



TITLE 24, PART 6

2028 CODE CYCLE

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

Topics: Air Side Distribution Measures

Modulating Dedicated Outdoor Air Systems (DOAS)

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April 21, 2026

Updates since last meeting

Language modifications
Modeling approach
Costs, B/C, LSC savings



Proposal Description

- Code Change Proposal
- Benefits
- Background Information



Summary of DOAS Submeasures

No.	Submeasure Name	Code Change Type	Impacted Code Section	Type	Upfront Costs?	Supporting Analysis Needed
1	Modulating DOAS (Air Valves)	Mandatory	120.1(d)6	Substantive	Yes	Full cost-effectiveness
2	Occ Standby Cleanup	Mandatory	120.1(d)5	Editorial	No	None
3	DOAS Delivery Option	Prescriptive Option	140.4(p)2	Substantive	No (negative)	LSC/source energy parity
4	SAT Revisions to reduce Reheat/re-cooling	Prescriptive Requirement	140.4(p)4	Substantive	No	None (but we could claim savings)
5	Design Min OA	Prescriptive Requirement	140.4(t)	Substantive	No	None (but we could claim savings)

1. Modulating Dampers. Proposed New Requirement: 120.1(d)6

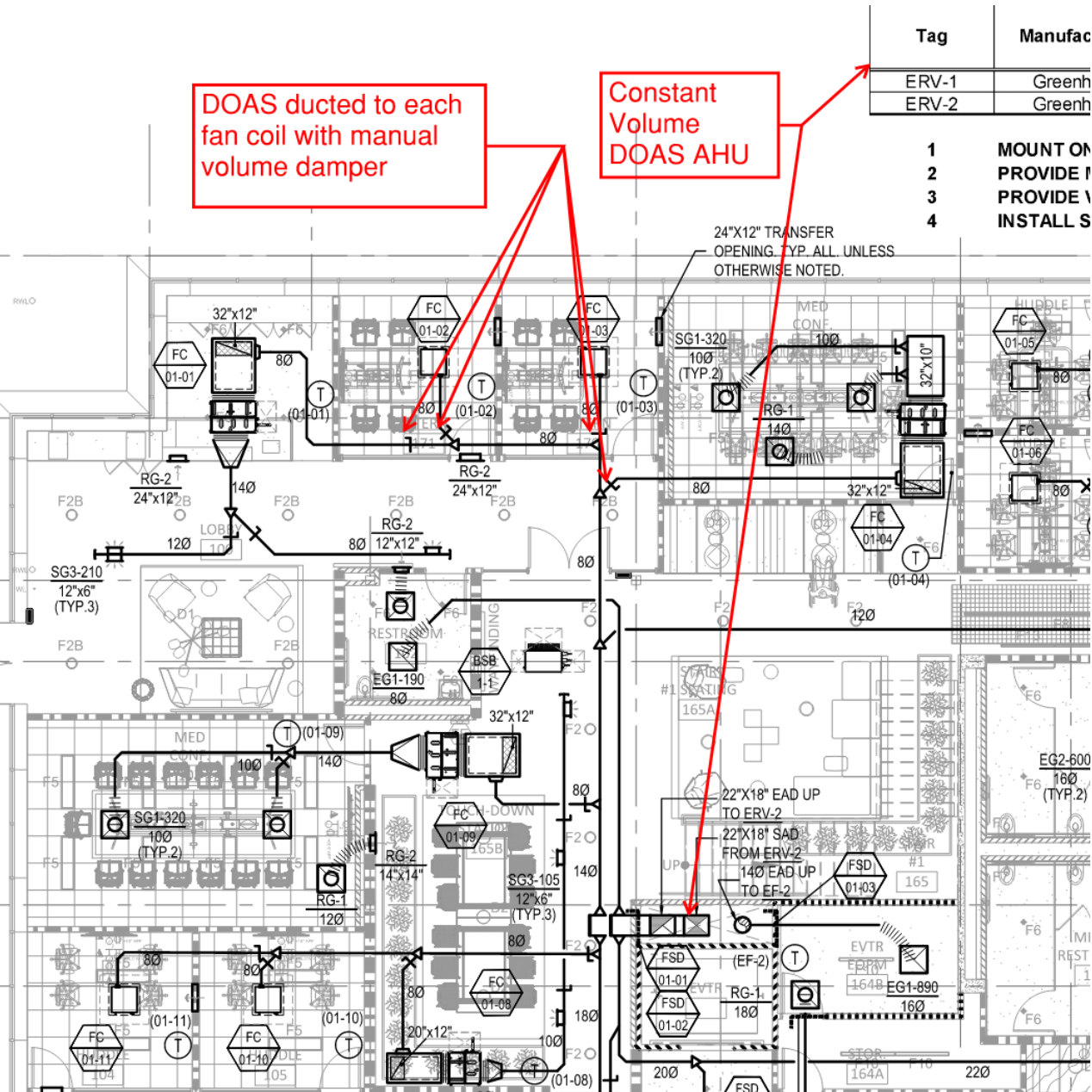
DOAS systems in buildings with design outdoor airflow rates $> 3,000$ cfm shall meet all of the following:

- A. Include modulating pressure independent dampers or other means of independently modulating outside air at each space conditioning zone
- B. Include demand ventilation controls for high density spaces per 120.1(d)4 (DCV)
- C. Reduce ventilation to unoccupied space conditioning zones while maintaining measured outside air ventilation rates to occupied zones per 120.1(d)5 (Occupied Standby)
- D. Modulate DOAS supply fan speed in accordance with 140.4(c)2 (VAV DSP sensor, DSP spt reset)

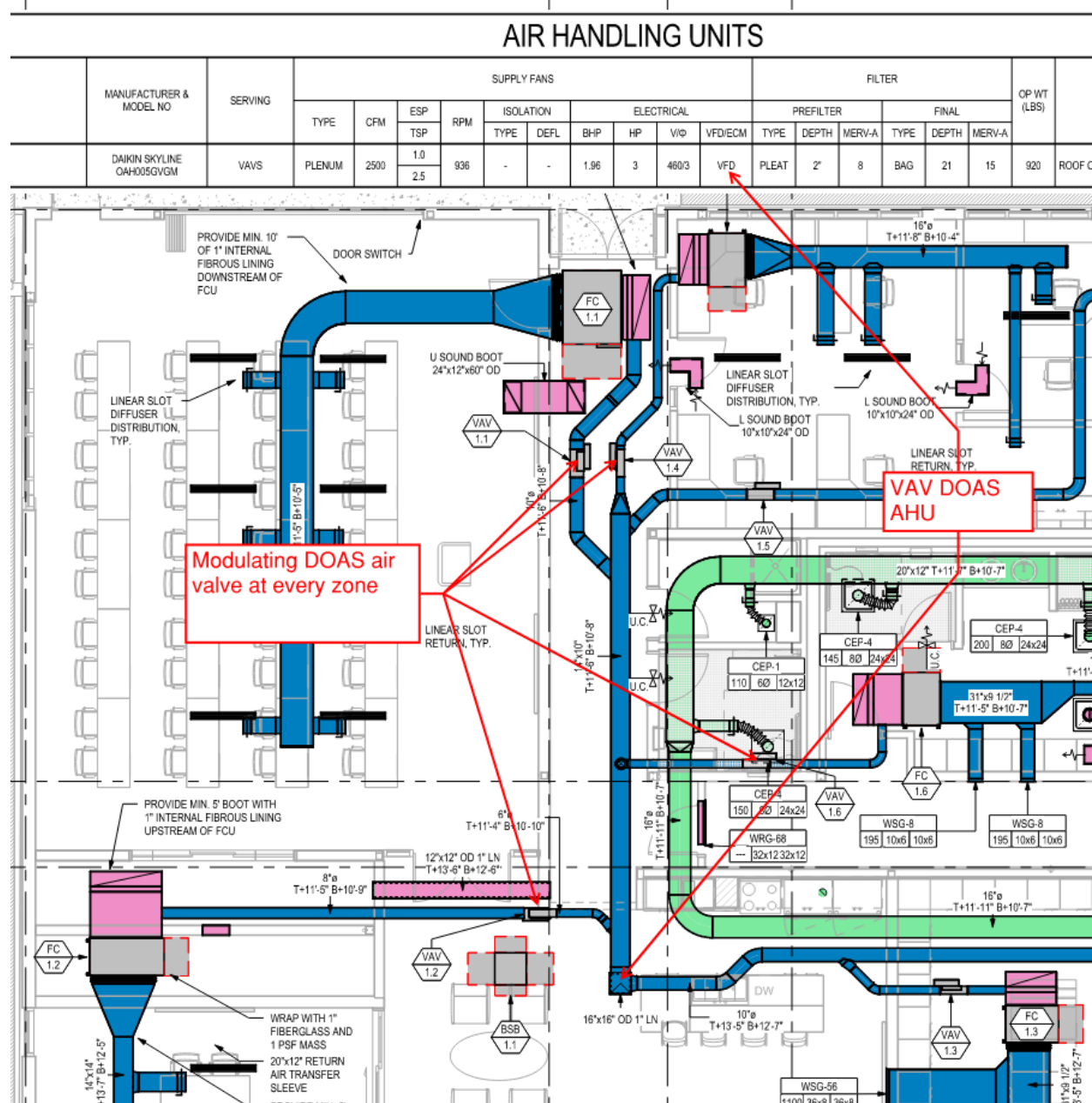
Exception: Additions or alterations to existing DOAS systems permitted before 2029 that do not include modulating dampers or other means of independently modulating outside air at each space conditioning zone.

