DOCKETED	
Docket Number:	25-BSTD-03
Project Title:	2028 Energy Code Pre-Rulemaking.
TN #:	273381
Document Title:	CA Statewide Utility Codes and Standards Enhancement Team Comments - Statewide CASE Team Comments on Air Distribution Measures In 2028 Title 24 Part 6 Pre-Rulemaking Express Terms
Description:	N/A
Filer:	System
Organization:	CA Statewide Utility Codes and Standards Enhancement Team
Submitter Role:	Public
Submission Date:	11/5/2026 12:27:14 PM
Docketed Date:	11/5/2026

Comment Received From: CA Statewide Utility Codes and Standards Enhancement Team
Submitted On: 11/5/2026
Docket Number: 25-BSTD-03

Statewide CASE Team Comments on Air Distribution Measures In 2028 Title 24 Part 6 Pre-Rulemaking Express Terms

Additional submitted attachment is included below.

CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

STATEWIDE CASE TEAM COMMENTS ON AIR DISTRIBUTION MEASURES IN 2028 TITLE 24 PART 6 PRE-RULEMAKING EXPRESS TERMS

November 5, 2026

California Energy Commission

Docket No. 25-BSTD-03

The California Statewide Codes and Standards Enhancement (CASE) initiative presents recommendations to support the California Energy Commission's (CEC's) efforts to update California's Energy Code (Title 24, Part 6), including revisions to simplify and clarify existing code requirements. Three California Investor-Owned Utilities (IOUs), Pacific Gas & Electric Company, San Diego Gas & Electric, and Southern California Edison, sponsored this effort as a group.

The Statewide CASE Team has significant concerns that the CEC's direction in the Express Terms for the two measures contained in the Air Distribution CASE Report differs considerably from what was proposed. The Statewide CASE Team maintains that the markups in the Express Terms, if finalized, would amount to dropping both measures. As a result, none of the savings identified in the CASE Report would be realized in California.

CEC's version of the language for Air Distribution measures was not workshopped. The language is significantly different from what was presented in the June 2026 workshop. Providing stakeholders with slightly more than three weeks to respond to these markups when they different so significantly from previously presented content was challenging.

1. PVAV Turndown Comments

The Statewide CASE Team requests that the CEC reconsider using the Packaged Variable Air Volume (PVAV) Turndown code language in the NR HVAC Air Distribution

Final CASE Report so that the savings described can be achieved.[1] If that cannot be done, the Statewide CASE Team urges that the new language addressing PVAV turndown in the Express Terms be deleted, as it conflicts with existing and newly proposed provisions and codifies cooling operation that is currently not permitted in the California Building Energy Efficiency Standards.

1.1 Departure from the Provisions Proposed in the CASE Report

The language proposed in the Express Terms for Section 401.3.14 [Section 140.4(m)] differs substantially from the CASE Report and will provide little, if any, energy or cost savings. Further, it codifies permission for multizone VAV systems to operate in a manner that is contrary to the intent of the 2025 California Building Energy Efficiency Standards. The Statewide CASE Team finds this result unexpected, since no comments were submitted to the docket on VAV turndown and, to the Statewide CASE Team's knowledge, no stakeholders have expressed opposition. Not adopting the proposed measure would result in California requirements that are less stringent than ASHRAE 90.1-2025 and IECC 2027, the commercial model building energy codes used in the rest of the United States.[2]

The intent of the Statewide CASE Team's proposal is to ensure that multizone PVAV systems that cannot significantly reduce airflow when mechanical cooling is in operation do not create a false cooling load in zones that must be countered by providing heat from a different source. For example, if the total mechanical cooling demand in a system is 10,000 Btu/h and the minimum turndown of the PVAV system is 25,000 Btu/h, the consumer is paying for 15,000 Btu/h of cooling they do not need, 15,000 Btu/h of hot water, and fan energy to move the excess air. In effect, it is worse than hot gas bypass, which puts a false load on the compressor but not on the reheat system or the fan.

ASHRAE SSPC 90.1-2025 and the IECC Commercial Consensus Committee recognize the problem and have added provisions to ameliorate it. ASHRAE 90.1-2025 and the soon-to-be-published IECC 2027 require that PVAV systems be capable of providing mechanical cooling at no more than the greater of 15 percent of design airflow or the sum of the minimum zone primary airflows. With wide participation from manufacturers,

[1] https://title24stakeholders.com/wp-content/uploads/2026/06/2028_Final-CASE-Report-HVAC-Air-Distribution.pdf

[2] The full form of ASHRAE 90.1 is ANSI/ASHRAE/IES Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings and the full name of IECC is the International Energy Conservation Code.

Addendum u to 90.1-2022 was passed with little opposition. The same language received no opposition during the IECC consensus process.

At the first Utility-Sponsored Stakeholder meeting, the CEC and stakeholders expressed concern that few PVAV air conditioners on the market meet ASHRAE and IECC requirements. The Statewide CASE Team proposed addressing these concerns by adding a compliance path that allowed excess cooled air to bypass the zones and return to the air conditioner instead of requiring airflow to be reduced to ASHRAE and IECC levels. Bypass has been used for multizone systems with constant-airflow fans since the 1960s and remains widely available in the market. The technology is well understood and inexpensive to implement.

The bypass compliance path requires that the air conditioner be able to provide mechanical cooling at not less than 200 cfm per ton of nominal cooling capacity, which is 50 percent of the typical full-load airflow. The Statewide CASE Team reviewed the catalogs of manufacturers that supply rooftop air conditioners (RTUs) in California and found that all the reviewed catalogs have standard models that meet the requirement. These findings were documented in the CASE Report in section 2.3.1.

The Statewide CASE Team understood that the proposed compliance path had resolved CEC staff's concerns of market availability. During the Pre-Rulemaking Staff Workshops for the 2028 Energy Code, the stakeholder who had previously expressed doubts about market availability indicated that her concerns had been resolved. CEC did not express any reservations to the Statewide CASE Team, other than minor issues involving existing systems in which installing a bypass duct would be difficult. The Statewide CASE Team proposed exceptions for those cases and believed any outstanding issues were resolved.

No comments were submitted to the docket for this submeasure, and the Statewide CASE Team worked with CEC staff to resolve concerns about market availabilty and alterations. Given this context, the Statewide CASE Team found the substantially different language in Section 401.3.14 [Section 140.4(m)] unexpected. The language proposed in the Express Terms does not appear to provide energy savings and conflicts with other sections of the code, as described below. The Statewide CASE Team requests that the CEC use the requirements proposed in the CASE Report for both the 2028 Energy Code and the Reference Appendices.

1.2 Proposed Section 401.3.14.4 Increases Energy Use, Forbids Bypass Systems, and Conflicts with Other Sections of the Code

The proposed language for the new Section 401.3.14.4 conflicts with other sections of the code, prohibits the use of systems with bypass, and would permit the use of RTUs

with poor turndown. The Statewide CASE Team believes the inclusion of this language will cause confusion and make compliance with the code more difficult, and recommends that it be struck in its entirety, regardless of whether the CASE Report proposal is adopted.

The text below is the new proposed language for Section 401.3.14.4 and is provided for reference:

> **401.3.14.4** *Multiple zone systems* in *nonresidential buildings* other than *Group R occupancies* shall meet all of the following:
>
> > **4.1.** Be able and configured to be able to reduce airflow from the supply fan to the minimum outdoor airflow required in Section 401.2.1.1.3 *[Section 120.1(c)3]*.
> >
> > **4.2**. When all zones are operating either within their *thermostat deadband* or in *occupied standby mode*, the system shall operate at a supply airflow no greater than the rate defined in Section 401.3.14.4.1. Upon calls for *mechanical heating* or *mechanical cooling* from the zones, the system supply airflow shall not exceed the sum of the *primary airflow* setpoints for each zone.
> >
> > **Exception to Section 401.3.14.4.2:** During *mechanical cooling*, the system may operate at the minimum *supply air* flow rate, in accordance with the equipment manufacturer's specifications.
>
> **Exception to Section 401.3.14.4:** Systems without *DDC*.

