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Acoustics — Measurement of airborne noise emitted and structure-borne vibration induced by small air-moving devices —

Part 1:
Airborne noise measurement

Acoustique — Mesurage du bruit aérien émis et des vibrations de structure induites par les petits équipements de ventilation — ~~Partie 1: Mesurage du bruit aérien~~

Partie 1: Mesurage du bruit aérien

FDIS stage

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ISO 20344, Personal protective equipment — Test methods for footwear

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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~~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).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ~~ISO's~~ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see ~~www.iso.org/iso/foreword.html~~www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

This second edition cancels and replaces the first edition (ISO 10302-~~-~~1:2011), which has been technically revised.

The main changes are as follows:

— ~~In Clause 3,~~In Clause 3, the most terms were editorially improved with no technical changes, and their cross-references to the main body were also clarified.

— ~~In Clause 4,~~In Clause 4, the allowable fan static pressure range, 750 Pa for a full-size plenum, was extended up to 1,500 Pa for a half-size plenum and 3,000 Pa for a quarter-size plenum.

— ~~In Clause 7,~~In Clause 7, for the selection of points of operation, in addition to the existing Method A (conventional method), Method B (alternative method) was introduced.

— In ~~Clause 11,~~Clause 11, Note was amended to clarify the reference to ~~Annex D.~~Annex D.

— In ~~Annex A,~~Annex A, to be consistent to the definition of micro-fan ~~(3.1.2),~~(3.1.2), the abscissa of ~~Figure A.1~~Figure A.1 and related descriptions were amended.

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A list of all parts in the ISO 10302-1 series can be found on the ISO website.

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 specifiesshows in detail methods for determining and reporting the airborne noise emissions of small air-moving devices (AMDs) used primarily for cooling electronic equipment, such as that for information technology and telecommunications.

To provide compatibility with measurements of acoustical noise emitted by such equipment, this document uses the noise emission descriptors and sound power measurement methods of ISO 7779. The descriptor of overall airborne noise emission of the AMD under test is the A--weighted sound power level. The one-third-octave-band sound power level is the detailed descriptor of the noise emission. Octave-band sound power levels may be provided in addition to the one-third-octave-band sound power levels.

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Acoustics — Measurement of airborne noise emitted and structure-borne vibration induced by small air-moving devices —

Part 1: Airborne noise measurement

1 Scope

This document specifies methods for measuring the airborne noise emitted by small air-moving devices (AMDs), such as those used for cooling electronic, electrical, and mechanical equipment where the sound power level of the AMD is of interest.

Examples of these AMDs include propeller fans, tube-axial fans, vane-axial fans, centrifugal fans, motorized impellers, and their variations.

This document describes the test apparatus and methods for determining the airborne noise emitted by small AMDs as a function of the volume flow rate and the fan static pressure developed by the AMD on the test apparatus. It is intended for use by AMD manufacturers, by manufacturers who use AMDs for cooling electronic equipment and similar applications, and by testing laboratories. It provides a method for AMD manufacturers, equipment manufacturers and testing laboratories to obtain comparable results. Results of measurements made in accordance with this document are expected to be used for engineering information and performance verification, and the methods can be cited in purchase specifications and contracts between buyers and sellers. The ultimate purpose of the measurements is to provide data to assist the designers of electronic, electrical or mechanical equipment which contains one or more AMDs.

Based on experimental data, a method is given for calculating the maximum volume flow rate of the scaled plenum up to which this document is applicable.

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.

