



# Fan Efficiency Regulations in the United States

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# Aaron Gunzner, PE

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- Supports various advocacy initiatives in codes, standards, and regulations
- Alternate Voting Member, ASHRAE 90.1 Mechanical Subcommittee
- Member, IAPMO Uniform Mechanical Code TC
- Corresponding Member, ASHRAE Technical Committees 5.2 and 5.6
- Staff Liaison for several AMCA advocacy committees



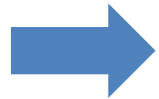
# Fan Efficiency Regulations in the United States

- For commercial fans, the U.S. Department of Energy has only regulated large-diameter ceiling fans since 2017. These are ceiling fans with diameters greater than 2.1 meters.
- Energy codes have covered (regulated) the application of commercial fans since 2013 through ASHRAE 90.1 and the International Energy Conservation Code
  - Efficiency metric initially was Fan Efficiency Grade (FEG)
  - FEG was adopted into state energy codes
  - Metric changed to Fan Energy Index (FEI) in 2019
  - FEI gradually replacing FEG in state energy codes
    - California
    - Florida
    - Connecticut
- Finally, after a decade of starts and stops, product regulations for commercial fans is happening

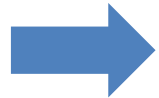


# A Torrent of New and Updated Fan-Efficiency Regulations

## New



Commercial and industrial fans: California



Commercial and industrial fans: U.S. Department of Energy (USDOE)

## Updated

- USA: Motors: Expansion in scope to include air-over motors
  - In process
- USA: Ceiling fans: New scope, product classes, efficiency levels, standby power
  - Undergoing first five-year revision



# USDOE Direction Based on Historical Events

- Metric is Fan Energy Index (FEI)
- Scope is most 1 HP shaft power (1 kW electrical input power) and above
- Cascading regulations (embedded fans) is possible, but not certain
- Most types of axial and centrifugal fans, but a long list of exemptions, including these for example:
  - Air curtain units
  - Jet fans
  - “Safety fans”
- Test method based on ANSI/AMCA Standard 210 / ISO 5801
- May increase scope to include circulating fans that are not ceiling fans



# What's Been Done for USDOE Regulation

**June 2011:** Preliminary determination of coverage

**February 2013:** Framework document

- FEG and FMEG metrics eliminated

**September 2015:** Publication of ASRAC term sheet (stakeholder-negotiated inputs to rulemaking)

- FEI chosen as metric

**November 2016:** Publication of NODA 3 (USDOE analysis of ASRAC inputs)

----- Gap during Trump administration -----

**August 2021:** Final determination of coverage

- Definition of “fan”

