INTERNATIONAL STANDARD

ISO 13350

Second edition
2015-10-01

Fans — Performance testing of jet fans

Ventilateurs — Essai de performance des ventilateurs accélérateurs

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

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The committee responsible for this document is ISO/TC 117, *Fans*.

This second edition cancels and replaces the first edition (ISO 13350:1999) which has been technically revised. The main changes are the following:

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— General (dated references on standards updated, e.g. ISO 5801:2007);

— *Clause 2* *"Normative references"* (references supplemented and updated);

— *Clause 3* *"Terms and definitions"* (addition of 3.2.1 "gross fan outlet area", 3.5.1 "motor input power", 3.5.2 "impeller power", 3.8.2 "thrust/motor input power ratio");

— *Figure 1* *"Gross and effective fan outlet areas"* (modified by marking of "gross fan outlet area A_2");

— *Clause 4* *"Symbols and abbreviated terms"* (supplemented and updated);

— *6.4* *"Input power"* (correction for density);

— *7.1* *"Determination of thrust"* (correction for density);

— *7.4* *"Test procedures"* (change of recommended calibration intervals);

— *Figure 7* *"Thrust measuring enclosure"* (modified by reducing the minimum distance between fan casing and floor/ceiling/wall);

— *8.1* *"Determination of sound level"* (Introduction of possibility to use other International Standards e.g. ISO 13347);

— *8.3* *"Enclosure suitability"* (requirement on running speed of the reference sound source deleted);

— *9.2* *"Test arrangement" for determination of vibration velocity* (Figure 9 "Vibration measuring position for jet fans" and requirement to use this configuration deleted);

— *9.3* *"Test procedure"* (general reference to ISO 14695);

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— *10.2 "Upstream chamber method"* ("venturi nozzle" replaced by "bellmouth");

— *10.4 "Directly connected flowrate-measuring"* ("venturi nozzle" replaced by "bellmouth");

— *11.2 "Product performance"* (reference to density 1,2 kg/m^3 added);

— *Annex C (informative)* (change of title: "Conversion rules" replaced by "Non-dimensional coefficients");

— *Annex C (informative)* (several character changed);

— *Annex C (informative)* (subclause on "Non-dimensional thrust/power ratio" added);

— *Annex D (normative)* (new normative Annex on "Efficiency based on thrust measurements").

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Introduction

The need for a new edition of ISO 13350 has been evident for some time. The use of the so-called jet fan to assist in the control of quality of air in vehicle and train tunnels has become increasingly popular. Longitudinal methods of ventilation can show advantages in both capital cost and running cost compared to alternative systems. Smoke and pollution control in emergency conditions can be readily provided. Jet fans can also be used for ventilation and smoke control in enclosed car parks.

This International Standard deals with the determination of those performance criteria essential to the correct application of jet fans. In describing the test and rating procedures, numerous references are made to ISO 5801 as well as to other relevant International Standards.

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Fans — Performance testing of jet fans

1 Scope

This International Standard deals with the determination of those technical characteristics needed to describe all aspects of the performance of jet fans as defined in ISO 13349. It does not cover those fans designed for ducted applications, nor those designed solely for air circulation, e.g. ceiling fans and table fans.

The test procedures described in this International Standard relate to laboratory conditions. The measurement of performance under on-site conditions is not included.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1940-1, *Mechanical vibration — Balance quality requirements for rotors in a constant (rigid) state — Part 1: Specification and verification of balance tolerances*

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ISO 3744, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for an essentially free field over a reflecting plane*

ISO 5801:2007, *Industrial fans — Performance testing using standardized airways*

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ISO 13347 (all parts), *Industrial fans — Determination of fan sound power levels under standardized laboratory conditions*

ISO 13349, *Fans — Vocabulary and definitions of categories*

ISO 14694, *Industrial fans — Specifications for balance quality and vibration levels*

ISO 14695, *Industrial fans — Method of measurement of fan vibration*

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 60034-14, *Rotating electrical machines — Part 14: Mechanical vibration of certain machines with shaft heights 56 mm and higher — Measurement, evaluation and limits of the vibration severity*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13349, ISO 5801 and the following apply.

3.1
effective fan dynamic pressure
p_d
conventional quantity representative of the dynamic component of the fan output, calculated, in the particular case of a jet fan, from the effective fan outlet velocity and the inlet density

Note 1 to entry: The effective fan dynamic pressure will not be the same as the average of the dynamic pressures across the section because it excludes from consideration that part of the dynamic energy flux, which is due only to departures from uniform axial velocity distribution.

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3.2.1
gross fan outlet area
A_2
surface plane bounded by the downstream extremity of the air-moving device

Note 1 to entry: Gross fan outlet area is, by convention, taken as the gross area in the outlet plane inside the casing or duct or silencer, (see Figure 1) without taken into account any obstructions inside the fan outlet.

3.2.2
effective fan outlet area
A_{eff}
<jet fan> outlet area with deductions for motors, fairings, or other obstructions (in the particular case of a jet fan)

Note 1 to entry: If the silencer centrebody reaches the outlet plane of the fan, then, the effective fan outlet area is defined as the annulus area at the fan outlet plane, as shown in Figure 1a).

Note 2 to entry: If the fan has a silencer without centrebody [see Figure 1b)], the effective fan outlet area will be close to the cross- sectional area inside the silencer in order to clear any exit bellmouth form.

Note 3 to entry: If the centrebody (motor or silencer core) does not extend to the outlet plane, the effective fan outlet area will approach the annulus area between the casing and the motor, but with some increase, as defined in Figure 1c), for the distance between the centrebody and the outlet. Where the motor is on the upstream side, Figure 1c) is applied to the impeller hub rather than the motor, as illustrated.

Note 4 to entry: For comparisons within the scope of research and development, alternative definitions have been used with some success.

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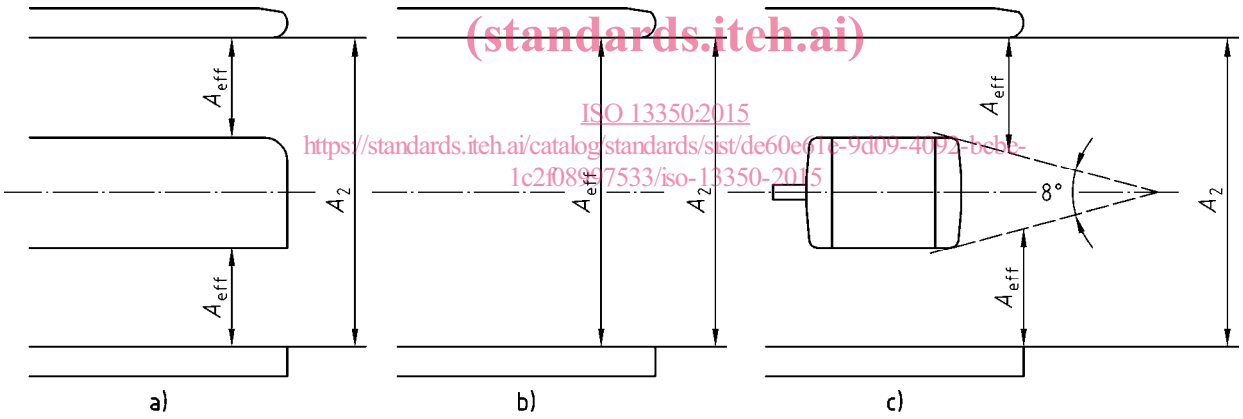

Figure 1 — Gross and effective fan outlet areas

3.3
effective fan outlet velocity
v_{eff}
velocity calculated from thrust at standard conditions, the standard air density, and the effective fan outlet area

Note 1 to entry: See 11.2.

3.4
fan outlet velocity
v_2
velocity calculated from the thrust at standard conditions, divided by gross fan outlet area, A_2

3.5.1
motor input power
P_e
electrical power supplied at the terminals of the electric motor drive

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3.5.2
impeller power
P_r
mechanical power supplied to the impeller of the fan

3.5.3
fan air power
P_u
conventional power output at standard conditions; in the particular case of a jet fan, product of inlet volume flow and effective fan dynamic pressure

3.6
impeller tip speed
v_p
peripheral speed of the impeller blade tips

3.7
thrust
T_m, T_c
fan thrust measured (T_m) or calculated (T_c) in accordance with this International Standard at standard conditions

3.8.1
thrust/impeller power ratio
r_r
thrust divided by impeller power

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Note 1 to entry: The thrust/impeller power ratio is calculated as $r_r = T_m/P_r$.

3.8.2
thrust/motor input power ratio
r_e
thrust divided by motor input power

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Note 1 to entry: The thrust/motor input power ratio is calculated as $r_e = T_m/P_e$.

3.9
fan guard
guard designed to prevent the ingestion of relatively large foreign bodies, such as drink cans, and sometimes fitted to the inlet and outlet of jet fans

Note 1 to entry: Guards can have a marked effect on the thrust performance and noise level. Where they are specified, measurements should be made with these guards in place.

3.10
chamber
airway in which the air velocity is small compared with that at the fan inlet or outlet

3.11
test enclosure
room, or other space protected from draught, in which the fan and test airways are situated

3.12
impeller balance grade
G grade as specified in ISO 14694

3.13
fan vibration velocity
unfiltered root mean square (r.m.s.) vibration velocity over the frequency range 10 Hz to 10 kHz measured in accordance with this International Standard and with ISO 14695

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3.14
fan impeller efficiency
η_r
fan air power divided by impeller power

3.15
fan overall efficiency
η_e
fan air power divided by motor input power

3.16
sound pressure level
L_p
ten times the logarithm to the base 10 of the ratio of the square of the sound pressure radiated by the sound source under test to the square of the reference sound pressure

3.17
sound power level
L_W
ten times the logarithm to the base 10 of the ratio of the sound power radiated by the sound source under test to the reference sound power

3.18
inlet sound power level
L_{W1}
sound power level of the fan determined at the fan inlet

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3.19
outlet sound power level
L_{W2}
sound power level of the fan determined at the fan outlet

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3.20
noise frequency range of interest
<general>frequency range including the octave bands with centre frequencies between 63 Hz and 8 000 Hz and the one-third octave bands with centre frequencies between 50 Hz and 10 000 Hz

4 Symbols and abbreviated terms

The following symbols and units shall apply for the parameters listed.

Abbreviated term/represented quantity	Symbol	SI unit
Impeller annulus area	A_a	m^2
Gross fan outlet area	A_2	m^2
Effective fan outlet area	A_{eff}	m^2
Nominal fan diameter	D_R	m
Length of upstream chamber side	D_3	m
Sound pressure level	L_p	dB (re 20 µPa)
Average sound pressure level of the measured device	$L_{p(m)}$	dB (re 20 µPa)
Average sound pressure level of the reference sound source	$L_{p(r)}$	dB (re 20 µPa)
Sound power level	L_W	dB (re 1 pW)
Inlet sound power level	L_{W1}	dB (re 1 pW)
NOTE: (T) denotes the term or quantity stated to be a function of the thrust (see Annex D). Example: $\eta_e(T)$ is the fan overall efficiency based on thrust.		

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Abbreviated term/represented quantity	Symbol	SI unit
Outlet sound power level	L_{W2}	dB (re 1 pW)
Sound power level of the reference sound source	$L_{W(r)}$	dB (re 1 pW)
Rotational speed	n	revolution/s
Differential pressure across a flow measuring device	p	Pa
Gauge pressure at the fan outlet	p_{e2}	Pa
Gauge pressure in the fan chamber	p_{e2}	Pa
Effective fan dynamic pressure	p_d	Pa
Volume flow	q_v	m^3/s
Impeller balance grade (ISO 14694)	G	µm
Motor input power	P_e	W
Impeller power	P_r	W
Fan air power	P_u	W
Thrust/impeller power ratio	r_r	N/W
Thrust/motor input power ratio	r_e	N/W
Non-dimensional thrust/power ratio	r_t	—
Calculated thrust	T_c	N
Measured thrust	T_m	N
Impeller tip speed	v_p	m/s
Effective fan outlet velocity	v_{eff}	m/s
Fan outlet velocity	v_2	m/s
Mean throughflow velocity in a tunnel at a specified section	v_t	m/s
Total pressure rise	Δp	Pa
Standard air density 1,2 kg/m^3	ρ	kg/m^3
Inlet density taken as equal to the density in the test enclosure	ρ_a	kg/m^3
Efficiency based on thrust	$\eta_r(T)$	—
Fan overall efficiency	η_e	—
Motor efficiency	η_m	—
Fan impeller efficiency	η_r	—
Fan overall efficiency based on thrust	$\eta_e(T)$	—
Flow coefficient	φ	—
Thrust coefficient	Θ	—
Power coefficient	ϕ_r	—
NOTE: (T) denotes the term or quantity stated to be a function of the thrust (see Annex D). Example: $\eta_e(T)$ is the fan overall efficiency based on thrust.		

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5 Characteristics to be measured

5.1 General

In order that a jet fan be correctly applied and give satisfactory performance and reliability in service, it is necessary to determine a number of technical performance characteristics in addition to knowing the more obvious mechanical features, such as mass, overall dimensions, and installation dimensions.

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