STATE OF WASHINGTON

# STATE BUILDING CODE COUNCIL

Washington State Energy Code Development

## Standard Energy Code Proposal Form

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Code being amended: ☒ Commercial Provisions ☐ Residential Provisions

Code Section # C202, C403.8.3, C403.8.6

Brief Description: *This proposal seeks to improve the FEI level requirement based on fan type and application for non-embedded fans.*

Proposed code change text: (Copy the existing text from the Integrated Draft, linked above, and then use underline for new text and ~~strikeout~~ for text to be deleted.)

### C202 General Definitions

**Embedded fan.** A fan that is set or fixed inside a piece of equipment whose purposes exceeds that of a fan or is different than that of a stand-alone fan. The equipment may have safety or energy efficiency requirements of its own. Examples of embedded fans include supply fans that are part of air-handling units, condenser fans in heat rejection equipment, fans as part of air curtain units, or forced draft combustion blowers in boilers or furnaces.

**Air circulating fan**. A fan that has no provisions for connection to ducting or separation of the fan inlet from its outlet using a pressure boundary, operates against zero external static pressure loss, and is not a jet fan or recirculating fan.

**Equivalent diameter**. The diameter of a circle with the same area as another geometric shape. For a rectangular cross section with width 'a' and heigh 'b', the equivalent diameter is given as $D = (4ab/\Pi)^{0.5}$

**Safety fan.** A fan whose operation meets one or more of the following:

(1) a reversible axial fan in cylindrical housing that is designed and marketed for use in ducted tunnel ventilation that will reverse operations under an emergency ventilation condition;

(2) a fan for use in explosive atmospheres tested and marked according to ISO 80079-36:2016, Explosive atmospheres -- Part 36: Non-electrical equipment for explosive atmospheres -- Basic method and requirements;

(3) an electric-motor-driven-Positive Pressure Ventilator as defined AMCA 240;

(4) a fan complying with ANSI/UL 705 Standard for Safety for Power Ventilators and listed as "Power Ventilators for Smoke Control Systems";

(5) a laboratory exhaust fan designed and marketed specifically for exhausting contaminated air vertically away from a building using high-velocity discharge.

**Induced-flow fan.** A type of laboratory exhaust fan with a nozzle and windband; the fan's outlet airflow is greater than the inlet airflow due to induced airflow. All airflow entering the inlet exits through the nozzle. Airflow exiting the windband includes the nozzle airflow as well as the induced airflow.

**C403.8.3 Fan efficiency.** Each fan and fan array shall have a fan energy index (FEI) of not less than ~~1.00~~ the values listed in Table C403.8.3 for fans without a motor controller at the design point of operation, as determined in accordance with ~~AMCA 208~~ DOE 10 CFR 431 Appendix A to Subpart J by an approved, independent testing laboratory and labeled by the manufacturer. Each fan and fan array used for a variable-air volume system shall have an FEI of not less than the values listed in Table C403.8.3 for motors with a controller ~~0.95~~ at the design point of operation as determined in accordance with ~~AMCA 208~~ DOE 10 CFR 431 Appendix A to Subpart J by an approved, independent testing laboratory and labeled by the manufacturer. The FEI for fan arrays shall be calculated in accordance with AMCA 208 Annex C.

**Exceptions:** The following fans are not required to ~~have a fan energy index~~ meet the FEI values listed in Table C403.8.3:

1. Fans that are not *embedded fans* with ~~motor nameplate horsepower~~ shaft input power of less than 1.0 hp (0.75 kW), or with ~~a nameplate~~ electrical input power of less than 0.89 kW, or with air power greater than 150 horsepower.
2. *Embedded fans* that have a motor nameplate horsepower of 5 hp (3.7 kW) or less or with a fan system electrical input power of 4.1 kW or less. *Embedded fans* greater than 5 hp (3.7kW) or with a fan system electrical input power greater than 4.1 kW shall have a FEI of not less than 1.00.
3. Multiple fans operated in series or parallel as the functional equivalent of a single fan that have a combined motor nameplate horsepower of 5 hp (3.7 kW) or less or with a fan system electrical input power of 4.1 kW or less. Multiple fans operated in series or parallel as the functional equivalent of a single fan that have a combined motor nameplate horsepower greater than 5 hp (3.7kW) or with a fan system electrical input power greater than 4.1 kW shall have a FEI of not less than 1.00.
4. Fans that are part of equipment covered under Section C403.3.2.
5. Fans included in an equipment package certified by an *approved agency* for air or energy performance.
6. *Ceiling fans*, ~~*circulation fans*~~ *air circulation fans*, and air curtains.
7. Fans used for moving gases at temperatures above 482°F (250°C).
8. ~~Fans used for operation in explosive atmospheres.~~
9. ~~Reversible fans used for tunnel ventilation.~~
10. ~~Fans that are intended to operate only during emergency conditions.~~

8. Fans outside the scope of AMCA 208.

~~11.~~9. *Safety Fans, Induced-flow fans* and jet fans.

**Table C403.8.3 – FEI Requirements by Fan Type**

| **Fan Type** | **Fan Energy Index (FEI) Without Motor Controller** | **Fan Energy Index (FEI) With Motor Controller (Applies a 0.95 correction for controller)** |
|---|---|---|
| Axial Inline | 1.1~~8~~0~~ * A[a]~~ | 1.~~18~~05~~ * A * 0.95~~ |
| Axial Panel | 1.00~~24 * A~~ | ~~1.24 * A*~~ 0.95 |
| Axial Power Roof Ventilator | 0.85~~ * A~~ | 0.81~~5 * A* 0.95~~ |
| Centrifugal Housed | 1.15~~ * A~~ | 1.09~~15 * A * 0.95~~ |
| Centrifugal Unhoused | 1.05~~23 * A~~ | 1~~1.23 * A * 0.95~~00 |
| Centrifugal Inline[a] | 1.07~~ * A~~ | 1.0~~7~~2~~ * A* 0.95~~ |
| Radial Housed | 1.00~~ * A~~ | ~~1.00 * A*~~ 0.95 |
| Centrifugal Power Roof Ventilator - Exhaust | 1.00~~ * A~~ | ~~1.00 * A*~~ 0.95 |

| | | |
|---|---|---|
| Centrifugal Power Roof Ventilator - Supply | 1.00 * A | 1.00 * A* 0.95 |

a. A = 1.00 for motors < 100 hp and A = $\frac{T_{mtr,2023}}{T_{mtr,2014}}$ for motors ≥ 100 hp and ≤ 250 hp.

Where:

$T_{mtr,2023}$ is the motor efficiency in accordance with table 8 at 10 CFR 431.25.
$T_{mtr,2014}$ is the motor efficiency in accordance with table 5 at 10 CFR 431.25.

b. a. FEI level applies to Tubular Centrifugal Inline fans. Square duct Centrifugal inline fans shall have an FEI of not less than 1.00.

**C403.8.6 Large-diameter ceiling fans and air circulating fans.** Where provided, *large-diameter ceiling fans* and *air circulating fans* shall meet the efficiency requirements of Table C403.8.6. *Large-diameter ceiling fans* shall also meet the requirements of Section C403.8.6.1.

**TABLE C403.8.6.1**
**CEILING AND CIRCULATING FAN EFFICIENCY REQUIREMENTS[a]**

| Equipment Type | Category | Minimum Efficiency[b,c] | Test Procedure |
|---|---|---|---|
| *Large diameter ceiling fan* | Blade span ≥ 84.5 in | CFEI ≥ 1.00 at high (maximum) speed; and CFEI ≥ 1.31 at 40% of high speed or the nearest speed that is not less than 40% of high speed | 10 CFR 430, Appendix U |
| *Air Circulating Fan* | ≥ 200 W input power | $Eff_{circ} \geq \frac{16D^5 + 200D^4}{Q^2}$ | 10 CFR 431, Appendix B to Subpart J |

a. The minimum efficiency requirements at both high speed and 40% of maximum speed shall be met or exceeded to comply with this code.

b. Ceiling fans are regulated as consumer products by 10 CFR 430.

c. Chapter 6 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

a. Chapter 6 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

b. $Eff_{circ}$ is the efficacy for *air circulating fans* (CFM/W). D is the impeller diameter for unhoused fans, and the lesser of impeller diameter and *equivalent diameter* for housed fans (inches). Q is the *air circulating fan* airflow rate, determined by the referenced test procedure at the maximum fan speed (cfm).