**September 2021:** Request for information, test procedure

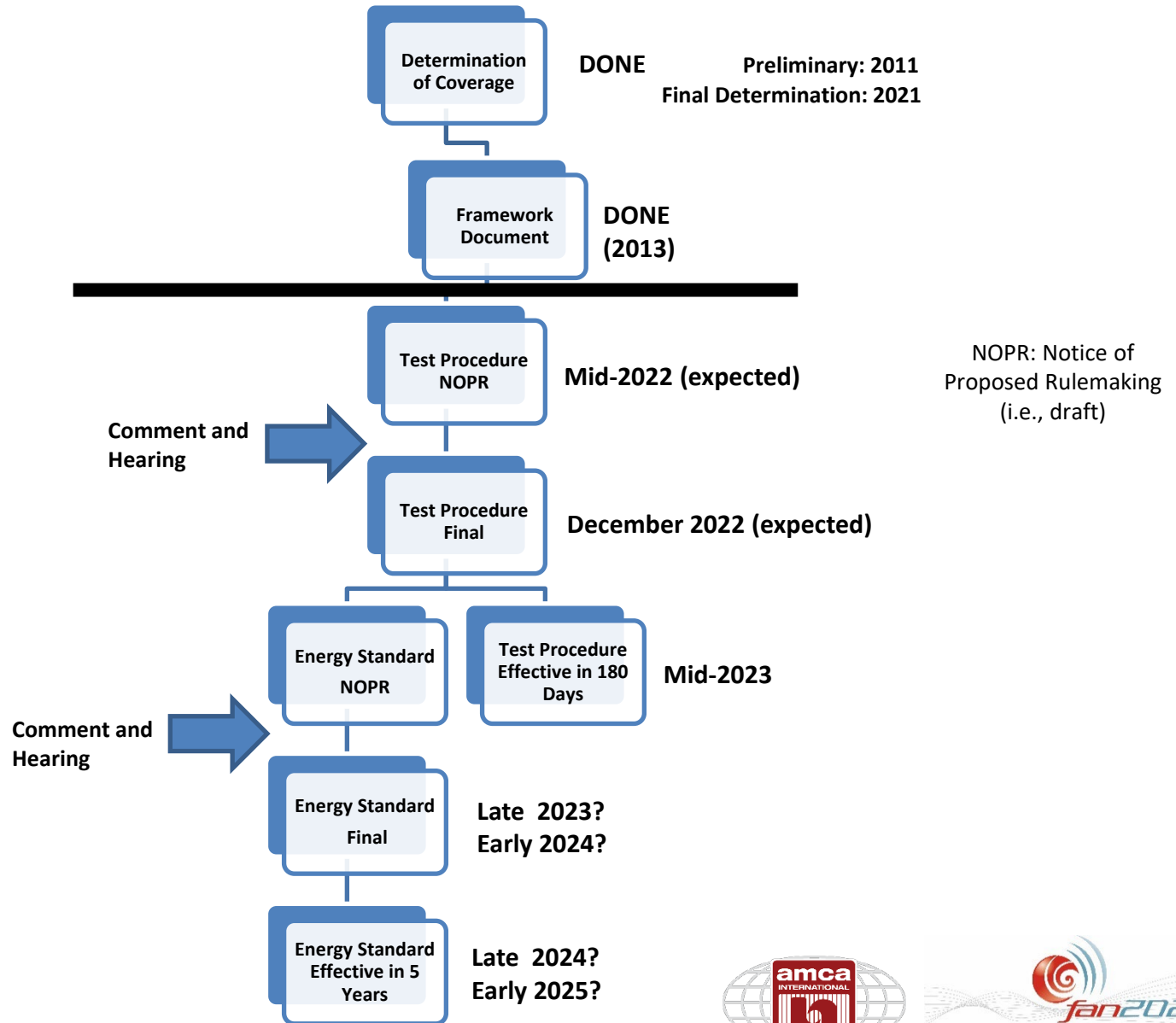
- Possible expansion of scope to include circulating fans that are not ceiling fans

**February 2022:** Request for information, energy standard

- Possible expansion of scope to include circulating fans that are not ceiling fans



# USDOE Schedule Estimate



# Significant Actions: USDOE

**Aug. 19, 2021:** Final determination, commercial and industrial fans, definition of “fan or blower”:

*Fan or blower means a rotary bladed machine used to convert electrical or mechanical power to air power, with an energy output limited to 25 kilojoule (kJ)/kilogram (kg) of air. It consists of an impeller, a shaft and bearings and/or driver to support the impeller, as well as a structure or housing. A fan or blower may include a transmission, driver, and/or motor controller.*

<https://www.regulations.gov/document/EERE-2011-BT-DET-0045-0020>





# During The “Trump Gap”: California Energy Commission (CEC)

In 2017, California Energy Commission initiated fan-efficiency regulation (California Title 20)

- Started where USDOE left off
- Legally binding efficiency regulation with test procedure, energy standard, surveillance, etc.
- Similar to federal regulation
  - Test procedure, energy standard, marking/labeling, surveillance mechanisms
- Draft regulation (“draft staff report”) published in 2018



