

Standard ECMA-275-1

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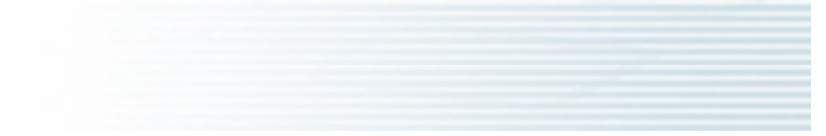
**Measurement of
airborne noise
emitted and
structure-borne
vibration induced by
small air-moving
devices –
Part 1: Airborne
noise measurement**

Standard



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Introduction

This part of ECMA-275 specifies 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 part of ECMA-275 uses the noise emission descriptors and sound power measurement methods of ECMA-74 (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.

ECMA-275-1 was prepared by Technical Committee 26, Acoustics, Task Group 1, *Noise and vibration measurement of small air-moving devices*.

When they were first published, ECMA-275-1 and ECMA-275-2 were named as fourth editions because they followed and replaced ECMA-275 third edition.

In the fifth edition of ECMA-275-1, allowable static pressure values for the test plenum are increased.

ECMA-275 series consists of the following parts, under the general title Measurement of airborne noise emitted and structure-borne vibration induced by small air-moving devices:

- *Part 1: Airborne noise measurement*
- *Part 2: Structure-borne vibration measurement*

This Ecma Standard was developed by Technical Committee 26 and was adopted by the General Assembly of December 2020.

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Measurement of airborne noise emitted and structure-borne vibration induced by small air-moving devices — Part 1: Airborne noise measurement

1 Scope

This part of ECMA-275 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 part of ECMA-275 describes, by referencing to ISO 10302-1:2011, 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 part of ECMA-275 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 part of ECMA-275 is applicable.

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 10302-1:2011, *Acoustics — Measurement of airborne noise emitted and structure-borne vibration induced by small air-moving devices — Part 1: Airborne noise measurement*

NOTE By referencing to ISO 10302-1:2011, there is no more normative reference here (except, JBMS-72-1:2011). For the purpose of practical application of ECMA-275-1, however, Bibliography documents [1 - 7] are also needed to read. In each normative clause of this part of ECMA-275, there is a note to list what document(s) are referred normatively by ISO 10302-1:2011.

JBMS 72:2003, *Acoustics — Method for the measurement of airborne noise emitted by micro-fans*

3 Terms and definitions

Refer to Clause 3 of ISO 10302-1:2011.

4 Limitations of measurement

Refer to Clause 4 of ISO 10302-1:2011 with the following exception regarding the fan static pressure limit of 750 Pa. Based on experimental data and modelled results, the allowable fan static pressure range shall extend up to at least 750 Pa for a full-size plenum, 1500 Pa for a half-size plenum and 3000 Pa for a quarter-size plenum.

NOTE 1 For static pressures above 750 Pa, the integrity of the plenum and the measurement may 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 Reference [10] for details.

NOTE 2 In Clause 4 of ISO 10302-1:2011, the following standards are referred normatively:

ISO 3741,
ISO 3744,
ISO 3745,
ISO 7779:2010.

5 Design and performance requirements for test plenum

Refer to Clause 5 of ISO 10302-1:2011.

NOTE 1 The document structure of Clause 5 of ISO 10302-1:2011 is as follows:

- 5.1 General
- 5.2 Test plenum: Main assembly
- 5.3 Mounting panel assembly
- 5.4 Adjustable exit port assembly
- 5.5 Insertion loss of test plenum
- 5.6 Instrumentation for static pressure measurement

NOTE 2 In Clause 5 of ISO 10302-1:2011, the following standards are referred normatively in the subclause shown in the parentheses:

ANSI/ASA S2.32 (5.3),
ISO 5801:2007 (5.6).

