# FINAL DRAFT International Standard

# ISO/FDIS 12759-6

# Fans — Efficiency classification for fans —

## Part 6: Calculation of the fan energy index

*Ventilateurs — Classification du rendement des ventilateurs —*

*Partie 6: Calcul de l'indice énergétique des ventilateurs*


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# Foreword

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This document was prepared by Technical Committee ISO/TC 117, *Fans*.

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# Introduction

The fan industry is of a global nature, with a considerable degree of exporting and licensing. To ensure that the defining fan performance characteristics are common throughout the world, a series of standards have been developed. It is the belief of the industry that there is now a need for minimum efficiency standards to be recognized.

To encourage their implementation, a classification system is proposed which incorporates a series of efficiency bands. With improvements in technology and manufacturing processes, the minimum efficiency levels can be reviewed and increased in time.

This document differs from others in this series in that the fan is not evaluated at its peak efficiency value. Rather, the fan is evaluated at every duty point within its stated performance range. In doing so, this document addresses both the design and selection of fans for reduced power consumption.

The fan energy index provides a consistent basis to compare fan energy performance across fan types and sizes at a given fan duty point. This document can be used by fan specifiers to communicate fan efficiency design intent and by those selecting fans to compare the energy use of various fan options. With improvements in technology and manufacturing processes, the minimum allowable fan energy index can be reviewed and increased in time.

# Fans — Efficiency classification for fans —

# Part 6: Calculation of the fan energy index

## 1 Scope

This document defines the calculation method for determining the fan energy index (FEI), which is an energy efficiency metric for fan duty points. This metric provides a standardized and consistent basis to compare fan energy performance across fan types and sizes at a given fan duty point.

This document is applicable to fans driven by electric motors and fans without drives. It is not applicable to circulating fans or air curtains.

The fan energy index can only be calculated for fan duty points above a minimum air power of 125 W (where air power is the product of volume flow rate and fan static pressure) or above a minimum volume flow rate of 2,0 $m^3$/s.

## 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.

ISO 5801:2017, *Fans — Performance testing using standardized airways*

ISO 12759-1, *Fans — Efficiency classification for fans — General information for fans*

ISO 12759-2:2019, *Fans — Efficiency classification for fans — Part 2: Standard losses for drive components*

ISO 13348, *Industrial fans — Tolerances, methods of conversion and technical data presentation*

ISO 13349-1, *Fans — Vocabulary and definitions of categories — Part 1: Vocabulary*

ISO 13350, *Fans — Performance testing of jet fans*

IEC 60034-30-1:2014, *Rotating electrical machines—Part 30-1: Efficiency classes of line operated AC motors (IE code)*

IEC 60034-2-1, *Rotating electrical machines—Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)*

IEC 60034-2-3, *Rotating electrical machines—Part 2-3: Specific test methods for determining losses and efficiency of converter-fed AC motors*

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*

## 3 Terms, definitions and symbols

For the purposes of this document, the terms and definitions given in ISO 13349-1 and ISO 12759-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

## 3.1 Terms and definitions

### 3.1.1 General terms

**3.1.1.1**
**fan**
rotary-bladed machine that receives mechanical energy and utilizes it by means of one or more *impellers* (3.1.1.2) fitted with blades to maintain a continuous flow of air or other gas passing through it and whose work per unit mass does not normally exceed 25 kJ/kg

Note 1 to entry: See ISO 13349-1:2022, 3.1.1 for a more complete definition.

**3.1.1.2**
**impeller**
rotating part of the *fan* (3.1.1.1) that imparts energy to the air stream

[SOURCE: ISO 13349-1:2022, 3.7.3, modified – changing gas flow to air stream]

**3.1.1.3**
**housing**
stationary part of the *fan* (3.1.1.1) that interacts with the air stream passing through the *impeller* (3.1.1.2)

Note 1 to entry: A housing can be an element around the *impeller* (3.1.1.2) which guides the air stream towards, through and from the impeller.

Note 2 to entry: A housing can have additional parts included within or attached to it that affect the performance of the *fan* (3.1.1.1), such as an inlet bell (also known as venturi), inlet cone, inlet radius, inlet ring, inlet guide vane, outlet guide vane or outlet diffuser.



**3.1.1.4**
**fan without drives**
non-driven fan
bare shaft fan
*fan* (3.1.1.1) without motor, *transmission* (3.1.1.8), or *motor controller* (3.1.1.14)

Note 1 to entry: In this definition, the term drive refers to motors, transmissions, and motor controllers.

**3.1.1.5**
**driven fan**
*fan* (3.1.1.1) driven by an electrical motor, with or without a *transmission* (3.1.1.8) or *motor controller* (3.1.1.14)

Note 1 to entry: In this document, the term motor always refers to an electric motor.

[SOURCE: ISO 13349-1:2022, 3.1.3, modified – Note 1 included in the body of the term]

**3.1.1.6**
**direct driven fan**
*driven fan* (3.1.1.5) configuration in which the *impeller* (3.1.1.2) is connected directly to the motor

**3.1.1.7**
**belt driven fan**
*driven fan* (3.1.1.5) configuration in which the *impeller* (3.1.1.2) is connected to the motor through a set of belts and pulleys mounted on the motor shaft and fan shaft

Note 1 to entry: This includes fans with *V-belt transmissions* (3.1.1.10) or *synchronous belt transmissions* (3.1.1.11).

**3.1.1.8**
**transmission**
component that transfers energy from a motor to an impeller

EXAMPLE Pulleys, belts, gears, couplings

**3.1.1.9**
**V-belt transmission**
form of *transmission* (3.1.1.8) utilizing drive belts having a substantially trapezoidal cross-section that use pulleys having smooth contact surfaces

Note 1 to entry: 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.

**3.1.1.10**
**synchronous belt transmission**
form of *transmission* (3.1.1.8) utilizing drive belts having a substantially rectangular cross-section containing teeth that engage corresponding teeth on the pulleys, resulting in no-slip power transmission

Note 1 to entry: These belts are sometimes called timing or toothed belts.

**3.1.1.11**
**standalone fan**
*fan* (3.1.1.1) in at least a minimum testable configuration

Note 1 to entry: 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. See 4.1.



Note 2 to entry: Standalone fans do not include provisions for air conditioning, air filtration, air mixing, air treatment or heating.

EXAMPLE Power roof ventilators, side-wall exhaust fans, inline fans, jet fans and induced-flow laboratory exhaust fans.

[SOURCE: ISO 13349-1:2022, 3.1.4, modified – addition of an example and of more detail to the notes]



**3.1.1.12**
**embedded fan**
integrated fan
*fan* (3.1.1.1) that is set or fixed firmly inside or attached to a surrounding piece of equipment whose purpose exceeds that of a *fan* (3.1.1.1) or is different than that of a *standalone fan* (3.1.1.11)

Note 1 to entry: The surrounding equipment can have safety or energy efficiency requirements of its own.

Note 2 to entry: Embedded fans are also known as integrated fans.

EXAMPLE 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.

**3.1.1.13**
**motor controller**
device that is used to control the speed of the motor and subsequently the *fan* (3.1.1.1)

**3.1.1.14**
**regulated motor**
motor whose efficiency or power usage is subject to regional or national regulation

EXAMPLES Europe: Commission Regulation (EU) 2019/1781

China: GB 18613

United States: Code of Federal Regulations 10CFR Part 431

**3.1.1.15**
**default motor efficiency**
default efficiency assigned to the motor at a given motor output power when either the specific motor is not identified or the efficiency of the motor used is unknown

Note 1 to entry: The use of a default efficiency is designed to represent typically available motors. Since motor efficiency regulations are controlled regionally, the default motor efficiency shall reflect these regulations. See 5.3.5 for examples.

**3.1.1.16**
**duty point**
single volume flow rate ($q_V$) and pressure ($p_f$ or $p_{fs}$) point within the published operating range of the *fan* (3.1.1.1)

**3.1.1.17**
**reference electrical power**
reference power used to relate the performance of all fans to a common baseline

Note 1 to entry: The reference electrical power defines a single value of fan electrical input power for a given volume flow rate and fan pressure.

### 3.1.2 Impeller types



NOTE See ISO 13349-1 for a more complete description of the variations between impeller types. The definitions below include only the differentiation needed for this standard.

**3.1.2.1**
**axial impeller**
propeller
*impeller* (3.1.1.2) 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* (3.1.2.5) ≤ 20°)

Note 1 to entry: Blades can either be single thickness or airfoil shaped.

**3.1.2.2**
**centrifugal impeller**
*impeller* (3.1.1.2) 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, either into open space or into a housing, with a *fan flow angle* (3.1.2.5) ≥ 70°

Note 1 to entry: *Impellers* (3.1.1.2) can be classified as single inlet or double inlet.

Note 2 to entry: 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**
form of *centrifugal impeller* (3.1.2.2) 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°to the axis of rotation

Note 1 to entry: Radial impellers can optionally have a back plate and/or shroud.

**3.1.2.4**
**mixed flow impeller**
*impeller* (3.1.1.2) with construction characteristics between those of an *axial impeller* (3.1.2.1) and *centrifugal impeller* (3.1.2.2) with a *fan flow angle* (3.1.2.5) between 20° and 70°

Note 1 to entry: Airflow enters axially through a single inlet and exits with combined axial and radial directions at a mean diameter greater than the inlet.

Note 2 to entry: Mixed flow impellers are sometimes known as diagonal impellers.

Note 3 to entry: Mixed flow impellers are abbreviated as MF in Table A.1.

**3.1.2.5**
**fan flow angle**
angle of the centreline of the air-conducting surface of a fan blade measured at the midpoint of its trailing edge with the centreline of the rotation axis, in a plane through the rotation axis and the midpoint of the trailing edge

### 3.1.3 Fan types

NOTE See ISO 13349-1 for a more complete description of the variations between fan types. The definitions below include only those fan types that are tested differently, function differently, or have a unique advantage, other than efficiency, over other fan types (e.g., sound levels, compact size) such that they can be expected to operate at a different FEI range than other fan types. Additional information on typical duct connections is also provided.

**3.1.3.1**
**centrifugal housed fan**
radial-flow fan
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



Note 1 to entry: Inlets and outlets can optionally be ducted.

**3.1.3.2**
**centrifugal inline fan**
fan with a centrifugal or mixed flow 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



Note 1 to entry: Inlets and outlets can optionally be ducted.

**3.1.3.3**
**centrifugal unhoused fan**
plenum fan
fan with a centrifugal impeller in which airflow enters through a panel and discharges into free space

Note 1 to entry: Outlets are not ducted.

Note 2 to entry: 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 ventilator**
**PRV**
fan with an internal motor and a housing to prevent precipitation from entering the building

Note 1 to entry: 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**
PRV with a centrifugal impeller that exhausts air from a building

Note 1 to entry: Inlets are typically ducted, but outlets are not ducted.

**3.1.3.6**
**centrifugal PRV supply**
PRV with a centrifugal impeller that supplies air to a building

Note 1 to entry: Inlets are not ducted, and outlets are typically ducted.

**3.1.3.7**
**axial PRV**
PRV with an axial impeller that either supplies or exhausts air to a building

Note 1 to entry: Inlets and outlets are typically not ducted.

**3.1.3.8**
**axial inline fan**
fan with an axial impeller and a cylindrical housing with or without turning vanes

Note 1 to entry: Inlets and outlets can optionally be ducted.

**3.1.3.9**
**axial panel fan**
fan with an axial impeller mounted in a short housing consisting of a panel, ring or orifice plate

Note 1 to entry: 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.

Note 2 to entry: These fans are sometimes known as propeller fans or plate-mounted axial fans.

**3.1.3.10**
**laboratory exhaust fan**
fan designed specifically for exhausting contaminated air vertically away from a building, with fan outlets typically constricted to achieve a high outlet velocity



Note 1 to entry: Laboratory exhaust fans can be designed with or without induced flow. Induced flow lab exhaust fans use their high velocity discharge to entrain additional air to mix with contaminated building exhaust air.

Note 2 to entry: Inlets can optionally be ducted, and outlets are not ducted.



**3.1.3.11**
**jet fan**
fan used for producing a high velocity flow of air in a space

Note 1 to entry: Typical function is to add momentum to the air within a tunnel. Inlets and outlets are not ducted.

**3.1.3.12**
**circulating fan**
fan used for the general circulation of air within a space that has no provision for connection to ducting or separation of the fan inlet from its outlet

**3.1.3.13**
**crossflow fan**
fan with a housing that creates an airflow path through the impeller in a direction at right angles to its axis of rotation and with airflow both entering and exiting the impeller at its periphery

Note 1 to entry: Inlets and outlets can optionally be ducted.

**3.1.3.14**
**fan array**
common application of fans using multiple fans in parallel between two plenum sections for a factory-packaged or field-erected air handling unit