<std>ISO 3741, Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Precision methods for reverberation test rooms</std>

<std>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</std>

<std>ISO 3745, Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Precision methods for anechoic rooms and hemi-anechoic rooms</std>

<std>ISO 5801, *Fans — Performance testing using standardized airways*</std>

<std>ISO 5801, *Fans — Performance testing using standardized airways*

ISO 7779:2018, Acoustics — Measurement of airborne noise emitted by information technology and telecommunications equipment</std>

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~~<std>ISO/IEC Guide 98-~~ISO/IEC Guide 98-3, Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995~~)</std>~~)

~~<std>~~ANSI/ASA S2.32, Methods for the experimental determination of mechanical mobility — Part 2: Measurements using single-point translational excitation~~</std>~~

~~<unknown>JBMS-72-~~JBMS-72-1:2010, *Acoustics — Method for the measurement of airborne noise emitted and structure-borne vibration induced by small air-moving devices — Part 1: Airborne noise measurement*~~</unknown>~~

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7779 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/

3.1 General definitions

3.1.1
air-moving device
AMD
fan
device for moving air which utilizes a rotating impeller driven by an electric motor with electronic or mechanical command

Note 1 to entry: An air-moving device has at least one inlet opening and at least one outlet opening. The openings can have elements for connection to ductwork or to other parts of the airflow path.

Note 2 to entry: Tests can be run with a particular frame, motor, and rotor, but with different accessories (e.g. finger guards). For the purposes of this document, each such configuration is referred to as an air-moving device.

Note 3 to entry: Within some industries, including information technology, the unmodified term “fan” means “axial flow air-moving device”, and the unmodified term “blower” means “centrifugal air-moving device”. In this document, the term “fan” is used to mean “air-moving device” and does not necessarily imply axial flow. Modifiers (such as axial, centrifugal or mixed flow) are added as necessary to distinguish between types.

3.1.2
micro-fan
air-moving device (see ~~3.1.1~~)3.1.1) which has a maximum volume flow rate less than or equal to 0,015 m³/s

Note 1 to entry: Micro-fans are a subset of fans under test according to this ~~part of ISO 10302~~document.

Note 2 to entry: ISO 5801 limits the range of applicability to Reynolds numbers of 12 000 or higher. This Reynolds number corresponds to the lower limit of volume flow rate of approximately 0,01 m³/s. Since lower volume fans are of interest for many cooling applications, the methodology of JBMS-72-1:2010, Annex A[1] is used to measure the *p*-*q* curve of a micro-fan.

[1] The English version of JBMS-72-1:2010, Annex A is freely available from ~~https://hyojunka.jbmia.or.jp/hyojun2/upload-v3/archive/JBMS-72-1-1.pdf~~https://hyojunka.jbmia.or.jp/hyojun2/upload-v3/archive/JBMS-72-1-1.pdf.

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3.2 Acoustical definitions

3.2.1
sound power level

~~L_W~~

L_W

ten times the logarithm to the base 10 of the ratio of the sound power, P, to a reference value, P_0, expressed in decibels

$$L_W = 10\lg \frac{P}{P_0}$$

$$L_W = 10\lg \frac{P}{P_0}$$

where the reference value, P_0, is 1 pW

Note 1 to entry: If a specific frequency weighting as specified in IEC 61672-1[6][8] and/or specific frequency bands are applied, this should be indicated by appropriate subscripts; e.g. L_{WA} denotes the A-weighted sound power level.

3.2.2
frequency range of interest

range extending from the 100 Hz one-third-octave band to the 10 kHz one-third-octave band

Note 1 to entry: The centre frequencies of these one-third-octave bands are defined in ISO 266[1].[1].

Note 2 to entry: For small, low-noise fans to be measured (i.e., micro-fans), depending on the size of applicable plenum, the radius of the test hemisphere may be reduced to less than 1 m, but not less than 0,5 m (see ~~8.2.1)~~ 8.2.1). However, a radius less than 1 m could itself impose limits on the frequency range over which tests are performed. For details, reference is made to ISO 7779:2018, B.1.

3.2.3
insertion loss of test plenum

ΔL

sound power level ~~(3.2.1)~~ (3.2.1) difference due to the presence of test plenum, defined as follows:

$$\Delta L_W = L_{W,\text{out}} - L_{W,\text{in}}$$

$$\Delta L_W = L_{W,\text{out}} - L_{W,\text{in}}$$

where

~~$L_{W,\text{out}}$~~ $L_{W,\text{out}}$	is the sound power level, in decibels, of a sound source determined when installed outside the test plenum;
~~$L_{W,\text{in}}$~~ $L_{W,\text{in}}$	is the sound power level, in decibels, of a sound source determined when installed inside the test plenum.