NOTE 3 In Clause 5 of ISO 10302-1:2011, the following figures and tables are referred normatively in the subclause shown in parentheses:

- Figure 1 — Test plenum (full size)** (5.1, 5.2.1, 5.2.2, 5.2.3, 5.2.6, 5.3, 8.2.1)
- Figure 2 — Test plenum — Film attachment detail** (5.1, 5.2.1, 5.2.3)
- Figure 3 — Test plenum — Gusset and vibration isolation** (5.1, 5.2.4, 5.2.6)
- Figure 4 — Test plenum — Pressure ring** (5.1, 5.2.7, 5.3, 5.6)
- Figure 5 — Mounting panel assembly** (5.1, 5.3)
- Figure 6 — Adjustable exit port assembly** (5.1, 5.4)
- Figure 7 — Adjustable exit port assembly — Aperture plate (stainless steel)** (5.1, 5.4)
- Figure 8 — Adjustable exit port assembly — Slider (stainless steel)** (5.1, 5.4)
- Figure 9 — Schematic correlation between p - q curve versus system impedance curves (not to scale)** [5.1, 7.2.1(New 7.2.2.1)]
- Figure 10 — Hemispherical surface — 10 measurement points** (5.1, 8.2.2)

Figure 11 — Coaxial circular five or more paths in parallel planes for microphone traverses in a free field over a reflecting plane (8.2.3)

Table 1 — Estimated values of the standard deviation of reproducibility of sound power levels of air-moving devices determined in accordance with this part of ISO 10302 (5.1)

Table 2 — Co-ordinates of hemispherical measurement surface for sources emitting discrete tones (10 measurement heights) (8.2.2)

6 Installation

Refer to Clause 6 of ISO 10302-1:2011.

NOTE 1 The document structure of Clause 6 of ISO 10302-1:2011 is as follows:

- 6.1 Installation of test plenum in test room
- 6.2 Direction of airflow
- 6.3 Mounting of air-moving device

NOTE 2 In Clause 6 of ISO 10302-1:2011, the following standard is referred normatively in the subclause shown in the parentheses:

ISO 7779:2010 (6.1).

7 Operation of air-moving device

Refer to Clause 7 of ISO 10302-1:2011, but replace 7.2 by the following.

NOTE 1 The document structure of Clause 7 of ISO 10302-1:2011 is as follows:

- 7.1 Input power
 - 7.1.1 Alternating current (AC) air-moving devices
 - 7.1.2 Direct current (DC) air-moving devices
- 7.2 Points of operation (AC and DC air-moving devices)
 - 7.2.1 Required points of operation
 - 7.2.2 Additional points of operation
 - 7.2.3 Procedure

NOTE 2 In Clause 7 of ISO 10302-1:2011, the following standard is referred normatively in the subclause shown in the parentheses:

ISO 5801:2007 (7.2.3)

JBMS-72-1:2011 (7.2.3 by referencing to is Annex A).

7.2 Points of operation (AC and DC air-moving devices)

7.2.1 General

For the selection of points of operation, there are the following 2 alternative methods.

Method A of 7.2.2 is, so called conventional method, which defines points of operation as a function of the maximum flow rate of the AMD of interest.

Method B of 7.2.3 is new method, which defines points of operation as a point at the intersection of the p - q curve of the AMD and the system impedance curve.

For compliance to this part of ECMA-275, the requirements of at least, either 7.2.2 and/or 7.2.3 are to be fully satisfied.

7.2.2 Method A (conventional method)

7.2.2.1 Required points of operation

The AMD shall be tested at three points of operation for each of the required line frequencies and voltages given in 7.1. These points of operation correspond to:

- a) the adjustable exit port (slider) completely open,
- b) 80 % of maximum volume flow rate on the p - q curve and
- c) 20 % of maximum volume flow rate on the p - q curve.

The actual static pressure reading at each point of operation shall be recorded.

NOTE 1 In this part of ECMA-275-1, p - q curve measurement is a pre-requisite for acoustical noise measurement. So the "maximum volume flow rate" means the point on the p - q curve, which corresponds to the condition of static pressure equal to 0. For instance, when the maximum volume flow rate of a fan under test is read 0,01 m³/s from the p - q curve, 80 % of maximum volume flow rate means 0,01 m³/s × 0,8 = 0,008 m³/s.

NOTE 2 Within the framework of this part of ECMA-275, a clear distinction is made between "slider completely open" and "maximum flow rate". In ISO 10302:1996 and other conventional standards this was not the case. Condition a) above, "slider completely open", was referred to as the "maximum flow rate" or "free delivery" condition. However, air-flow resistance by the plenum influences the actual point of operation. For example, the three smooth lines near the abscissa in Figure 9 of ISO 10302-1:2011 indicate the system impedance curves of the quarter scale, half scale and full scale plenum respectively, with slider completely open.