# During The “Trump Gap”: California Energy Commission (CEC)

- 2018-2021: AMCA published FEI standard (AMCA 208) and FEI test standard (AMCA 214)
  - AMCA 214 committee included California Title 20 project manager, efficiency advocates, USDOE contractor
  - Perhaps the first time that industry, regulators, advocates participated in development of a new test standard meant exclusively for regulators
- February 2022: Express terms (“nearly complete” proposed regulatory language) published
  - Review period ends April 29, 2022
  - Numerous steps and possibly another review cycle to follow
- Long story short: California fan regulation could be in effect by summer/fall 2023
  - This will have national implications
  - Possible other US states will replicate the California regulation



# Draft California Requirements

Definition of “fan” follows USDOE but includes scope (size) and exemptions:

- Size scope:
  - Shaft power  $\geq 1.0$  HP or
  - Electrical input power  $\geq 1.0$  kW
  - Maximum is 150 HP (110 kW)
- Metric: Fan energy index (FEI) for all covered fans
- Lower limit: FEI  $\geq 1.00$  for covered fans
- Method of test: ANSI/AMCA 214-21, *Test Procedure for Calculating Fan Energy Index (FEI) for Commercial and Industrial Fans and Blowers*
  - ISO 5801 and AMCA 210 are approved test standards
  - Uses applicable content from AMCA 207 (ISO 12759-2) and AMCA 208 (ISO 12759-6) (in process) for calculating FEI rating at duty point
- Fan data does not have to be third-party-certified



# Exemptions

- Safety fans as defined in regulatory language (still refining)
- Ceiling fans
- Circulating fans
- Induced-flow fans
- Jet fans
- Cross-flow fans
- Embedded fans as defined in AMCA 214
- Fans in motor vehicles
- Fans that create a vacuum above 30 in. wg
- Air-curtain units



# Draft California Regulation

Allows calculated ratings from basic models

- Manufacturers will be able to use fan laws and other “alternative efficiency determination methods” (AEDMs) per Annex E in AMCA 214

Test sample

- Only one unit for compliance certification; however, manufacturers are free to increase sample size for testing
- Sample size of one unit enables use of historical data



# Product Labeling and Compliance Filing – (Still Refining)

## Product labeling and compliance filing data

- Problem: Compliance parameters not aligned with Annex H in AMCA 214

## Marking requirements for permanent label (nameplate)

- Problem: Nameplate parameters not aligned with Annex H in AMCA 214

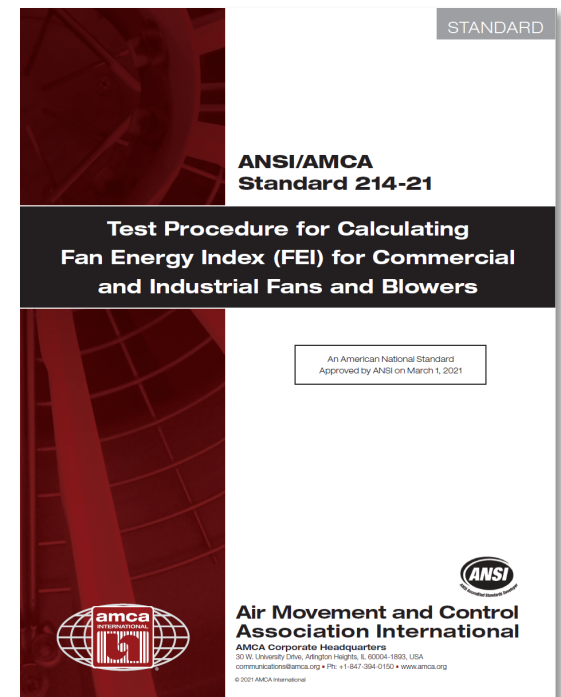
## Manufacturers restricted from publishing fan-performance data where $FEI < 1.00$

- Problem: Engineers, etc. need performance data for entire fan curve
- AMCA seeking to allow catalogs, software outputs to “distinguish” compliance vs. non-compliance



# Side Note About AMCA 214

- Balance is required for ANSI standards. AMCA invited USDOE and California regulators and efficiency advocates to serve on technical committee. Regulators participated as voting members; advocates as mix of voting and non-voting.
- AMCA 214 designed to make use of FEI easier for regulators:
  - Combines portions of AMCA 207 (part-load efficiencies), AMCA 208 (calculating FEI), and AMCA 211 (ratings calculations and certification for fans)
  - References fan test procedures that can yield performance data used to calculate FEI. For example:
    - Commercial/industrial fans: AMCA 210-16, ISO 5801:2017
    - Jet fans: AMCA 250-12, ISO 13350:2016



# Side Note About AMCA 214

- Used to calculate FEI for a single duty point
- Establishes “single-path” test procedure for fans by type
  - *Table 7.1—Fan Types, Test Configurations and FEI Pressure Basis*
- A fan type can be rated using only one pressure basis for compliance purposes
- Other configurations can be used for marketing purposes only
- Annex E: Interpolation methods, fan laws, and other methods to calculate ratings
- Annex H: Normative—required reported values (the tricky part about using FEI)





# From AMCA 214: Table 7.1

- Fan types are allowed only one pressure-basis for rating for compliance.
- FEI ratings depend on pressure basis
  - Different equations
- Other pressure basis is allowed for marketing purposes
- Test configurations also assigned

Table 7.1 — Fan Types, Test Configurations and FEI Pressure Basis

Fan Type	Test Standard <sup>1</sup>	Required		Optional <sup>3</sup>	
		Test Configuration (See Figure 7.1)	FEI Pressure Basis	Test Configuration (See Figure 7.1)	FEI Pressure Basis
Centrifugal housed <sup>2</sup>	AMCA 210	B or D	Total	A or C	Static
Radial housed	AMCA 210	B or D	Total	A or C	Static
Centrifugal inline	AMCA 210	B or D	Total	A or C	Static
Centrifugal unhooded	AMCA 210	A	Static	N/A	N/A
Centrifugal PRV exhaust	AMCA 210	A or C	Static	N/A	N/A
Centrifugal PRV supply	AMCA 210	B	Total	A	Static
Axial inline	AMCA 210	D	Total	C	Static
Axial panel	AMCA 210	A	Static	N/A	N/A
Axial PRV	AMCA 210	A or C	Static	N/A	N/A
Laboratory exhaust, excluding induced flow	AMCA 210	A or C	Total	N/A	N/A
Laboratory exhaust induced flow	AMCA 260	A or C	Total	N/A	N/A
Jet fan	AMCA 250	E	Total	N/A	N/A
Circulating	AMCA 230	E	Total	N/A	N/A

Notes:

1. ANSI/AMCA Standard 210 can be substituted with ISO 5801 and ANSI/AMCA Standard 250 can be substituted with ISO 13350, if ISO is used instead of AMCA standards.
2. In this table, the centrifugal housed fan type does not include centrifugal inline fans.
3. All fans shall be tested using the configuration in the "required" column. As some markets may also require an FEI value tested to an alternate configuration, tests using the configuration in the "Optional" column may be performed at the manufacturer's discretion. FEI for that configuration may be published in addition to the FEI derived from the required tests.



# From AMCA 214: Figure 7.1

- Fan types are required to use specified configurations as assigned in Table 7.1






Test Configuration	Duct Configuration	
A	Free inlet, free outlet with partition	
B	Free inlet, ducted outlet	
C	Ducted inlet, free outlet	
D	Ducted inlet, ducted outlet	
E	Free inlet, free outlet without partition	

Figure 7.1 – Test configurations

# Side Note About AMCA 214

- Annex H:
  - Solves the riddle of how to regulate using a metric that is calculated at a duty point
  - Developed to enable efficient and accurate regulation of FEI-rated fans
  - FEI changes across fan curve; infinite possible duty points (and FEI ratings)
  - Developed to “bound” compliance with three specific cases:
    - Fans offered for sale only at discrete speeds
    - Fans offered for sale over continuous range of speeds limited by required minimum FEI
    - Fans offered for sale over continuous range of speeds limited for reasons other than required minimum FEI



# Summary

- California is regulating commercial and industrial fans ahead of U.S. Department of Energy (USDOE)
  - Expected to take effect in summer/fall 2023
- USDOE may complete federal test procedure in 2022
  - Could take effect in 2023 ahead of California regulation, which could complicate things
- USDOE may complete federal energy standard in 2023
  - Could take effect in 2029
- California fan regulation would remain in effect until DOE regulation goes into effect
- FEI is metric
- Most commercial/industrial fans  $\geq 1$  kW (1 HP) and  $\leq 150$  HP, including custom fans, covered
  - Long list of exemptions, including fans embedded in packaged equipment
- ANSI/AMCA Standard 214-21 was developed to help regulators use FEI as an efficiency metric



# Questions?

Contact:

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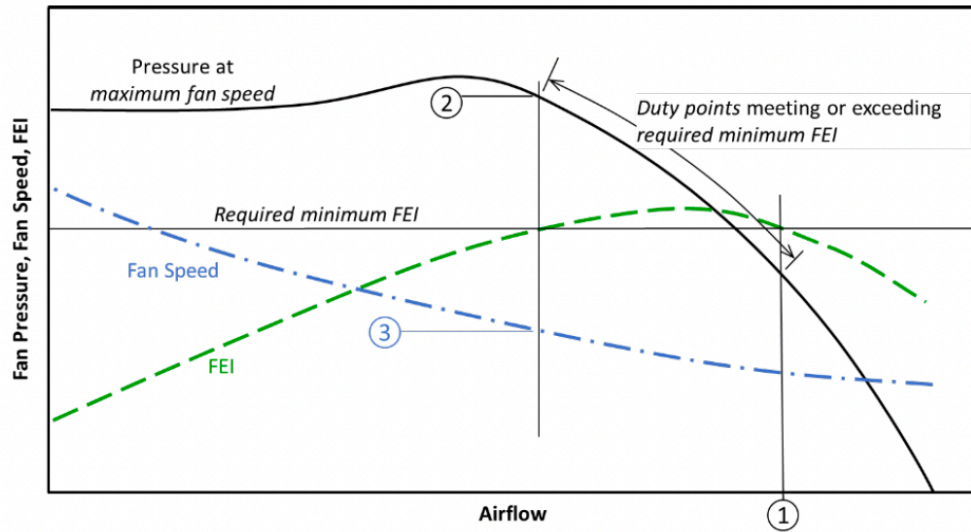
[agunzner@amca.org](mailto:agunzner@amca.org)



Extra Slides:

AMCA 214-21 Annex H Figures

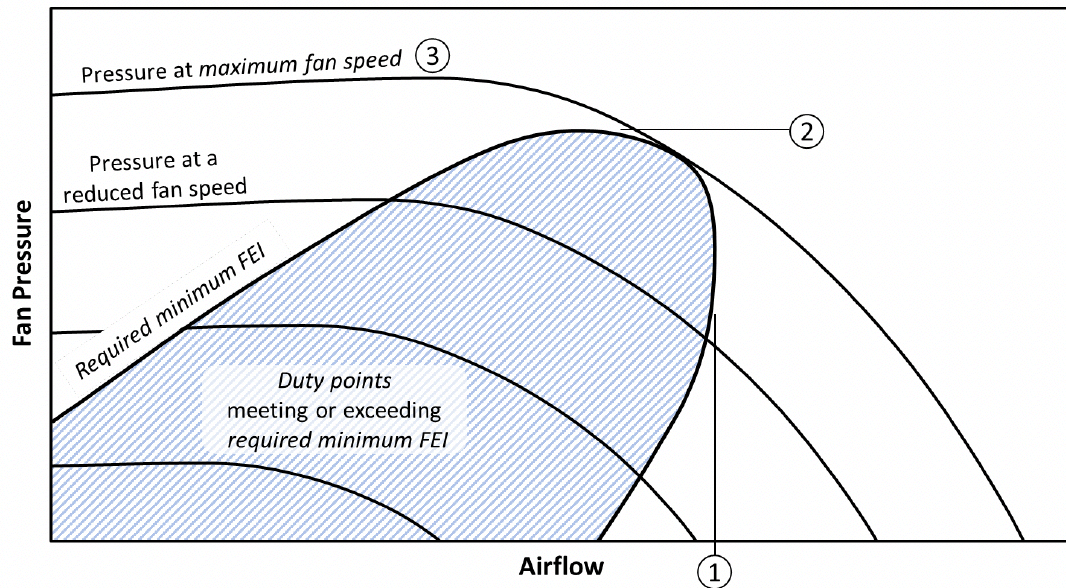




Definition of points	
1 -	Maximum airflow
2 -	Maximum pressure
3 -	Maximum fan speed
Note: These three points meet or exceed required minimum FEI	

Figure H.1 — Fans Offered for Sale Only at Discrete Speeds (example shown has significant variation of speed with load)

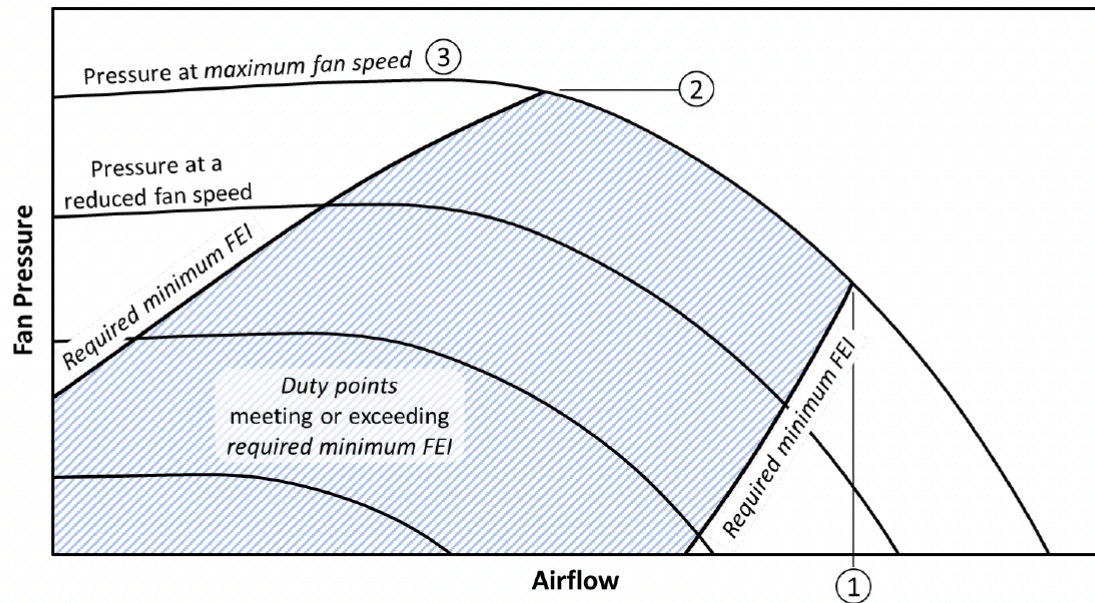




Definition of points	
1 -	Maximum airflow
2 -	Maximum pressure
3 -	Maximum fan speed
Note: These three points meet or exceed required minimum FEI	

**Figure H.2 — Fans Offered for Sale Over a Continuous Range of Speeds Limited by Required Minimum FEI**





Definition of points	
1 -	Maximum airflow
2 -	Maximum pressure
3 -	Maximum fan speed
Note: These three points meet or exceed required minimum FEI	

**Figure H.3 — Fans Offered for Sale Over a Continuous Range of Speeds Limited by Reasons Other than the Required Minimum FEI (e.g., maximum structural speed)**