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Fans — Determination of fan sound power levels under standardized laboratory conditions —

Part 4: Sound intensity method

Ventilateurs ~~industriels~~ — Détermination des niveaux de puissance acoustique des ventilateurs dans des conditions de laboratoire normalisées —
~~Partie 4: Méthode par intensité acoustique~~

Partie 4: Méthode de l'intensité acoustique

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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 document 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at ~~www.iso.org/patents.~~www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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

This fourth edition cancels and replaces the third edition (ISO 13347-4:2004), which has been technically revised. It also incorporates the Technical Corrigendum ISO 13347-4:2004/Cor 1:2006.

The main changes are as follows:

— ~~the~~ inclusion of acoustic methods for installation category E fans;

— ~~—~~ symbols ~~have been~~ harmonized with those used in ISO 5801 and other ISO standards ~~as~~ listed ~~in Normative~~as normative references ~~[2]~~[2];

— ~~—~~ closer alignment with the superordinate ISO 9614 series relating to sound intensity measurement;

— ~~—~~ editorial ~~corrections have been incorporated~~revisions.

A list of all parts in the ISO 13347 series can be found on the ISO website.

~~**ICS 17.140.20; 23.120**~~

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Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

This document establishes a method for determining the sound power level of a fan. The method is reproducible in all laboratories which are qualified according to the requirements of this document.

The method specified in this document employs standard sound measurement instrumentation. The test set-ups are generally designed to represent the physical orientation of a fan as installed, in accordance with ISO 5801 or ISO 13350.

Since sound power levels are considered independent of the acoustic environment around the fan, a good comparison can be made between two or more fans proposed for any specific air performance condition. Moreover, these values establish an accurate base for estimating the acoustical outcome of the fan installation in terms of sound pressure levels. A successful estimate of sound pressure levels requires extensive information on the fan and the environment in which it is to be located.

It is often advantageous for the equipment user to employ acoustical consultation to ensure that all factors which affect the final sound pressure levels are considered. More detailed information on the complexity of this situation may be found in acoustic textbooks.

This document has been developed in response to the need for a reliable and accurate enveloping surface method for determining the sound power levels of fan equipment. Where possible, it has been based on existing National standards and combines state-of-the-art with practical considerations.

NOTE~~:~~ The ~~Bibliography of this document has~~bibliography contains further references for those wishing to explore this subject in greater detail ~~[1]~~(see References [1] to ~~[7]~~[7]).

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Fans — Determination of fan sound power levels under standardized laboratory conditions — Part 4: Sound intensity method

Fans — Determination of fan sound power levels under standardized laboratory conditions — Part 4: Sound intensity method

1 Scope

This document specifies a method to measure sound power by using sound intensity measurements on a measurement surface which encloses the sound source. It This document provides guidelines on the acoustical environment, ambient noise, measurement surface, and number of measurements. The installation categories are generally designed to represent the physical orientation of a fan installed in accordance with ISO 5801, ISO 13350 and also defined in ISO 13349-1.

This document applies is applicable to fans as defined in ISO 5801 and ISO 13349-1. It This document is limited to the determination of airborne sound emission for the specified installation categories. Vibration is not measured, nor is the sensitivity of airborne sound emission to vibration effects determined.

The sizes of the fan, which can be tested in accordance with this document are limited only by the practical aspects of the test installations.

2 Normative references

The following referenced documents are indispensable for the application 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 5136, *Acoustics — Determination of sound power radiated into a duct by fans and other air-moving devices — In-duct method*

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

ISO 9614-1, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 1: Measurement at discrete points*

ISO 9614-2, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 2: Measurement by scanning*

ISO 13347-1, *Fans — Determination of fan sound power levels under standardized laboratory conditions — Part 1: General overview*

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

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

IEC 1043, *Electroacoustics; Instruments for the measurement of sound intensity; measurement with pairs of pressure sensing microphones*

3 Terms and Definitions, symbols and units

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5801, ISO 13349-1 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~~https://www.iso.org/obp

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

NOTE Some definitions have been expanded to fit the specific needs of this document. Further acoustic definitions can be found in ISO 13347-1.

3.1.1 ~~**3.1.1**~~
fan inlet
opening, usually circular or rectangular, through which the air first enters the fan casing

~~[SOURCE: ISO 13349-1]~~

Note 1 to entry: If the fan is provided with an inlet-connecting flange or spigot, the fan inlet dimensions are measured inside this connection. The inlet area is the gross area measured inside this flange, i.e. no deductions are made for blockages, such as motors and bearing supports.

Note 2 to entry: When the inlet area is not clearly defined, agreement can be reached between the parties to the contract.

