

ANSI/AMCA Standard 230-23

Laboratory Methods of Testing Air Circulating Fans for Rating and Certification

An American National Standard
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Air Movement and Control Association International

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Laboratory Methods of Testing Air Circulating Fans for Rating and Certification

1. Purpose

The purpose of this standard is to establish uniform methods for laboratory testing of air circulating fans to determine performance for rating or certification.

2. Scope

This standard shall be used as the basis for testing electrically powered air circulating fan heads and ceiling fans when air is used as the test gas. The scope is limited to air circulating fans with an input power greater than or equal to 125 W—except for ceiling fans, which do not have a lower input power limit. The diameter of the fan being tested shall be limited by the minimum dimensions as shown in the applicable test figures.

Exclusions:

- Jet fans as defined in ANSI/AMCA Standard 214
- Powered roof ventilators, induced flow fans, laboratory exhausts
- Positive pressure ventilators as defined in ANSI/AMCA Standard 240
- Compressors
- Positive displacement machines

Only tests that fulfill all mandatory requirements of this standard may be designated as tests conducted in accordance with this standard.

3. References

ANSI/AMCA Standard 208-18, Calculation of the Fan Energy Index, Air Movement and Control Association International Inc., Arlington Heights, IL USA.

ANSI/AMCA Standard 214-21, Test Procedure for Calculating Fan Energy Index (FEI) for Commercial and Industrial Fans and Blowers, Air Movement and Control Association International Inc., Arlington Heights, IL USA.

ANSI/AMCA Standard 240, Laboratory Methods of Testing Positive Pressure Ventilators for Aerodynamic Performance Rating, Air Movement and Control Association International Inc., Arlington Heights, IL USA.

ANSI/AMCA Standard 250, Laboratory Methods of Testing Jet Fans for Performance, Air Movement and Control Association International Inc., Arlington Heights, IL USA.

ANSI/ASHRAE Standard 41.1-2020, Standard Methods for Temperature Measurement, American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc., Peachtree Corners, GA USA.

ANSI/ASHRAE Standard 41.11-2020, Standard Methods for Power Measurement, American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc., Peachtree Corners, GA USA.

ASHRAE Handbook — Fundamentals, American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc., Peachtree Corners, GA USA.

Axial Flow Fans and Ducts, Krieger Publishing Co., New York, NY USA.

Guideline 2-2010 (RA 2014), Engineering Analysis of Experimental Data [Withdrawn], American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc., Peachtree Corners, GA USA.

IEC 62301: 2011, Household electrical appliances — Measurement of standby power, International Electrotechnical Commission, Geneva, Switzerland.

ISO/IEC 17025, Testing and calibration laboratories, International Organization for Standardization, Geneva, Switzerland.

Psychrometric Equations for the Partial Vapor Pressure and the Density of Moist Air — Report to AMCA Standard 210/ASHRAE 51P Committee, Air Movement and Control Association International Inc., Arlington Heights, IL USA.

Special Publication 330, The International System of Units (SI), National Institute of Standards and Technology, Gaithersburg, MD, USA.

Steam Tables — Compact Edition, The American Society of Mechanical Engineers, New York, NY USA.

4. Definitions/Units of Measurement/Symbols

4.1 Definitions

4.1.1 Air circulating fan

A fan that has no provision 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 (as defined in ANSI/AMCA Standard 214). Refer to Annex B for additional details on examples and categorization of air circulating fans.

4.1.1.1 Air circulating fan head (ACFH), housed

An air circulating fan that is not a ceiling fan with an axial or centrifugal impeller and a housing.

4.1.1.2 Air circulating fan head (ACFH), unboxed

An air circulating fan without housing, having an axial impeller with a ratio of fan-blade span in centimeters (inches) to a maximum rate of rotation (in revolutions per minute) less than or equal to 1.524 mm/rpm (0.06 in./rpm) and discharging air in a horizontal direction. The impeller may or may not be guarded.

4.1.1.3 Ceiling fan

A nonportable fan that is designed to be suspended from the ceiling or overhead structure of a building, usually with a vertically oriented fan shaft. The impeller may or may not be guarded. A ceiling fan has a ratio of fan blade span in millimeters (inches) to maximum rotation rate (in revolutions per minute) greater than 1.524 mm/rpm (0.06 in./rpm) and discharges air up or down.

4.1.1.4 Cylinder

A circular housing with a width greater than 20 cm (8 in.).

4.1.1.5 Housing

A surrounding, continuous physical barrier that directs airflow into or away from the impeller, typically a box, cylinder, panel, orifice plate, ring or scroll.

4.1.1.6 Ring

A circular housing with a width less than or equal to 20 cm (8 in.).

4.1.2 Fan performance variables

4.1.2.1 Discharge area

Area of a circle having a diameter equal to the blade tip diameter.

4.1.2.2 Electrical input power

The electrical power required to drive the fan and any elements in the drive train that are considered a part of the fan. Electrical input power (W_E) is the measured electrical input power (W_O) converted to standard air density.

4.1.2.3 Fan outlet area

The gross inside area, perpendicular to the airstream, measured at the plane of the outlet opening.

4.1.2.4 Fan speed

The rotational speed of the impeller.

4.1.2.5 Fan thrust

The reaction force due to the momentum change of the mass flow through the fan.

4.1.2.6 Standby power consumption

The electrical power consumed when the fan is connected to a main power source, fan speed is 0 rpm and the unit offers one or more of the following user-oriented or protective functions:

- Facilitates the activation or deactivation of other functions (including active mode) by remote switch (including remote control), internal sensor or timer.
- Continuous tasks, including information or status displays (including clocks) or sensor-based functions.

4.1.3 Force

4.1.3.1 Load differential

The difference in measured force, using either standard weights or a load cell, when the fan is energized vs. when it is not energized.

4.1.4 Miscellaneous

4.1.4.1 Determination

A complete set of measurements for the free-air operation of an air circulating fan. A determination shall, at a minimum, include the following measurements:

- Ambient dry-bulb temperature, °C (°F)
- Ambient wet-bulb temperature, °C (°F)
- Barometric pressure, Pa (in. Hg)
- Electrical input power, W
- Fan diameter, m (ft)
- Fan speed, rpm
- Input current, A
- Input voltage, V
- Load differential, N (lbf)
- Number of phases, Φ

4.1.4.2 Shall and should

The word *shall* is to be understood as mandatory, the word *should* as advisory.

4.1.4.3 Test

A series of determinations for one or more points of fan operation, e.g., various fan speeds, voltages or frequencies.

4.1.5 Pressure

4.1.5.1 Absolute pressure

The value of pressure when the datum pressure is absolute zero. It is always positive.

4.1.5.2 Barometric pressure

The absolute pressure exerted by the atmosphere.

4.1.5.3 Pressure

Pressure is force per unit area. This corresponds to energy per unit volume of fluid.

4.1.6 Psychrometrics

4.1.6.1 Air density

The mass per unit volume of air.

4.1.6.2 Dry-bulb temperature

The air temperature as measured by a dry temperature sensor.

4.1.6.3 Standard air

Air with a density of 1.2 kg/m^3 (0.075 lbm/ft^3), a ratio of specific heats of 1.4 and a viscosity of $1.8185 \times 10^{-5} \text{ Pa}\cdot\text{s}$ ($1.222 \times 10^{-5} \text{ lbm}\cdot\text{s}$). Air at 20°C (68°F), 50% relative humidity and 101.325 kPa (29.92 in. Hg) barometric pressure has these properties, approximately.

4.1.6.4 Wet-bulb depression

The difference between the dry-bulb and wet-bulb temperatures at the same location.

4.1.6.5 Wet-bulb temperature

The air temperature measured by a temperature sensor covered by a water-moistened wick and exposed to air in motion. When properly measured, it is a close approximation of the temperature of adiabatic saturation.

4.1.7 Test configuration

4.1.7.1 Minimum testable configuration

A fan with sufficient components (impeller, shaft, driver, bearings, etc.) to allow for wire-to-air testing and rating calculation. Appurtenances and other devices that are sold or supplied with the product must be installed on the test fan, but not energized. If sold or supplied with the fan, an on/off switch or speed control device shall be included in the minimum testable configuration.

4.2 Units of measurement

4.2.1 System of units

The International System of Units (SI units) are the primary units employed in this standard, with inch-pound (I-P) units given as the secondary reference. SI units are based on the fundamental values of the International Bureau of Weights and Measures, and I-P units are based on the values of the National Institute of Standards and Technology, which are in turn based on the values of the International Bureau.

4.2.2 Basic units

The SI unit of length is the meter or the millimeter; the I-P unit of length is the foot or the inch. The SI unit of mass is the kilogram; the I-P unit of mass is the pound mass. The unit of time is either the minute or the second. The SI unit of temperature is either the Kelvin or the degree Celsius; the I-P unit of temperature

is either the degree Fahrenheit or the degree Rankine. The SI unit of force is the newton; the I-P unit of force is the pound force.

4.2.3 Velocity

The SI unit of velocity is the meter per second; the I-P unit of velocity is the foot per minute.

4.2.4 Thrust

The SI unit of thrust is the newton; the I-P unit is the pound force.

4.2.5 Pressure

The SI unit of pressure is the pascal. The I-P unit of pressure is either the inch water gauge or the inch mercury. Values in inch mercury shall be used only for barometric pressure measurements.

The inch water gauge shall be based on a 1-in. column of distilled water at 68 °F under standard gravity and a gas column balancing effect based on standard air. The inch mercury shall be based on a 1-in. column of mercury at 32 °F under standard gravity in a vacuum.

4.2.6 Power

The unit of input power is the watt.

4.2.7 Speed

The unit of rotational speed is the revolution per minute.

4.2.8 Gas properties

The SI unit of density is the kilogram per cubic meter; the I-P unit of density is the pound mass per cubic foot. The SI unit of viscosity is the pascal-second; the I-P unit of viscosity is the pound mass per foot-second. The SI unit of gas constant is the joule per kilogram-kelvin; the I-P unit of gas constant is the foot-pound force per pound-mass-degree Rankine.

4.2.9 Dimensionless groups

Various dimensionless quantities appear in the standard. Any consistent system of units may be employed to evaluate these quantities unless a numerical factor is included, in which case units must be as specified.

4.2.10 Physical constants

The SI value of standard gravitational acceleration shall be taken as 9.80665 m/s², which corresponds to mean sea level at 45° latitude; the I-P value of standard gravitational acceleration is 32.1740 ft/s², which corresponds to mean sea level at 45° latitude. The SI density of distilled water at saturation pressure shall be taken as 998.278 kg/m³ at 20°C; the I-P value is 62.3205 lbm/ft³ at 68°F. The density of mercury at saturation pressure shall be taken as 13595.1 kg/m³ at 0°C; the I-P value is 848.714 lbm/ft³ at 32°F. The specific weights in kg/m³ (lbm/ft³) of these fluids in vacuum under standard gravity are numerically equal to their densities at corresponding temperatures.

4.3 Symbols and subscripts

Table 1 — Symbols and Subscripts

Symbol	Description	SI Unit	I-P Unit
A	Fan outlet or discharge area	m ²	ft ²
D	Fan diameter	m	ft
CFEI	Ceiling fan energy index	Dimensionless	
E	Input voltage	V	V
Eff_{circ}	Efficacy of a circulating fan	(m ³ /s)/W	cfm/W
Eff_t	Thrust efficiency ratio	N/kW	lbf/kW
F_t	Thrust at standard air density	N	lbf
ΔF	Load differential	N	lbf