Examples

Constant Volume (non-compliant):



Variable Volume (compliant):



2. Clarification of Occupied Standby Zone Controls: 120.1(d)5

Current:

Space conditioning zones shall include occupied standby controls when all of the following are true:

- All rooms served by the zone are permitted to have their ventilation air reduced to zero while in occupied-standby mode per Table 120.1-A
- Occupant sensors are required by Section 130.1(c)5 and 6

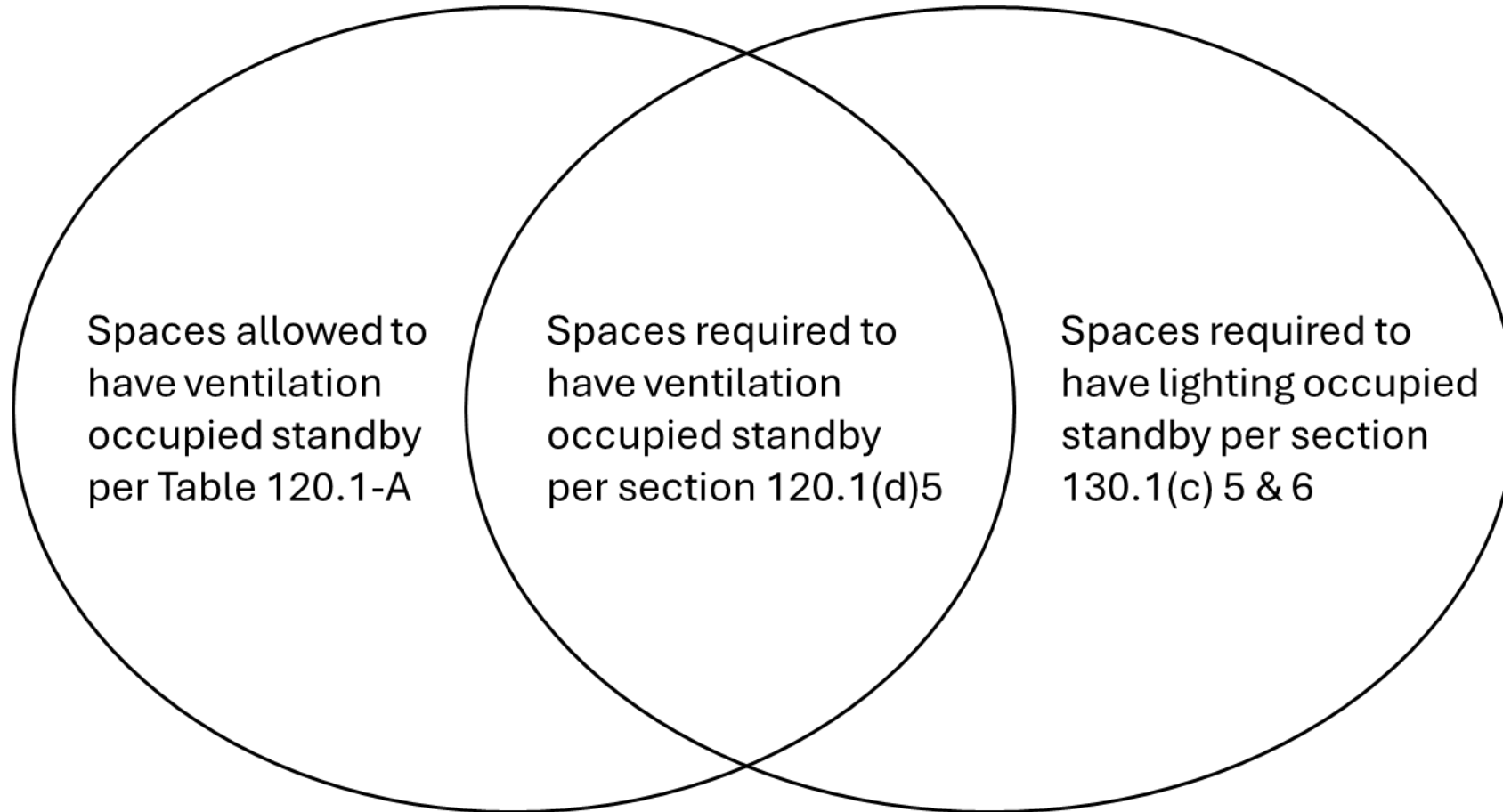
Proposed:

Space conditioning zones serving one or more of the following space types shall include occupied standby controls:

- Post-secondary classrooms
- Lecture halls
- Conference, meeting, or training rooms
- Multipurpose rooms < 1,000 ft²
- Breakrooms
- Enclosed offices
- Open-plan office areas
- Corridors
- Stairwells

2. Occupied Standby Cleanup

Ventilation occupied standby requirements are complex as written



Today, Designers Must Parse Multiple Requirements in Disparate Sections of Title 24 Part 6

Excerpt of Table 120.1-A (ventilation occ standby allowed)

TABLE 120.1-A– Minimum Ventilation Rates

Occupancy Category – Educational Facilities	Minimum Occupant Load Density (persons / 1000 ft ²)	Area-based Minimum Ventilation R _a (cfm/ft ²)	Air Class	Notes
Daycare (through age 4)	14	0.15	2	--
Daycare sickroom	5	0.15	3	--
Classrooms (ages 5-8)	25	0.15	1	--
Classrooms (age 9 -18)	25	0.15	1	--
Lecture/postsecondary classroom	25	0.15	1	F
Lecture hall (fixed seats)	71	0.15	1	F
Art classroom	25	0.15	2	--
Science laboratories	25	0.15	2	--
University/college laboratories	25	0.15	2	--
Wood/metal shop	10	0.15	2	--
Computer lab	25	0.15	1	--
Media center	25	0.15	1	A
Music/theater/dance	33	0.15	1	F
Multiuse assembly	33	0.15	1	F



TABLE 120.1-A– Continued Minimum Ventilation Rates

Occupancy Category - Food and Beverage Service	Minimum Occupant Load Density (persons / 1000 ft ²)	Area-based Minimum Ventilation R _a (cfm/ft ²)	Air Class	Notes
Restaurant dining rooms	33	0.15	2	--
Cafeteria/fast-food dining	33	0.15	2	--
Bars, cocktail lounges	33	0.2	2	--
Kitchen (cooking)	3	0.15	2	--

Section 130.1(c)5 & 6 (lighting occ standby required)

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.

Mandatory Ventilation = Occupied Standby Requirements

This is harder than it needs to be

Poll

How would you characterize the burden of the current HVAC occupied standby requirements?

- Easy
- Moderate
- Difficult
- Depends on application (send detail in chat)

3. New DOAS Delivery Option: 140.4(p)

(p) Dedicated outdoor air systems (DOAS).

...The DOAS outdoor air shall be delivered using one of the following options:

1. Existing: Directly to the occupied space
2. Existing: At the outlet of any terminal heating or cooling coils and shall cycle off any zone heating and cooling equipment when there is no call for heating or cooling in the zone.

