AMCA International
Air Movement and Control Association International, Inc.
The International Authority on Air System Components Since 1917

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August 16, 2023

Mr. John Cymbalsky and Mr. Jeremy Dommu
U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
1000 Independence Avenue SW
Washington, DC 20585-0121

Via email to: expartecommunications@hq.doe.gov
Docket: EERE-2021-BT-STD-0011, Ceiling Fans
EX PARTE MEMORANDUM for remote meeting on August 14, 2023, from 3:00 - 3:30PM EDT

Dear Mr. Cymbalsky and Mr. Dommu:

On behalf of Air Movement and Control Association International, Inc. (AMCA)[1], thank you for hosting a meeting that was initiated by AMCA to discuss data sources and analyses pertaining to large diameter ceiling fans as presented in the technical support document (TSD) and Notice of Proposed Rulemaking (NOPR) for an updated ceiling fan energy conservation standard. The TSD and NOPR were published in the *Federal Register* on June 22, 2023. The meeting participants are listed below and the material covered is detailed in the attached slide presentation, which is unrevised from that reviewed during the meeting.

Participants:

John Cymbalsky, program manager, DOE
Jeremy Dommu, project manager, DOE
Peter Sandvik, Guidehouse
Vagelis Vossos, LBNL
Aaron Gunzner, AMCA International
Michael Ivanovich, AMCA International
Tom Catania, Consultant to AMCA
Christian Taber, Big Ass Fans
Ryan Perkinson, 4FrontES
Daniel Rice, Hunter
Tyson Sargent, Greenheck Fan Corp.
Tim Albers, Nidec-Motor
Kirk Anderson, Nidec-Motor

Sincerely,
Aaron Gunzner, PE, Senior Manager, Advocacy
AMCA International, agunzner@amca.org
Attachment 1: PowerPoint slides from August 14, 2023 meeting.

[1] AMCA International, established in 1917, is a not-for-profit association of manufacturers of fans, dampers, louvers, air curtains, and other air-system components for commercial HVAC, industrial-process, and power-generation applications. With programs such as certified ratings, laboratory accreditation, verification of compliance, and international standards development, its mission is to advance the knowledge of air systems and uphold industry integrity on behalf of its approximately 400 member companies worldwide.

Ex-parte meeting - AMCA & DOE

August 14, 2023
3-3:30PM Eastern

EL2 - PM Direct Drive Motor

DOE notes that AC induction motors - “For typical motor sizes, efficiency ranges between ~80-87%.”

DOE notes for PM motors - “Permanent magnet direct drive fans, by contrast, are often marketed with operating efficiencies over 90%[11,12].”

11 Nidec, Nidec Introduced New Variable Speed Fan Motors, New Integrated Systems, Feb. 2019. St. Louis, MO. (Last Accessed February 7, 2023) acim.nidec.com/motors/motion-control/news-and-media/press-releases/2019/nidec-introduces-new-variable-speed-fan-motors

APPENDIX B: MOTOR MINIMUM FULL-LOAD EFFICIENCY STANDARDS (CONTINUED)

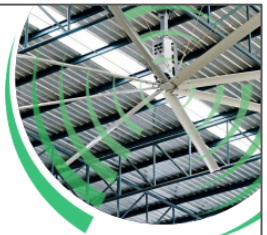
Enclosure	Speed	hp	Voltage	Energy Efficient	Premium Efficiency
TEFC	1,800	1	Low	82.5	85.5
TEFC	1,800	1.5	Low	84.0	86.5
TEFC	1,800	2	Low	84.0	86.5

https://www.energy.gov/eere/amo/articles/premium-efficiency-motor-selection-and-application-guide-handbook-industry

Small Motor Rule standard energy efficiency levels for polyphase small electric motors