The proposed requirement to turn down the system airflow when all zones are in deadband goes beyond the requirements of ASHRAE 90.1 and may be preempted. Furthermore, equipment that meets the requirement may not be widely available.

The proposed language requires that the system "Be able and configured to be able to reduce airflow from the supply fan to the minimum outdoor airflow required in Section 401.2.1.1.3 [Section 120.1(c)3]." For systems serving buildings with low outdoor air requirements, that airflow will be significantly lower than that required by ASHRAE 90.1, which only requires turndown to the greater of 15 percent of design airflow or the sum of the zone minimum primary airflows. Establishing requirements for federally regulated equipment that go beyond those in ASHRAE 90.1 is a preemption risk.

Further, the Statewide CASE Team is aware that at least some equipment on the market cannot meet the proposed requirement and asks CEC staff to confirm the availability of equipment that does meet the proposed requirement.

Because the proposed requirement is central to the proposed language, the Statewide CASE Team suggests that Section 401.3.14.4 be struck in its entirety.

The exception to Section 401.3.14.4.2 explicitly allows mechanical cooling at the airflow specified by the manufacturer. This allowance conflicts with Section 401.3.6.2 [Section 140.4(d)2], Zones served by VAV Systems.

The language proposed by CEC permits multizone VAV systems to operate at the manufacturer-specified minimum airflow for mechanical cooling. Section 401.3.6.2 [Section 140.4(d)2] limits zone airflow for zones that are reheating air to either (1) 50 percent of peak primary airflow or (2) the design outdoor airflow rate specified by Section 401.2.1.1.3 [Section 120.1(c)3]. When only a few zones require mechanical cooling, those requirements often cannot be met at the manufacturer's minimum airflow.

Example:

- The system has 15 zones, each with 2,000 cfm peak primary airflow, for a total of 30,000 cfm.
- The system design airflow is 300 cfm/ton.
- The manufacturer's minimum airflow for mechanical cooling is 200 cfm/ton.

If two zones require mechanical cooling, the total system airflow would be 20,000 cfm. The 13 zones in deadband would need to increase their total airflow to 16,000 cfm, or 1,231 cfm per zone equal to 61.5%. The maximum airflow allowed under Section 401.3.6.2 [Section 140.4(d)2] is 50% which would be1,000 cfm in this example.

The Statewide CASE Team recognizes that this violation can occur under the current code with equipment on the market. The purpose of the code change proposed in the CASE Report is to ensure that systems designed with equipment that has high minimum mechanical cooling airflows do not excessively reheat air. CEC's proposed language instead codifies the use of this equipment, moving in the opposite direction from ASHRAE 90.1 and IECC. Therefore, the Statewide CASE Team recommends removing the exception.

The exception to Section 401.3.14.4.2 violates 401.3.6.2.2 [Section 140.4(d)2], which limits zone airflow rate during deadband.

Section 401.3.6.2.2 [Section 140.4(d)2] limits zone airflow during deadband operation to "the design zone outdoor airflow rate as specified by Section 401.2.1.1.3 [Section 120.1(c)3]." Allowing the system to operate at the manufacturer-specified minimum cooling airflow would violate that requirement whenever the system receives a call for mechanical cooling and a significant number of zones are in deadband.

The proposed language on airflow turndown during thermostat deadband and occupied standby mode would put zones with exhaust requirements in violation of Section 401.2.1.1.4 [Section 120.1(c)4], Exhaust ventilation.

Section 401.2.1.1.4 sets minimum exhaust airflow rates for certain spaces, such as commercial kitchens, janitor closets, and copy rooms. The proposed requirement, in Section 401.3.14.4.2, that the system airflow be reduced to the minimum outdoor airflow required in Section 401.2.1.1.3 will place designs in violation when the exhaust airflow rate exceeds the ventilation rate.

To address this issue, the Statewide CASE Team proposed a "design minimum outdoor air rate" that accounts for spaces with exhaust airflow requirements. The proposed language from the CASE Report is shown below.

> **401.3.21 [New Section] Design Minimum Outdoor Air Rate**. The design minimum outdoor air rate supplied to each space shall not exceed the larger of the following:
>
> **1.** 110% of the minimum outdoor air rate required for ventilation by Equation 401.2-B [Equation 120.1-F]
>
> **2.** the rate required for make-up of process exhaust systems minus available transfer air, per 401.3.16 [Section 140.4(o)]
>
> **3.** the rate required to meet special pressurization relationships required for health or safety.
>
> **Exception to Section 401.3.21:** Hotel/motel buildings and nonresidential buildings with Group R occupancies.

The language proposed by CEC limits outdoor airflow to 100 percent of the values shown in Section 401.2.1.1.3 [Section 120.1(c)3].

The proposed language unnecessarily limits outdoor airflow to the minimum values allowed in Section 401.2.1.1.3 [Section 120.1(c)3]. Designers should have some flexibility to provide additional outdoor airflow to improve ventilation. The Statewide CASE Team proposed allowing prescriptively designed systems to provide up to 110 percent of the minimum airflow.

The second sentence of proposed Section 401.3.14.4.2 would forbid the use of bypass systems.

The second sentence of proposed Section 401.3.14.4.2 states, "upon calls for mechanical heating or mechanical cooling from the zones, the system supply airflow shall not exceed the sum of the primary airflow setpoints for each zone." While this

statement is a tautology for systems without bypass, the greater concern is that it would forbid the use of bypass to save reheating and cooling energy. When a system uses bypass, the total system airflow necessarily exceeds the sum of the primary airflows. For this reason, the Statewide CASE Team recommends that the sentence be struck.

2. Modulating DOAS Comments

The CEC Express Terms effectively drop the modulating DOAS measure. The savings described in the Air Distribution CASE Report would not be realized if these markups are retained in the final 2028 version of Title 24, Part 6.

2.1 Express Terms Omit Several DOAS Submeasures Without Explanation or Justification

In addition to effectively dropping the primary submeasure of the proposal (modulating dampers, submeasure a), the Express Terms omit several additional submeasures from the modulating DOAS proposal without explanation or justification. These submeasures include:

- **Prescriptive Supply Air Option (Submeasure c)**
    - This submeasure would provide an additional prescriptive compliance pathway for designers who wish to deliver ventilation air to zones by ducting it into the inlet of the VRF FCU. This compliance pathway was carefully constructed to avoid potential energy penalties. It is lower cost and can be energy neutral if implemented correctly.
    - Some stakeholders raised objections to this submeasure in July 2026. However, the Statewide CASE Team maintains that the basic physics described in Section 3.1.2.3 of the Final CASE Report is valid. If a system follows the exact set of requirements contained in the proposed compliance pathway, the DOAS system would not consume more energy than it would with other options.
    - If CEC were to restore this submeasure in the 45-Day language, the Statewide CASE Team would recommend that CEC also include the Section 401.3.3 [Section 140.4(a)3] markups related to this submeasure

that were shared with CEC after the CASE Report was published.[3] This language is reproduced below for convenience.

…

401.3.3.3 [Section 140.4(a)3D] Indoor fans.

Indoor fans used to comply with the requirements of Section 401.3.3.1.1 [Section 140.4(a)3Ai] or Section 401.3.3.1.2 [Section 140.4(a)3Aii] shall have a maximum fan power of 0.35 W/cfm at design airflow, and shall have not less than three speeds ~~and shall turn off when there is no demand for heating or cooling in the space~~. At 66 percent air-flow the power draw shall be no more than 51 percent of the fan power at full fan speed, and at 33 percent air flow the power draw shall be no more than 12 percent of the fan power at full fan speed.

