TITLE 24, PART 6 | 2028 CODE CYCLE

Welcome to the Statewide CASE Team's Utility Sponsored Stakeholder Meeting

Topics: Smart Dedicated Outdoor Air System (DOAS)

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CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

Agenda

- Proposal Description
- Market and Technical Consideration
- Technical Barriers and Solutions
- Per Unit Energy and Cost Methodology
- Compliance and Enforcement
- Discussion and Next Steps

Proposal Description

- Code Change Proposal
- Benefits
- Background Information

Proposed Code Change

Mandatory measure package

- Sub measure 1: Require modulating **Air Valves** for DOAS serving occupied standby and DCV Zones (New Section 120.1(d)6)
  - DOAS systems in buildings with design outdoor airflow rates > 3,000 cfm and with any zones required to have occupant sensing ventilation controls or DCV controls shall include modulating pressure independent air valves or other means of modulating outside air at all space conditioning zones.

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

- Sub measure 2: Clarify Where **Occupied Standby** is Currently Required (Clarify Section 120.1(d)5A)
  - Remove the references to Table 120.1-A and Section 130.1(c)5-6
  - Explicitly list the space types currently required to have occupied standby per the intersection of Table 120.1-A and Section 130.1(c)5-6:
    - Post-secondary classrooms, lecture halls, conference, meeting, and training rooms, multipurpose rooms < 1,000 ft2, breakrooms, enclosed offices and open plan areas, corridors, stairwells.

Proposed Code Change

Prescriptive measure package

- Sub measure 3: Require **VFD** for DOAS supply and exhaust fans instead of 3-speed fans (Modify Section 140.4(p)3)
  - ~~DOAS supply and exhaust fans shall have a minimum of three speeds to facilitate system balancing.~~
  - DOAS supply and exhaust fans in DOAS systems required to modulate by 120.1.d.6 shall modulate fan speed in coordination with zone ventilation airflow modulation.
- Sub measure 4: Modify **Supply Air Temperature** from 60°F to 55°F (Modify Section 140.4(p)4)
  - ~~DOAS with mechanical cooling providing ventilation to multiple zones and operating in conjunction with zone heating and cooling systems shall not use heating or heat recovery to warm supply air above 60°F when representative building loads or outdoor air temperature indicates that the majority of zones require cooling.~~
  - DOAS providing ventilation to multiple zones and operating in conjunction with zone heating and cooling systems shall not use heating or heat recovery to warm supply air above 55°F and shall not use mechanical cooling to cool supply air below 75°F.

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Benefits of the Proposed Change

Air Valves will:

- Reduce overventilation of partially occupied or unoccupied spaces which saves **cooling and heating energy**
- Improve **indoor air quality** monitoring

Clarifying where Occupied Standby is required will:

- Save **heating, cooling and fan energy** by improving compliance and enforcement

VFDs for DOAS units will:

- Reduce **fan energy** at part load

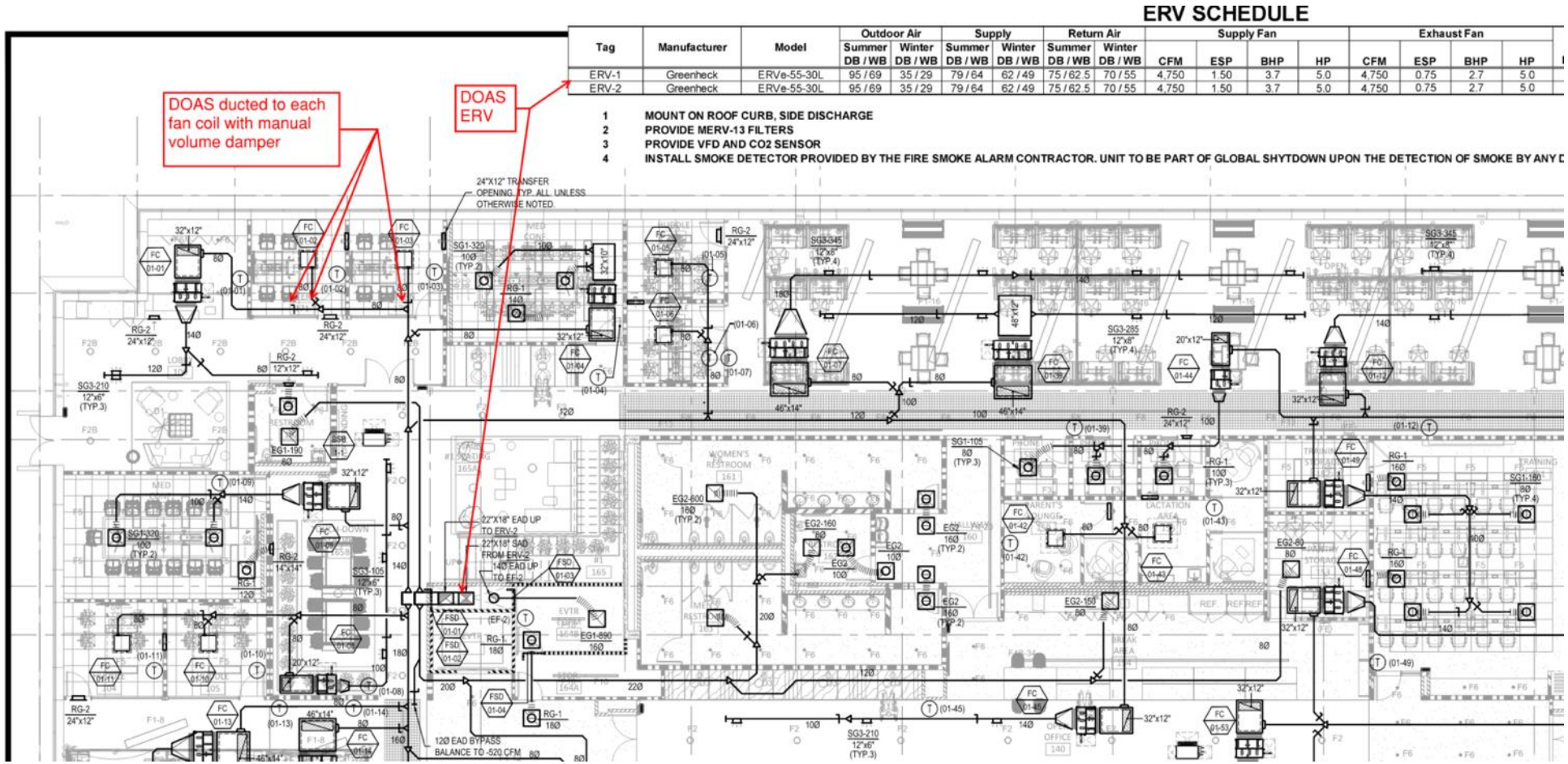
Limiting DOAS Pre-Heating and Pre-Cooling will:

- Eliminate **re-heating and re-cooling energy**

Background Information

Sub measure 1 (Mandatory): Air Valves

Example of DOAS WITHOUT Air Valves

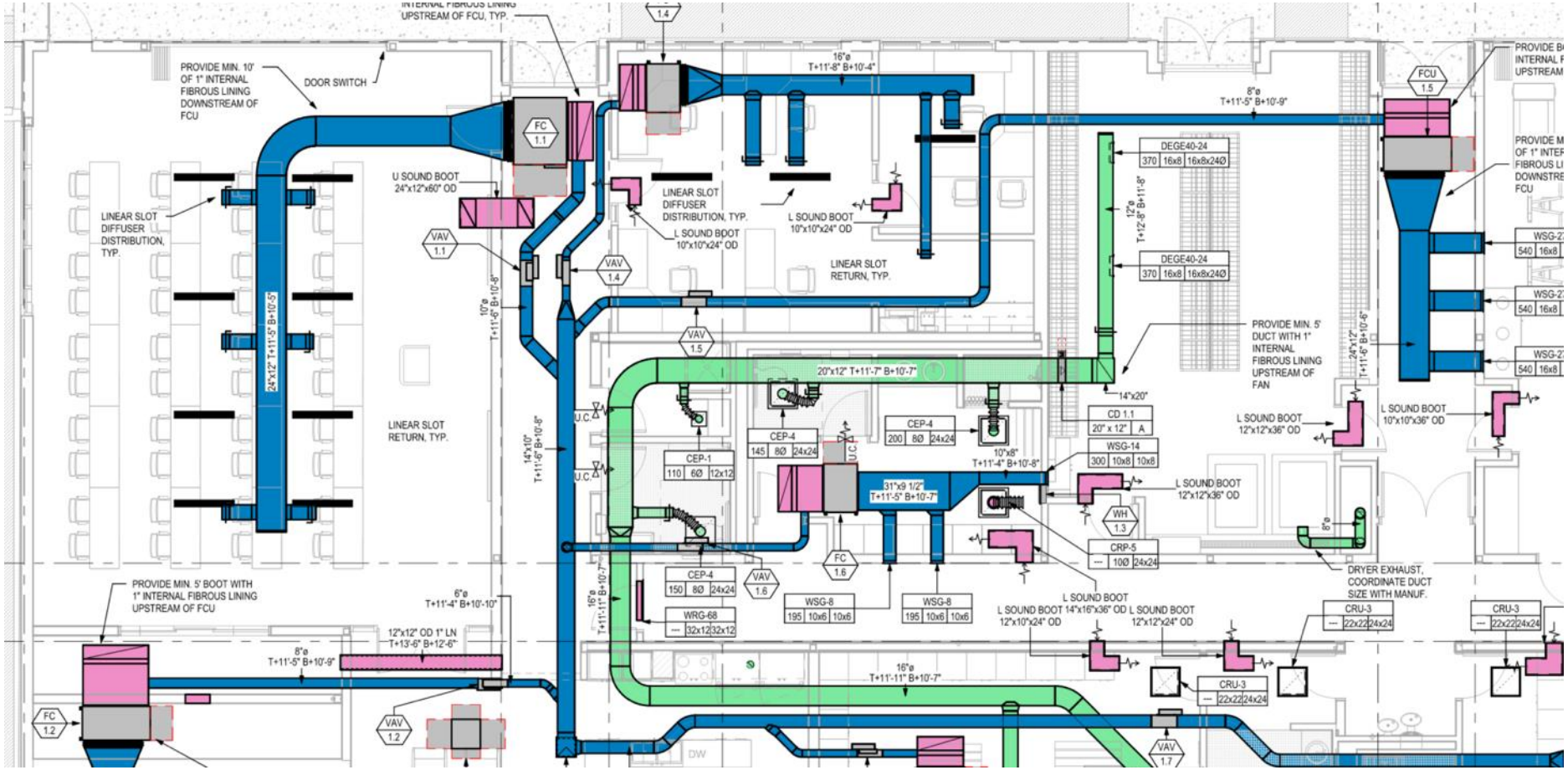


Tag	Manufacturer	Model	Outdoor Air		Supply		Return Air		Supply Fan				Exhaust Fan			
			Summer DB / WB	Winter DB / WB	Summer DB / WB	Winter DB / WB	Summer DB / WB	Winter DB / WB	CFM	ESP	BHP	HP	CFM	ESP	BHP	HP
ERV-1	Greenheck	ERVe-55-30L	95 / 69	35 / 29	79 / 64	62 / 49	75 / 62.5	70 / 55	4,750	1.50	3.7	5.0	4,750	0.75	2.7	5.0
ERV-2	Greenheck	ERVe-55-30L	95 / 69	35 / 29	79 / 64	62 / 49	75 / 62.5	70 / 55	4,750	1.50	3.7	5.0	4,750	0.75	2.7	5.0

Background Information

Sub measure 1 (Mandatory): Air Valves

Example of DOAS WITH Air Valves



Background Information

Sub measure 1 (Mandatory): Air Valves

Justification for new requirement:

A common interpretation of Title 24 is that DOAS systems are exempt from DCV (CO2) requirements and from occupied standby requirements.

DCV and Occupied Standby are huge energy savers, particularly post-pandemic with remote work and extended hours of operation.

Background Information

Sub measure 2 (Mandatory): Clarify DOAS Occupied Standby Control

Cross referencing between Table 120.1-A and Section 130.1(c)5 and 6 is extremely tedious

TABLE 120.1-A– Continued Minimum Ventilation Rates

Occupancy Category - *General*	Minimum Occupant Load Density (persons / 1000 ft²)	Area-based Minimum Ventilation R_a (cfm/ft²)	Air Class	Notes
Break rooms	33	0.15	1	F
Coffee Stations	33	0.15	1	F
Conference/meeting	33	0.15	1	F
Corridors	5	0.15	1	F
Occupiable storage rooms for liquids or gels	2	0.15	2	B

TABLE 120.1-A– Continued Minimum Ventilation Rates

Occupancy Category - *Hotels, Motels, Resorts, Dormitories*	Minimum Occupant Load Density (persons / 1000 ft²)	Area-based Minimum Ventilation R_a (cfm/ft²)	Air Class	Notes
Bedroom/living room	3	0.15	1	F
Barracks sleeping areas	5	0.15	1	F
Laundry rooms, central	5	0.15	2	--
Laundry rooms within dwelling units	5	0.15	1	--
Lobbies/pre-function	33	0.15	1	F
Multipurpose assembly	33	0.15	1	F

F – Ventilation air for this occupancy category shall be permitted to be reduced to zero when the space is in occupied-standby mode.

5. **Occupant sensing controls.** In offices 250 square feet or smaller, multipurpose rooms of less than 1,000 square feet, classrooms, conference rooms, and restrooms, lighting shall be controlled with occupant sensing controls to automatically shut OFF all of the lighting in 20 minutes or less after the control zone is unoccupied.

   In areas required by Section 130.1(b) to have multi-level lighting controls, the occupant sensing controls shall function either as a:

   A. Partial-ON occupant sensing controls capable of automatically activating between 50 and 70 percent of controlled lighting power, or

   B. Vacancy sensing controls, where all lighting responds to a manual ON input only.

   In areas not required by Section 130.1(b) to have multilevel lighting controls, the occupant sensing controls shall function either as:

      A. Automatic full-on occupant sensing controls; or

      B. Partial-ON occupant sensing controls, or

      C. Vacancy sensing controls, where all lighting responds to a manual ON input only.

   In addition, controls shall be provided that allow the lights to be manually shut OFF in accordance with Section 130.1(a) regardless of the sensor status.

6. **Full or partial-OFF occupant sensing controls.** For warehouse aisle ways, warehouse open areas, library book stack aisles, corridors, stairwells, offices greater than 250 square feet, parking garages, parking areas, loading areas, and unloading areas, the installed lighting shall meet the following requirements:

   A. In warehouse aisle ways and warehouse open areas, lighting shall be controlled with occupant sensing controls that automatically reduce lighting power by at least 50 percent when the areas are unoccupied. The occupant sensing controls shall independently control lighting in each warehouse aisle way, and shall not control lighting beyond the aisle way being controlled by the sensor.

   Exception to Section 130.1(c)6A: When metal halide lighting or high pressure sodium lighting is installed in warehouses, occupant sensing controls shall reduce lighting power by at least 40 percent.

   B. In library book stack aisles 10 feet or longer that are accessible from only one end, and library book stack aisles 20 feet or longer that are accessible from both ends, lighting shall be controlled with occupant sensing controls that automatically reduce lighting power by at least 50 percent when the areas are unoccupied. The occupant sensing controls shall independently control lighting in each aisle way, and shall not control lighting beyond the aisle way being controlled by the sensor.

   C. In corridors and stairwells, lighting shall be controlled by occupant sensing controls that separately reduce the lighting power in each space by at least 50 percent when the space is unoccupied. The occupant sensing controls shall be capable of automatically turning the lighting fully ON only in the separately controlled space, and shall be automatically activated from all designed paths of egress. Lighting in stairwells and common area corridors that provide access to guestrooms of hotel/motels shall meet the requirements of this section instead of complying with Section 130.1(c)1.

   D. In office spaces greater than 250 square feet, general lighting shall be controlled with occupant sensing controls that meet all of the following:

      i. The occupant sensing controls shall be configured so that lighting shall be controlled separately in control zones not greater than 600 square feet. All control zones in offices greater than 250 square feet shall be shown on the plans; and

      ii. In 20 minutes or less after the control zone is unoccupied, the occupant sensing controls shall uniformly reduce lighting power in the control zone to no more than 20 percent of full power. Control functions that switch control zone lights completely off when the zone is vacant meet this requirement; and

      iii. In 20 minutes or less after the entire office space is unoccupied, the occupant sensing controls shall automatically turn off lighting in all control zones in the space; and

      iv. In each control zone, lighting shall be allowed to automatically turn on to any level up to full power upon occupancy within the control zone. When occupancy is detected in any control zone in the space, the lighting in other control zones that are unoccupied shall operate at no more than 20 percent of full power.

   Exception to Section 130.1(c)6D: Under-shelf or furniture-mounted task lighting controlled by a local switch and either a time switch or an occupancy sensor.

   E. In parking garages, parking areas and loading and unloading areas, general lighting shall be controlled by occupant sensing controls that meet the requirements below instead of complying with Section 130.1(c)1:

      i. The occupant sensing controls shall uniformly reduce lighting power in the control zone to between 20 percent and 50 percent of full power and with at least one control step; and

Background Information

Sub measure 3 (Prescriptive): Modify 3-Speed fan to VFD fan

- Most DOAS are already variable speed.
- Variable speed control is less expensive than a 3-speed motor so variable speed is not an incremental cost.
- The only incremental cost is a duct pressure sensor and control logic to modulate fan speed to maintain duct pressure at setpoint. This is a relatively small cost.