Purpose of code change:

*A federal test procedure for FEI has been in place for several years and was brought about through industry support working with DOE. However, a rulemaking was never developed to accompany the test procedure which is referenced by all energy codes currently (IECC, Title 24, WSEC, 90.1). Additionally, as of 1/13/25, the DOE has rescinded the NOPR and does not plan to institute a rulemaking in the future.*

*Fans in the market can achieve the current FEI levels across all manufacturers, and the 2021 WSEC not currently push the market to adopt better fan design. The proposed levels here closely match those put forth by AMCA in their comments to the DOE with regards to their 2024 NOPR. This code change would increase the efficiency of non-embedded fans throughout the commercial market during the selection phase, leading to less energy costs for building owners and tenants.*

*In addition, the term "embedded fan" was shown to be a defined term in the 2021 WSEC but no definition was provided. Therefore, a definition has been proposed to clarify the distinction between embedded and non-embedded fans.*

Your amendment must meet one of the following criteria. Select at least one:

- ☐ Addresses a critical life/safety need.
- ☐ The amendment clarifies the intent or application of the code.
- ☐ Addresses a specific state policy or statute. (Note that energy conservation is a state policy)
- ☒ Consistency with state or federal regulations.
- ☐ Addresses a unique character of the state.
- ☐ Corrects errors and omissions.

Check the building types that would be impacted by your code change:

- ☐ Single family/duplex/townhome
- ☒ Multi-family 1 – 3 stories
- ☒ Multi-family 4 + stories
- ☒ Commercial / Retail
- ☒ Institutional
- ☒ Industrial


| | |
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## Economic Impact Data Sheet

**Is there an economic impact:** ☒ Yes ☐ No

Briefly summarize your proposal's primary economic impacts and benefits to building owners, tenants, and businesses. If you answered "No" above, explain your reasoning.

*The primary economic impact of this proposal is the balance between the benefits of customers' avoided energy costs, and the upfront costs of increased equipment prices and manufacturer market adjustments. This fan efficiency proposal considers the manufacturing cost and installed cost of replacing existing or installing new stand-alone fans and blowers (i.e. non-embedded.) These impacts are derived from the US Department of Energy's (DOE's) 10 CFR Parts 429 and 431 Notice of Proposed Rulemaking (NOPR) published on January 19, 2024 (DOE NOPR). In the NOPR (which this proposal matches with several adjustments) DOE summarizes a positive impact on manufacturers, commercial and industrial customers, and the broader economy during the 2030 to 2059 compliance period. Nationwide, the DOE estimates an incremental investment of $5.7 billion would yield more than $40 billion in operating cost savings, including avoided energy costs. It further estimates more than $30 billion in combined health and climate benefits for a combined net benefit of just over $70 billion.*

*The DOE's January 2024 NOPR considers nine equipment classes (as per Table C403.8.3 shown above) and estimates manufacturing costs along with derived fan sales prices and installed costs. The DOE's December 2023 technical support document shares detailed methods for how these costs are estimated, including details on forecasting electricity prices and estimating avoided energy costs. Below we summarize how we interpret these DOE outputs and adjust to fit the code proposal, along with taking into account comments from AMCA on the proposed levels and their suggested adjustments. This proposal uses these same nine DOE fan equipment classes to derive estimated energy savings and incremental construction costs.*