…

401.3.17.2 [Section 140.4(p)2] The DOAS ~~supply~~ outdoor air shall be delivered using one of the following options:

1.D~~d~~irectly to the occupied space and shall cycle off any zone heating and cooling equipment fans, circulation pumps and terminal unit fans when there is no call for heating or cooling in the zone. ~~or~~

…

- **Limit on Mechanical Cooling and Heating Setpoints in DOAS systems to Prevent Reheating and Recooling (Submeasure d)**
    - This submeasure is intended to reduce the likelihood of reheating or recooling ventilation air by limiting mechanical conditioning. This measure places no limit on passive conditioning (i.e., E/HRV systems).
    - The Statewide CASE Team identified no written objections to this measure in the July 2026 comments.
- **Maximum Outdoor Air in Prescriptive Language (Submeasure e)**
    - This submeasure is intended to place a prescriptive upper limit on ventilation airflow rates in nonresidential buildings. The ACM Reference Manual sets an upper limit in the standard design for performance

[3] The statement in 401.3.3.3 is proposed to be deleted because it is in conflict with proposed revisions to 401.3.17.2. Those revisions allow the indoor fans to stay on at low speed in deadband because it is lower first cost and energy neutral with respect to total fan energy (DOAS + FCU indoor fans).

compliance, so the Statewide CASE Team proposed reflecting that limit in the prescriptive code as well. This submeasure is intended to prevent overventilation of spaces and save energy at no upfront cost.

- The Statewide CASE Team identified no written objections to this measure in the July 2026 comments.

Although the Statewide CASE Team does not support CEC's decision to exclude submeasure c, the decision may explained given the adverse comments submitted to the docket on this submeasure. However, it is unclear why submeasures d and e were also omitted from the Express Terms. The Statewide CASE Team requests that CEC provide its justification for excluding each of the three submeasures from the Express Terms.

2.2 Technical Discussion of High-Efficiency HRV Exception

Stakeholders raised valid concerns about the justification for modulating DOAS hardware when an exhaust air heat recovery system has high sensible effectiveness. The primary driver of savings for the modulating DOAS dampers is the reduction of thermal cooling and heating loads on the overall HVAC system. The benefit of modulating dampers is that very warm or cold air is not brought into the building when indoor spaces are unoccupied. Stakeholder objections centered on the idea that a highly efficient HRV essentially provides the same benefit. The Statewide CASE Team agrees with this point and worked in response to the stakeholder comments on an exception for high- efficiency HRV DOAS systems.

This HRV exception does not conflict with the prescriptive HRV measure in Section 401.3.18 [140.4(q)] because the existing prescriptive requirement is only for 60 percent sensible effectiveness. In contrast, the exception applies to 82 percent sensible effectiveness.

Stakeholders repeatedly pointed out that the Northwest Energy Efficiency Alliance (NEEA) "Advanced Performance DOAS" (AP DOAS) specification should serve as the basis for an exception to the measure.

Between July and August 2026, the Statewide CASE Team conducted a modeling exercise to assess the effect of increasing the sensible effectiveness of the HRV unit. The analysis was similar to the original CASE analysis, except that sensible effectiveness was adjusted in 5 percent increments up to 85 percent. The modeling found that, at the AP DOAS specification level (82 percent sensible effectiveness), an exception would be energy equivalent to the modulating damper design choice, making the exception a valid approach to reducing outdoor air thermal energy loads on the

system. The Statewide CASE Team sent the exception to CEC by email on September 4, 2026. The proposed HRV exception language is reproduced below.

Exception to Section 401.2.1.2.5: Buildings that meet all of the following:

1. Total design ventilation rate < 20,000 CFM.
2. Either:
   a. The total design ventilation rate divided by the total building area is < 0.3 cfm/ft2, or
   b. Located in CZ 11-16.
3. At least 50% of the building is scheduled to be occupied less than 70 hours/week.
4. All ventilation is provided by an exhaust air heat recovery DOAS unit(s)
5. The heat recovery unit(s) is certified in accordance with AHRI Standard 1060/1061 and listed in the current AHRI Certified Product Directory.
6. AHRI-certified software documents that the unit(s) has a sensible effectiveness > 82% at design airflow.
7. The heat recovery unit(s) has a total combined fan power less than 0.77 W/cfm
8. All building exhaust, such as toilet, breakroom, and copy room exhaust, are exhausted through the heat recovery unit(s).
9. The heat recovery unit(s) has a heat exchanger bypass control damper(s) around the supply and/or exhaust air side of the heat exchanger that is open only when the weighted majority of thermal zones are in cooling mode and the outside air dry bulb is less than the return air dry bulb. Thermal zones shall be weighted by outside air cfm when calculating the majority.

Though the list of requirements to qualify for the exception may appear overwhelming at first glance, each element is necessary to ensure that the system achieves its theoretical efficiency. A brief justification for each clause in the exception is provided below. As the table shows, several of these requirements are already present in the prescriptive sections of the code, while others are straightforward clauses that ensure the unit achieves its rated sensible efficiency levels in practice.

Table 1: Explanation of Elements of High Efficiency HRV Exception

No.	Requirement	Explanation
1	Total design ventilation rate < 20,000 cfm	The limit exists because, as the size of the ventilation system increases, the relative cost burden of modulating dampers decreases relative to the energy savings achieved.
2	The total design ventilation rate divided by the total building area is < 0.3 cfm/ft^2, or the building is located in climate zones 11–16.	The first part of this requirement is intended to allow offices to qualify for the exception in any climate zone. The second part allows any building, including schools, to qualify if it is located in climate zones 11–16, which include the more extreme regions of the state.
3	At least 50% of the building is scheduled to be occupied less than 70 hours/week.	This requirement prevents buildings with higher expected occupancy rates from qualifying, since these buildings would have greater opportunities to save energy through airflow reductions.
4	All ventilation is provided by an exhaust air heat recovery DOAS unit(s).	This requirement ensures that the expected energy savings are achieved through heat recovery.
5	The heat recovery unit(s) is certified in accordance with AHRI Standard 1060/1061 and listed in the current AHRI Certified Product Directory.	The requirement for certification in accordance with AHRI 1060 is already included in the prescriptive exhaust air heat recovery requirements in Section 401.3.18 [Section 140.4(q)].

6	AHRI-certified software documents that the unit(s) has a sensible effectiveness > 82% at design airflow.	This means that the exhaust air heat recovery system can either add or remove, depending on whether the outdoor air is colder or warmer than indoor air, 82% of the sensible energy leaving the building and transfer it to or from the incoming airstream.
7	The heat recovery unit(s) has a total combined fan power less than 0.77 W/cfm.	This requirement ensures that the unit has an efficient supply fan. This value matches both the prescriptive multiple-zone heat pump HVAC requirement in Section 401.3.3.4 [Section 140.4(a)3E] and the NEEA AP DOAS specification.
8	All building exhaust, such as toilet, breakroom, and copy room exhaust, is exhausted through the heat recovery unit(s).	This requirement ensures that the exhaust air heat recovery unit provides the sensible effectiveness implied by its rating. If certain exhaust airstreams are diverted away from the HRV unit's exhaust airstream, there may not be sufficient air to transfer thermal energy to or from the incoming airstream.
9	The heat recovery unit(s) has a heat exchanger bypass control damper(s) around the supply and/or exhaust air side of the heat exchanger that is open only when the weighted majority of thermal zones are in cooling mode and the outside air dry bulb is less than the return air dry bulb. Thermal zones shall be weighted by outside air cfm when calculating the majority.	The requirement ensures that the HRV does not operate when airside economizing is favorable for the building relative to exhaust air heat recovery. This requirement is already included in the prescriptive exhaust air heat recovery requirements in Section 401.3.18 [Section 140.4(q)].

2.3 Stakeholder Engagement in Spring and Summer 2026

The Statewide CASE Team considers stakeholder feedback an essential component of the code measure development process. The triennial CASE process is built around the idea that draft measures should be presented to the public at multiple points during development. The 2028 modulating DOAS measure was no exception. At the April 2026 stakeholder meeting, the Statewide CASE Team received valuable feedback from the community.