Note 3 to entry: The fan inlet is defined by the airflow, when you reverse the airflow, what was previously the outlet, now becomes the inlet

~~3.1.2~~[SOURCE: ISO 13349-1:2022, 3.7.1]

3.1.2
fan outlet
opening, usually circular or rectangular, through which the air finally leaves the fan casing

~~[SOURCE: ISO 13349-1]~~

Note 1 to entry: If the fan is provided with an outlet connecting flange or spigot, the fan outlet dimensions are measured inside this connection. When the fan is delivered with a diffuser and the performance is quoted with this fitted, the area of the fan outlet may be taken as equal to the outlet area of the diffuser.

Note 2 to entry: Fan outlet area is, by convention, taken as the gross area in the outlet plane inside the casing, without deduction for motor, fairings or other obstructions. When the outlet area is not clearly defined, agreement can be reached between the parties to the contract.

Note 3 to entry: The fan outlet is defined by the airflow, when you reverse the airflow, what was previously the inlet, now becomes the outlet

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3.1.3
[SOURCE: ISO 13349-1:2022, 3.7.2]

3.1.3
inlet sound power level
sound power level of a fan determined at the *fan inlet* (3.1.1)(3.1.1) in a specified installation category A, B, C, D or E

3.1.4 3.1.4
outlet sound power level
sound power level of a fan determined at the *fan outlet* (3.1.2)(3.1.2) in a specified installation category A, B, C, D or E

3.1.5 3.1.5
casing sound power level
sound power level radiated from a fan casing

Note 1 to entry: If the fan drive is external to the fan casing, the casing sound power shall include the sound power generated by and radiated from the fan drive

Note 2 to entry: When cataloguing a range of fans, it is not always possible to include the motor noise, as this will vary according to the power and type of motor selected. Motor noise may then be omitted, provided this fact is clearly stated.

3.2 Symbols — Fan sound power levels

Considering all possible combinations for installation conditions specified in ISO 13347-1, fifteen different sound power level (L_W) descriptions are defined in Table 1 Table 1, for example $L_{W\,(A,in)}$.

Table 1 — Sound power levels

Number	Subscript	Description
1	(A,in)	free-inlet sound power level, installation category A.
2	(A,in + cas)	free-inlet sound power level plus radiated noise; installation category A.
3	(A,out)	free-outlet sound power level; installation category A.
4	(A,out + cas)	free-outlet sound power level plus radiated noise; installation category A.
5	(B,in)	free-inlet sound power level; installation category B.
6	(B,in+cas)	free-inlet sound power level plus casing-radiated noise; installation category B.
7	(B,out)	ducted outlet sound power level; installation category B.
8	(C,in)	ducted inlet sound power level; installation category C.
9	(C,out)	free-outlet sound power level; installation category C.
10	(C,out+cas)	free-outlet sound power level plus casing-radiated noise; installation category C.
11	(D,in)	ducted inlet sound power level; installation category D.
12	(D,out)	ducted outlet sound power level; installation category D.
13	(D,cas)	casing-radiated sound power level; installation category D.
14	(E,in)	non-ducted inlet sound power level; installation category E.
15	(E,out)	non-ducted outlet sound power level; installation category E.
16	(E,cas)	casing-radiated sound power level; installation category E.

Number	Subscript	Description
17	(E,tot)	total sound power level of a fan, installation category E (includes the contributions from the inlet, outlet, fan casing and drive).

All of the symbols in this table may be used to indicate levels in one-third octave or octave frequency bands as well as overall sound power levels and A-weighted sound power levels, provided that the sound power to which the symbols relate is clearly defined.

Where noise from the drive may contribute to the noise radiated from a casing then this should be clearly stated by the addition of + dr, e.g. ~~$L_{W\,(D,cas\,+\,dr)}$~~$L_{W\,(D,cas\,+\,dr)}$

NOTE 1 Not all of the above levels need to be measured for a particular fan.

NOTE 2 For installation category E, the inlet, outlet and casing-radiated sound power level can be established using sound intensity methods (this document) or in some circumstances, methods using ISO 13347-3.

3.3 Other ~~Symbols~~symbols

For consistency and mutual understanding, it is recommended that the symbols and units shown in ~~Table 2~~Table 2 be used in reporting and calculation.