*For each equipment class, the DOE reviewed respective fans from the AMCA sales database and manufacturer fan selection software to determine FEIs for baseline and max-efficiency technology fans. Typically, these were set at respective 5$^{th}$ and 95$^{th}$ percentiles of FEIs for all available fans —with some exceptions. The DOE then chose design pathways with stepped efficiency levels, including an intermediate level corresponding with FEI = 1.0 fans. Upon reviewing the application of FEI to tan selections, we believe the design pathways are not representative of realistic designs (AMCA agrees with this statement) and therefore adjustments need to be made to better reflect actual designs compared to what the DOE proposed. Some industry stakeholders—manufacturers and industry associations, including AMCA —suggested during the rulemaking comment period that many of the DOE's proposed FEI standards for each equipment class are impracticable for higher-air-power duty points. This was especially concerning for embedded fans, though AMCA also notes many standalone fans at the proposed FEI levels would make it harder to find a viable replacement. Setting a standard at a higher level that requires manufacturers to re-tool to meet proposed levels may be appropriate for a standard, however we do not suggest this as an approach for state code. Therefore, we have proposed to remove embedded fans from the scope of the proposal, and to more closely align with AMCA's proposed FEI levels by fan equipment class rather than DOE's higher FEI levels in the NOPR.*

*One additional deviation from the NOPR is how to treat fans with motor controllers. The DOE proposes a set of equations to credit fans with motor control, however, many stakeholder comments on the NOPR noted unnecessary complexity in its approach. Instead, as commented by manufacturers and associations including AMCA and AHRI, we propose using a 5% credit to the minimum FEI standard for each respective fan class with motor controllers. I.e., a fan with a motor controller would need to meet 95% of its respective minimum FEI. This follows how the ASHRAE 90.1-2022 standard and California's Title 24 Energy Code applies credits for fans with motor controllers. The rationale is that fans with motor controllers can save energy by pushing lower air volumes in variable flow applications, but their design is intrinsically slightly less efficient than a single speed.*

Provide your best estimate of the **construction cost** (or cost savings) of your code change proposal? (See OFM Life Cycle Cost **Analysis tool** and **Instructions;** use these **Inputs**. **Webinars on the tool can be found Here and Here**)

$0.03/square foot (For residential projects, also provide $Click here to enter text./ dwelling unit)

Show calculations here, and list sources for costs/savings, or attach backup data pages:

*For each of the nine NOPR fan classes, the DOE estimates manufacturing costs from a teardown of fan equipment, including raw materials, part fabrication, and assembly, into a final product. The NOPR also assessed typical markups to generate sales prices (on average, 135% of the manufactured cost). Stakeholders commented that this approach is mostly accurate, though with some critique for specific fan types. For the purposes of a high-level economic impact assessment, these costs are sufficiently accurate. We include install cost estimates, which allow us to compare installed costs. We further calculated incremental installed cost relative to FEI=1.0 fans (above and beyond the current energy code requirement). Only one category, Axial Power Roof Ventilators are shown to have a relaxed FEI compared to what is required currently however AMCA and DOE agreed this was appropriate for this fan category. As such, costs are negative compared to an FEI 1.0 compliant fan.*

| Class | Proposed Efficiency level | FEI | Incremental installed cost relative to FEI 1.0 ($) |
|---|---|---|---|
| Axial Inline | EL3 | 1.18 | $592 |
| Axial Panel | EL3 | 1.24 | $47 |
| Axial Power Roof Ventilator | EL4 | 0.85 | -$1,737 |
| Centrifugal Housed | EL3 | 1.15 | $24 |
| Centrifugal Unhoused | EL3 | 1.23 | $80 |
| Centrifugal Inline | EL4 | 1.07 | $651 |
| Radial Housed | EL3 | 1.00 | $0 |
| Centrifugal Power Roof Ventilator - Exhaust | EL4 | 1.00 | $0 |
| Centrifugal Power Roof Ventilator - Supply | EL4 | 1.00 | $0 |

*We sourced installed costs from the NOPR technical support document (EERE-2022-BT-STD-0002-0133) Table 8.5.1-17 Average LCC and PBP Results. To obtain a $/sqft we used 2019 CBSA data for average building size (determined to be a 32,100 sqft building), an assumption of 4 standalone fans per building, and an average EUI data from the 2022 Seattle Benchmarking data. From there we relied on average costs (except Axial Power Roof Ventilators) to determine an incremental $/sqft for the LCC tool.*

Provide your best estimate of the **annual energy savings** (or additional energy use) for your code change proposal?