7.2.2.2 Additional points of operation

Additional tests may be run at other points of operation, including the point of maximum overall static efficiency, to establish the sound power level versus volume flow rate curve. Some AMDs (e.g. small tube-axial fans) may be unstable when operated near the maximum overall static efficiency point. Tests should not be conducted at unstable points of operation.

7.2.3 Method B (alternate method)

7.2.3.1 Required points of operation

The AMD shall be tested at point of operation at the intersection of the p - q curve of the AMD and the system impedance curve of the candidate system expected to install the AMD, for each of the required line frequencies and voltages given in 7.1. These test points correspond to the actual points of operation of the candidate system.

7.2.3.2 Additional points of operation

Optionally, the points of operations specified in 7.2.2.1 can be added.

7.2.4 Procedure

Points of operation shall be established as in steps a) to c).

- a) The fan static pressure at the designated percent volume flow rates shall be read from the AMD aerodynamic performance curve (p - q curve) determined (prior to acoustical noise measurement) in accordance with ISO 5801 or Annex A, as applicable, with the same direction of airflow.
- b) If the ambient atmospheric density during the noise test differs by more than 1 % from that recorded in accordance with ISO 5801 or Annex A, as applicable, the fan static pressure shall be corrected as follows:

$$p_{s,2} = p_{s,1} \left(\frac{273 + t_1}{273 + t_2} \right) \times \frac{p_{amb,2}}{p_{amb,1}} \quad (1)$$

where

- $p_{s,2}$ is the fan static pressure to be set on the test plenum, in pascals
- t_2 is the air-flow temperature during acoustical noise measurement in degrees Celsius;
- $p_{amb,2}$ is the atmospheric pressure during acoustical noise measurement, in kilopascals;
- $p_{s,1}$ is the fan static pressure during volume flow rate measurement, in pascals;
- t_1 is the air-flow temperature during volume flow rate measurement, in degrees Celsius;
- $p_{amb,1}$ is the atmospheric pressure during volume flow rate measurement, in kilopascals.

- c) The slider shall be adjusted to obtain the reading of the fan static pressure, $p_{s,2}$, within ± 1 % of the maximum fan static pressure, determined with a pressure-measuring instrument satisfying the requirements of 5.6.

The fan and the fan static pressure shall be allowed to stabilize at each point of operation.

If measurements are made at the maximum overall static efficiency point, care should be taken when adjusting the plenum for this point of operation. Some AMDs have three or more values of volume flow rate corresponding to the same fan static pressure in the region of maximum overall static efficiency. Only the point with the highest volume flow rate is the maximum overall static efficiency point. To obtain this point of operation, start from free delivery and increase the static pressure until the point of operation is reached.

If an AMD is unstable (e.g. unsteady speed or pressure) at one of the recommended points of operation, decrease the fan static pressure until stability is achieved and use the new point of operation thus reached. The instability shall be reported and the alternative point of operation shall be described.

NOTE The AMD aerodynamic performance curve obtained according to ISO 5801 or Annex A can differ from the performance on the test plenum. This difference is assumed to be equivalent to that typical of normal AMD applications, and no corrections for test plenum differences should be made.

8 Measurement procedures

Refer to Clause 8 of ISO 10302-1:2011.

NOTE 1 The document structure of Clause 8 of ISO 10302-1:2011 is as follows:

- 8.1 General
- 8.2 Microphone positions for measurements in an essentially free field over a reflecting plane
 - 8.2.1 General
 - 8.2.2 Fixed points on a hemisphere
 - 8.2.3 Coaxial circular paths in five or more parallel planes
- 8.3 Preparations for measurements
- 8.4 Operational test of air-moving device

NOTE 2 In Clause 8 of ISO 10302-1:2011, the following standards are referred normatively:

- ISO 7779:2010 (8.1),
- ISO 3744(8.2.1, 8.2.3),
- ISO 3745(8.2.1)

9 Measurement uncertainty

Refer to "Clause 9 & Annex E" of ISO 10302-1:2011.

