Madani, Mo

From: Amanda Hickman <amanda@thehickmangroup.com>
Sent: Thursday, August 01, 2019 1:25 PM
To: Madani, Mo
Cc: The Hickman Group; Amanda Hickman
Subject: Fwd: nameplate
Attachments: C202 definition Fan Nameplate Electrical Input Power.pdf; C403.2.12.2 Fan Motor selection.pdf; Mod_8122_G1_General_ASHRAE, Sheila Hayter ltr Florida.pdf; narrative for C403.2.12.2 (fan motor selection).docx; HPAC Engineering article - March 2019.pdf

Mo,

What is the process for taking items off the consent agenda at the next Commission meeting? I would like to have EN8175 and EN8184 discussed again.

Thanks,
Amanda

Amanda Hickman
President/Consultant

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Proposed Code Modifications
USER: Armin Hauer

Modification #	8175
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Modification Status	Pending DBPR Review
TAC	(Select One)
TAC Recommendation	Pending Review
Commission Action	Pending Review
Archived	No
Code Version	2020
Code Change Cycle	2020 Triennial Original Modification 11/02/2018 - 12/15/2018
Sub Code	Energy Conservation
Chapter & Topic	Chapter 2 - [CE] - Definitions
Section	202
Related Modifications	C403.2.12.2 Motor nameplate horsepower
Affects High Velocity Hurricane Zone (HVHZ)	No

Summary of Modification

added definition

Text of Modification

Fan Nameplate Electrical Input Power. The nominal electrical input power rating stamped on a fan assembly nameplate.

Rationale

Definition is needed for an update to C403.2.12.2.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code (553.73(9)(b),F.S.)

no impact

Impact to building and property owners relative to cost of compliance with code (553.73(9)(b),F.S.)

no impact

Impact to industry relative to the cost of compliance with code (553.73(9)(b),F.S.)

no impact

Impact to small business relative to the cost of compliance with code (553.73(9)(b),F.S.)

no impact

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public (553.73(9)(a)2,F.S.)

The associated proposal C403.2.12.2 corrects an IP / SI conversion error related to shaft power: 6 bhp equals 4476 W mechanical power.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction (553.73(9)(a)3,F.S.)

The associated proposal C403.2.12.2 moves the clause about fan system motor nameplate into the exceptions section for better clarity.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities (553.73(9)(a)4,F.S.)

The associated proposal C403.2.12.2 increases the design options for load-matching variable-speed fan motors, accommodates new motor and drive technologies, and it simplifies the motor selection criteria for fans.

Does not degrade the effectiveness of the code (553.73(9)(a)5,F.S.)

The associated proposal C403.2.12.2 moves the clause about fan system motor nameplate into the exceptions section for better clarity.

History

Date Submitted	12/14/2018
Date TAC Recommendation Set	12/14/2018
Date Commission Action Set	12/14/2018

DBPR Staff Notes

Record of Modification

There are no records that match the search criteria.

Cancel Print

Jump to Top

Proposed Code Modifications
USER: Armin Hauer

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Modification Status	Pending DBPR Review
TAC	(Select One)
TAC Recommendation	Pending Review
Commission Action	Pending Review
Archived	No

Code Version	2020
Code Change Cycle	2020 Triennial Original Modification 11/02/2018 - 12/15/2018
Sub Code	Energy Conservation
Chapter & Topic	Chapter 4 - [CE] - Commercial Energy Efficiency
Section	403.2.12.2
Related Modifications	C202 Definitions
Affects High Velocity Hurricane Zone (HVHZ)	No

Summary of Modification

Correct conversion error related to shaft power. Move the clause about fan system motor nameplate for better clarity. Increase the design options for load-matching variable-speed fan motors, accommodates new motor and drive technologies, and it simplifies the motor selection criteria for fans.

Text of Modification

C403.2.12.2 Fan m~~M~~otor selection~~-nameplate horsepower~~

For each fan, the *fan brake horsepower* shall be indicated on the construction documents and the selected motor shall be no larger than the first available motor size greater than the following:

1. For fans less than 6 bhp (~~4413~~ 4476 W), 1.5 times the *fan brake horsepower.*

2. For fans 6 bhp (~~4413~~ 4476 W) and larger, 1.3 times the *fan brake horsepower.*

Exceptions:

1. Fans equipped with electronic speed control devices to vary the fan airflow as a function of load.
2. Fans with *fan nameplate electrical input power* of less than 0.89 kW.
3. Systems complying with Section 403.8.1 *fan system motor nameplate hp* (Option 1).
~~**Exceptions:**~~ 4. Fans with motor *nameplate horsepower* less than 1 hp (746 W)~~-are exempt from this section.~~

Rationale

This proposal increases the design options for load-matching variable-speed fan motors, accommodates new motor and drive technologies, and it simplifies the motor selection criteria for fans.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code (553.73(9)(b),F.S.)