Table 2 — Symbols, units

Symbol	Term	SI unit
a, b, c	Measurement surface dimensions	m
c	speed of sound	m/s
D_{21}	quality indicator for sound field directivity	dB
D_{23}	quality indicator for reverberation or reflection	dB
E_W	adjustment to sound power level for duct end correction(s)	dB
$E_{W,i}$	duct inlet end correction	dB
$E_{W,o}$	duct outlet end correction	dB
d	duct diameter	m
d_e	equivalent duct diameter (of rectangular duct)	m
I	sound intensity	W/m²
~~$\bar{I}$~~$\bar{I}$	surface average sound intensity	W/m²
I_n	sound intensity I at measurement location n	W/m²
I_{ref}	reference intensity, re 1 pW/m² (1 × 10⁻¹² W/m²)	W/m²
~~$\overline{L_I}$~~$\bar{L}_I$	surface average sound intensity level	dB
~~$\overline{L_{|I|}}$~~$\bar{L}_{|I|}$	surface average level of the unsigned sound intensity	dB
L_{If}	fan sound intensity level	dB
~~$\overline{L_{If}}$~~$\bar{L}_{If}$	surface average fan sound intensity level	dB
L_{Iq}	RSS sound intensity level	dB
~~$\overline{L_{Iq}}$~~$\bar{L}_{Iq}$	surface average RSS sound intensity level	dB
L_p	sound pressure level, re 20 µPa (2 x 10⁻⁵ Pa)	dB
~~$\overline{L_p}$~~$\bar{L}_p$	surface average sound pressure level	dB
L_{ph}	recorded sound pressure level of background (noise) as measured over the normal microphone path/position	dB

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Symbol	Term	SI unit
~~$\overline{L_{pb}}$~~ $\bar{L}_{pb}$	surface average of background sound pressure level	dB
L_W	sound power level, re 1 pW (1 x 10^{-12} W)	dB
$L_{W,m}$	sound power level determined without end correction adjustment	dB
$L_{W,i}$	inlet sound power level determined with end correction adjustment	dB
$L_{W,m,i}$	inlet sound power level determined without end correction adjustment	dB
$L_{W,o}$	outlet sound power level determined with end correction adjustment	dB
$L_{W,m,o}$	outlet sound power level determined without end correction adjustment	dB
$L_{W,q}$	Sound power level of the reference sound source (RSS) obtained from the RSS calibration	dB
l	duct length	m
R_W	sound power level reference source adjustment	dB
r	radius	m
ρ	density	kg/m³
S	measurement surface area	m²
S_i	cross-sectional area of inlet at measurement area	m²
S_o	cross-sectional area of outlet at measurement area	m²
S_{ref}	reference area, 1 m²	m²
z	elevation	m

4 Instruments and methods of test

4.1 General

Full details of the instrumentation and its requirements are given in ISO 13347-1. Particular requirements for this document are given in the following subclauses. A sound intensity measurement instrument and probe that meet the requirements of IEC 1043 shall be used. For sound intensity measurements, the use of two or more different configurations of the intensity probe, or different probes, may be required to cover the entire frequency range in conformance with ~~Table 3~~ Table 3.

Table 3 — Tolerances for the instrumentation system

One-third octave band centre frequency Hz	Tolerance dB
50 to 80	±1,5
100 to 4 000	±1,0
5 000 to 8 000	±1,5
10 000	±2,0
12 500	±3,0

4.2 Reference sound source (RSS)

The RSS should periodically be used to qualify the performance of the sound intensity measurement system and personnel, and to determine a sound power level adjustment for the specific site conditions. To be used

for these purposes, the RSS shall be of an appropriate type, be calibrated accurately and be properly maintained. The RSS shall be in accordance with the requirements specified in ISO 13347-1.

The useful frequency range for accurate sound intensity measurements is dependent upon the character of the sound field. Care should be taken to verify that sound intensity measurements are accurate in the actual measurement environment.

4.3 Calibration and field check

The instrument, including the probe, shall comply with IEC 1043 and be verified regularly in a laboratory. The calibrator shall be checked at least once every year to verify that its output has not changed. In addition, an electrical calibration of the instrumentation system over the entire frequency range of interest shall be performed periodically, at intervals of not more than one year.

Before each sound power determination, the following calibration checks shall be performed. A calibration check of the entire measuring system at one or more frequencies within the frequency range of interest shall be made for each microphone. An acoustical calibrator conforming to IEC 1043 shall be used for this purpose.

In addition to the calibration check, the field check procedure for sound intensity measurement specified by the manufacturer shall be performed. If no field check procedure is specified, the following procedure shall be performed.

The intensity probe shall be placed on the measurement surface, oriented normal to the surface, at a position where the noise is characteristic for the fan equipment under test. The sound intensity shall be measured. The intensity probe shall be rotated through 180° and placed with its acoustical centre in the same position as the initial measurement. The sound intensity shall be measured again. The intensity probe should be mounted on a stand or other mechanical device so that its acoustical centre retains the same position when the probe is rotated. For the octave band with the highest level, the absolute difference between the two levels shall be less than the value in ~~Table 4~~Table 4 for the measuring equipment to be acceptable. The two sound intensities shall be of opposite sign.

Table 4 — Tolerances for difference in sound intensity levels for field check

Octave band centre frequency Hz	Difference dB
63 to 125	1,5
250 to 4 000	1,0
8 000	1,5

4.4 Performance verification

Periodically, the performance of the instrumentation system may be verified by determining the sound power of a reference sound source using the procedures specified in ISO 13347-1.

The sound power level determined for the reference source shall differ from its calibrated value over the frequency range of interest by no more than the tolerances given in ~~Table 5~~Table 5.

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