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Fans — Air curtain units —

Part 2: Laboratory methods of testing for sound power

Ventilateurs — Rideaux d'air —

Partie 2: Méthodes d'essai en laboratoire des niveaux de puissance 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 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

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

ISO 27327 consists of the following parts, under the general title *Fans — Air curtain units:*

— *Part 1: Laboratory methods of testing for aerodynamic performance rating*

— *Part 2: Laboratory methods of testing for sound power*

The following parts are under preparation:

— *Part 3: Test method to determine energy effectiveness* [Technical Report]

This corrected version of ISO 27327-2:2014 incorporates the following correction:

— the sentence "This first edition of ISO 27327-2:2014 cancels and replaces ISO 13347-1:2004 and ISO 13347-2:2004" has been removed from the Foreword.

Introduction

The need for this part of ISO 27327 has been evident for some time. While a number of national standards exist for the measurement of fan noise, none addressed the particular considerations required for the noise testing of air curtain units.

Forming part of the ISO/TC 117 series of fan standards, this part of ISO 27327 deals with the determination of the air curtain unit sound power level appropriate to a particular application. In describing the test and rating procedures, numerous references are made to ISO 5801 and ISO 13347, as well as to other ISO standards.

The test procedures described in this part of ISO 27327 relate to laboratory conditions. The measurement of performance under site conditions is not included. Acoustic system effects can be considerable where the airflow into and out of the air curtain unit is not free from swirl nor fully developed.

This part of ISO 27327 describes methods for determining sound power levels of air curtain units in one-third-octave bandwidths and one-octave bandwidths.

Data obtained in accordance with this part of ISO 27327 can be used for the following purposes, amongst others:

a) comparison of air curtain units which are similar in size and type;

b) comparison of air curtain units which are different in size, type, design, speed, etc.;

c) determining whether an air curtain unit is suitable for a specified upper limit of sound emission;

d) scaling air curtain unit noise from one size and speed to another size and speed of the same type of air curtain unit;

e) prediction of sound pressure level in application of the air curtain unit;

f) engineering work to assist in developing machinery and equipment with lower sound emissions.

Fans — Air curtain units —

Part 2:
Laboratory methods of testing for sound power

1 Scope

This part of ISO 27327 deals with the determination of the acoustic performance of air curtain units. In addition, it can be used to determine the acoustic performance of air curtain units combined with an ancillary device.

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 266:1997, *Acoustics — Preferred frequencies*

ISO 3740:2000, *Acoustics — Determination of sound power levels of noise sources — Guidelines for the use of basic standards*

ISO 3741:2010, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Precision methods for reverberation test rooms*

ISO 3743-1, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for small movable sources in reverberant fields — Part 1: Comparison method for a hard-walled test room*

ISO 3743-2, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering methods for small, movable sources in reverberant fields — Part 2: Methods for special reverberation test rooms*

ISO 3747, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering/survey methods for use in situ in a reverberant environment*

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

ISO 6926:1999, *Acoustics — Requirements for the performance and calibration of reference sound sources used for the determination of sound power levels*

ISO 13347-1:2004, *Industrial fans — Determination of fan sound power levels under standardized laboratory conditions — Part 1: General overview*

ISO 13347-2:2004, *Industrial fans — Determination of fan sound power levels under standardized laboratory conditions — Part 2: Reverberant room method*

ISO 13349:2010, *Fans — Vocabulary and definitions of categories*

ISO 27327-1:2009, *Fans — Air curtain units — Part 1: Laboratory methods of testing for aerodynamic performance rating*

3 Terms, definitions, symbols and units

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 3740, ISO 3747, ISO 5801, ISO 13347-1, ISO 13347-2, ISO 13349, ISO 27327-1 and the following apply.

3.1.1
inlet sound power level
sound power level of an air curtain unit determined at the air curtain unit inlet in test installation type A

3.1.2
outlet sound power level
sound power level of an air curtain unit determined at the air curtain outlet in test installation type A

3.1.3
total sound power level
sound power level of an air curtain unit in test installation type E

3.1.4
casing sound power level
sound power level radiated from an air curtain unit casing

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

3.1.5
frequency range of interest
frequency range including octave bands with centre frequencies between 63 Hz and 8 000 Hz and one-third octave bands with centre frequencies between 50 Hz and 10 000 Hz

Note 1 to entry: For special purposes, the frequency range can be extended at either end, provided that the test environment and instrument accuracy are satisfactory for use over the extended frequency range. For air curtain units which radiate sound at predominantly high (or low) frequency, the frequency range of interest can be limited in order to optimize the test facility and procedures.

3.1.6
blade passage frequency (BPF)
frequency of air curtain unit impeller blades passing a single fixed object

Note 1 to entry: The blade passage frequency is calculated by the following formula:

$$\mathrm{BPF}=\frac{xn}{60}\ \mathrm{Hz}$$

where

x is the number of blades;

n is the fan speed, expressed in revolutions per minute.