3. New: At the inlet to zonal terminal heating or cooling coils. When there is no call for heating or cooling in the zone, the zone heating and cooling equipment shall either:

1. cycle off if there is a path for the outside air to reach the space, such as a return grille, or
2. be controlled to reduce supply airflow to no more than the required outdoor air

4. SAT Revisions to Reduce Reheat / Re-cooling: 140.4(p)

Current:

DOAS shall not warm supply air above 60°F when representative building loads or outdoor air temperature indicates that the majority of zones require cooling

Proposed:

DOAS shall not warm supply air above 55°F and shall not use mechanical cooling to cool supply air below 75°F. DOAS units serving zonal systems without latent cooling capability may mechanically cool supply air below 75°F when the outdoor dewpoint temperature is above 55°F

5. New Prescriptive Requirement: 140.4(t)

(t) Design Minimum Outdoor Air Rate. The outdoor air rate supplied to each space shall not exceed the larger of the following unless the zone is in economizer free cooling mode:

1. the minimum outdoor air rate required for ventilation by Equation 120.1-F
2. the rate required for make-up of process exhaust systems minus available transfer air, per 140.4(o)
3. the rate required to meet special pressurization relationships required for health or safety

Benefits of the Proposed Changes (by Submeasure)

1. Modulating Dampers will:
 - Reduce overventilation of partially occupied or unoccupied spaces which saves **cooling, heating, fan energy**
 - Improve **indoor air quality** monitoring
2. Clarifying where Occupied Standby is required will:
 - Save **heating, cooling and fan energy** by improving compliance and enforcement
3. New DOAS Delivery Option will:
 - Not increase energy use
 - Reduce first cost
4. Limiting DOAS pre-heating and pre-cooling will:
 - Eliminate **re-heating and re-cooling energy**
5. Limiting Design Min OA will:
 - Save **heating, cooling and fan energy**