Positive impact. This proposal increases the design options for load-matching variable-speed fan motors, accommodates new motor and drive technologies, and it simplifies the motor selection criteria for fans.

Impact to building and property owners relative to cost of compliance with code (553.73(9)(b),F.S.)

Positive impact. This proposal increases the design options for load-matching variable-speed fan motors, accommodates new motor and drive technologies, and it simplifies the motor selection criteria for fans.

Impact to industry relative to the cost of compliance with code (553.73(9)(b),F.S.)

Positive impact. This proposal increases the design options for load-matching variable-speed fan motors, accommodates new motor and drive technologies, and it simplifies the motor selection criteria for fans.

Impact to small business relative to the cost of compliance with code (553.73(9)(b),F.S.)

Positive impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public (553.73(9)(a)2,F.S.)

This proposal corrects an IP / SI conversion error related to shaft power: 6 bhp equals 4476 W mechanical power.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction (553.73(9)(a)3,F.S.)

This proposal moves the clause about fan system motor nameplate into the exceptions section for better clarity.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities (553.73(9)(a)4,F.S.)

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Sheila J. Hayter, P.E., FASHRAE
President

Reply to: Nat'l Renewable Energy Lab
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February 6, 2019

Florida Building Commission
Florida Department of Business and Professional Regulation
2601 Blair Stone Road
Tallahassee, FL 32399

RE: Florida State Commercial Energy Code Proposed Modification # 8122

Dear Florida Building Commissioners:

Thank you for the opportunity to provide input on the proposed updates to the Florida Commercial Energy Code which is pending review by Technical Advisory Committee and the Florida Building Commission. ASHRAE, founded in 1894, is an international organization of over 56,000 members, including almost 1,900 in Florida. The Society and its members focus on building systems, energy efficiency, indoor air quality and sustainability within the industry. Through research, standards writing, publishing, certification and continuing education, ASHRAE shapes tomorrow's built environment today.

As the State of Florida considers updating its commercial energy code, we ask the state to incorporate by reference the most recent version of ANSI/ASHRAE/IES Standard 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings,* which is the 2016 version, including all of its appendices as a compliance path for your state.

This Standard, first published in 1975, is the basis for the energy standard of most U.S. commercial buildings. For over 40 years, this Standard has served as the leading resource for state and local jurisdictions that wish to promote energy efficiency, engaging interests across the building and construction sector, and yielding increased levels of efficiency in a balanced manner with input from all affected parties. As are all ASHRAE Standards, Standard 90.1 is developed and improved through the private-sector in accordance with American National Standards Institute's (ANSI) consensus-driven process.

U.S. federal law mandates the most recent version of ANSI/ASHRAE/IES Standard 90.1 as the basis for State commercial building energy codes. The Energy Conservation and Production Act mandates that all states comply with this Act. Each time the Standard is updated, which is every three years, the Act requires the Secretary of Energy to make a determination with respect to whether the revised standard would improve energy efficiency in commercial buildings. When the U.S. Department of Energy issues an affirmative determination on Standard 90.1, states are statutorily required to certify within two years that they have reviewed and updated the commercial provisions of their building energy code, with respect to energy efficiency, to meet or exceed the revised standard.

Thank you for your consideration of this modification to the Florida Energy Code. Please contact GovAffairs@ashrae.org if you need additional information.

Sincerely yours,

Sheila J. Hayter, PE, FASHRAE
ASHRAE President SY2018-19

narrative for C403 2 12 2 (fan motor selection)

C403.2.12.2 Motor nameplate horsepower

Overview of past and existing requirement

2012 International Energy Conservation Code

CHAPTER 4 [CE] COMMERCIAL ENERGY EFFICIENCY

Fifth Printing: Dec 2015

C403.2.10.2 [redacted] horsepower.

For each fan, the selected fan motor shall be no larger than the first available motor size greater than the brake horsepower (bhp). The fan brake horsepower (bhp) shall be indicated on the design documents to allow for compliance verification by the *code official*.

Exceptions:

1. For fans less than 6 bhp (4413 W), where the first available motor larger than the brake horsepower has a nameplate rating within 50 percent of the bhp, selection of the next larger nameplate motor size is allowed.
2. For fans 6 bhp (4413 W) and larger, where the first available motor larger than the bhp has a nameplate rating within 30 percent of the bhp, selection of the next larger nameplate motor size is allowed.

Section C403.2.12.2 has existed in IECC at least since 2012. It limits the nominal motor output power relative to the fan's impeller shaft power with the intention to prevent oversizing of fan motors. That is founded by the knowledge that uncontrolled motors at part-load operation generally waste energy. (Emphasis on uncontrolled.)

Notes:

- *IECC 2015 introduced an exception for "Systems complying with Section C403.8.1 fan system motor nameplate hp (Option 1)."*
- *IECC 2018 introduced another exception for motors with nameplate horsepower of less than 1 hp.*

2018 International Energy Conservation Code

CHAPTER 4 [CE] COMMERCIAL ENERGY EFFICIENCY

Third Printing: Mar 2019

C403.8.2 Motor nameplate horsepower (Mandatory).

For each fan, the fan brake horsepower shall be indicated on the construction documents and the selected motor shall be not larger than the first available motor size greater than the following:

1. For fans less than 6 bhp (4413 W), 1.5 times the fan brake horsepower.
2. For fans 6 bhp (4413 W) and larger, 1.3 times the fan brake horsepower.
3. Systems complying with Section C403.8.1 *fan system motor nameplate hp* (Option 1).

Exception: Fans with motor nameplate horsepower less than 1 hp (746 W) are exempt from this section.

narrative for C403 2 12 2 (fan motor selection)

Discussion of requirements in C403.2.12.2

1.
    1.1. Designers, installers, and users may have solid reasons for oversizing motors, such as a desired safety margin, or a heavier construction with larger bearings for critical applications. They are striking a balance between first cost, maintenance, and projected electricity consumption.
    The 2017 FEC and IECC restrict choices.

    1.2. Horsepower rating of US government regulated electric motors is done based on AC power supply with constant 60 hertz. However, motors for load-matching variable speed fans cannot be selected merely by motor nameplate horsepower but by the impeller's required torque to meet the fan duty point for the building's design condition.
    Example:
    A motor with a 10 hp 60 hertz nameplate but operating from a variable frequency drive (VFD) at 45 hertz can reliably put out only 7.5 hp at its motor shaft for an extended period. I.e. proportionally less shaft power due to lower VFD frequency.
    The building code affects matching of government regulated motors to fan loads that require 100% motor torque at less than 60 hertz with VFDs.

    1.3. US government efficiency standards use tables of motor nameplate horsepower versus efficiency. The higher the nameplate horsepower is the higher is the required minimum motor efficiency.
    If a variable frequency drive is used with a US DOE regulated motor, then a nominally oversized regulated motor in many cases yields higher "wire-to-shaft" efficiency than a smaller motor.
    See related article in HPAC Engineering Magazine March 2019.
    HPAC Engineering article - March 2019.p
    https://secure.viewer.zmags.com/publication/34705823#/34705823/13
    In the case of VFD-controlled fans, the building code prevents the choice of more efficient motor sizes.

    1.4. Governmentally non-regulated motors have no traceable and enforceable horsepower rating. Examples of non-regulated motors are air-over rated and inverter-only types.
    The building code has no basis for a nameplate horsepower criterion in the case of DOE-exempt electric motors.

    1.5. Highly integrated combinations of fans with motors and electronic variable speed drives cannot be certified for nameplate horsepower based on a universally accepted laboratory test standard. Such fan assemblies are instead rated "wire-to-air"; which means by electrical input power (in kilowatts) and the corresponding air performance.
    The building code has no basis for a nameplate horsepower criterion in the case of "wire-to-air rated" fan assemblies.

