental heating shall not warm ventilation supply air to a temperature greater than 55°F (13°C).

    If the CEC wants to impose limits on delivered air temperature, doing so on the heating side only seems prudent to eliminate the need for unnecessarily tempering the small volume of ventilation air and doesn't create issues for spaces that may need to dehumidify on the cooling side. Similar to the FCU tradeoff option noted above, the supply air temperature limit could also be a tradeoff in the compliance software. Here a designer would be allowed to exceed a 55°F supply air temp during heating so long as it is offset by another measure.

12. Are there California climate zones, heat recovery designs, neutral-air DOAS designs, or operating conditions where additional clarification would be helpful?

    Response: Delivering low volume air in a traditional DOAS (meaning directly ducted to the room with a low-flow grille or second best, downstream of the heating/cooling equipment) is best practice for allowing the ventilation air to mix in the room without the need for tempering. While some climate zones will require tempering to avoid introducing cold air into space, using high sensible heat recovery can greatly lower this requirement.