Motor output power, hp/kW	Four poles, %
0.25/0.18	69.5
0.33/0.25	73.4
0.5/0.37	78.2
0.75/0.55	81.1
1.0/0.75	83.5
1.5/1.1	86.5
2.0/1.5	86.5
3.0/2.2	86.9

https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=6&action=viewlive



Blade Runner

High Volume, Low Speed Fan Motors

Electrical Parameters

28 Poles, Class F Insulation System

DESCRIPTION	1HP – 230VAC	1HP – 460VAC	2HP – 230VAC	2HP – 460VAC
K_t *(Nm/Arms) @ (Rated Torque/Speed) ± 10%*	13.71	27.42	28.80	57.60
K_e *(Vrms/kRPM) ± 10%*	940	1880	1880	3600
Resistance *(L-L) ± 10%, (Ohms)*	3.03	10.24	4.40	16.55
Inductance *(mH @ 1kHz) ± 10%*	89.29	314	145.88	567
Drive System Input Voltage	230VAC	460VAC	230VAC	460VAC
Rated Torque *(Nm)*	86	86	170	170
Rated Speed *(RPM)*	90	90	60	60
Motor Rated Input Current *(Amps)*	6	3	6	3
Motor Rated Power *(kW)*	0.8 kW	0.8 kW	1.2 kW	1.2 kW
Efficiency at Rated *Torque/Speed ± 5%*	82%	82%	80%	80%

**Performance may vary slightly depending on the Variable Frequency Drive used for testing*

EL2 - PM Direct Drive Motor

DOE notes - “The primary efficiency advantage of permanent magnet direct drive motors is that they do not require a gearbox to effectively rotate the blades of a LDCF. Therefore, the transmission efficiency, which typically ranges from 88-93% for the reference ceiling fan, is 100% for permanent magnet direct drive motors. Using a direct-drive motor inherently results in performance exceeding the reference fan by 7-12%.”

Parameter	Diameter			
	8-Foot	12-Foot	20-Foot	20-Foot (w/VFD)
Airflow (CFM)	33,500	82,500	187,000	187,000
Airfoil Efficiency (%)	42%	42%	42%	42%
Shaft Power (bhp)	0.66	1.47	1.98	1.98
Transmission Efficiency (%)*	89.3%	91.7%	92.5%	96%
Motor Efficiency (%)	81.53%	85.95%	87.31%	87.31%
Speed Control Efficiency (%)	100%	100%	100%	96%
Reference Fan Power (W)	702.4	1387.0	1832.4	1,838.1
CFEI100	1.00	1.00	1.00	1.00

Market Analysis - Use of Only AMCA CRP Data

DOE Notes - “based on manufacturer literature, gear-driven ceiling fans, including those marketed using standard motor efficiencies, commonly achieve CFEI100 values 15 to 40 percent higher than the assumed reference fan. The certified values for these gear-driven ceiling fans are shown in Figure 5.5.4.”

Example - TSD Figure 5.5.6 is CFEI100 @ 480V, 240V is significantly different per CCMS listings

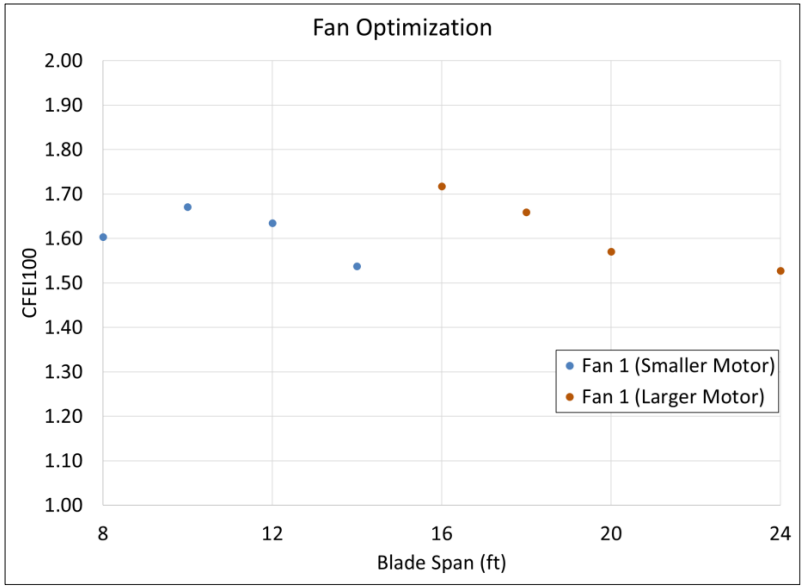


Figure 5.5.6 LDCF Fan Family Optimization of CFEI100 Values with Blade Span

Baseline Fan Models - CFEI Values

- Unclear why the calculated CFEI values from the TSD power and airflow data differ from the minimum CFEI values at each EL listed in the TSD tables.