Note 1 to entry: The insertion loss of the test plenum is expressed in decibels.

3.3 Aerodynamic definitions

3.3.1
test plenum
structure on to which the air-moving device under test is mounted for acoustical noise emission measurements

Note 1 to entry: The plenum provides a flow resistance to the air-moving device, but permits sound from the air-moving device to radiate freely into the test room with only minimal attenuation. Thus, the sound power radiated by the air-moving device can be determined from acoustical measurements made outside the test plenum.

3.3.2
AMD aerodynamic performance curve
“*p-q* curve”
presentation of fan static pressure as a function of volume flow rate under *standard air conditions* (3.3.6)(3.3.6) and constant operating voltage and frequency

Note 1 to entry: For the purpose of this document, a qualifier, “aerodynamic”, before “performance curve” is inserted to distinguish from acoustical noise emission characteristics against volume flow rate.

Note 2 to entry: The presentation is derived in accordance with ISO 5801 or Annex A,Annex A, which complement each other. The method for small air-moving devices of volume flow rate up to 0,015 m³/s is specified in Annex A.Annex A.

Note 3 to entry: For convenience, in this part of ISO 10302document, the term “*p*–*q* curve” is used.

3.3.3
point of operation
point on the *AMD aerodynamic performance curve* (3.3.2)(3.3.2) corresponding to a particular volume flow rate

Note 1 to entry: The point of operation is controlled during a test by adjusting the “slider” on the test plenum exit port assembly.

3.3.4
overall static efficiency
$\eta_{o,s}$
$\boldsymbol{\eta_{o,s}}$
<for air-moving device of interest>volume flow rate multiplied by the fan static pressure and divided by the input electrical power

Note 1 to entry: The overall static efficiency, $\eta_{o,s}$, expressed as a percentage, is given by

$$\eta_{o,s} = \frac{p_{s,f}\, q_V}{P_{input}} \times 100$$

$$\eta_{o,s} = \frac{p_{s,f} q_V}{P_{input}} \times 100$$

where

$p_{s,f}$ $p_{s,f}$ is the fan static pressure, in pascals;

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q_V is the volume flow rate, in cubic metres per second;

P_{input} is the motor input power, in watts (true power, not including reactive component), supplied at the terminals of the electric drive motor.

Note 2 to entry: The air-moving device is defined to include the motor, impeller and frame; therefore, the overall static efficiency includes both the electromechanical efficiency of the motor and the aerodynamic efficiency of the impeller and frame.

3.3.5
standard air density
density under *standard air conditions* ~~(3.3.6)~~(3.3.6)

Note 1 to entry: The value is 1,20 kg/m³.

3.3.6
standard air conditions
<for aerodynamic performance measurement> specified meteorological conditions

Note 1 to entry: For the purposes of this document, the conditions are: 20 °C temperature; 50 % relative humidity; and 1,013 × 10⁵ Pa ambient pressure.

4 Limitations of measurement

This method is useful up to the maximum volume flow rate, $q_{V,max}$, as a function of nominal air volume, V, of the plenum used and up to a fan static pressure of 750 Pa.

Based on experimental data and modelled results, the allowable fan static pressure range is extended up to at least 750 Pa for a full-size plenum, 1 500 Pa for a half-size plenum and 3 000 Pa for a quarter-size plenum.

NOTE 1 For static pressures above 750 Pa, the integrity of the plenum and the measurement can be impacted by the thickness of the polyester film, the size of the plenum, and the construction of the mounting plate and the outlet port. A thinner polyester film and a larger plenum size will result in increased strain on the polyester film. If a fan is operating at a static pressure above 750 Pa, closely monitor for leaks, particularly around the mounting panel and outlet port. See References ~~[14] and [15]~~[15] for details.

$$q_{V,max} = \frac{q_{V,0}}{V_0} V \quad (1)$$

where

$q_{V,max}$ is the maximum volume flow rate of the scaled plenum, in cubic metres per second;

$q_{V,0}$ is the maximum volume flow rate of the full-size plenum, in cubic metres per second, $q_{V,0} = 1 \text{ m}^3/\text{s}$;

V_0 is the nominal air volume of the full-size plenum defined in ~~Clause 6,~~Clause 6, in cubic metres, $V_0 = 1{,}3 \text{ m}^3$;

V is the nominal air volume of the scaled plenum, in cubic metres.