0.07 KWH/ square foot (or) Click here to enter text.KBTU/ square foot

Show calculations here, and list sources for energy savings estimates, or attach backup data pages

*For each of the nine NOPR fan classes, the DOE estimates fan energy consumption over their lifetime, considering operating hours, load profiles, and difference in fan efficiency between the "no-new-standards case" and the projected* *energy use under the proposed new FEI (and corresponding efficiency level). We utilized energy savings estimates for each fan class using a baseline FEI=1.0 (as specified in the current WSEC) compared to an efficiency level close to what AMCA proposed in their comments to DOE. For more information, see the NOPR technical support document (EERE-2022-BT-STD-0002-0133), Chapter 7, and Table 7.2.11 GFBs: Average Annual Energy Use by Equipment Class for each Standards Case (kWh). As noted above, for Axial Power Roof Ventilators, savings are negative compared to an FEI 1.0 compliant fan due to the proposed level being lower.*

| **Class** | **Proposed Efficiency level** | **FEI** | **Annual energy savings relative to FEI 1.0 (kWh)** | **AMCA Comments on FEI levels** |
|---|---|---|---|---|
| Axial Inline | EL3 | 1.18 | 751.0 | Design pathway includes guide vanes, which may not allow for direct replacement with non-guide vane applications. Potential to improve aerodynamic design further-though at higher cost to match higher savings. |
| Axial Panel | EL3 | 1.24 | 748.0 | AMCA recommends a lower FEI to accommodate specific applications where higher FEI fans are not practical and would result in specifying alternate equipment. E.g., axial panel exhaust fan installed in wall-opening where opening can't be modified. |
| Axial Power Roof Ventilator | EL4 | 0.85 | (900.0) | ACEEE, ASAP and NRDC note that the installed cost of the Axial PRV fan seems high. Especially because most of the market's fans are available at EL4/5. |
| Centrifugal Housed | EL3 | 1.15 | 651.0 | AMCA believes centrifugal-housed fans, as widely available in the market, are already within 15% of peak efficiency. It recommends an FEI similar to EL3. |
| Centrifugal Unhoused | EL3 | 1.23 | 394 | For stand-alone fans only. Many fans available at higher EL3 than proposed by AMCA. |
| Centrifugal Inline | EL4 | 1.07 | 334 | Similar to US DOE proposal, assumes mixed flow fans are able to serve all centrifugal inline fan applications. Many more fans available in the EL3 to EL4 range should make this less of an issue. |
| Radial Housed | EL3 | 1.00 | - | Many more radial housed fans available at EL3. |
| Centrifugal Power Roof Ventilator - Exhaust | EL4 | 1.00 | - | Most centrifugal PRV exhaust fans sold are already at this FEI level. It's also aligned with FEI=1.0. |
| Centrifugal Power Roof Ventilator - Supply | EL4 | 1.00 | - | Most centrifugal PRV - Supply fans fall within the EL4 level. There are few options at EL5 or above levels. |

*For more details on how the energy consumption per fan unit varies by efficiency level, see Chapter 7 of the NOPR technical support document (EERE-2022-BT-STD-0002-0133).*

*To obtain a kWh/sqft we used 2019 CBSA data for average building size (determined to be a 32,100 sqft building), an assumption of 4 standalone fans per building, and average EUI data from the 2022 Seattle Benchmarking data. From there we relied on average costs (except Axial Power Roof Ventilators) to determine a kWh/sqft for the LCC tool.*

List any **code enforcement** time for additional plan review or inspections that your proposal will require, in hours per permit application:

*This code change proposal would not increase additional plan review time as current code already requires an FEI level for these fans. This would simply require a more stringent level than is currently included.*

***Small Business Impact.*** Describe economic impacts to small businesses:

*None anticipated. Fans with FEI levels in excess of 1.0 are widely available and routinely specified on permit sets currently.*

***Housing Affordability.*** Describe economic impacts on housing affordability:

*N/A*

***Other.*** Describe other qualitative cost and benefits to owners, to occupants, to the public, to the environment, and to other stakeholders that have not yet been discussed: