TITLE 24, PART 6 | 2028 CODE CYCLE

Reducing Maximum Airflow During Deadband Operation for Variable Air Volume HVAC Systems

Codes and Standards Enhancement (CASE) Proposal

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September 23, 2025

CALIFORNIA ENERGY CODES & STANDARDS
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Proposal Description

- Code Change Proposal
- Benefits
- Background Information

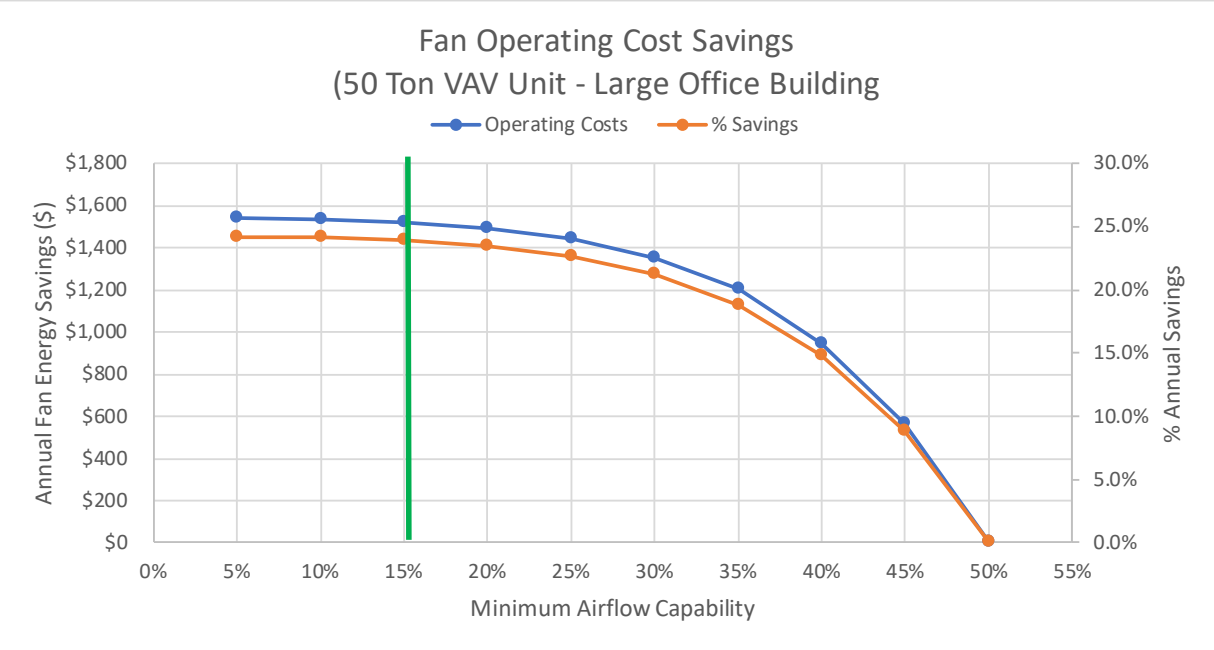
Proposed Code Change

- Applies to multizone variable air volume (VAV) systems in new buildings, additions, and alterations where a new central hydronic air handler, DX air conditioner, or DX heat pump is installed.
- Prescriptively, the central fan of a multizone VAV system must be capable of and configured to reduce airflow to the greater of the sum of the VAV box primary flows or 15% of the design air handler airflow.
- Currently, there is no code requirement that says that MZ VAV DX systems must be able to provide mechanical cooling at low airflow (i.e., is not locked out). This measure would require that AHUs be capable of continuing to provide mechanical cooling down to 15% of the design airflow rate.

See Title24stakeholders.com for proposal description, justification, draft code language, and requested data

Benefits of the Proposed Change

- There will be electrical energy savings for buildings that use packaged VAV systems.
- There can be additional heating and cooling where a high turndown is resolved by bringing in excess outdoor air.
- Savings for hydronic VAV systems will likely be minimal, as they are often designed with low turndown.