The feedback revealed that the Statewide CASE Team did not fully recognize the potential for high-efficiency HRV systems to achieve the same objective as the modulating damper approach for DOAS systems. In response to the HRV feedback, the Statewide CASE Team developed the high-efficiency HRV exception, which is discussed in Section 2.2.

Other stakeholder feedback revealed differences in interpretation of the current code requirements. In some instances, stakeholder questions about the measure's objectives and analysis allowed the Statewide CASE Team to improve the language before the Final CASE Report was published in June 2026. A summary of the spring 2026 docketed comments on the modulating DOAS measure is provided in Table 2.

Table 2: Summary of Commenters on Modulating DOAS Measure Prior to Final CASE Report Publication

Date	Commenter
4/27/2026	Neil Bulger
4/27/2026	Andrew Reilman
4/27/2026	Jonathan Heller
5/22/2026	Nick O'Neil
5/29/2026	Charlie Stephens
5/31/2026	Louis Starr

In addition to these docketed comments, NEEA staff reached out to the Statewide CASE Team, which led to several productive conference calls during which the measure details and the analytical approach for the high-efficiency HRV exception were discussed. Table 3 summarizes all conference calls that the Statewide CASE Team held with stakeholders regarding the modulating DOAS measure after the second stakeholder meeting in April 2026.

Table 3: Meetings between The Statewide CASE Team and DOAS Commenters

Date	Meeting Attendees
4/30/2026	Neil Bulger (Andrew Reilman and Jon Heller were invited but could not attend), CEC
5/26/2026	NEEA
7/2/2026	Charlie Stephens, Louis Starr, and Nick O'Neill
7/13/2026	NEEA
7/21/2026	Charlie Stephens, Louis Starr, and Nick O'Neill

Table 4 provides a consolidated summary of the stakeholder comments received before publication of the Final CASE Report and the Statewide CASE Team's responses. These responses were shared with CEC and the stakeholders at the time but were not docketed.

Table 4: Summary of Issues Raised by Commenters and CASE Team Responses Prior to CASE Report Publication

Consolidated Issue	Statewide CASE Team Response
1. Overall DOAS design philosophy (submeasures a, c, and d) Commenters argue that efficient DOAS design should separate ventilation from sensible space conditioning, supply ventilation air at or near neutral temperature, and allow zone FCU/VRF fans to shut off when there is no thermal load. Commenters contend that submeasures a, c, and d partially recouple ventilation and space conditioning and therefore undermine a principal efficiency benefit of DOAS.	The Statewide CASE Team does not agree with this interpretation that DOAS air should be "neutralized" in California. Central heating or cooling of ventilation air can create downstream recooling or reheating. The proposal allows designers to retain a separate 100% outdoor-air system. The proposal would simply require thermal zone-level ventilation modulation, provide another FCU ducting option, and limit DOAS mechanical heating and cooling.
2. Existing code requirements for DCV and occupied standby (submeasure a) Commenters argue that existing Title 24 requirements may already require DOAS systems to comply with demand-controlled ventilation (DCV) and occupied-standby requirements. If that interpretation is correct, they argue that the appropriate remedy is clarification, guidance, or enforcement rather than imposing additional ventilation-control hardware.	The CEC advised the Statewide CASE Team in 2023 that DOAS systems did not have to comply with DCV and occupied standby, which prompted the measure. Furthermore, if DCV is required for DOAS systems, the logical conclusion is that DOAS must be capable of modulating airflow to portions of the ventilation zone when one DOAS unit serves multiple thermal zones.
3. Per-zone ventilation modulation may be overly prescriptive and costly (submeasure a) Commenters argue that requiring independent ventilation modulation at every thermal zone could impose unnecessary	The language in the Final CASE Report applies to buildings with more than 3,000 cfm of outdoor airflow and does not mandate a particular terminal device. It permits modulating pressure-independent dampers or

controls, airflow-measurement hardware, installation costs, and complexity. They also argue that thermal zones and ventilation-control zones do not necessarily need to have identical boundaries.	other means of independently modulating outdoor air, including multiple smaller variable-speed DOAS units. The CASE analysis included the added hardware costs, used code-minimum HRV equipment in both the base and measure cases, and found the measure cost-effective in every California climate zone examined. The Statewide CASE Team also reports that its sensitivity analyses continued to show lifecycle energy cost savings.
4. Ventilation isolation areas may provide a less prescriptive alternative to per-zone modulation (submeasure a) Commenters recommend considering a Washington State Energy Code-style approach that establishes ventilation isolation areas, rather than requiring independent modulation at every thermal zone. They argue that this approach could achieve much of the intended ventilation reduction with fewer control devices and greater design flexibility.	Isolation areas and modulating DOAS serve different purposes. Isolation areas divide large portions of building with different schedules, but do not enable DCV or occupied standby at individual HVAC zones. Title 24 Section 401.2.2.7 [120.2(g)] already contains a substantially similar isolation requirement. The Statewide CASE Team accepted an editorial revision changing “space conditioning systems” to “HVAC systems” so that the provision clearly includes DOAS but does not view isolation areas as an alternative to zone modulation.
5. California field research raises questions about the cost-effectiveness of zone-level DCV (submeasure a) Commenters cite PG&E-funded California field research as evidence that adding DCV controls to individual thermal zones of a DOAS was not cost-effective in at least some studied applications. They argue that this evidence should be	The Statewide CASE Team added a discussion of the PG&E Code Readiness field research in the Final CASE Report in section 3.1.3.3. Further discussion of the Statewide CASE Team’s response to this issue can be found in Section 2.4 of this comment letter. In short, the scenarios studied in the code readiness project were fundamentally different than what is

addressed before zone-level ventilation modulation is required in new construction.	proposed in this measure due to the code readiness sites being existing buildings, the cost-effectiveness analysis not completed with LSC, and the code readiness savings only counted fan energy, not heating and cooling energy, which significantly undervalued the benefits of DCV with DOAS systems.
6. BAS and controls costs may be understated in the cost-effectiveness analysis (submeasure a) Commenters argue that implementing zone-level DCV and occupied-standby sequences may require central building automation system (BAS) capabilities that are not fully represented in the measure cost. If additional BAS hardware or programming is necessary, they argue that those costs should be incorporated into the lifecycle cost analysis.	Large new buildings are already required to have DDC under Title 24 Section 401.2.2 [Section 120.2], and sufficiently large multizone VRF systems already have programmable centralized controls. Regardless, the "non-integrated" case in the CASE analysis includes zone and DOAS controllers and does not require a separate BAS. See the cost-effectiveness comment in Section 2.6 for more detail.
7. Ventilation-rate assumptions may affect calculated savings and cost-effectiveness (submeasure a) Commenters question whether the assumed outdoor-air rates adequately represent actual mixed-space offices and educational buildings. They argue that the measure should be evaluated at realistic whole-building ventilation rates because higher outdoor-air rates could materially affect equipment sizing, energy savings, control costs, and overall cost-effectiveness.	The 0.15 cfm/ft² value applies only to low-density spaces, while 0.75 cfm/ft² is used for high-density spaces. Reported building averages are 0.27 cfm/ft² for offices, 0.63 cfm/ft² for K–12 schools, and 0.57 cfm/ft² for higher education. The sensitivity analyses described in the report continued to find the measure cost-effective. The CASE assumptions reflect industry-standard practice. In response to related fan-power comments, the Statewide CASE Team requested any contrary fan-power data for comparison.
8. The occupied-standby clarification may inadvertently change applicability (submeasure b)	The premise of this comment is incorrect because offices at or below 250 ft² are covered by Section