NOTE 2 The value of the interior air volume of a full-size plenum of 1,3 m³ is rounded up from 1,296 m³ = 1,2 m (width) × 1,2 m (depth) × 0,9 m (height).

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NOTE 3 It is noted that the "nominal air volume" means approximate air volume calculated from the outer dimensions of the plenum. For instance, in case of 1/4 sized plenum, the nominal air volume of the plenum, excluding the leg height, becomes $V = b \cdot l \cdot h$ = 0,3 m × 0,3 m × 0,225 m = 0,020 25 m^3, where b is width, l is depth, and h is height.

For the purposes of this document, it is recommended that the smallest plenum possible be applied, provided that the maximum volume flow rate of the fan is within the limit of ~~Formula (1).~~Formula (1).

The method defined in this document, by reference to ISO 7779, ~~provides~~provided for determination of sound power levels in a qualified environment, ~~using~~shall use either a comparison method in a reverberation test room based on ISO 3741, or a direct method in essentially free-field conditions over a reflecting plane based on ISO 3744 or ISO 3745. The method specified in this document can be applied to air-moving devices (AMDs) which radiate: a) broad-band noise; b) narrow-band noise; or c) noise that contains discrete frequency components.

The method specified in this document permits the determination of acoustical noise emission levels for an individual unit under test. If these levels are determined for several units of the same production series, the results may be used to determine a statistical value for the production series.

CAUTION~~-~~ — Vibration, flow disturbances, insertion loss and other phenomena can alter radiated sound power in the actual application; therefore, the results of measurements made in accordance with this document can differ from the results obtained when AMDs are installed in equipment.

NOTE 4 This document does not describe measurement of the structure-borne noise generated by AMDs.

5 Design and performance requirements for test plenum

5.1 General

The design specified is intended to meet the limits stated for maximum volume flow rate and maximum fan static pressure. The design provides an acoustically transparent, adjustable flow resistance to the AMD.

NOTE 1 See ~~5.5~~5.5 for requirements for confirming acoustical transparency in accordance with this document.

The reference design of the plenum is specified in ~~5.2 to 5.6 and shown in Figure 1 to Figure 8.~~5.2 to 5.6 and shown in Figure 1 to Figure 8. Also addressed in these subclauses and elsewhere in this document are permitted variations from this design, primarily the option of reducing the linear dimensions of the frame and some dimensions of other parts, while maintaining geometric proportions, in the range from full to quarter scale. Such a reduction reduces the maximum permitted volume flow rate of AMDs to be tested in direct proportion to the reduction in volume of the plenum [see ~~Formula (1)], i.e.,~~Formula (1)], i.e. by the linear scale raised to the third power.

NOTE 2 These variations can better accommodate the use of smaller or quieter fans as well as test chambers with doors too narrow for the reference design plenum.

Permitted variations have been shown to yield standard deviations of reproducibility within the range of ~~Table 1.~~Table 1. The degree to which other deviations from the reference design affect the uncertainty of the determination of sound power levels of AMDs is not known.

5.2 Test plenum: main assembly

~~**5.2.1 General:**~~ The test plenum shall consist of an airtight chamber constructed with a frame covered with an airtight acoustically transparent polyester film, a mounting panel, and an adjustable exit port assembly as shown in ~~Figure 1.~~Figure 1. The plenum shall conform to the requirements specified in 5.2.1 to 5.2.6.

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Formatted: Body Text, Adjust space between Latin and Asian text, Adjust space between Asian text and numbers, Tab stops: Not at 0.7 cm + 1.4 cm + 2.1 cm + 2.8 cm + 3.5 cm + 4.2 cm + 4.9 cm + 5.6 cm + 6.3 cm + 7 cm