Background Information

- Packaged multizone VAV (PVAV) systems are commonly used for:
  - Offices, which always have low primary airflow, and
  - Large schools, which are required to employ Demand Control Ventilation (DCV), so have many hours with reduced primary airflow.
- Many packaged rooftop units have limited turndown. It is common for controllers to require a minimum fan speed of 50% of the design airflow rate or more.
- These minimum flows originated with two-speed motors. Though equipment today uses VFDs, they still often operate as two-speed fans, as this is the familiar way to operate single-zone VAV systems.
- Many manufacturers offer full variable-speed operation, but only for upgraded controls intended for multizone VAV operation.
- This measure is inspired by Addendum u to ASHRAE 90.1-2022, which ASHRAE and ANSI approved on December 31, 2024 (ASHRAE 90.1-2022, Addendum u).
- Most hydronic systems likely already comply with the proposed turndown, but this will be confirmed.

Marked-up Code Language

See Title24stakeholders.com for marked-up code language

Title 24, Part 1	Title 24, Part 6	Reference Appendices
▪ No changes	▪ 140.4(m) – fan control	▪ NA7.5.6.2 – acceptance testing

Market and Technical Considerations

- Current Conditions and Trends
- Potential Barriers and Solutions
- Technical feasibility

Current Market Conditions

- Many manufacturers already comply with some of their equipment, typically for the larger equipment (40 tons of cooling and more).
- Some equipment will need a software update to comply.
- Smaller equipment that is typically used for single-zone VAV systems is less likely to have the required fan turndown capability.
- It is often difficult to find the minimum total airflow in manufacturers' literature.
- Currently, many DX systems will lock out their compressor when airflow drops to a low level, which causes designers to artificially raise zone minimum airflow rates to enable any amount of mechanical cooling in part load. This wastes cooling and reheat energy.
- Few construction drawing equipment schedules call out a minimum airflow capability. They usually show a minimum outdoor airflow, but not that the equipment must be capable of reducing total airflow to that level.
- It is likely that most hydronic systems comply with this measure.

Market Barriers and Solutions

Market Barriers	Potential Solutions
1. Some manufacturers are reluctant to upgrade their controls in some models to provide the needed turndown.	Ensure that designers understand that for packaged VAV systems, they must ensure they choose a model that complies. Further, the federal test procedure that goes into effect on January 1, 2029, penalizes units that cannot turn down to 25% airflow, which will encourage manufacturers to make the upgrade.

Current Market Share

Market share: percentage of buildings that already use the proposed technology or design practice (at or above the proposed stringency level)

Current Market Share

New Construction and Additions	**20%** ▪ Represents share of PVAV projects ▪ Based on review of plans available in ConstructConnect
Alterations	**20%** ▪ Represents share of PVAV projects ▪ Extrapolated from ConstructConnect new construction, as alteration plans are not readily available.

Poll

What is the current share of new PVAV systems for new construction and additions that are capable of and configured to turn down to the greater of 15% of design airflow or the minimum outdoor airflow?

a. 0% to 25%
b. 26% to 50%
c. 51% to 75%
d. Nearly all PVAV systems
e. Don’t know

Poll

What is the current share of replacement (altered) PVAV DX units that are capable of and configured to turn down to the greater of 15% of design airflow or the minimum outdoor airflow?

a. 0% to 25%
b. 26% to 50%
c. 51% to 75%
d. Nearly all PVAV systems
e. Don’t know

Technical Considerations

- There are no technical barriers. Even two-speed PVAVs use VFDs today.
- Manufacturers will have to upgrade fan controls.
- Some qualification may be required for minimum airflow sensors to ensure compressor capacity control function.
- The new packaged unitary air-conditioner and heat pump federal test procedure that goes into effect on January 1, 2029, penalizes all DX equipment that cannot turn down to 25 percent airflow, so manufacturers will have a strong incentive to upgrade their controls if they cannot turndown below 50 percent today.
- Installers will still likely have to configure the minimum fan airflow, as the actual requirement is the lower of 15 percent of design airflow or the minimum outdoor air requirement.

Technical Barrers and Solutions

Slide NOT shown

Technical Barriers	Potential Solutions
1. None of that we are aware.	1. N/A

Poll

What else should we know? Are there market or technical barriers or solutions we should consider?