Commenters argue that simplifying occupied-standby applicability into a space-type table could omit existing floor-area and occupancy-sensor triggers and thereby expand occupied-standby requirements to spaces that are not currently subject to them. They contend that such an expansion would be a substantive code change rather than merely an editorial clarification.	601.2.2.3.5 [Section130.1(c)5] and offices above 250 ft² are covered by Section 601.2.2.3.6 [Section 130.1(c)6]. The disputed interpretation demonstrates the need for the editorial clarification.
9. DOAS air delivered to an FCU inlet may not reliably reach the occupied space when the FCU fan is off (submeasure c) Commenters argue that, without FCU fan operation, outdoor air introduced at an FCU inlet could pressurize the unit, stagnate, or find a return-air path without necessarily flowing through the occupied space. They therefore question whether this configuration can reliably provide required ventilation when the FCU is off.	The Statewide CASE Team accepted this concern and revised the final language. The FCU-inlet option now requires ventilation air to flow through the occupied space before being returned or exhausted, including a barrier between the area surrounding the FCU and the broader return plenum. The Statewide CASE Team also added more detail and compliant and noncompliant illustrations to the Final CASE Report. Existing direct-to-zone and discharge-side options remain available for designers.
10. DOAS air delivered through an FCU inlet may increase zone-fan energy (submeasure c) Commenters argue that delivering ventilation air through the FCU inlet could require the FCU fan to operate whenever ventilation is required, including periods with no sensible heating or cooling load. They contend that this could eliminate a significant benefit of decoupled DOAS systems, namely the ability to turn zone fans completely off during thermal deadband.	The Statewide CASE Team emphasizes that FCU-inlet delivery is an optional prescriptive pathway, not a mandatory design. The proposal includes guardrails that require the FCU fan either to cycle off when ventilation air can flow through the space without fan assistance or to reduce its speed to no more than the airflow needed to match required outdoor air and no more than 50% of maximum speed. Designs or FCUs that cannot meet those conditions cannot use this pathway. FCU fan assistance reduces the static

	pressure imposed on the central DOAS fan, offsetting at least part of the zone-level fan energy.
11. Existing direct-to-zone or FCU discharge-side ventilation delivery may be preferable to FCU-inlet delivery (submeasure c) Commenters argue that existing approaches that discharge DOAS air directly to the occupied zone or to the FCU discharge preserve independent ventilation delivery and allow the FCU fan to shut off. They question whether adding FCU-inlet delivery provides sufficient benefit to justify potentially recoupling ventilation with zone-fan operation.	The existing options are still available for designers. Discharge-side delivery can increase DOAS external static pressure, require ductwork and diffusers sized for combined FCU and DOAS flow, and may create over-pressurization or fan-curve risks. Inlet delivery would be an additional, lower-cost option subject to the airflow and ventilation-path limitations and would not replace discharge-side or fully decoupled delivery.
12. The proposed DOAS supply-air-temperature limits could shift sensible cooling to the DOAS system (submeasure d) Commenters interpreted the proposed 55°F provision as potentially encouraging or requiring cold DOAS supply air. They argue that cooling ventilation air to approximately 55°F would cause the DOAS to provide sensible space cooling rather than primarily ventilation and latent conditioning, potentially resulting in unwanted cooling of zones that do not have a simultaneous cooling load.	The Statewide CASE Team acknowledges that the draft CASE Report did not clearly describe submeasure d. The final proposal does not require 55°F supply air; it limits mechanically heated or cooled DOAS from cooling outdoor air below 75°F in cooling mode or heating it above 55°F in heating mode, subject to exceptions. The Statewide CASE Team states that the provision applies to mechanically heated or cooled DOAS systems, not E/HRV-only DOAS systems, and is intended to preserve the role of zone HVAC equipment in serving design-day sensible loads while avoiding unnecessary recooling and reheating.

13. Supply-air-temperature limits should not penalize passive heat recovery or near-neutral ventilation (submeasure d) Commenters argue that high-effectiveness HRVs and ERVs can naturally produce DOAS supply temperatures around 60–70°F under some conditions without mechanical conditioning. They are concerned that the proposed temperature limits could restrict efficient heat-recovery operation or require unnecessary mechanical conditioning of otherwise acceptable ventilation air.	The Statewide CASE Team states that the final temperature limits apply to mechanical heating and cooling, not E/HRV-only DOAS operation. Passive heat recovery may therefore produce near-neutral supply air without violating the provision. The Statewide CASE Team removed the proposed restriction that could have limited heat-recovery operation above 55°F, while maintaining that routinely using mechanical conditioning to neutralize ventilation air in California can create unnecessary recooling or reheating.
14. The proposed mechanical-cooling limit needs to accommodate legitimate dehumidification (submeasure d) Commenters argue that some California applications may require the DOAS to cool outdoor air below the proposed limit to control latent loads and indoor humidity. They contend that a broad restriction on mechanical cooling below 75°F could prevent appropriate dehumidification where the terminal zone equipment cannot adequately handle latent loads.	The Statewide CASE Team revised the proposal to allow cooling below 75°F where the DOAS must meet latent loads at design conditions, including specified conditions for systems whose zonal equipment lacks latent-cooling capability or for qualifying dehumidification design conditions. The late-May response reiterates that this exception was added to the Final CASE Report because limited California applications may require DOAS dehumidification.
15. Statements about typical industry practice need supporting evidence (submeasure a) Commenters challenge statements that designers commonly omit modulating DOAS controls or treat DCV and occupied standby as inapplicable to DOAS. They argue that generalizations about current design practice should be	The Statewide CASE Team revised the Final CASE Report to characterize current design practice more carefully. It previously reported reviewing at least 12 DOAS designs and finding only two with modulating controls, while the referenced field research also found that most studied systems were constant volume. The main point is that current code still permits constant-

supported by surveys, design reviews, compliance data, field studies, or other documented evidence.	volume DOAS and that the proposal would end that option for in-scope DOAS systems.
16. Occupancy assumptions may not represent California offices and educational buildings (submeasure a) Commenters question using post-pandemic occupancy studies, particularly office-focused studies, to characterize occupancy patterns for multiple building types. They argue that K–12 schools and other educational facilities have different occupancy patterns and that California-specific or building-type-specific occupancy data would provide a stronger basis for savings estimates.	Without ERV in the base or measure case, the measure is cost-effective at 100% occupancy, based on DCV savings alone and without occupied-standby savings, for offices, K–12 schools, and post-secondary schools. When a code-minimum ERV is added, the measure is cost-effective at 80% occupancy. The Statewide CASE Team considers the occupancy-rate dispute nondeterminative of cost-effectiveness. This issue received continued attention after the spring period and remains an active discussion as of November 2026.
17. The EnergyPlus/spreadsheet modeling method may not adequately represent a decoupled DOAS system (submeasure a) Commenters question using a hybrid modeling approach rather than explicitly modeling separate ventilation and sensible-conditioning systems serving each zone. They argue that the methodology should either model the physical DOAS configuration more directly or be validated against measured California DOAS performance.	The Statewide CASE Team initially attempted a more direct EnergyPlus representation but encountered unexplained results. The hybrid modeling approach explicitly controls hourly zone outdoor airflow. Approximately 10% of total modeled savings comes from fan energy, and the measure remains cost-effective without that portion.
18. Increased control complexity could affect operational persistence and fault detection (submeasure a) In the follow-up exchange, the commenter raises concern that coupling ventilation delivery to FCU operation and adding	The Statewide CASE Team takes the opposite view: per-zone airflow monitoring would continuously measure outdoor-air delivery and allow operators or occupants to be alerted to insufficient ventilation. It

additional control dependencies could create operational or maintenance problems and potentially obscure failures to deliver required ventilation. The commenter therefore questions whether the proposed configuration will reliably maintain ventilation over the life of the system.	cites experience with DOAS systems that reportedly failed to maintain code-minimum zone ventilation without such feedback. Currently, if a DOAS system does not provide sufficient airflow to zones and the systems are not monitored, the building operator may have no way of knowing.

Overall, the Statewide CASE Team appreciated the feedback from stakeholders in April–May 2026. The feedback meaningfully improved the final CASE Report, which was published in June. Following publication, CEC held a workshop on June 24, where all five modulating DOAS submeasures were presented to the public. CEC provided the public an opportunity to submit written comments to the docket following the workshop, and several of the commenters mentioned above submitted additional docketed comments, as summarized in Table 5.