Per Unit Energy and Cost Impacts

Methodology and Assumptions

- Energy and Energy Cost Savings
- Incremental Costs

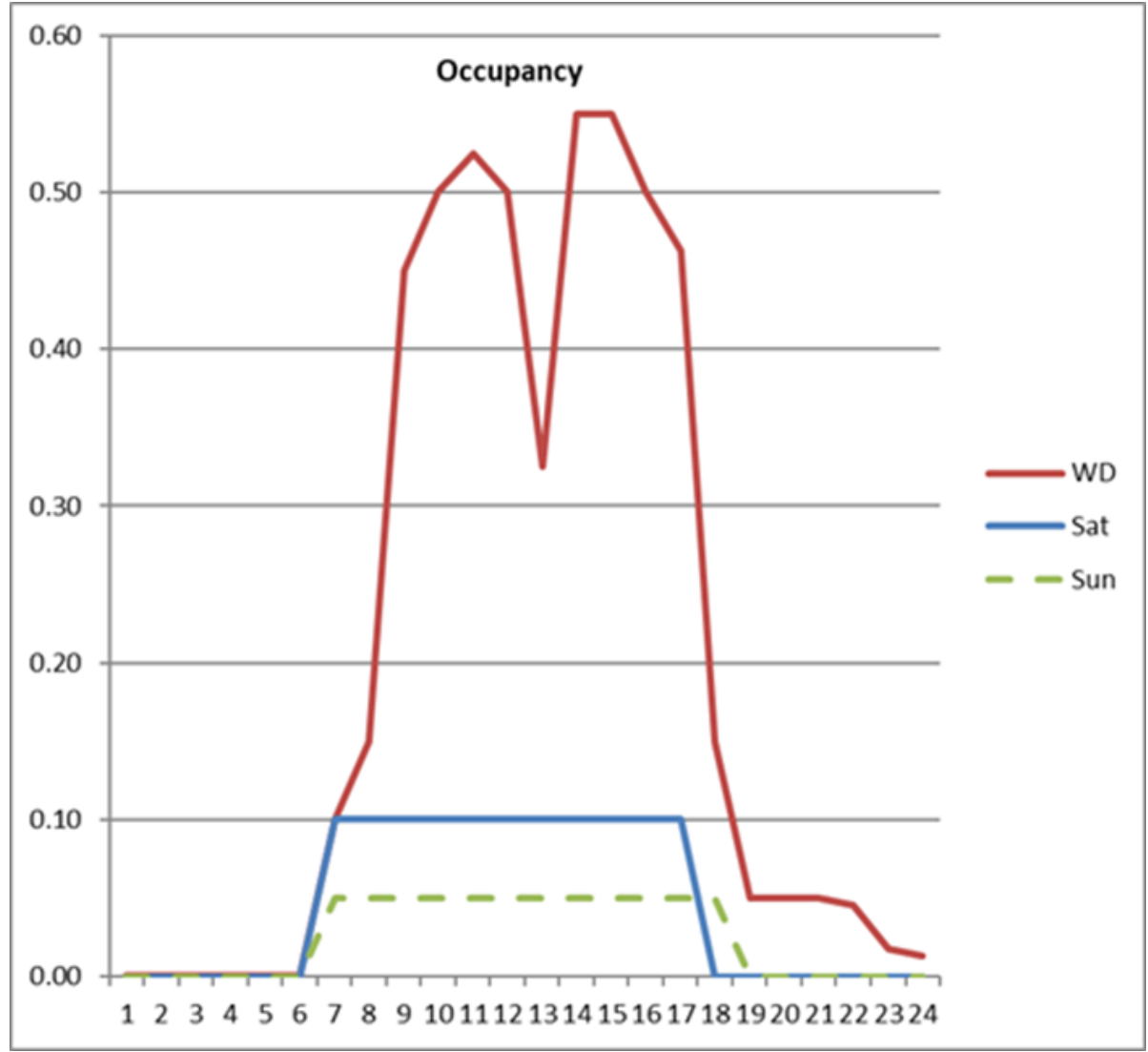
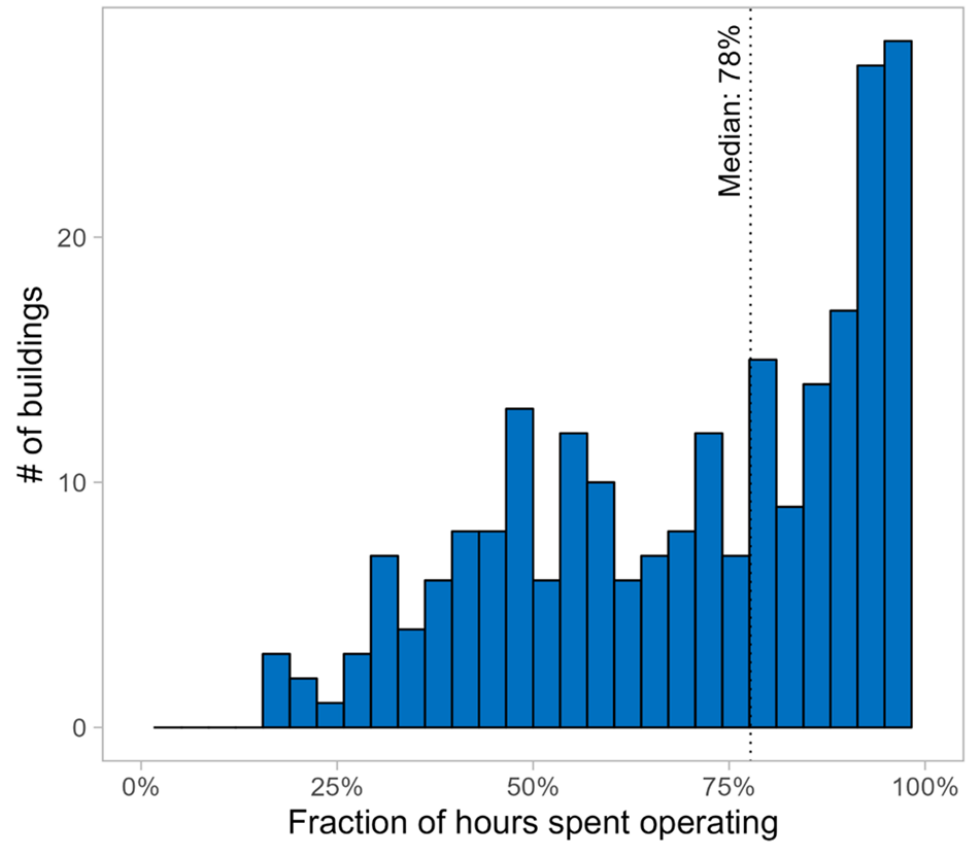