2. Editorial issues
   Section C403.2.12.2 is unclear and it includes an IP-to-SI conversion error.

narrative for C403 2 12 2 (fan motor selection)

Proposal summary:

A. Revise the title of the section to emphasize that this section relates to motors <u>for fans</u>
B. Further emphasize in the title that this section deals with acceptable <u>selection</u> of motor sizes for fans.
C. Move the text from line (3) into the list of exceptions for better clarity.
D. Correct the SI equivalent of 6 bhp shaft power to 4476 watts shaft power.
E. Exempt all fans that are equipped with electronic speed controls, because of high efficiency at part load. (Variable frequency drives, electronically commutated motors [ECM], and any other advanced-motor system).
F. Exempt highly integrated combinations of motors and fans if they are rated in terms of electrical power rather than motor horsepower and nameplated with less than 0.89 kilowatts.

Note:
FEC 2017 does not yet reflect the exception of motors with nameplate output power of less than 1 horsepower, which IECC introduced in 2018.

2018 International Energy Conservation Code

CHAPTER 4 [CE] COMMERCIAL ENERGY EFFICIENCY

Third Printing: Mar 2019

C403.8.2 Motor nameplate horsepower (Mandatory).

For each fan, the fan brake horsepower shall be indicated on the construction documents and the selected motor shall be not larger than the first available motor size greater than the following:

1. For fans less than 6 bhp (4413 W), 1.5 times the fan brake horsepower.
2. For fans 6 bhp (4413 W) and larger, 1.3 times the fan brake horsepower.
3. Systems complying with Section C403.8.1 *fan system motor nameplate hp* (Option 1).

Exception: Fans with motor nameplate horsepower less than 1 hp (746 W) are exempt from this section.

I am not advocating for or against this 1 horsepower exception.

Armin Hauer 2019-07-30

BY JOHN BADE AND ARMIN HAUER, AMCA HIGH PERFORMANCE AIR SYSTEMS COMMITTEE

Fan-System Comparisons Made Reliable With AMCA 207

Standard enables calculation of efficiency of individual components

With few exceptions, energy-efficiency metrics for HVAC equipment are based on electrical-power input vs. desired output. One glaring exception concerns fans. Most fan manufacturers provide only shaft input power and impeller speed. Of course, the electrical power needed to drive a fan (A) depends on the individual efficiencies of the rest of the system: transmission (B), motor (C), and variable-speed drive (D) (Figure 1). Electrical-power input is calculated by multiplying shaft input power by each of the efficiencies:

$P = H_i \times \eta_b \times \eta_m \times \eta_c \times 0.7457$ (IP)
$P = H_i \times \eta_b \times \eta_m \times \eta_c$ (SI)
where:
P = Electrical-power input (kW)
H_i = Fan-shaft input power (HP for IP, kW for SI)
η_b = transmission efficiency (%)
η_m = motor efficiency (%)
η_c = speed-controller efficiency (%)
0.7457 = Conversion of horsepower to kilowatts

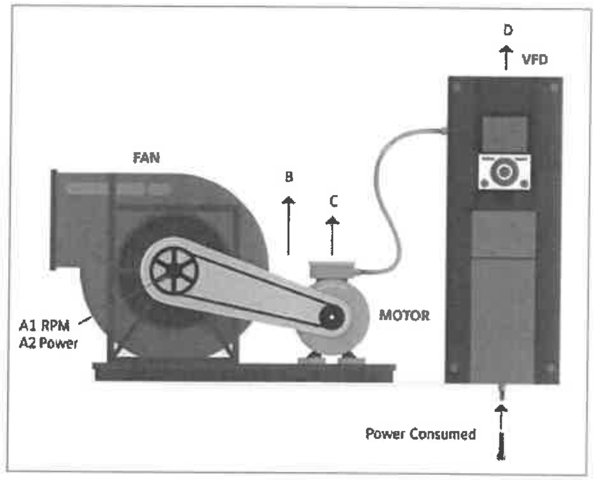

Figure 1. Components of a conventional fan system.

Historically, a significant problem for fan-system engineers was the lack of a standard method for calculating individual-component efficiencies, which made reliable comparisons of systems nearly impossible (Figure 2). The dilemma was exacerbated by the growing popularity of integrated electronically commutated fan/motor/controller packages, for which a manufacturer can certify only electrical input power, forcing designers to try to compare apples and oranges.

Recognizing this problem, *Air Movement and Control Association (AMCA) International* developed ANSI/AMCA Standard 207, *Fan System Efficiency and Fan System Input Power Calculation*. ANSI/AMCA Standard 207 provides tools enabling reliable comparisons of the electrical-power input of different fan-system configurations at varying loads, including motor service factor.

ANSI/AMCA Standard 207 covers most conventional fan systems, starting with the familiar fan total or static efficiency and fan-shaft input power based on fan airflow performance tested in accordance with ANSI/AMCA Standard 210, *Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating*; ANSI/AMCA Standard 230, *Laboratory Methods of Testing Air Circulating Fans for Rating and Certification*; ANSI/AMCA Standard 260, *Laboratory Methods of Testing Induced Flow Fans for Rating*; or ISO 5801, *Industrial Fans -- Performance Testing Using Standardized Airways*, and rated in accordance with AMCA Publication 211, *Certified Ratings Program Product Rating Manual for Fan Air Performance*.

Transmission-efficiency equations are provided for V-belts, synchronous belts, and flexible couplings. Direct-drive connections are considered to be 100-percent efficient. ANSI/AMCA Standard 207 assumes belts and pulleys are properly aligned and tensioned.

Motor-efficiency calculations apply only to three-phase induction motors within the scope of the Energy Independence and Security Act (EISA) in North America—that is, three-phase NEMA MG 1 Premium Efficiency general-purpose motors—and motors regulated under European and Chinese standards. This includes open-drip-proof and totally enclosed, fan-cooled (TEFC) motors from 1 to 500 HP. Other types of motors are explicitly excluded. Single-phase, 575-V, and permanent-magnet motors are out of scope.

Speed controllers must be typical pulse-width-modulated variable-frequency drives (VFDs) programmed to maintain a fixed ratio of voltage to frequency at or below synchronous speed. VFDs programmed for constant torque control operate in a very different manner. Other

John Bade is an energy-efficiency consultant. Armin Hauer is manager, regulatory and government affairs, for ebm-papst Inc.

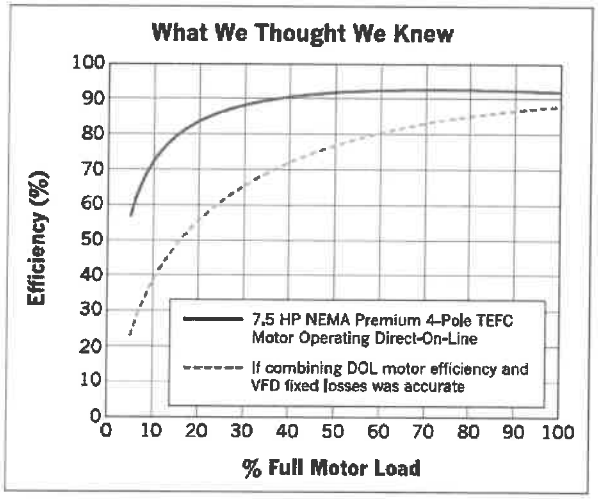

Figure 2. What the air-systems industry thought it knew about motor losses with VFDs.

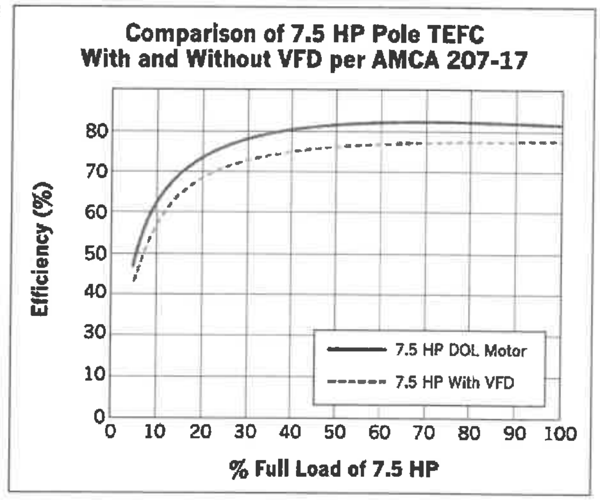

Figure 3. Comparison of a 7.5-HP four-pole TEFC motor operating DOL and one operating with a VFD per ANSI/AMCA Standard 207.

characteristics defining VFD efficiency, such as carrier frequency and lead length, are assumed to be within typical operating parameters. Of course, if a system does not have a VFD, speed-controller efficiency is not part of the equation.

One of the greatest benefits of ANSI/AMCA Standard 207 is that much of what was previously "known" about part-load motor-system efficiency has been debunked. Consider:

Myth: VFD losses are 100-percent parasitic and constant over a motor's output-power range, leading to huge inefficiencies at low load.