Table 5: Summary of Commenters on Modulating DOAS Measure After Final CASE Report Publication

Date	Commenter
7/17/2026	Neil Bulger
7/17/2026	Charles Stephens
7/17/2026	Nick O'Neil
7/20/2026	Louis Starr

These comments responded to specific questions raised by CEC during the workshop and provided additional perspectives on the modulating DOAS submeasures, primarily submeasure a. The Statewide CASE Team developed responses to these comment letters but did not docket them. Instead, the responses were shared directly with CEC off docket on July 30. Because the comment letters tended to address similar issues, Table 6 provides a consolidated summary of the issues and the Statewide CASE Team's responses.

Table 6: Summary of Issues Raised by Commenters and CASE Team Responses After CASE Report Publication

Consolidated Issue	Statewide CASE Team Response
1. Whether the proposal's mandatory designation is adequately supported Neil Bulger argued that the 2019 occupied-standby requirement assumed zone-level ventilation modulation hardware already existed, whereas the proposed DOAS requirement would mandate purchasing that capability at substantially higher incremental cost. The commenter contends that lifecycle cost-effectiveness alone does not establish that a higher-cost, architecture-dependent measure should be mandatory with no compliance alternative.	The 2028 lifecycle cost analysis is independent of the 2019 analysis and is based on the costs and savings documented in the current CASE Report. The 2019 analysis is not relevant to the current discussion. The current analysis uses constant-volume DOAS as the baseline and includes modulating dampers, CO2 sensors, occupancy sensors, controls, and commissioning. The Statewide CASE Team is not aware of any statutory requirement that mandatory measures be limited to low-cost measures. The measure allows for multiple approaches to compliance: (1) using pressure-independent modulating dampers, (2) applying a VFD-driven DOAS to each thermal zone with DCV, or (3) taking the high-efficiency HRV exception.
2. Whether the cost model understates the number of zone devices Neil Bulger argued that the analysis assumes a one-to-one ratio between base-case ventilation outlets and measure-case space-conditioning zones, even though some current DOAS designs may use one ventilation outlet or control zone for multiple thermal zones. The commenter contends that damper, controls, and airflow-measurement costs would increase if the measure requires more controlled zones than the base case.	Title 24 requires the correct ventilation quantity to be ducted to each space. A code-compliant base-case DOAS either serves each space directly or serves each thermal-zone FCU, which is then ducted to the spaces. The modeled base case therefore includes a manual volume damper at each thermal zone, and the measure upgrades that existing damper to a pressure-independent modulating control damper. Designs that aggregate ventilation in the manner described by commenters are not considered code-compliant baselines.

3. Terminology for modulating dampers versus venturi air valves Neil Bulger noted that portions of the supporting materials use both "pressure-independent air valve" and "pressure-independent damper." The commenter argues that a venturi air valve can cost materially more than the damper priced in the CASE analysis, so the code language and cost estimate must refer to the same device.	"Air valve" was legacy terminology from the draft report. The intended device is a modulating damper, not a venturi air valve, and the Statewide CASE Team acknowledges that the inconsistent wording caused confusion. Appendix F2 of the CASE Report contained the draft code language, which was provided for informational purposes only and was not the final language.
4. Whether DCV may be implemented at the DOAS-unit level Nicholas O'Neil proposed unit-level DCV using a duct-mounted CO2 sensor and DOAS fan turndown, arguing that this approach provides lower-cost savings without zone-level modulation.	Unit-level DCV serving multiple spaces is not allowed by Title 24 or ASHRAE Standard 62.1 because CO_2 must be measured in each high-density space and ventilation must be modulated at the space level. Averaging return-air CO_2 can underventilate a fully occupied room when other rooms are empty. The Statewide CASE Team contends that compliant options are either a dedicated DOAS per thermal zone or modulating controls for each thermal zone served by a DOAS unit that encompasses multiple thermal zones.
5. High-efficiency HRV alternative or exception Nicholas O'Neil and Louis Starr propose an exception for high-performance DOAS designs using high-effectiveness heat recovery, low combined fan power, bypass controls, decoupled ventilation, and grouped ventilation zones. They argue that such designs can reduce the conditioning penalty of overventilation enough to provide comparable or greater savings at lower controls cost.	The Statewide CASE Team considers this a reasonable alternative. An exception without limits on zone grouping could eliminate most DCV and occupied-standby savings. The high-efficiency HRV exception is discussed in Section 2.2 and is recommended as the preferred approach to addressing this issue rather than dropping the measure.
6. Static-pressure reset, operating reliability, and persistence Louis Starr argued that large modulating DOAS systems may experience elevated static pressure, ineffective static-pressure reset, high pressure drops across partially closed dampers, sensor drift, overrides, and long-term commissioning needs that erode expected savings.	The Statewide CASE Team does not believe these concerns are supported by the analysis presented in the comments. Static-pressure reset operates successfully in many buildings, reset savings are not necessary for the measure to remain cost-effective, and a modulating DOAS uses less fan energy than a constant-volume DOAS. Title 24 includes CO_2-sensor calibration requirements.

7. Field calibration of airflow-measurement stations Louis Starr argued that project specifications and certified TAB practice may require field calibration and setup of terminal airflow measurement, even if code allows factory calibration. The commenter contends that the incremental cost should include verification, minimum and maximum flow setup, damper checks, controller stability checks, and documentation.	Title 24 permits factory or field calibration, and the cited PG&E and ASHRAE research found factory calibration sufficiently accurate, with no significant accuracy improvement from field calibration. See Section 3.4.3.2 of the Final CASE Report for more information. Modulating DOAS devices generally operate at higher fractional airflow than minimum-flow VAV reheat boxes and therefore should have better measurement accuracy. A sensitivity analysis adding $1,500 per zone for field calibration remained cost-effective and was included in the Final CASE Report; contractor feedback indicated an expected cost no greater than $150 per zone.
8. HVAC operating-hours assumption Louis Starr disputes the 90-hour-per-week office HVAC schedule used in the analysis and argues that new offices may operate closer to 50 hours per week. The commenter also challenges whether the cited scheduling references represent actual building operation.	The Statewide CASE Team performed a sensitivity analysis using 53 operating hours per week and still found the measure cost-effective. The 53 hour per week run was viewed as an extremely conservative estimate and unsupported by any research conducted by the Statewide CASE Team. For example, the CBECC run hours for office prototypes is 95 hours/week.
9. Baseline and standard-design assumptions Nicholas O'Neil argued that the analysis should use DOAS with heat recovery and efficient fans as the baseline for offices and schools, making the incremental savings from zone modulation small.	The Title 24 standard design for the in-scope multizone office and school systems is System 15, a packaged VAV system with an air-to-water heat pump, not a DOAS baseline. The Statewide CASE Team also states that E/HRV equipment was included in both the base and measure cases for the measure analysis so that energy-recovery effects did not drive the reported savings. As noted elsewhere, the Statewide CASE Team has developed a high-efficiency HRV exception which is now being recommended as part of the measure. See section 2.2 of this comment letter for more detail on the exception.

In summary, the commenters provided valuable perspectives and correctly noted that high-efficiency HRV systems would achieve the same ends as modulating DOAS dampers. Their feedback helped the Statewide CASE Team improve the Final CASE Report. However, it is the opinion of the Statewide CASE Team that the commenters did not raise issues that would justify CEC effectively dropping the modulating DOAS measure from the Express Terms.

2.4 Code Readiness Reports Are Not Directly Comparable to the CASE Measure

Section 3.1.3.3 of the Final CASE Report reviews PG&E Code Readiness DOAS research conducted from 2018–2024. The research provides useful field evidence on DOAS performance. However, it is only partly applicable because the studies focused on existing buildings, while the proposed measure applies to new construction. The research found that some practitioners already interpret Title 24 as requiring DCV for DOAS. One project implementing DCV reduced fan demand by about 30 percent (from 3.5 to 2.5 kW), while another achieved about 6 percent fan-energy savings. Importantly, these studies exclude heating and cooling savings, which the CASE analysis estimates account for roughly 90 percent of the measure's energy savings.

