

ANSI/AMCA Standard 208-18

Calculation of the Fan Energy Index

An American National Standard
Approved by ANSI on January 24, 2018



Air Movement and Control Association International

AMCA Corporate Headquarters

30 W. University Drive, Arlington Heights, IL 60004-1893, USA

communications@amca.org ■ Ph: +1-847-394-0150 ■ www.amca.org

Documents
Document Sharing Hub

© 2018 AMCA International and ASHRAE
Not for Resale.

ANSI/AMCA Standard 208-18

Calculation of the Fan Energy Index



Air Movement and Control Association International
30 West University Drive
Arlington Heights, Illinois
60004



AMCA Publications

Authority AMCA Standard 208-17 was adopted by the membership of the Air Movement and Control Association International Inc. on November 22, 2017. It was approved as an American National Standard on January 24, 2018

Copyright © 2018 by the Air Movement and Control Association International Inc.

All rights reserved. Reproduction or translation of any part of this work beyond that permitted by Sections 107 and 108 of the United States Copyright Act without the permission of the copyright owner is unlawful. Requests for permission or further information should be addressed to the executive director, Air Movement and Control Association International Inc. at 30 West University Drive, Arlington Heights, IL 60004-1893 U.S.

Objections The Air Movement and Control Association (AMCA) International Inc. will consider and take action upon all written complaints regarding its standards, certification programs or interpretations thereof. For information on procedures for submitting and handling complaints, write to

AMCA International
30 West University Drive
Arlington Heights, IL 60004-1893 U.S.A.

European AMCA
Avenue des Arts, numéro 46
à Bruxelles (1000 Bruxelles)

Asia AMCA Sdn Bhd
No. 7, Jalan SiLC 1/6,
Kawasan Perindustrian SiLC Nusajaya,
Mukim Jelutong, 79200 Nusajaya, Johor
Malaysia

Disclaimer AMCA uses its best efforts to produce publications for the benefit of the industry and the public in light of available information and accepted industry practices. However, AMCA does not guarantee, certify or assure the safety or performance of any products, components or systems tested, designed, installed or operated in accordance with AMCA publications or that any tests conducted under its publications will be non-hazardous or free from risk.

Review Committee

Tim Mathson (Chair)	Greenheck Fan
John Bade	Johnson Controls
Joanna Mauer	Appliance Standards Awareness Project
Sarah Widder	Pacific Northwest National Lab
Jason Meinke	Phillips and Temro Industries
Kai Aschenbach	Ziehl-Abegg
Justin Lim	Northern Blower Inc.
Z. Patrick Chinoda	Revcor, Inc.
Fernando A. Ruiz	Equipos Electromecanicos, S.A. de C.V.
Rae Jane Araujo	Howden American Fan
Adam Sterne	Acme Engineering & Manufacturing Corporation
Trinity Persful	Clarage
Franco Cincotti	Comefri USA
Lee Buddrus	Acme Engineering & Manufacturing Corporation
Jonathan Hollist	MacroAir
Madan Baral	Revcor Inc.
Rad Ganesh	Twin City Fan
John Fox	Air King Ventilation Products
Bob Valbracht	Loren Cook Company
Venkatesvaran Somasundaram	Royal Court Affairs
Mike Wolf	Greenheck Fan
Ola Wettergren	Systemair, Inc.
Sham Morten Gabr	Multi Wing
Kim G. Osborn	Nortek Air Solutions
Michael Patton	Branford Haoll Career Institute
Sekar Chinnaiyan	Saipem
Joshua Lynch	S&P USA
Dustin Meredith	Trane
Devon Washington	Consumers' Energy