Background Information

4. DOAS ~~with mechanical cooling~~ providing ventilation to multiple zones and operating in conjunction with zone heating and cooling systems shall not use heating or heat recovery to warm supply air above ~~60°F~~ 55°F ~~when representative building loads or outdoor air temperature indicates that the majority of zones require cooling~~ and shall not use mechanical cooling to cool supply air below 75°F.

Sub measure 4 (Prescriptive): Modify Supply Air Temperature

- The proposed change should have no incremental cost:
  - If the system has the ability to limit heating and heat recovery to prevent warming SAT above 60F then it also has the ability to prevent warming SAT above 55F
  - If the zones have cooling capabilities then DOAS does not need to cool supply air below 75F
- The proposed change will save energy by:
  - Avoiding overheating at the DOAS up to 60F and then recooling at the zones in cooling back down to 55F
  - Avoiding overcooling at the DOAS down to 55-65F and then reheating at the zones not in cooling back up to 70-90F.
- The inclusion of DOAS “with mechanical cooling” in the current language does not make sense since the presence or absence of mechanical cooling is unrelated to the ability of the system to limit heating. But this clause exempts most DOAS systems, since most DOAS systems do not have mechanical cooling. Removing the clause “with mechanical cooling” removes this loophole.
- Removing the language about “majority of zones require cooling” simplifies the code, simplifies the controls, and saves energy because energy is saved even if a minority of zones require cooling.

Marked-up Code Language

See Title24stakeholders.com for marked-up code language

Title 24, Part 1	Title 24, Part 6	Reference Appendices
▪ None	▪ Refer to Measure Summary document for additional details ▪ 120.1(d)5Bviii (new) ▪ 120.1(d)5Aiii ▪ 140.4(p)3 ▪ 140.4(p)4	▪ Refer to Measure Summary document for additional details ▪ NA 7.5.4.2

Market and Technical Considerations

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

Current Market Conditions

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- DOAS Systems with VFD fans are prevalent in the market
- Air valves with Air Flow Measuring Stations (AFMS) are available in the market but not widely adopted
- AFMS are equipped with diagnostic features (FDD) that can identify issues within the DOAS air valves
- Information is not available on warm air temperature
- Data not available on what spaces that are not code-mandated for DCV run on occupied mode when not occupied

Poll

What % of the DOAS systems in the market use air valves with AFMS to control the ventilation air in each zone?

a. None
b. <25%
c. 26% – 50%
d. 51% – 75%
e. I do not know

Poll

Are there any alternatives to air valves with AFMS in the market to control the ventilation air in each zone?

a. Yes
b. No
c. I do not know
d. I can provide additional details on other options.

Market Barriers and Solutions

Market Barriers	Potential Solutions
1. Cost of adding air valves with AFMS	1. Evaluate the operational cost reduction over the incremental cost 2. Train the facility personnel on FDD features of DOAS system to improve preventive maintenance and reduce downtime

Current Market Share

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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	<5%
Alterations	0%

Technical Considerations

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- Collect several real DOAS designs for different building types and sizes (large office, small office, K-12, assembly, etc.)
- Distinguish the proposal for different types of DOAS systems mainly as referenced in the ASHRAE research project RP-1865:
  - DOAS-1 provides cooling and dehumidification
  - DOAS-2, similar to DOAS-1, but with its dependency of sensible cooling and heating based on the outlet air temperature of the heat recovery wheel rather than the outdoor air temperature. The recovery could be full, partial, or none.
  - DOAS-3, similar to DOAS-3 with a preheating coil in the upstream of the energy recovery device

Technical Barrers and Solutions

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Technical Barriers	Potential Solutions
1. Lack of knowledge of AFMS and air valves 2. Unproven the impact of space humidity and outside humidity on DOAS SAT	1. Develop training material 2. Coordinate with stakeholders and add additional information to the compliance manual

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

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- Using CEC's methodology and metrics
- Model New Construction with default standard design
- Model Alterations with modified standard design

Energy Modeling Assumptions

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

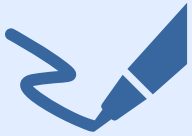
Prototypical Buildings	Climate Zones
▪ Small Office ▪ Large Office ▪ Medium Office ▪ Large School ▪ Small School ▪ Assembly	▪ All climate zones

Key Modeling Assumptions

Prototype: Small Office, Large Office, Medium Office, Large School, Small School, Assembly