The research also highlighted substantial unrealized opportunities: 8 of 15 DOAS units had VFDs, but only 3 operated as VAV, and measured CO_2 levels below 1,000 ppm at sites without DCV suggested potential overventilation during low occupancy. A Santa Rosa retrofit study estimated modulating dampers and DCV at \$9/ft^2, but the CASE Report considers this comparison of limited relevance because its new-construction analysis estimates an upfront cost of under \$2/ft^2. RS Means indicates that existing building HVAC contract work is more expensive than new construction, but that the cost difference is typically within the range of 100 to 200% of new construction costs. This finding implies the possibility that the \$9/ft^2 figure could be an outlier, but regardless, it is significantly greater than the CASE Team's finding of \$2/ft^2 in new construction. Recall that this measure is not proposed to be applicable to existing buildings. Overall, the Code Readiness work supports the technical feasibility of modulating DOAS, while its retrofit-focused costs and incomplete accounting of HVAC savings limit direct comparison with the proposed measure.

In addition, the cost-effectiveness analysis in the Code Readiness Reports did not use long-term system cost (LSC). The underlying analysis was not published or described in detail, making its assumptions difficult to compare with those of the CASE analysis.

Although the Code Readiness DOAS research was a valuable resource, its cost-effectiveness analysis does not provide a directly comparable basis for evaluating the cost-effectiveness of the proposed modulating DOAS measure. The analyses are not directly comparable.

2.5 Code Ventilation and DCV Requirements Apply at the Room Level, Not System Level

The Statewide CASE Team is concerned that viewpoints indicate a lack of clarity about the ventilation requirements. Title 24 Part 6 states that minimum ventilation airflow must be provided at the room level, not at the ventilation system level. Therefore, it is not sufficient to sense CO_2 levels in the return duct, since ventilation zones often span multiple rooms or thermal zones. This control strategy may not account for room-specific ventilation requirements and is not a code-compliant approach to DCV.

Stated differently, if a ventilation zone covers multiple rooms or thermal zones and the DOAS diffusers cannot independently deliver airflow to those different areas, sensing CO_2 levels in the return duct and adjusting airflow only at the DOAS supply fan creates a very high likelihood that some rooms or spaces will not receive code-minimum ventilation airflow. Failure to provide code-minimum ventilation would violate the code.

A demand-controlled ventilation requires dynamic control of airflow to different areas within a “ventilation zone.” A DOAS unit serves a ventilation zone, which, in most cases, will cover multiple thermal zones and likely multiple rooms. The requirement for demand-controlled ventilation effectively implies that DOAS systems require dynamic controls, not fixed dampers, since some thermal zones or rooms can curtail their outdoor airflow due to room-specific occupancy patterns, while others cannot do so.

Occasionally, a DOAS unit serves a single space that perfectly overlaps with a thermal zone. Because variable-speed motors typically drive DOAS supply fans, modulating dampers are not needed, as the supply fan can fully control airflow. However, these situations are rare. In most cases, the thermal zones and ventilation zones will not align. To comply with DCV, a DOAS system must be capable of modulating airflow to specific subsets, such as individual rooms or thermal zones.

In summary, the demand-controlled ventilation requirement logically implies the need to modulate airflow since ventilation zones span multiple rooms with diverse code ventilation requirements and turndown opportunities such as occupied standby and demand-controlled ventilation. Because mixed-air systems are predominantly variable-air-volume systems, this is straightforward for that HVAC system type. The same logic applies to DOAS systems. DOAS should be required to modulate airflow unless it serves a single thermal zone or room or uses a high-efficiency HRV to avoid the energy penalty of bringing outdoor air into a conditioned space.

2.6 Cost-Effectiveness Analysis in the CASE Report

Section 3.4 of the Final CASE Report includes an in-depth discussion of the cost-effectiveness analysis. Section 3.4.3 focuses on first-cost estimates and provides significant detail on the upfront costs of complying with submeasure a. The costs were estimated separately for an "integrated" and "non-integrated" controls scenario, and the measure was cost-effective in both cases. The Integrated scenario referred to a system in which a broader control system or FCU hardware could be used. In contrast, non-integrated assumed that the full cost of controlling the VAV DOAS units would be required to comply with the measure.

The measure adds costs for modulating dampers, airflow measurement, controls, occupancy/CO_2 sensors, and duct-static-pressure-based fan control, partly offset by eliminating manual balancing dampers and associated balancing labor. Incremental equipment, maintenance, and replacement costs are included over the 30-year analysis period. These costs were collected from a Bay Area HVAC contractor in the most expensive market in the state, representing a worst-case cost scenario.

The upfront costs are balanced by energy savings over the life of the equipment. The Statewide CASE Team surveyed 12 actual building drawings to determine the appropriate fraction of spaces that qualify for DCV, occupied standby, both, or neither. This breakdown allowed the Statewide CASE Team to model the systems with and without airflow-limiting measures and then postprocess the results to derive the standard- and proposed-design energy consumption. Restricting airflow to unoccupied zones reduces heating and cooling energy consumption, resulting in energy cost savings included in the cost-effectiveness analysis.

CEC staff have noted that modulating dampers need to be installed on every discharge unit in a DOAS system, since smaller zones would have them but would not provide significant energy-savings benefits. Although this is true, the measure remains cost-effective.

The benefit-to-cost ratios (BCRs) are above 1.0. For office prototypes, they range from roughly 2.04 to 4.34, depending on climate zone; large schools range from about 2.75 to 6.05, and small schools range from about 4.54 to 9.17. The report also tests several sensitivities, including shorter HVAC operating hours and the addition of field calibration costs, and reports that the measure remains cost-effective.

CEC's revisions eliminate the requirement for modulation on DOAS systems serving multiple thermal zones, thereby eliminating the savings associated with the Statewide CASE Team's proposed measure.

Stakeholders have discussed whether earlier editions of Title 24, Part 6 require DCV for DOAS systems. However, this does not affect the cost-effectiveness finding because

the Air Distribution CASE Report contains a benefit-to-cost ratio greater than 1.0 in all 16 climate zones for requiring DOAS systems to be variable air volume. This does not require DOAS systems to be tied to VRF fan-coil units; it simply requires modulating dampers at all terminals.

2.7 Specific Concerns with CEC's Proposed Express Terms Language for Modulating DOAS

The Statewide CASE Team is concerned that the markups to the mandatory DCV and occupied-standby language provided by CEC in the Express Terms will not yield energy savings, will cause confusion among practitioners and potentially a loophole for all ventilation systems.

The new mandatory requirement for continuously variable-speed supply fans on ventilation systems located in Section 401.2.1.2.3.2.1 does not provide meaningful energy savings without a corresponding requirement to modulate airflow to different parts of the ventilation zone when rooms or spaces are unoccupied. If a DOAS system with a variable-speed fan is unable to vary the air volume to different diffusers it serves, it is still effectively a constant-air-volume system using fixed damper position throughout the distribution system conflicting with Section 401.2.1.4.2 [Section 120.1(f)2]. As stated in the Final CASE Report, market research indicates that variable-speed motors on DOAS supply fans are industry-standard practice, so requiring the motors alone would not provide a meaningful additional benefit. The energy-saving benefit of a variable-speed motor depends on its speed being varied in operation, not merely on the motor being present in the system.

The purpose of the new Equation 401.2-D is unclear to the Statewide CASE Team. The equation is difficult to parse and appears to restate existing ventilation-turndown requirements. The Statewide CASE Team interprets the equation as requiring DCV where modulating dampers exist but remaining silent on where modulating dampers are required. The equation therefore appears to be tautological and to reinforce existing requirements rather than establish a new requirement.