Diameter (ft)	Efficiency Level	Min CFEI100	Min CFEI40	TSD CFEI100	TSD CFEI40
8	EL0	1.00	1.31	1.19	2.53
	EL1	1.22	1.31	1.31	2.70
	EL2	1.36	1.31	1.72	2.37
12	EL0	1.00	1.31	1.16	1.90
	EL1	1.22	1.31	1.31	2.29
	EL2	1.36	1.31	1.52	2.67
20	EL0	1.00	1.31	1.16	2.07
	EL1	1.22	1.31	1.32	2.25
	EL2	1.36	1.31	1.50	2.44

Baseline Fan Models - 8’ LDCF Low Speed Data

- Unclear why the 8’ diameter EL2 fan has the higher power consumption at 20% and 40% speeds than EL0 & EL1 fans.

Diameter (ft)	Efficiency Level	20% Power (W)	40% Power (W)	60% Power (W)	80% Power (W)	100% Power (W)
8	EL0	28.5	62	134	297.3	590.2
	EL1	27.5	58	122.2	269.6	536.0
	EL2	**42.7**	**66.3**	98.9	200.6	407.7
12	EL0	53.0	120.9	270.3	603.5	1196.3
	EL1	40.4	100.4	237.8	536.3	1060.3
	EL2	34.3	85.8	304.1	460.6	910.5
20	EL0	49.4	138.4	350.6	799.5	1576.4
	EL1	49.3	127.6	309.4	700.5	1383.7
	EL2	48.2	117.3	274.4	617.5	1221.6

EL1 - Optimized Fan

- Verification of what optimized means - TSD points to:
  - Motors/drives ideally loaded (over/under), therefore motor is less efficient
  - Optimization of fan includes
    - Unique power drive system (ex. motor/gearbox/drive) for every blade span
      - ~$50/fan manufacturer cost
    - Also mentioned, but unclear if included
      - Blade angle
      - Blade design
      - Fan speed (rpm)