Standard Design

1. Standard design with 2025 code-compliant system
2. Manual damper with default schedules for thermal zones
3. 60°F SAT
4. Default shut-off controls for mandated zones
5. 3-Speed fan for balancing



Proposed Design

1. Modified parameters for each sub measure
2. Modified schedule to reflect air valves with zone-specific AFMS
3. 55°F SAT (tentative proposal)
4. Model occupied standby for spaces where required
5. Model demand control ventilation for spaces where required
6. VFD Fans with flow controls

Incremental Cost Framework

Prototype(s): Small Office, Large Office, Medium Office, Large School, Small School, Assembly

Baseline

First Cost

1. Equipment
2. Installation
3. Commissioning
4. Other

30-Year Maintenance Costs

1. Equipment Replacement
2. Regular Maintenance

Proposed

First Cost

1. Equipment
2. Installation
3. Commissioning
4. Other

30-Year Maintenance Costs

1. Equipment Replacement
2. Regular Maintenance

Approach for Gathering Costs

- Collect several real DOAS designs for different building types and sizes (large office, small office, K-12, assembly, etc.) either with or without air valves. Then modify the design the other way so we have designs for several buildings both ways.
- Work with mechanical and controls contractors to price each building with and without air valves.
- Work with mechanical and controls contractors to estimate incremental maintenance costs.

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Compliance Verification

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

Key Aspects of Compliance Verification

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- Modify compliance forms and add details in the Reference Appendices document.
- Provide additional details in the Compliance Manual
- More details will be presented in the next stakeholders' meeting after finalizing the measure description and code language

Compliance Barriers and Solutions

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Compliance Verification Barriers	Potential Solutions
1. Lack of awareness of the functions of air valve and its application 2. Adoption guidance for different HVAC systems and DOAS systems integration 3. Lack of clarity on roles and responsibilities of designers, commissioning agents and ATTs 4. Lack of details for testing and inspection requirements	1. Conduct additional research and add a clarification section in the compliance manual 2. Collect information on current issues and solutions from the building community market actors including but not limited to designers, contractors and AHJs 3. Develop training materials to define the roles and responsibilities 4. Review current DOAS sections in various documents and add/modify content as needed

Compliance Software Updates

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- Expand shut-off control feature to all zones
- Modify SAT threshold to 55°F (subject to change on further research and analysis)
- Change DOAS fan type
- Modify default ventilation schedules for all thermal zones where DCV and shut-off control are required
- Collect a list of the lack of features to model compliance and design features from the practicing professionals and modelers
- Review the current CBECC's capability and identify improvements to incorporate the changes to the exceptions
- Include clarifications and requirements in the Alternative Calculation Methods manual, and modify the modeling standard and proposed design requirements

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More information on
CEC's 2028 proceeding website.

We want to hear from you!

CALIFORNIA ENERGY CODES & STANDARDS
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Appendix

Background slides

CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

Pacific Gas and Electric Company

SOUTHERN CALIFORNIA EDISON
Energy for What's Ahead

SDGE

LA DWP Los Angeles Department of Water & Power

SMUD

Proposed Code Change

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Mandatory measure package

- Require modulating Air Valves for DOAS at all space conditioning zones (Modify Section 120.1(d)5Bviii)

  Modify Section 120.1(d)5B(viii): Space decoupled ventilation systems (e.g., DOAS) serving spaces required to have occupant sensing ventilation controls shall include modulating pressure independent air valves or other means of modulating outside air at all space conditioning zones. This shall be done to disable ventilation to unoccupied zones while maintaining measured outside air ventilation rates to occupied zones within 10 percent of the design minimum outside air ventilation rate per 120.1(f)2 and shall include demand ventilation controls for high-density spaces per 1201.(d)3.

- Clarify Where Occupied Standby is Currently Required (Clarify Section 120.1(d)5Aiii)
  - Spaces meeting these criteria:
    - Post-secondary classrooms and lecture halls, Conference, meeting, and training rooms, Multipurpose rooms < 1,000 ft2, Breakrooms, Enclosed offices and open plan office areas, Corridors and stairwells

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Proposed Code Change

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Prescriptive measure package

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- Sub measure 4: Modify Supply Air Temperature

  Modify Section 140.4(p)4: DOAS with mechanical cooling providing ventilation to multiple zones and operating in conjunction with zone heating and cooling systems shall not use heating or heat recovery to warm supply air above 55°F when representative building loads or outdoor air temperature indicates that the majority of zones require cooling

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