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Docket Number:	17-BSTD-01
Project Title:	2019 Building Energy Efficiency Standards PreRulemaking
TN #:	217495
Document Title:	Mechanical Ventilation System Energy Performance
Description:	This comment recommends that the CASE team pursue an additional code change with respect to fan energy use of dwelling unit mechanical ventilation systems. The proposed change would introduce minimum fan efficacy requirements that can save significant energy.
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NEWPORT VENTURES

May 9, 2017

California Energy Commission
1516 Ninth Street, MS-34
Sacramento, CA 95814

Re: Docket 17-BSTD-01, Mechanical Ventilation Energy Use

Dear CEC Staff and CASE Initiative Team:

This comment recommends that the CASE team pursue an additional code change with respect to fan energy use of dwelling unit mechanical ventilation systems. The proposed change would introduce minimum fan efficacy requirements that can save significant energy.

While the 2016 BEES require mechanical ventilation for low-rise dwelling units, it has very limited requirements with respect to the energy performance of these systems – a missed opportunity for energy savings across all system types. Following are recommended minimum energy performance requirements for dwelling unit ventilation systems organized by system type. These are recommended for high-rise and low-rise dwelling units.

Exhaust systems: Where installed, 2019 BEES should require that exhaust fans used for dwelling unit outdoor air ventilation be ENERGY STAR rated (i.e., a minimum fan efficacy of 2.8 cfm/W). Currently, CALGreen requires that all bathroom exhaust fans be ENERGY STAR rated, even if they are operated only intermittently by occupants. A similar minimum performance requirement should be established for exhaust-only dwelling unit ventilation fans, which typically operate continuously and can have a much larger impact on a dwelling unit's energy use. Additionally, many exhaust-only dwelling unit ventilation systems are not located in bathrooms, meaning they're outside the scope of the CALGreen efficacy requirements. At a minimum, an ENERGY STAR rating should be required for any exhaust fan used to provide dwelling unit outdoor air ventilation in California. Further, the State of Oregon is proposing to require ENERGY STAR exhaust fans in all low-rise residential baths with no distinction between bathrooms and powder rooms like in California.

Balanced systems: The 2018 IECC just adopted a prescriptive fan efficacy for H/ERVs of 1.2 cfm/W (i.e., 0.84 cfm/W). This value was first established in the Canadian ENERGY STAR H/ERV specification and is a reasonable number to use in California.

Central Fan Integrated systems: CFI systems are required by Title 24 to use no more than 0.58 W/cfm of air flow across the heat exchanger, a value that is less aggressive than the IECC's requirement for such systems to have electronically commutated motors (2015 IECC R403.6.1). That said, Title 24's fan efficacy of 0.58 W/cfm could be considered is a reasonable target, <u>if</u> it is applied to *outdoor air* across all ventilation modes, and not the total of outdoor air and recirculated air. Without such a requirement, traditional CFI systems can easily use 4x the fan energy of a balanced ventilation system (see Exhibit A for more information). Based on Title 24 requirements, a traditional CFI operating in heating or cooling mode will consume 0.58 W/cfm of recirculated air and outdoor air. The outdoor air fraction of a traditional CFI system operating in ventilation-only mode may be as low as 10%, meaning the fan power per cfm of outdoor air is about 10x the 0.58 W/cfm value. Such a system should not be permitted in the prescriptive path. If CFI systems continue to be approved in the prescriptive path, they should have controls that assure comparable energy performance to alternative systems. For example, any CFI system whose fan power does not exceed 0.58 W/cfm of *outdoor air* during any ventilation cycle would be a good candidate for prescriptive path compliance. This could be achieved by a CFI/exhaust combination system that uses the central fan to supply outdoor air in heating or cooling mode and uses an exhaust fan to provide outdoor air in other modes, provided there is not a control mode that uses the central fan to supply outdoor air when there is not a call for heating, cooling, or economizing.

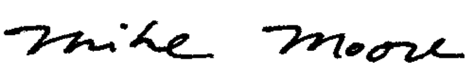
Within the performance path, it is necessary to ensure that approved building energy simulation software is able to accurately model the energy use of the CFI system (i.e., the ventilation fan energy use in heating and cooling mode should be the total fan energy use multiplied by the fraction of outdoor air to total air, ventilation-only cycles are identified by time of day, full attribution of TOU fan energy is given to such cycles, etc.). For verification purposes, CEC should continue to require that CFI systems be certified to the commission as Intermittent Ventilation Systems.

Dedicated supply systems: Where installed, dedicated supply fans (i.e., those not integrated with operation of a central heating and cooling fan) could likely achieve at least 2.8 cfm/W (the same requirement as proposed for exhaust fans). ENERGY STAR does not rate supply fans; however, ENERGY STAR rated in-line exhaust fans, which are similar to dedicated supply fans, are required to achieve at least 3.8 cfm/W. While in-line exhaust fans are similar to dedicated supply fans, the ENERGY STAR specification for these units is not directly applicable because it does not consider filtration that would be needed for in-line supply fans. Such filtration requirements could reduce fan efficacy. At a minimum, an efficacy of 2.8 cfm/W is recommended for dedicated supply systems.

Central ventilation systems for high-rise multifamily dwelling units: The CASE "Second Stakeholder Meeting for Residential Indoor Air Quality" presentation given on March 16, 2017, highlighted central duct sealing and self-balancing dampers in individual dwelling units as two proposed requirements for central systems. While these features bear significantly on central system performance and energy use, fan efficacy also merits attention. As noted in the graph on p 23 of the presentation, energy savings associated with improvements to these systems were due to "duct sealing and fan replacement". U.S. DOE Building America work in this area has resulted in recommendations for direct-drive, variable speed fans; also, fans with DC motors can offer significant energy savings over fans powered by PSC motors.[1] There are some provisions for fan motor performance in Title 24, such as Section 140.4(c); however, Section 140.4(c)4's requirement for fractional HVAC motors to be electronically commutated is only applicable to high-rise residential dwelling units. While low-rise dwelling units are not as likely to specify central ventilation systems, any low-rise application that elected to specify a central ventilation system should also require an electronically commutated motor.

Thank you for the opportunity to provide this comment.

Sincerely,



Mike Moore, P.E.
ASHRAE 62.2 Indoor Air Quality Subcommittee Chair

[1] U.S. DOE Building America. 2011. Ventilation in Multifamily Buildings. https://energy.gov/sites/prod/files/2013/12/f5/carb_ventilation_webinar.pdf.

Exhibit A – Estimation of Fan Energy Use for a Typical CFI System

CFI ventilation systems are typically designed to limit the outdoor air fraction to 5-20% of the total fan flow. When a call for ventilation overlaps a heating or cooling call, the fan power used for ventilation can be calculated as the total fan power multiplied by the fraction of outdoor air flow to recirculated air flow. When there is no need for heating or cooling, however, the fan power used to provide ventilation is the total fan power.

For example, suppose a 1000 sqft apartment has a 1 ton central heating and cooling system with a central fan that moves 400 cfm/ton at an efficacy of 0.58 W/cfm (typical efficacy based on CA studies). ASHRAE 62.2-2016 would require 52.5 cfm of outdoor air for this dwelling unit on a continuous basis or as a time-weighted average over any four-hour block of time.

Suppose the engineer specifies 60 cfm of outdoor air (i.e., 15% of the total 400 cfm air flow through the air handler) for 3.5 out of every four hours (i.e., the run time required to be considered equivalent to a continuous ventilation rate of 52.5 cfm).

For this system, total central fan run time is 8760*(3.5/4) = 7665 hours/year. Assuming that there is a call for heating or cooling 7.8% of the year (as documented on slide 20 of the Second Stakeholder Meeting for Residential Indoor Air Quality, March 16 pre-rulemaking presentation), the fan energy used for providing outdoor air in heating and cooling modes can be estimated as:
(7.8%)*(7665 hours)*(0.58 W/cfm)*(400 cfm/ton)*(1 ton)*(60 cfm OA/400 cfm total) = 21 kWh.
The fan energy used for providing outdoor air in ventilation-only mode can be estimated as:
(1-7.8%)*(7665 hours)*(0.58 W/cfm)*(400 cfm/ton) = 1639 kWh.
Total fan energy use for ventilation = 1660 kWh.

Alternatively, if an ERV is specified that provides 52.5 cfm continuously at a fan efficacy of 1.2 cfm/W (the minimum permitted by the 2018 IECC, residential), the total fan energy use can be calculated as: (52.5 cfm)*(1/1.2 W/cfm)*(8760 hours) = 383 kWh. This fan energy use is further offset by the ERV's energy recovery.