NOTE 1 In Clause 9 of ISO 10302-1:2011, the following standard is referred normatively:

- ISO/IEC Guide 98-3.

NOTE 2 In Clause 9 of ISO 10302-1:2011, the following table is referred normatively:

Table 1 — Estimated values of the standard deviation of reproducibility of sound power levels of air-moving devices determined in accordance with this part of ISO 10302.

10 Information to be recorded

Refer to Clause 10 of ISO 10302-1:2011.

11 Information to be reported

Refer to Clause 11 of ISO 10302-1:2011.

Annex A (normative)

Micro-fans p - q curve measurement method

A.1 Scope

In the main body of ISO 10302-1:2011, the acquisition of p - q curve of the fan under test is prerequisite for airborne noise emission measurement. For this purpose, the methods of ISO 5801 based on measurement by using the air chamber are cited.

According to ISO 5801:2007, 22.4.2, Table 4, the applicability of the methods is limited to the condition with a Reynolds number of approximately 12 000 or higher. This Reynolds number corresponds to the lower limit of volume flow rate of approximately 0,0015 m³/s.

Actual fans are becoming smaller and smaller, and are violating the Reynolds number assumption. Therefore a complementary method to ISO 5801 is required for these fans. In ISO 10302-1:2011, these fans are referred to as micro-fans (3.1.2 of ISO 10302-1:2011).

This annex specifies new methodology of p - q curve measurement of micro-fans, by reference to JBMS-72:2003, Annex A. Experimental data show that this method is useful to, at least, the maximum volume flow rate of 0,015 m³/s. See Figure A.1.

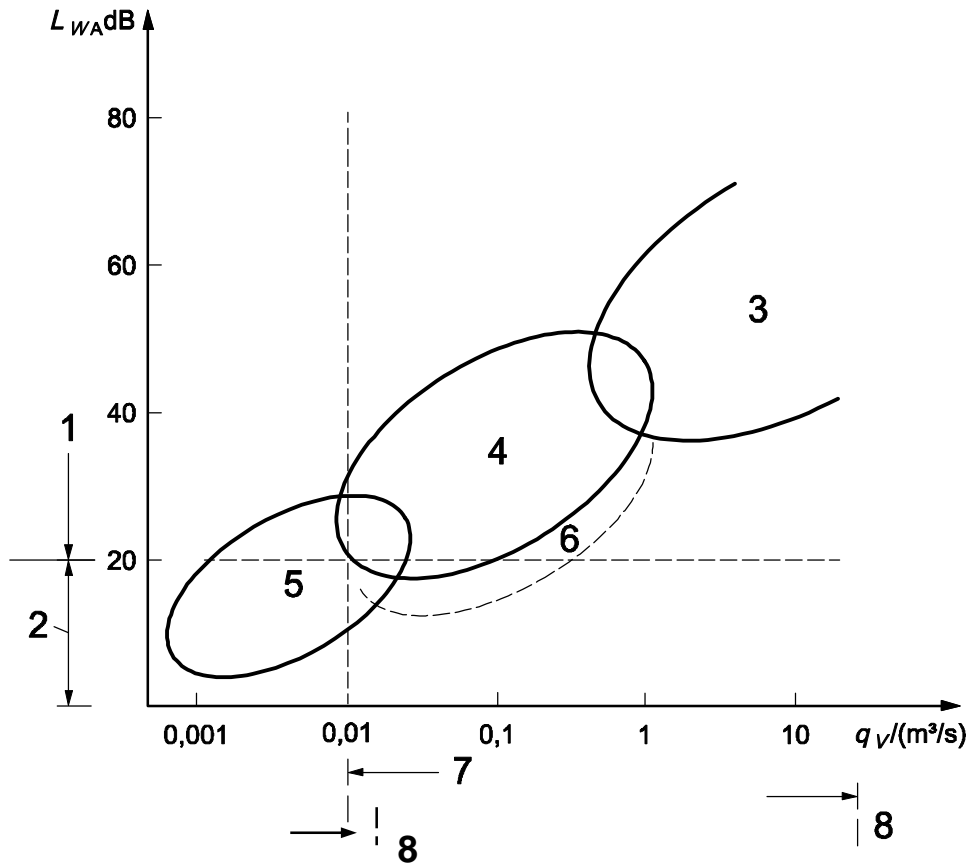


Figure A.1 – Correlation between volume flow rate of micro-fans and conventional fans