Mark Bublitz	The New York Blower Company
Andrew Casey	Lasko Products
Richard Peppin	RION Co, Ltd
Armin Hauer	ebm-papst Inc.
Steve Dikeman	AcoustiFLO
Neal Boyd	Norther Blower
Christian Taber	Big Ass Fans
Aly Mohammed	James Cubitt & Partners Engineering Consultancy
Mansoor Bhavnagarwala	H&H Consulting
Ahmed Mohamed Abdel	Tiba Engineering Industries
Shahul Hameed	Voltas
Vasanthi Iyer	Lasko Products
Manoj Khati	Anshan Fan Group Co., Ltd
Logan Mikesell	Vostermans Ventilation, Inc
PS Nishar	Etisalat Facilities Management
Dr. R Rajasekar	Spruce Airwin Mech Engg PVT LTD
Gary Shamshoian	Best Technologies/HVAC Manufacturing, Inc.
Ang Kee Goh	MMC-Gamuda KVMRT (T) Sdn. Bhd.
Efe Unal	Aironn Ventilation Group
David Mayer	Greenheck Fan
Alexander Han	Jangho Group Co. Ltd.
Mike Brendel	Lau Fan
Matt Raymond	New York Blower
Alejandro Galdamez	California Energy Commission
Louis Starr	NEEA
Bryan Boyce	Energy Solutions
Reiner Kelch	System Air GmbH
Samuel Brugnaroto	GSI Brazil
David Johnson	Berner International LLC
Aron Reid	New York Blower

Thomas Gustafson

Joe Brooks

Hartzell Air Movement

AMCA International Staff

Contents

1. Purpose and Scope.....	7
2. Normative References	7
3. Definitions/Units of Measure/Symbols	8
3.1 Definitions.....	8
3.2 Symbols.....	11
4. General	12
4.1 Minimum testable configuration.....	12
4.2 FEI pressure basis.....	12
4.3 Appurtenances	12
5. Fan Energy Index.....	13
5.1 General.....	13
5.2 Reference fan electrical input power	14
6. Use of FEI	20
6.1 Requirements for use of FEI	20
Annex A Fan Types, Test Configurations and FEI Pressure Basis (Normative).....	22
A.1 Use of test or installation types	22
A.2 Fans tested using thrust.....	24
Annex B Usage of FEI (informative).....	25
B.1 General.....	25
B.2 Published FEI values	25
B.3 Examples of consumer use of FEI	27
B.5 Codes and regulatory references.....	28
Annex C Fan Arrays (Informative).....	29
C.1 General	29
C.2 Calculation procedure	29
C.3 Labeling	29
C.4 Example	29
Annex D Embedded Fans (informative).....	31
D.1 Location of an embedded fan within the unit	31
D.2 Economizers	31
D.3 Application of the embedded fan	33
D.4 Applying the FEI to an embedded fan	33
D.5 Embedded fans tested in-accordance with an equipment test standard.....	33

Calculation of the Fan Energy Index

1. Purpose and Scope

This standard defines the calculation method for the fan energy index (FEI), which is an energy efficiency metric for fans inclusive of motors and drives. This metric provides a standardized and consistent basis to compare fan energy performance across fan types and sizes at a given fan duty point.

Fan specifiers can use FEI to understand and communicate the fan efficiency design intent. Legislative or regulatory bodies can use FEI to define the energy efficiency requirements of fans.

The scope includes all fan and motor sizes and all applications, including fans with fan air performance based on tests in accordance with one of the following fan test standards: ANSI/AMCA Standard 210, ANSI/AMCA Standard 230, ANSI/AMCA Standard 250, ANSI/AMCA Standard 260, ISO 5801, or ISO 13350. All other fans are excluded (including air curtain units that are tested in accordance with ANSI/AMCA Standard 220).

2. Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

1. ANSI/AMCA Standard 99-16
Standards Handbook
2. ANSI/AMCA Standard 207-17
Fan System Efficiency and Fan System Input Power Calculation
3. ANSI/AMCA Standard 210-16/ASHRAE Standard 51-16
Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating
4. AMCA Publication 211
Certified Ratings Program Product Rating Manual for Fan Air Performance
5. ANSI/AMCA Standard 230-15
Laboratory Methods of Testing Air Circulating Fans for Rating and Certification
6. ANSI/AMCA Standard 250-12
Laboratory Methods of Testing Jet Tunnel Fans for Performance
7. ANSI/AMCA Standard 260-13
Laboratory Methods of Testing Induced Flow Fans for Rating
8. IEC 60034-2-1 Ed. 2.0 b:2014
Rotating electrical machines—Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)
9. IEC 60034-30-1 Ed. 1.0 (2014-03)
Rotating electrical machines—Part 30-1: Efficiency classes of line operated AC motors (IE code)
10. IEEE 112-2004
IEEE Standard Test Procedure for Polyphase Induction Motors and Generators
11. IEEE 114-2010
IEEE Standard Test Procedure for Single-Phase Induction Motors
12. ISO 5801:2007
Fans—Performance testing using standardized airways
13. ISO 13350:2015
Fans—Performance testing of jet fans

14. NEMA MG 1-2016 (with 2017 Supplement [Part 34]) *Motors and Generators*

15. GB/T 1032-2012

Test procedures for three-phase induction motors

3. Definitions/Units of Measure/Symbols

3.1 Definitions

For the purposes of this document, the terms and definitions given in ANSI/AMCA Standard 207, ANSI/AMCA Standard 99 and the following apply.

3.1.1 General definitions

3.1.1.1 Duty point

A single airflow and pressure point within the published operating range of the fan.

3.1.1.2 Reference fan

A conceptual fan used to relate all fans to a common baseline. The reference fan is one capable of producing the required airflow and fan pressure at a specified shaft input power, uses a V-belt transmission, has a motor efficiency based on a four-pole, 60 Hz, IE3 motor and does not include a speed control.

3.1.1.3 Regulated motor

A motor whose efficiency or power usage is subject to regulations under IEC 60034-30, GB 18613 or Subpart B or X in Part 431 of Title 10 of the Code of Federal Regulations (10CFR 431).

3.1.1.4 Default motor efficiency

A default efficiency assigned to the motor at its operating point when either the specific motor is not identified or the efficiency of the motor used is unknown. The assumed motor efficiency is representative of a premium efficiency (IE3) three-phase, four-pole, general purpose squirrel-cage induction motor.

3.1.1.5 Embedded fan

A fan that is set or fixed firmly inside or attached to a surrounding piece of equipment whose purpose exceeds that of a fan or is different than that of a standalone fan. This equipment may have safety or energy efficiency requirements of its own. Examples of embedded fans include supply fans in air handling units, condenser fans in heat rejection equipment, tangential blowers in air curtain units and induced or forced draft combustion blowers in boilers or furnaces.

3.1.1.6 Standalone fan

A fan in at least a minimum testable configuration, as defined in Section 4.1. This includes any motor, transmission or motor controller if included in the rated fan. It also includes any appurtenances included in the rated fan, and it excludes the impact of any surrounding equipment whose purpose exceeds or is different than that of the fan. Standalone fans do not include provisions for air conditioning, air filtration, air mixing, air treatment or heating. Examples include power roof ventilators, side-wall exhaust fans, whole house fans, inline fans, ceiling fans, jet tunnel fans and induced-flow laboratory exhaust fans.

3.1.1.7 Bare shaft fan

A fan without motor, transmission or motor controller.

3.1.1.8 Continuous control fan

A fan that has the capability to vary the operation of the fan continuously over the fans operating range either by varying the speed of the fan or varying the pitch of the impeller.

3.1.1.9 Non-continuous control fan

A fan that varies its operation to a discrete number of non-continuous operating points.

3.1.1.10 Fan

A rotary bladed machine used to convert power to air power, with an energy output limited to 25 kJ/kg of air, consisting of an impeller, a shaft, bearings and a structure or housing. It includes any transmissions, driver and/or controls if integrated, assembled or packaged by the manufacturer at the time of sale.

3.1.1.11 Impeller

A rotary bladed aerodynamic component that transfers mechanical energy to the airstream delivered by the fan.

3.1.1.12 Structure

Any component(s) of the fan necessary to support the impeller.

3.1.1.13 Housing

Any component or components of the fan that direct airflow into or away from the impeller and/or provide protection to the internal components. A housing may serve as a fan's structure.

3.1.1.14 Inlet

The area in contact with the fan's inlet area.

3.1.1.15 Outlet

The area in contact with the fan's outlet area

3.1.1.16 Motor controller

Any device that can be used to control the speed of the fan.

3.1.1.17 Driven fan

A fan configuration including a driver and, if included by the manufacturer, transmissions and controls.

3.1.1.18 Transmission

Any component that transfers energy from a driver to an impeller.

3.1.1.19 Direct-driven fan

A driven fan configuration in which the fan impeller is connected directly to the driver.

3.1.1.20 Belt-driven fan

A driven fan configuration in which the fan impeller is connected to the driver through a set of belts and sheaves mounted on the driver shaft and fan shaft. This includes fans with V-belt or synchronous belt power transmission.

3.1.1.21 V-belt power transmission

Drive belts having a substantially trapezoidal cross section that use sheaves (pulleys) having smooth contact surfaces. Conventional V-belts have a constant cross section along their length, while notched V-belts (also known as cogged V-belts) have slots running perpendicular to their length. The slots reduce bending resistance and offer improved efficiency over conventional V-belts. This standard does not account for this improved efficiency.

3.1.1.22 Synchronous belt power transmission

Drive belts having a substantially rectangular cross section containing teeth that engage corresponding teeth on the sheaves (pulleys), resulting in no-slip power transmission. These belts are sometimes called timing or toothed belts.

3.1.2 Impeller types

3.1.2.1 Axial impeller

An impeller (propeller) with a number of blades extending radially from a central hub in which airflow through the impeller is axial in direction; that is, airflow enters and exits the impeller parallel to the shaft axis (i.e., with a fan flow angle less than or equal to 20 degrees). Blades can either be single thickness or airfoil shaped.

3.1.2.2 Centrifugal impeller

An impeller with a number of blades extending between a back plate and shroud in which airflow enters axially through one or two inlets and exits radially at the impeller periphery. The airflow exits either into open space or into a housing with a fan flow angle greater than or equal to 70 degrees. Impellers can be classified as single inlet or double inlet. Blades can be tilted backward or forward with respect to the direction of impeller rotation. Impellers with backward tilted blades can be

airfoil shaped (AF), backward curved single thickness (BC), backward inclined single thickness flat (BI) or radial tipped (RT). Impellers with forward tilted blades are known as forward curved (FC).

3.1.2.3 Radial impeller

A form of centrifugal impeller with a number of blades extending radially from a central hub in which airflow enters axially through a single inlet and exits radially at the impeller periphery into a housing with impeller blades positioned such that the outward direction of the blade at the impeller periphery is perpendicular within 25 degrees to the axis of rotation. Impellers can optionally have a back plate and/or shroud.

3.1.2.4 Mixed flow impeller

An impeller with construction characteristics between those of an axial and centrifugal impeller with a fan flow angle greater than 20 degrees and less than 70 degrees. Airflow enters axially through a single inlet and exits with combined axial and radial directions at a mean diameter greater than the inlet.

3.1.2.5 Fan flow angle

The angle of the centerline of the air-conducting surface of a fan blade measured at the midpoint of its trailing edge with the centerline of the rotation axis, in a plane through the rotation axis and the midpoint of the trailing edge.

3.1.3 Fan types

3.1.3.1 Centrifugal housed fan

A fan with a centrifugal or radial impeller in which airflow exits into a housing that is generally scroll shaped to direct the air through a single fan outlet. Inlets and outlets can optionally be ducted.

3.1.3.2 Centrifugal inline fan

A fan with a centrifugal impeller in which airflow enters axially at the fan inlet and the housing redirects radial airflow from the impeller to exit the fan in an axial direction. Inlets and outlets can optionally be ducted.

3.1.3.3 Centrifugal unhooded fan

A fan with a centrifugal impeller in which airflow enters through a panel and discharges into free space. Inlets and outlets are not ducted. This fan type also includes fans designed for use in fan arrays that have partition walls separating the fan from other fans in the array.

3.1.3.4 Power roof/wall ventilator (PRV)

A fan with an internal driver and a housing to prevent precipitation from entering the building. It has a base designed to fit over a roof or wall opening, usually by means of a roof curb.

3.1.3.5 Centrifugal PRV exhaust

A PRV with a centrifugal impeller that exhausts air from a building. Inlets are typically ducted, but outlets are not ducted.

3.1.3.6 Centrifugal PRV supply

A PRV with a centrifugal impeller that supplies air to a building. Inlets are not ducted, and outlets are typically ducted.

3.1.3.7 Axial PRV

A PRV with an axial impeller that either supplies or exhausts air to a building. Inlets and outlets are typically not ducted.

3.1.3.8 Axial inline fan

A fan with an axial impeller and a cylindrical housing with or without turning vanes. Inlets and outlets can optionally be ducted.

3.1.3.9 Axial panel fan

A fan with an axial impeller mounted in a short housing that can be a panel, ring or orifice plate. The housing is typically mounted to a wall separating two spaces and the fans are used to increase the pressure across this wall. Inlets and outlets are not ducted.