Key Modeling Assumptions

- Large office modeled as all private offices (low density) and as all conf room (high density)
- Schedules:
 - HVAC hours: 6a-8p weekdays, 8a-6p weekends
 - Low Density: always unoccupied (to determine theoretical maximum occupied standby savings)
 - High Density: model as unoccupied (for max OS savings) and again with realistic load profile schedules for people, lights, plugs (for theoretical max DCV savings)
- Baseline Model:
 - model each zone as constant volume packaged single zone heat pump without economizer with fixed min OA at design min OA (either 0.15 cfm/ft² for low density or 0.75 cfm/ft² for high density)
 - baseline fan power of 0.58 W/cfm
- Proposed Model:
 - Same as baseline but with economizer with airflow capacity = design min OA.
 - Min OA = 0 cfm (note: economizer can still bring in OA for free cooling), except min OA = 0.15 cfm/ft² for K-12
 - fan power= 51% of baseline (80% speed) to account for CV to VAV and DSP reset
- Spreadsheet Post-Processing: Iterate on percent of time zones are unoccupied (i.e. fraction of theoretical maximum OS savings) to find B/C > 1

Research on HVAC Operating Hours and Load Profiles

- Strategic Energy Group HVAC Scheduling Study: Typical HVAC runtime: 14 hours per day, Monday–Saturday, Off on Sundays. 14 x 6 = 84 hours/week ([link](#))
- UC Berkeley Center for the Built Environment survey of hundreds of buildings found typical HW heating system operates 130 hours/week ([link](#))



Research on Actual Occupancy Schedules

Study / Source	Original study metric	Assumed office-hours window	Hours/wk in metric	HVAC-weighted occupancy
<u>XY Sense – Workplace Utilization Index (Global, Q2–Q3 2025)</u>	43% avg global utilization (business hours) [xysense.com]	08:00–18:00, Mon–Fri (assumed)	50 h	23.9%
<u>XY Sense – Workplace Utilization Index (North America, Q2–Q3 2025)</u>	36% avg utilization (North America) [xysense.com]	08:00–18:00, Mon–Fri (assumed)	50 h	20.0%
<u>Density – Workplace Benchmark (Q1 2025)</u>	47% avg daily peak floor utilization (busy-day peak, not all-day average) [density.io]	08:00–18:00, Mon–Fri (assumed)	50 h	26.1%
<u>Kastle – Back-to-Work Barometer (Jan–Feb 2025)</u>	54.2% of pre-pandemic attendance (weekly avg) [axios.com] , [credaily.com]	07:00–19:00, Mon–Fri (badge/activity window, assumed)	60 h	36.1%

Incremental Cost Framework

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



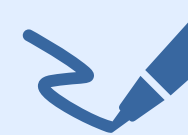
Baseline

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

- Surveyed several large VRF/DOAS designs to determine typical:
 - ft²/zone
 - Ratio of zone areas:
 - Low density occupied standby zones (e.g. office space)
 - High density OS + DCV zones (e.g. conf rooms, classrooms)
 - Neither (e.g. storage, toilet)
- Worked with mechanical and controls contractor on total incremental first cost and maint. cost per zone and per AHU for:
 - Delete manual volume damper (MVD) and MVD balancing
 - Modulating damper with air flow sensor (e.g. Price RDV)
 - Damper actuator
 - New or modified zone controller
 - Occ sensor for OS zones
 - CO₂ sensor for DCV zones
 - DOAS AHU duct static pressure sensor and associated fan speed controls

Incremental First Cost and Maintenance Cost Data

Scope	Base Case	Proposed Case Non-Integrated	Proposed Case Integrated
manual volume damper (MVD)	\$ 150	\$ -	\$ -
Balancing per MVD	\$ 250	\$ -	\$ -
Modulating air valve (e.g Price RDV)	\$ -	\$ 600	\$ 600
Controls (NI Occ or CO2 sensors)	\$ -	\$ 1,250	\$ 500
Occ Sensor (per zone)	\$ -	\$ 600	\$ 100
CO2 Sensor (per zone)	\$ -	\$ 1,000	\$ 260
Incr. First Cost for OS zone		\$ 2,050	\$ 800
Incr. First Cost for OS+DCV zone		\$ 3,050	\$ 1,060
Incr. First Cost for Neither zone		\$ 1,450	\$ 700
Incr. Maint. for OS zone (\$/yr)		\$ 56	\$ 18
Incr. Maint. for OS+DCV zone		\$ 123	\$ 35
Incr. Maint. for Neither zone		\$ 36	\$ 14
Incr. First Cost per AHU		\$ 6,000	\$ 6,000
Incr. Maint. Cost per AHU		\$ 50	\$ 50