Open ended response

Per Unit Energy and Cost Impacts

Methodology and Assumptions

- Energy and Energy Cost Savings
- Incremental Costs

Energy and Energy Cost Savings Methodology

- Used building energy modeling to estimate savings
- The baseline .idf files created by CBECC 2025 were used.
- Per square foot energy savings are based on the size of the CBECC prototype.
- Assuming the savings apply only to PVAV, but will confirm through review of plans that hydronic systems typically comply

Energy Modeling Assumptions

- Simulating energy savings in EnergyPlus with CBECC rulesets
- Simulating using the following prototypical buildings and climate zones

Prototypical Buildings

- Large office building
- Medium office building
- Large school
- Laboratory

Climate Zones

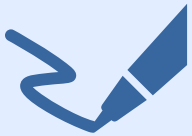
- Simulating in Climate Zones 1-16

Key Modeling Assumptions

Prototype: Medium Office

Standard Design

1. 70% of medium office buildings would be affected by measure.
2. 10% of large office buildings may be affected.
3. The number of laboratories affected is yet to be determined.
4. The baseline will be 50% fan turndown capability/
5. Meet the requirements for DCV control of Section 120.1(d)(4) and Occupied Standby requirements of Section 120.1(d)(5).



Proposed Design

1. Same as the Standard Design, but the fan will be capable of turning down to 15% of design airflow for DX and hydronic PVAV systems.

Incremental Cost Framework

Prototype(s): Large and Medium Offices, Large Schools, and Laboratories

Baseline

First Cost

1. Fan controls capable of turndown to 50 percent
2. Installation
3. Commissioning

30-Year Maintenance Costs

1. Equipment Replacement
2. Regular Maintenance

Proposed

First Cost

1. Fan controls capable of turndown to 15 percent
2. Installation – no change
3. Commissioning – small change due to improved acceptance test.

30-Year Maintenance Costs

1. Equipment Replacement – assume 15-year life, so one replacement unit with incremental controller cost
2. Regular Maintenance – no change

Approach for Gathering Costs

- Review building documents (using Construct Connect, e.g.) to identify buildings with VAV DX systems and identify:
  - Percentage of systems using bypass ducts
  - Manufacturers and models
  - Minimum turndown of installed systems
- Reach out to manufacturers, system designers to identify costs

Compliance Verification

- Key Aspects of Compliance Verification
- Barriers and Solutions
- Revisions to Compliance Software

Key Aspects of Compliance Verification

- The VAV system compliance form will need to be updated by adding a field where the minimum fan turndown information must be provided.
- NA7.5.6 Supply Fan Variable Flow Controls will be updated.
  - Add a construction inspection requirement that the fans are capable of and configured to meet the requirements
  - Update the reduced airflow step of the Functional Testing Requirements to require testing with the zone terminals set to the minimum flow, and the unit is in deadband with the compressor off.

Compliance Barriers and Solutions

Compliance Verification Barriers	Potential Solutions
1. Some DX equipment does not have the capability to turn down to 15% of design airflow. It is difficult to find the minimum turndown information in manufacturers' literature. 2. AHJs need a way to enforce the requirement.	1. Equipment that meets the requirement is readily available. The same requirement will be in ASHRAE 90.1-2025 and IECC 2027, so manufacturers will have to update their controls. 1. As the requirement begins to be enforced across the country, manufacturers will likely make the information more prominent. 2. Proposed improvements to the VAV fan acceptance test will provide assurance that the installed units meet these requirements.

Compliance Software Updates

- Prescriptively, add a user input field (similar to the hydronic VAV systems) where a user can enter the minimum central fan airflow that the unit can achieve while still operating the compressor.
- CBECC will have to calculate the system's maximum airflow and the minimum outdoor airflow to determine whether the fan turndown must meet the greater of 15% or the minimum outdoor airflow.

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More information on
CEC's 2028 proceeding website.

We want to hear from you!

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Cost Effectiveness Results

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Climate Zone	Benefits *30-year Energy Cost Savings + Other PV Savings* (2029 PV$)	Costs *Total Incremental PV Costs* (2029 PV$)	Benefit-to-Cost Ratio
1	$#,### – $#,###	$#,### – $#,###	#.# – #.#
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			

Results vary by prototypical building

134.79

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