Key

- 1 lower limit of measurement by conventional method with 1 m radius (limit due to conventional microphone sensitivity)
- 2 range in which new measurement method is required
- 3 region intended for industrial fans
- 4 region intended for IT equipment fans
- 5 region of micro-fans
- 6 region of extremely low noise fans
- 7 approximate lower limit of measurement by conventional method based on ISO 5801
- 8 approximate upper limit of volume flow rate 0,015 m³/s, in accordance with JBMS-72:2003, Annex A

L_{WA} A-weighted sound power level, in decibels (re 1 pW)

q_V volume flow rate, in cubic metres per second

NOTE Figure A.1 was derived by translating JBMS-72:2003¹, Figure A.1, and shows schematic correlation between volume flow rate of micro-fans and conventional fans.

¹ JBMS-72:2003 had been replaced by JBMS-72-1:2011, but its English version is not available now.

Annex B **(informative)**

Effects of air density

Refer to Annex B of ISO 10302-1:2011.



Annex C (informative)

Data formats for presentation

C.1 Example

The following pages show one example.

AIR-MOVING DEVICE NOISE EMISSION TEST REPORT

Sheet 1 of 4

Manufacturer:

Model:

Part/serial number:

Nameplate data:

Manufacture date:

Description:

The data presented in this report has been determined in conformance with the requirements of Part 1 of ISO 10302, *Acoustics — Measurement of airborne noise emitted and structure-borne vibration induced by small air-moving devices — Part 1: Airborne noise measurement*.

Method of sound power determination: [Reverberation room/Essentially free field over a reflecting plane]

Test voltage: [DC/AC]

Test frequency: (if AC powered)

Test environmental conditions:

Temperature : °C

Relative humidity : %

Air density : kg/m³

Barometric pressure: Pa

Prepared by:

Date:

Organization performing test:

Document number:

AIR-MOVING DEVICE NOISE EMISSION TEST REPORT

Sheet 2 of 4

Air-moving device aerodynamic performances

NOTE Tables C.1 and C.2 are alternative.

Table C.1 – Data table according of Method A (conventional method) of 7.2.2 of ECMA-275-1.

Rating data				Measurement data	
Points of operation	Electrical power in W	Reference volume flow in m ³ /s	Reference fan static pressure in Pa	Rotational frequency in min ⁻¹	<i>L</i> _{WA} re 1 pW in dB
the adjustable exit port (slider) completely open					
80 % of maximum volume flow rate					
20 % of maximum volume flow rate					
the point of maximum overall static efficiency (optional)					

Table C.2 – Data table according of Method B (alternative method) of 7.2.3 of ECMA-275-1.

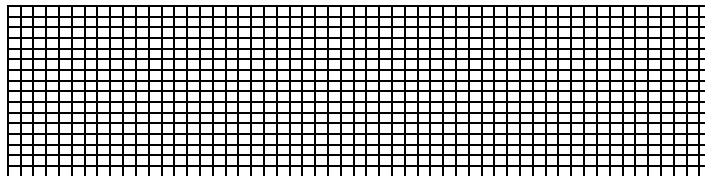
Rating data				Measurement data	
Points of operation	Electrical power in W	Reference volume flow in m ³ /s	Reference fan static pressure in Pa	Rotational frequency in min ⁻¹	<i>L</i> _{WA} re 1 pW in dB
at point of operation at the intersection of the <i>p-q</i> curve of the AMD and the system impedance curve of the candidate system					
the adjustable exit port (slider) completely open (optional)					
80 % of maximum volume flow rate (optional)					
20 % of maximum volume flow rate (optional)					