CEC's editorial markups that replace the word "room" with "space" are unnecessary and do not improve the code's clarity. The marked-up language still contains instances of "room," including in Section 401.2.1.2.4.2.1. Similarly, although CEC replaces "outside" with "outdoor" in some locations, the markups still contain instances of "outside," including in Section 401.2.1.2.4.2.4. The Statewide CASE Team supports a consistent approach to terminology, but these changes must be applied throughout the code to meaningfully improve clarity.

The Statewide CASE Team recommended applying the 3,000 cfm outdoor-air threshold at the building level rather than the system level to prevent designers from dividing

DOAS systems into multiple systems, each below the threshold. The building-level threshold could be reconsidered, but the Statewide CASE Team maintains that the regulation should apply to the building rather than the system to close potential loopholes.

New language in Section 401.2.1.2.3.5.6 [Section 120.1(d)5B] is problematic in that it creates a loophole for zones that would have previously been required to shut off ventilation when in occupied-standby mode.

The Express Terms markups to Section 401.2.1.2.3.5.6 [Section 120.1(d)5B] are shown below:

6. Where the ventilation system serving the zone is capable of shutting off outdoor air to that zone independently of the other zones it serves, ~~I~~in 5 minutes or less after entering occupied-standby mode, mechanical ventilation to the zone shall be shut off until the space becomes occupied or until ventilation is needed to provide space heating or conditioning. When mechanical ventilation is shut off to the zone, the ventilation system serving the zone shall reduce the system ~~outside~~ outdoor air rate by the amount of ~~outside~~ outdoor air required for the zone.

This change would apply to all ventilation systems and seemingly gives designers a way to not comply if they do not include the capability of independent zone control. This change is not supported with any analysis or cost justification, but effectively changes the scope of occupied standby, which has been a mandatory requirement for several code cycles. This change seems in line with the logic that DCV can be achieved by varying the outdoor air at the inlet of the DOAS system using variable speed supply and exhaust fans rather than at the individual spaces with modulating dampers.

If CEC does not pursue the full modulating DOAS code markups, the Statewide CASE Team recommends reverting to the 2025 Title 24 language rather than adopting the language proposed in the Express Terms. The Express Terms markups are vague, provide no meaningful improvements, results in loopholes, and are likely to reduce compliance rates and may even increase energy consumption in nonresidential buildings in California.

2.8 Effect of the Measure on DOAS System Design

The measure makes it explicit that in-scope DOAS serving multiple thermal zones need to be capable of variable air volume (VAV). However, making the ventilation air variable volume does not convert a DOAS system into a conventional mixed-air VAV system. Characterizing the measure that way would imply fan-powered reheat boxes and mixed-air delivery, neither of which is required by the measure.

For larger DOAS systems that do not qualify for the recommended high-efficiency HRV exception, the measure requires the capability to lower airflow at the zone level to realize heating and cooling savings when the zone is unoccupied.

Ventilation air does not need to be ducted into the fan coil unit, so fully decoupled DOAS systems remain allowable. The only change is that ventilation air would now be controlled using motorized dampers and associated controls hardware. This change does have the effect of making the DOAS system variable air volume, but in this context it means only that the DOAS system is *not* a constant-air-volume system. Nothing else in the system configuration needs to change.

DOAS systems can deliver ventilation air to zones in three main ways:

- Fully decoupled;
- Air brought to the inlet of the FCU (currently not allowed, but proposed in submeasure c of the CASE Report); and
- Air brought to the outlet of the FCU.

All three options can work with the modulating DOAS measure. The measure does not require a reheat coil or fan coil at the ventilation discharge. At various points in the process, stakeholders have characterized the modulating DOAS measure as turning VRF+DOAS systems into VAV systems. While the measure changes the ventilation air from CAV to VAV, it does not otherwise change the fundamental system configuration or convert a VRF+DOAS system into a conventional mixed-air VAV system.

2.9 Ongoing Coordination with CEC

The Statewide CASE Team appreciates the ongoing engagement with CEC on this measure as of early October 2026 and is committed to continuing the dialogue.

The engagement has focused on the occupancy schedules used in the CASE analysis. The Statewide CASE Team altered the default 2025 CBECC schedules for schools and offices because those schedules do not reflect real-world occupancy patterns. In addition, when developing the draft analysis in fall 2025, the Statewide CASE Team did not yet have access to CEC's final schedules. It therefore proceeded with its own assumptions to meet the project deadlines.

The office analysis is cost-effective with an ERV in the base case even when the extremely conservative 53-hour-per-week operating schedule is used. It is important to note that the HVAC operating hours assumed in the prototype schedules, across all prototypes, do not coincide with business hours as those are not in lockstep. Also, 53

hours per week is not in any schedule found in ACM Appendix 5.4.B but is rather a byproduct of our own sensitivity analysis.

CEC staff have questioned the use of 80 percent occupancy in occupied standby zones. This assumption is conservative and exceeds the occupancy rates in the Statewide CASE Team's research, which ranged from 30 to 50 percent (see section 3.4.2 of the Final CASE Report). The Statewide CASE Team initially assumed that the spaces were 100 percent occupied, which is also a conservative assumption since no schedule for any space in ACM Appendix 5.4.B assumes 100 percent occupancy, but reduced the rate to 80 percent after determining that the 53-hour-per-week operating schedule,100 percent occupancy, and an ERV in the base case were modeled simultaneously. The 80 percent occupancy assumption aligns with the "assembly" space type that is assigned to conference rooms and other high density spaces in ACM Appendix 5.4.A..

CEC has raised questions about the use of the term "office" in Table 32 of the Final CASE Report. The term encompasses the small, medium, and large office prototypes, all of which are cost-effective. The prototypes were simply merged in that table to save space in the table. The results across the three office prototypes are consistent with each other since the three prototypes are assumed to have the same breakout of DCV, OS, and "neither" spaces on a given floor.

For the school analysis, the Statewide CASE Team is reanalyzing the measure using the latest school occupancy schedule and is committed to continue coordinating with CEC.

CEC has expressed concerns about the use of the term "ASHRAE Guideline 36 logic" in the code language. The term was included to clarify the DCV compliance approach. However, it is not critical to the measure, and references to Guideline 36 can be removed, or particular sections within the Guideline can be specified without affecting the modulating DOAS measure.

3. Conclusion

For the reasons stated in these comments, the Statewide CASE Team asks that CEC reconsider its direction in the Express Terms and instead adopt language based on the Final CASE Report for both the PVAV and modulating DOAS measures.

Stakeholders have provided feedback and identified potential improvements to both measures, consistent with the public rulemaking process of past cycles. Regarding PVAV, stakeholder feedback and CEC concerns about product availability led to the addition of the bypass duct pathway for compliance. For modulating DOAS, stakeholder feedback noted the viability of a high-efficiency HRV exception. Other issues and

potential challenges with both measures have been raised and, in every case, the Statewide CASE Team sought to understand and adjust the measures in response to the feedback. The feedback received throughout the process did not indicate that the measures required changes as substantial as those in the Express Terms.

Both measures are projected to save energy, improve occupant comfort in buildings, and likely improve indoor air quality through enhanced monitoring capabilities. The PVAV measure would help prevent overcooling of spaces and save significant reheat energy. The modulating DOAS measure would reduce airflow to unoccupied spaces when it is not needed, saving energy. The high-efficiency HRV exception would allow building owners seeking to install systems similar to the NEEA AP DOAS specification to avoid modulating dampers.

Additional enhancements to the measures may be needed and the Statewide CASE Team is committed to continue collaborating on refining the measures. If CEC does not agree, the Statewide CASE Team respectfully suggests returning to the 2025 language rather than move forward with the markups in the Express Terms. These have not been workshopped, supported with energy savings analysis, or demonstrated to be cost effective. The markups conflict with other sections and do not appear to address the core issues. This may increase confusion and lower compliance rates in the market and potentially increase energy consumption in nonresidential buildings in California.