Parametric Analysis Results

- Benefit/Cost Ratio > 1.0 for all of these scenarios

Bldg Type	OA CFM	ERV	Zone ft2	Ctrl Option	HVAC hrs/week	Space Types		Occupancy Rate	
						O.S.	O.S.+DCV	O.S.	O.S.+DCV
Office	>=3,000	No	825	Integrated	90	70%	20%	85%	85%
Office	>=3,000	Yes	825	Integrated	90	70%	20%	85%	85%
Office	>=3,000	No	825	Non-Integr.	90	70%	20%	65%	70%
Office	>=1,000	No	825	Integrated	90	70%	20%	65%	70%
Office	>=3,000	No	300	Integrated	90	70%	20%	65%	70%
Office	>=3,000	Yes	550	Integrated	90	70%	20%	65%	70%
Office	>=3,000	Yes	700	Integrated	53	70%	20%	80%	80%
K-12 school	>=3,000	No	720	Integrated	90	10%	80%	100%	100%
K-12 school	>=2,000	No	720	Integrated	90	10%	80%	100%	100%
K-12 school	>=2,000	Yes	720	Integrated	90	10%	80%	100%	100%
K-12 school	>=2,000	No	720	Non-Integr.	90	10%	80%	100%	100%
K-12 school	>=2,000	Yes	720	Non-Integr.	90	10%	80%	100%	100%
K-12 school	>=3,000	Yes	720	Non-Integr.	53	10%	80%	100%	100%
Hgher Ed.	>=3,000	No	1200	Integrated	90	20%	70%	100%	100%
Hgher Ed.	>=2,000	No	1200	Integrated	90	20%	70%	100%	100%
Hgher Ed.	>=2,000	Yes	1200	Integrated	90	20%	70%	100%	100%
Hgher Ed.	>=2,000	No	1200	Non-Integr.	90	20%	70%	100%	100%
Hgher Ed.	>=2,000	Yes	1200	Non-Integr.	90	20%	70%	100%	100%
Hgher Ed.	>=3,000	Yes	800	Non-Integr.	90	20%	70%	100%	100%
Hgher Ed.	>=3,000	Yes	800	Non-Integr.	53	20%	70%	100%	100%

Research showed average occupancy rate during HVAC operation was ~40%. Measure is cost-effective even at much higher occupancy rates so VERY conservative!





Compliance Verification

- Key Aspects of Compliance Verification
- Revisions to Compliance Software

Key Aspects of Compliance Verification

- Compliance should be straightforward because:
 - Designer/contractors/AHJs are very familiar with:
 - VAV boxes
 - Existing acceptance tests for occupied standby, DCV, duct static pressure setpoint reset.
 - VRF manufacturers may incorporate Modulating DOAS into their fan coil controls
- We will provide additional details regarding the measure intent and how to comply in the Compliance Manual
- Compliance forms anticipated to be modified:
 - NRCC-MCH-E
 - NRCA-MCH-06-A
 - NRCA-MCH-19-A

Compliance Software Updates

- This is a mandatory measure, so compliance software updates are not strictly required
- However, compliance software should be updated because:
 - Currently unable to model Modulating DOAS
 - Currently unable to model Occupied Standby
 - Currently unable to model Demand Control Ventilation
 - Default schedules are not realistic and do not give credit for Occupied Standby or DCV.
- Fixing these flaws with allow:
 - Modeling of Modulating DOAS, Occupied Standby, and DCV
 - More accurate comparisons of system types
 - Baseline VRF models to include Modulating DOAS for buildings with $> 3,000$ cfm OSA
 - Proposed models to include Modulating DOAS (e.g. to get credit for buildings with $< 3,000$ cfm OSA)

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More information on

[CEC's 2028 proceeding website.](#)

**We want to
hear from you!**