AIR-MOVING DEVICE NOISE EMISSION TEST REPORT

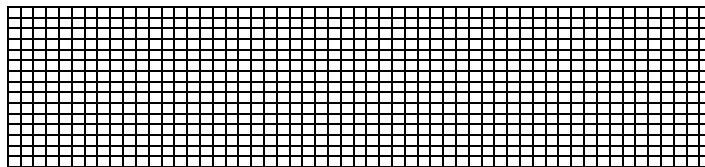
Sheet 3 of 4

Air-moving device aerodynamic performances

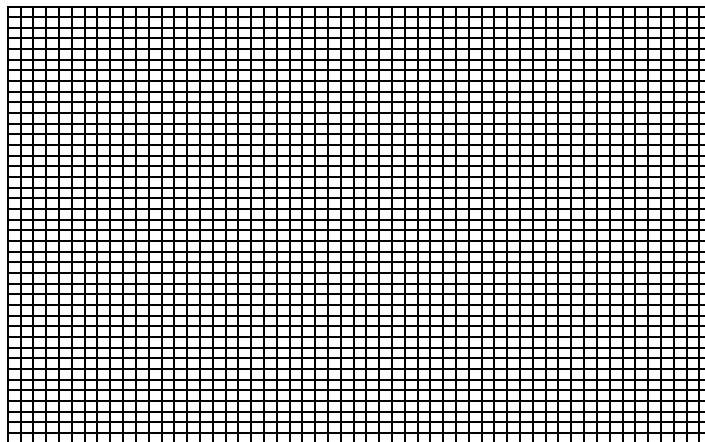
L_{WA} (dB re 1 pW)



Rotational frequency
(min^{-1})



Fan static pressure
(Pa)



Volume flow rate in standard air condition (m^3/s)

Model: _____ Part/Serial number: _____

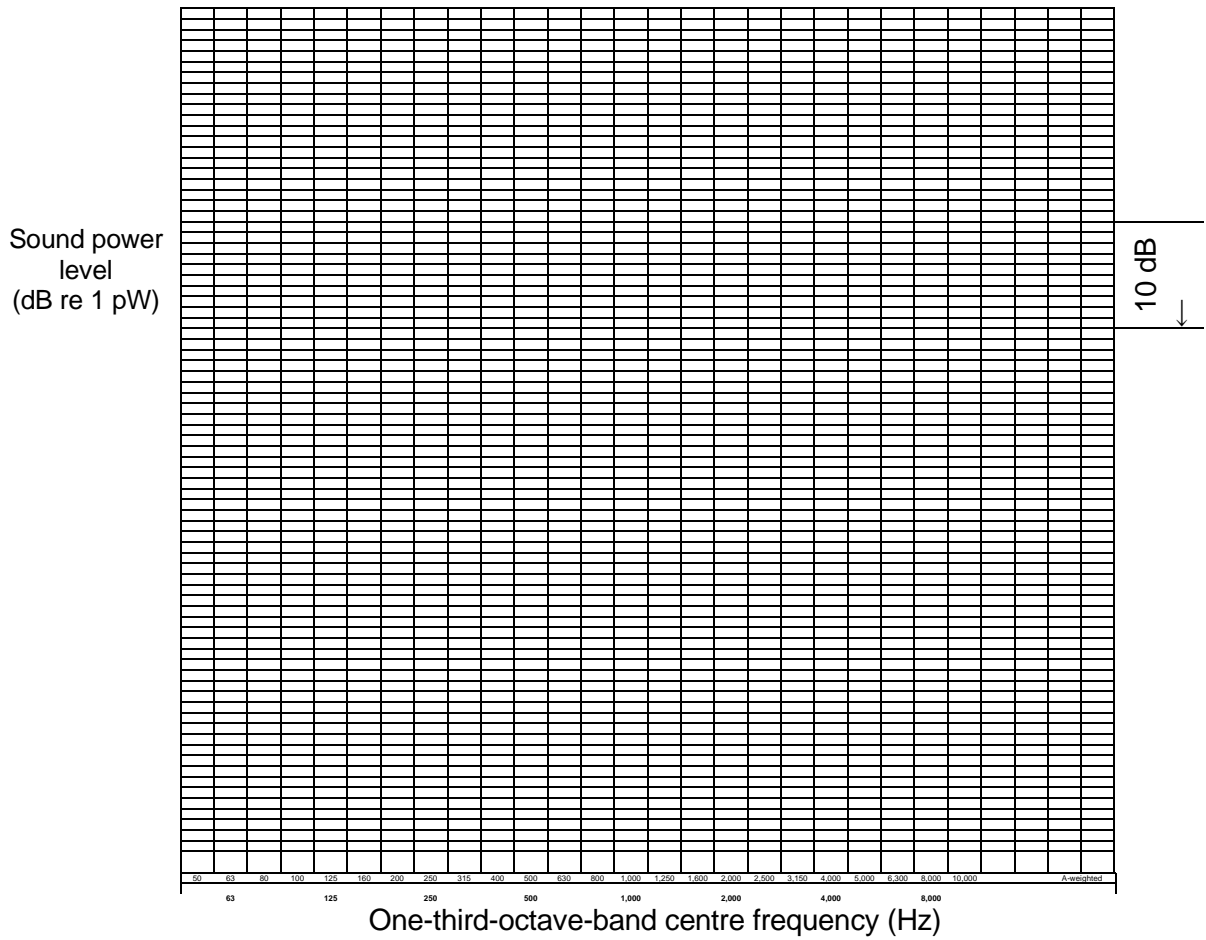
Test voltage: _____ Power line frequency (if applicable): _____