3.1.7
chamber
enclosure used to regulate flow and absorb sound; it can also conform to air test chamber conditions outlined in ISO 5801

3.1.8
air curtain unit inlet area
A_1
summation of open areas (slots, holes, louvres, openings, etc.) through which air will flow into the air curtain unit; normally a grille and/or air inlet opening

3.1.9
air curtain unit outlet area
A_2
summation of open areas through which air will discharge out of the air curtain; normally a grille and/or air outlet opening

3.1.10
reverberant room
enclosure meeting the requirements of Annex A and/or Annex B of ISO 13347-2:2004

3.1.11
standard air
air with a density of 1,2 kg/m^3

Note 1 to entry: Standard air has a ratio of specific heats of 1,4 and a viscosity of 1,815 × 10^{-3} kg/m·s.

Note 2 to entry: Air at 16 °C dry bulb temperature, 50 % relative humidity, and 100 kPa barometric pressure has these properties, but this is not part of the definition.

Note 3 to entry: Air at 20 °C dry bulb temperature, 50 % relative humidity, and 101,325 kPa barometric pressure has these properties, but this is not part of the definition.

3.2 Air curtain unit sound power levels

Considering all possible combinations for installation conditions specified in Clause 4, five different sound power level (L_W) descriptions are defined in Table 1, e.g. L_W (A,in).

Table 1 — Sound power levels

Number	Suffix	Description
1	(A,in)	free-inlet sound power level, type A installation
2	(A,out)	free-outlet sound power level; type A installation
3	(E,tot)	total sound power level; type E installation (includes the contributions from the inlet, outlet, casing, and drive)
4	(A,in+cas)	free-inlet sound power level plus casing-radiated noise; type A installation
5	(A,out+cas)	free-outlet sound power level plus casing-radiated noise; type A installation

NOTE 1 All of these symbols can 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 can contribute to the noise radiated from a casing, then this should be clearly stated by the addition of "+dr", e.g. L_W (A,in+cas+dr).

NOTE 2 Not all of the above levels need to be measured for a particular air curtain unit.

NOTE 3 Where some portion of inlet noise is included in the measurement of outlet noise, this shall be clearly stated by the addition of "+in" or other similar notation, e.g. L_W (A,out+in).

3.3 Other symbols

For consistency and mutual understanding, it is recommended that the symbols and units shown in Table 2 be used in reporting and calculation. Unless otherwise noted, the subscript number refers to the mid-frequency of the octave band or one-third octave band number.

Table 2 — Symbols, units

Symbol	Term	SI unit
A_1	air curtain unit inlet area	m^2
A_2	air curtain unit outlet area	m^2
c	speed of sound	m/s
D_{min}	minimum distance between equipment under test and reverberant room measurement surface	m
f	frequency	Hz
L_p	sound pressure level, re 20 µPa (2×10^{-5} Pa)	dB
L_{pc}	corrected sound pressure level of the air curtain unit	dB
L_{pb}	recorded sound pressure level of room background as measured over the normal microphone path	dB
$\overline{L_{pb}}$	background sound pressure level	dB
L_{pm}	recorded sound pressure level of air curtain unit and room background as measured over the normal microphone path	dB
L_{pq}	corrected sound pressure level of the RSS	dB
L_{pqm}	recorded sound pressure level of the RSS and room background as measured over the normal microphone path	dB
L_{ps}	recorded sound pressure level of pure tone noise source	dB
L_W	sound power level, re 1 pW (1×10^{-12} W)	dB
L_{Wr}	sound power level of RSS	dB
λ	wavelength	m
M	Mach number	dimensionless
p	sound pressure	Pa
p_{ref}	reference sound pressure, 20 µPa (2×10^{-5} Pa)	-
s	standard deviation	dB
θ	air temperature	K
W	sound power	W
W_{ref}	reference sound power, re 1 pW (1×10^{-12} W)	dB

4 Limitations on use

4.1 General

For reverberant room tests, the size of the air curtain unit is limited to less than 2 % of the room volume.

The test procedures specified in this part of ISO 27327 are intended principally for tests conducted using standardized test configurations and under specified environments and conditions and cannot be appropriate to site test conditions.

The air curtain unit installation conditions conform to the following two categories of installation types:

— type A: free inlet, free outlet;

  Used when measuring inlet noise only or outlet noise only, i.e. (i) ducted ACUs or (ii) recessed ACUs where the air inlet and air discharge of the ACU communicate with separate spaces (air inlet – ceiling void; air discharge – space to be served)

— type E: free inlet, free outlet.