TSD Example of Fan Optimization

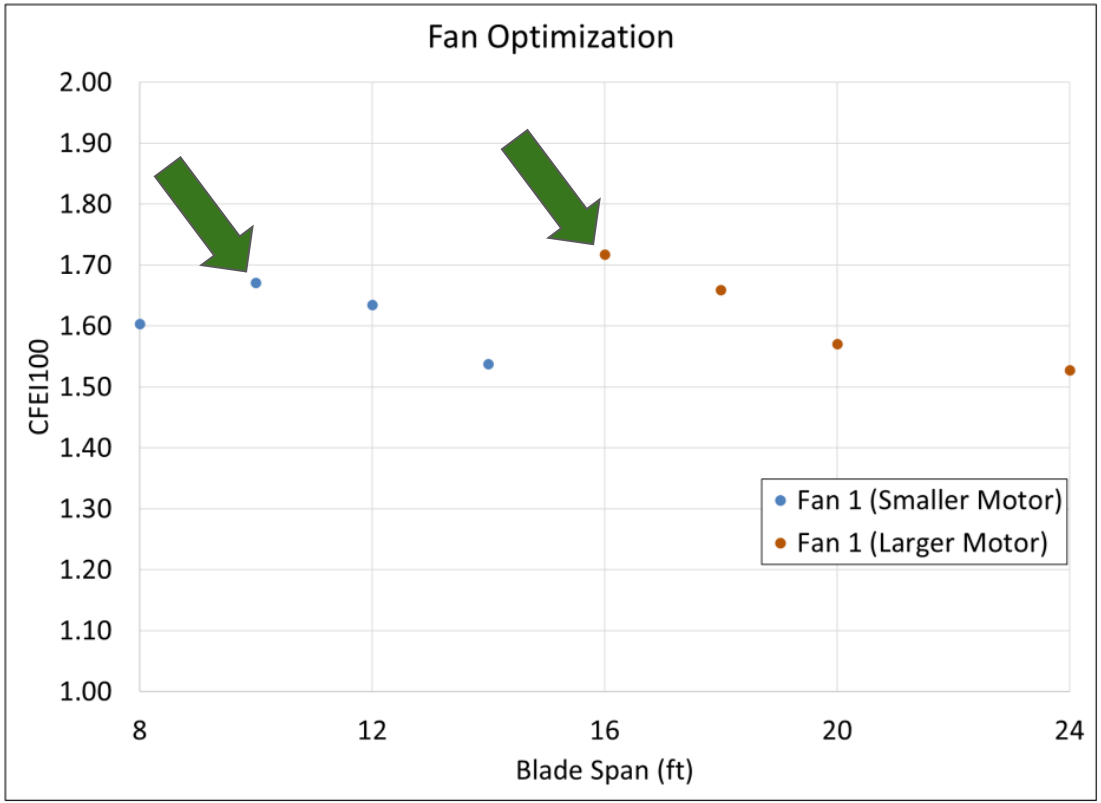


Figure 5.5.6 LDCF Fan Family Optimization of CFEI100 Values with Blade Span

Fan & Motor/Drive Used in Figure 5.5.6

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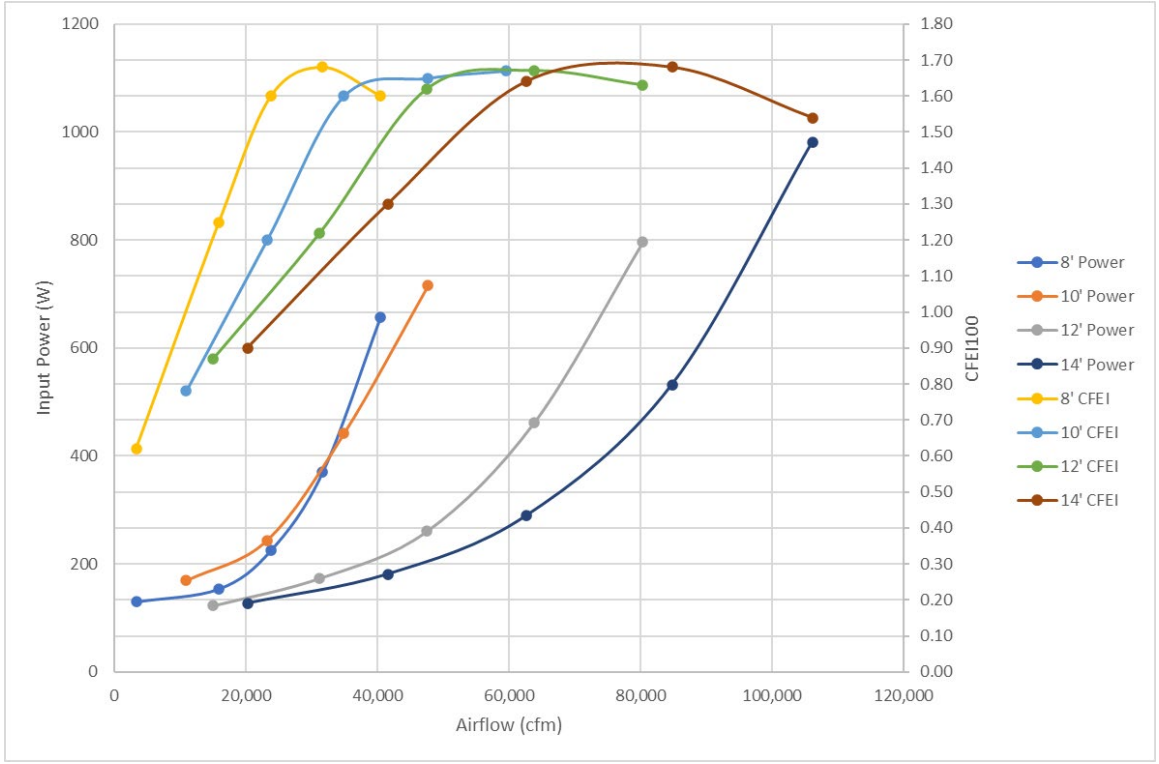
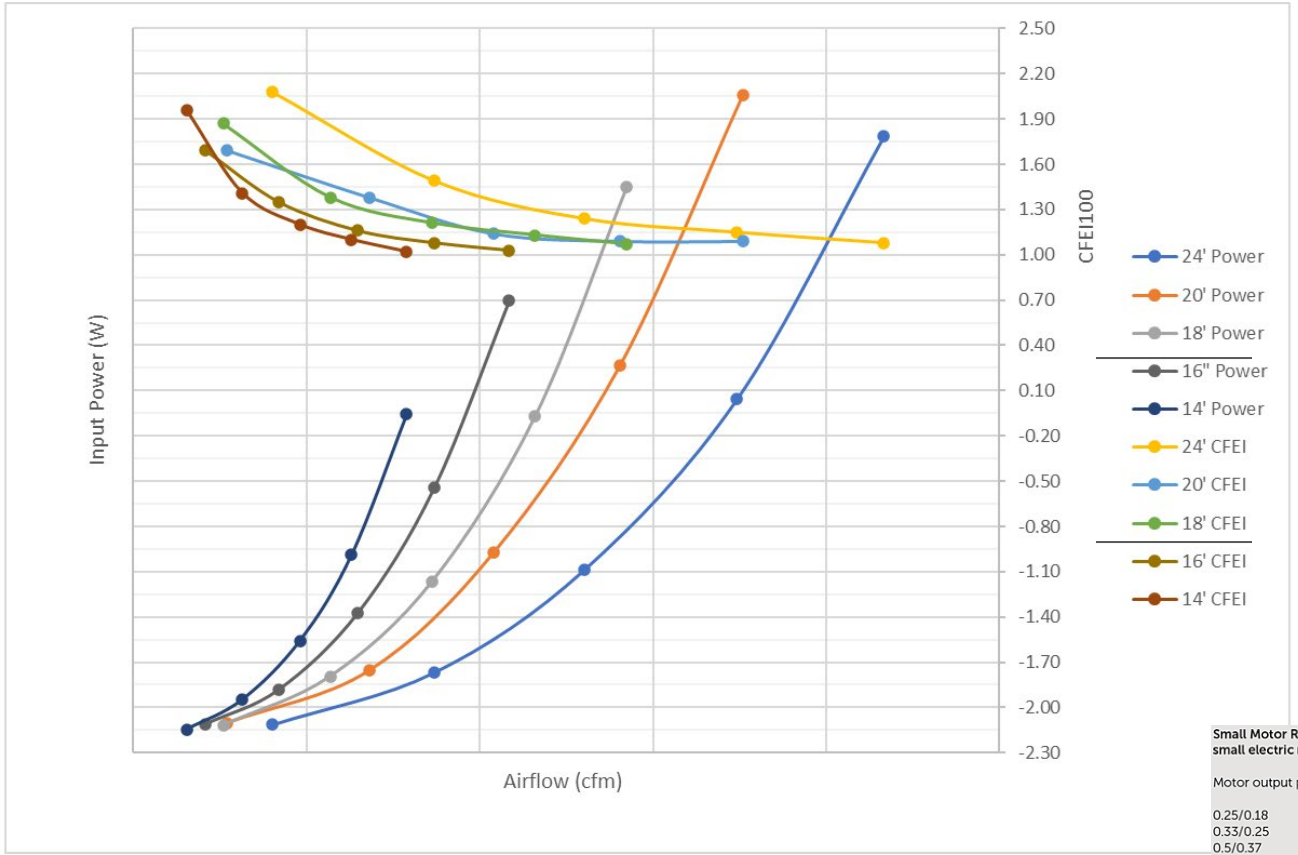
Optimization Example - PM Motor (~16% AMCA EL1 Fail)



Optimization Example - AC Motor (~53% AMCA EL1 Fail)



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3.0/2.2	86.9