

### C-3: Occupant standby control for HVAC (C403.2.4.2)

*Summary:* HVAC systems often operate in building zones that are vacant for extended periods of time. Occupant-based controls can use thermostats in conjunction with occupancy sensors that switch systems to standby mode when the space is empty. The proposed requirement is limited to high-occupancy spaces that typically have extended vacant time periods, such as conference rooms and classrooms. Occupancy sensor controls in these spaces will reduce operation of HVAC, saving fan energy, VAV reheat, and heating and cooling of unneeded outside air.

A comment review for DOE proposal C-3 was added on December 18, 2015.

*Stakeholder Feedback:* There was one public comment received for proposal C-2. The comment is summarized below, followed by a DOE review:

- It would be helpful to have language describing the energy and economic impact of proposal C-4 being published in the 2018 IECC on this proposal.

*Review:* Generally, DOE analyzes measures individually against the current code, as it is unknown what other proposals may be included. When an entire new edition is completed, DOE completes an analysis of the interactive effects of proposals in the new code edition in its entirety.

In response to this comment, DOE will submit proposal C-3 as originally posted.

== = IECC PROPOSAL:

*Modify Section C403.2.6.1 as follows:*

**C403.2.6.1 Demand controlled ventilation.** Demand control ventilation (DCV) shall be provided for spaces ~~larger than 500 square feet (46.5 m<sup>2</sup>) and with an average design~~ occupant load of at least 25 people per 1,000 square feet (93 m<sup>2</sup>) of floor area (as established in Table 403.3 of the *International Mechanical Code*) as follows:

1. DCV that modulates the outside air in proportion to the people in the space shall be provided for spaces larger than 500 square feet (46.5 m<sup>2</sup>) where the supply airflow rate minus any makeup or outgoing transfer air requirement is at least 1,200 cfm (566 L/s) and served by systems with one or more of the following:
  - 1.1. An air-side economizer.
  - 1.2. Automatic modulating control of the outdoor air damper.
  - 1.3. A design outdoor airflow greater than 3,000 cfm (1416 L/s).
2. Spaces larger than 150 square feet (14 m<sup>2</sup>) where the supply airflow rate minus any makeup or outgoing transfer air requirement is at least 200 cfm (95 L/s) shall be provided with one of the following:
  - 2.1 DCV that closes the ventilation damper or shuts off the ventilation fan when an occupant sensor indicates the space has been vacant for 20 minutes and while the space is vacant, shuts off air supply to the space or limits air supplied to the makeup air requirement unless the space temperature is 2°F or more below the heating temperature setpoint or 2°F or more above the cooling temperature setpoint.
  - 2.2 DCV that modulates the outside air in proportion to the people in the space.

**Exception:** Demand control ventilation is not required for systems and spaces as follows:

1. Systems with energy recovery complying with Section C403.2.7.
2. ~~Multiple zone systems without direct digital control of individual zones communicating with a central control panel.~~
3. ~~Systems with a design outdoor airflow less than 1,200 cfm (566 L/s).~~
4. ~~Spaces where the supply airflow rate minus any makeup or outgoing transfer air requirement is less than 1,200 cfm (566 L/s).~~
5. Ventilation provided for process loads only. Systems installed for the sole purpose of providing makeup air to meet exhaust requirements.

**Reason.** Demand controlled ventilation saves energy by reducing the heating and cooling of outside air for ventilation, and by reducing the fan energy for serving vacant spaces. The proposal clarifies language to meet the original intention of application to spaces where occupancy is 25 people or more per 1000 square feet. It also moves some exceptions into positive requirements. The last exception is reworded to improve clarity and compliance. The proposal further distinguishes between demand controlled ventilation (DCV) that modulates the ventilation air (usually with a CO<sub>2</sub> sensor) and lower-cost DCV that shuts off ventilation air when a space is vacant. The lower-cost shut-off DCV is cost-effective in smaller spaces that have high occupancy. For the lower-cost shut off method, readily available occupancy sensor thermostats are incorporated with a moderate standby temperature setback so that thermal loads will not keep the fan operating while the space is vacant.

*Energy Savings:* An analysis of energy impact shows that savings from the controlling HVAC based on occupancy as proposed ranges from \$20 to \$257 per 150 square foot room. More details are found in the cost-effectiveness analysis referenced in the cost impact section.

The U.S. Department of Energy (DOE) develops its proposals through a public process to ensure transparency, objectivity and consistency in DOE-proposed code changes. Energy savings and cost impacts are assessed based on established methods and reported for each proposal, as applicable. More information on the process utilized to develop the DOE proposals for the 2018 IECC can be found at: <https://www.energycodes.gov/development/2018IECC>.

**Cost Impact.** Based on a CASE study<sup>1</sup> conducted for California Title 24 in 2011, the added cost of occupancy sensor controlled thermostats in new construction is \$178 per zone. The occupancy sensor is integral to the thermostat in some cases, and a separate unit in others. Low voltage occupancy sensors are available to allow for low cost HVAC controls installation. In the case of VAV boxes, the thermostat and occupancy sensor cost will cover a low-voltage occupancy sensor and an additional input into the box controller or integrating the HVAC DDC system with the occupancy sensors in the lighting control system.

*Cost-effectiveness:* The use of occupancy sensor control for high occupancy spaces down to 150 square feet was found cost-effective in the cited CASE study and similar provisions were included in California Title 24. PNNL performed a cost-effectiveness analysis using the established DOE methodology.<sup>2</sup> Results of the cost-effectiveness analysis showed that the average savings-to-investment ratio (SIR) ranges from 2.3 in small offices to 11.8 in large offices. A proposal is cost-effective when the SIR is greater than 1.0, indicating that the present value of savings is greater than the incremental cost. The complete cost-effectiveness analysis is available at: <https://www.energycodes.gov/development/2018IECC>.

---

<sup>1</sup> PECL, and Taylor Engineering. (2011). "Light Commercial Unitary HVAC, 2013 California Building Energy Efficiency Standards, CODES AND STANDARDS ENHANCEMENT INITIATIVE (CASE)." California Utilities Statewide Codes and Standards Team for California Energy Commission.

<sup>2</sup> Hart, R., and Liu, B. (2015). *Methodology for Evaluating Cost-effectiveness of Commercial Energy Code Changes*. Pacific Northwest National Laboratories for U.S. Department of Energy; Energy Efficiency & Renewable Energy. PNNL-23923 Rev1. <https://www.energycodes.gov/development/commercial/methodology>.