Used when measuring total noise; i.e. (i) surface-mounted ACUs or (ii) recessed ACUs where the air inlet and air discharge of the ACU communicate with the same space

4.2 Noise source

The noise source is an air curtain unit. The noise measured can contain contributions from the fan drive and transmission.

4.3 Character of noise

Steady broadband with discrete frequency tones.

4.4 Uncertainty

Engineering grade, as defined in ISO 3740.

4.5 Quantities to be measured

Sound pressure levels in one-third octave frequency bands at discrete microphone positions or on a prescribed path.

Air curtain unit aerodynamic performance indicators, where applicable, e.g. rotational speed, static pressure, and flow rate.

5 Measurement uncertainty

Measurements made in conformance with this part of ISO 27327 tend to result in standard deviations which are equal to or less than those given in Table 3. These standard deviations take into account the cumulative effects of all causes of measurement uncertainty such as source location, instrument calibration, and sampling. They do not reflect variations in the sound power radiated by the air curtain unit itself due to, for example, changes in installation type or manufacturing tolerances. For further information, refer to Annex B.

Table 3 — Uncertainty in determination of the frequency-band sound power levels

One-third octave band frequencies Hz	Standard deviation dB
50 63 80	6,0*
100 125 160	3,0
200 250 315	3,0
400 500 630	3,0
800 1000 1250	3,0
1600 2000 2500 3150 4000 5000	3,0
6300 8000 10000	3,0

The uncertainties in Table 3 do not allow for the variations in sound power levels due to manufacturing tolerances. These are consequent differences between one air curtain unit and another of the same nominal design, rotational speed, etc. In any specifications which are part of a contract, it is necessary to apply tolerances to sound values. These can be calculated for a normal distribution of data by multiplying the quoted standard deviations by 2 to obtain 95 % confidence limits. A further deviation should also be added to account for manufacturing tolerances, as described in ISO 13348.

NOTE 1 When octave-band data are calculated, the uncertainty of each octave band level will not be greater than the largest uncertainty of the three constituent one-third octave bands.

NOTE 2 Only octave bands are shown for the reverberant room method in accordance with ISO 3743 (both parts).

NOTE 3 Figures marked with * in Table 3 have only been added to ISO 3740:2000. For general purposes, therefore, many existing rigs are designed to operate at a cut-off frequency of 100 Hz, thus giving the octave bands of interest as those between 125 Hz and 8 000 Hz.

Some air curtain units have significant quantities of noise in the 63 Hz octave band, and, for special purposes, it is permissible to extend the measurements to this band, provided the test environment and instrument accuracy are satisfactory over this extended range.

The uncertainty given for these low frequencies can only be achieved by exercising extreme care, and wherever possible, results should be restricted to octave bands of 125 Hz and above.

NOTE 4 Where the reverberant room is in full conformity with ISO 3743-1 (hard-walled test room), then the uncertainty can be reduced.

NOTE 5 Sound power levels obtained by using the methods described herein are for a fully developed flow into the air curtain unit without pre-swirl and straight-line flow out of the air curtain unit without swirl. Any disturbance in the airflow will increase the levels in a real installation.

NOTE 6 The figures given in column 2 are taken from ISO 13347-2.

The standard deviations in Table 3 are equivalent to those obtained from the engineering methods described in ISO 3743 (both parts) and ISO 3744, as appropriate. They are those which would result from a set of measurements which were undertaken on a single air curtain unit in a large number of different laboratories and include the cumulative effects of all causes of measurement uncertainty.

The repeatability of measurements in any one laboratory can be considerably better than the values in Table 3 would indicate.

6 Instrumentation

6.1 General

Depending on the test method, the instrumentation shall be as specified in this part of ISO 27327, together with ISO 3741, ISO 3743 (both parts), ISO 3744, ISO 13347-1, and ISO 13347-2. ISO 13347-1 also details the requirements for the reference sound source which shall be used to qualify the test room and shall be the basis of the substitution method.

Instrumentation shall be so designed as to determine the mean-square value of the sound pressure in octave and/or one-third octave bands averaged over time and space.

6.1.1 Microphone

A microphone of a standardized sound level meter shall be used.

6.1.2 Microphone cable

The microphone/cable system shall be such that the sensitivity does not change with temperature in the range encountered in the test. Cable flexing due to either microphone traversing or airflow across the cable should not introduce cable noise which interferes with the measurements.

6.1.3 Sound level meter or other microphone amplifier

The sound level meter or other amplifier used to amplify the microphone signal shall comply with the electrical requirements for sound level meters. The flat response shall be used.

6.2 Frequency analyser

The frequency analyser shall have the capacity of frequency analysing into one-third octave bandwidths in accordance with ISO 266.

6.3 Turbulence screens and windshields

6.3.1 Windshields

A microphone exposed to excessive air velocity will give a falsely high reading. This can be rectified by fitting the microphone with a nose cone or a foam ball.