Date: _____ Other information: _____

AIR-MOVING DEVICE NOISE EMISSION TEST REPORT

Sheet 4 of 4

Air-moving device
Sound power level spectrum



Model: _____ Part/Serial number _____

Test voltage: _____ Power line frequency (if applicable): _____

Date: _____ Other information: _____



Annex D **(informative)**

Air-moving device acoustical noise specification

Refer to Annex D of ISO 10302-1:2011, except that ISO 10302-1 is to be replaced by ECMA-275-1.

NOTE The document structure of Annex D of ISO 10302-1:2011 is as follows:

D.1 General

D.2 Specification formats for a single air-moving device

D.2.1 Determination of specification values

D.2.2 Recommended specification format

D.2.3 Alternative specification format

D.3 Specification formats for a lot of air-moving devices



Annex E (informative)

Guidance on the development of information on measurement uncertainty

Refer to Annex E of ISO 10302-1:2011.

NOTE The document structure of Annex E of ISO 10302-1:2011 is as follows:

E.1 General

E.2 Model function

E.3 Input quantities and their contributions to measurement uncertainty

E.3.1 General

E.3.2 Mean time-averaged sound pressure level, $\overline{L'_{p(ST)}}$

E.3.3 Background noise correction, K_1

E.3.4 Measurement surface area, S

E.3.5 Correction for acoustical environment correction, K_2

E.3.6 Meteorological correction, C

E.3.7 Angle of sound incidence, δ_{angle}

E.3.8 Sound measuring instrumentation, δ_{sim}

E.3.9 Mounting conditions, δ_{mount}

E.3.10 Operating conditions, δ_{oc}

E.3.11 Sampling, δ_{mic}

E.3.12 Measurement method, δ_{meth}

E.4 Uncertainty budget

E.5 Combined standard uncertainty and expanded uncertainty



Bibliography

- [1] ISO 3741, Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Precision methods for reverberation test rooms
- [2] 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
- [3] ISO 3745, Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Precision methods for anechoic test rooms and hemi-anechoic test rooms
- [4] ISO 5801:2007, Industrial fans — Performance testing using standardized airways
- [5] ISO 7779:2010, Acoustics — Measurement of airborne noise emitted by information technology and telecommunications equipment
- [6] ISO/IEC Guide 98-3, Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)
- [7] ANSI/ASA S2.32, Methods for the experimental determination of mechanical mobility — Part 2: Measurements using single-point translational excitation
- [8] JBMS-72:2003, *Acoustics — Method for the measurement of airborne noise emitted by micro-fans*
- [9] JBMS-72-1:2011, Acoustics — Method for the measurement of airborne noise emitted and structure-borne vibration induced by micro-fans small air-moving devices — Part 1: Airborne noise measurement
- [10] S. Bard, A. Alfoqaha and R. Boyes, An analysis of the integrity of the ISO 10302-1 small air-moving device test plenum under high static-pressure loading, Proceedings of Noise-Con 2019, San Diego, CA, pp. 633-641, 2019