Fact: The efficiency curve of a motor operating in conjunction with a VFD with a constant ratio of voltage to frequency is very different than that of the same motor operating direct on line (DOL) at a constant 50 Hz or 60 Hz.

Varying voltage with frequency maintains a constant flux and, therefore, a very flat efficiency curve for the motor itself. Further, VFD losses do not remain constant as load decreases.

Figure 3 shows that the difference in efficiency between a motor operating DOL and one operating in conjunction with a VFD is relatively constant over the range of motor output power.

Myth: An oversized motor yields much lower efficiencies when the system operates at part load.

Fact: Concerns about part-load efficiency are valid when a motor is operated DOL. Surprisingly, though, when motors of different sizes are operated with a VFD, their efficiencies and power consumption are nearly identical.

Table 1 shows the power consumption of motor/VFD combinations of different sizes with a fan-shaft power of 7 HP (5.2 kW) at the air-system design condition. The

Motor Load		Electric-Power Input (kW)			
Percent	HP	5-HP Motor	7.5-HP Motor	10-HP Motor	15-HP Motor
100	7.0	6.24	5.95	5.93	5.93
95	6.7	5.91	5.66	5.64	5.65
90	6.3	5.58	5.36	5.36	5.37
85	6.0	5.26	5.06	5.07	5.09
80	5.6	4.94	4.77	4.78	4.81
75	5.3	4.63	4.48	4.50	4.53
70	4.9	4.32	4.19	4.21	4.25
65	4.6	4.01	3.90	3.93	3.97
60	4.2	3.71	3.62	3.64	3.69
55	3.9	3.41	3.33	3.36	3.41
50	3.5	3.11	3.04	3.08	3.13
45	3.2	2.81	2.76	2.80	2.85
40	2.8	2.52	2.48	2.52	2.57
35	2.5	2.22	2.19	2.23	2.29
30	2.1	1.93	1.91	1.95	2.01
25	1.8	1.64	1.63	1.67	1.74
20	1.4	1.36	1.35	1.39	1.46
15	1.1	1.07	1.07	1.11	1.18
10	0.7	0.78	0.79	0.83	0.90
5	0.4	0.50	0.51	0.55	0.62
All motors are 460/3/60 four-pole TEFC					

Table 1. VFD power consumption with four-pole, EISA-compliant TEFC motors of different sizes, each with a 7-HP (3.2 kW) design load.

difference in electricity consumption is slight. In fact, it is shown in table form because a graph of the data looks almost like a single line.

Designers Should Request AMCA 207 Calculations From Manufacturers

Until now, designers have had no easy way to compare the electricity consumption of different fan systems and instead have been reliant on general assumptions that do not always hold true. For example, contrary to popular belief, a high-efficiency permanent-magnet motor does not guarantee lower power consumption. In the vast majority of fan systems, fan-impeller efficiency overshadows differences in motor/drive efficiency. In a typical system, the impeller accounts for 75 percent or more of wire-to-air power losses. A super-high-efficiency motor/drive system gains a few points of wire-to-shaft efficiency over a conventional system, but if its impeller is even only slightly less efficient at the intended duty, then all of the gains will be lost.

Designers should ask manufacturers for electrical-input-power calculations per ANSI/AMCA Standard 207 for fans with induction motors. This will allow a straightforward duty-point-specific comparison with fan packages that are rated based on electrical-input-power measurements.

Adoption of AMCA 207

ANSI/AMCA Standard 207 will rapidly become part of everyday life in the fan world. It will be used by fan manufacturers to calculate fan energy index (FEI) (read "Meet the new Fan Energy Index," https://www.hpac.com/industry-perspectives/meet-new-fan-energy-index). Not only will use of FEI be required starting with the 2019 version of ANSI/ASHRAE/IES 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings*, the California Energy Commission has proposed a requirement that all fans sold in California meet minimum FEI requirements. Additionally, the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) is in the process of changing AHRI Standard 430, *Performance Rating of Central Station Air-handling Unit Supply Fans*, to require the reporting of electrical power input instead of shaft power input, with an option to provide a calculation per ANSI/AMCA Standard 207. HPAC

For more information about and to purchase ANSI/AMCA Standard 207, go to www.amca.org/store.