INTERNATIONAL STANDARD

ISO 13347-3

First edition
2004-08-15

Industrial fans — Determination of fan sound power levels under standardized laboratory conditions —

Part 3: Enveloping surface methods

Ventilateurs industriels — Détermination des niveaux de puissance acoustique des ventilateurs dans des conditions de laboratoire normalisées —

Partie 3: Méthodes de la surface enveloppante

Reference number
ISO 13347-3:2004(E)

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Published in Switzerland

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13347-3 was prepared by Technical Committee ISO/TC 117, *Industrial fans*.

ISO 13347 consists of the following parts, under the general title *Industrial fans — Determination of fan sound power levels under standardized laboratory conditions*:

— *Part 1: General overview*

— *Part 2: Reverberant room method*

— *Part 3: Enveloping surface methods*

— *Part 4: Sound intensity method*

Introduction

This part of ISO 13347 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 part of ISO 13347.

The method employs standard sound measurement instrumentation, applied to rooms which are restricted in certain acoustic properties. The test set-ups are generally designed to represent the physical orientation of a fan as installed, in accordance with ISO 5801.

Since sound power levels are considered independent of the acoustic environment around the fan, a good comparison may 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 text books.

Industrial fans — Determination of fan sound power levels under standardized laboratory conditions —

Part 3: Enveloping surface methods

1 Scope

This part of ISO 13347 applies to industrial fans as defined in ISO 5801 and ISO 13349. It is limited to the determination of airborne sound emission for the specified set-ups. Vibration is not measured, nor is the sensitivity of airborne sound emission to vibration effects determined.

The sizes of fan which can be tested in accordance with this part of ISO 13347 are limited only by the practical aspects of the test set-up. Dimensional limitations, test fan dimensions, and air performance will control the room size, power and mounting requirements for the test fan. (Small fans may be tested according to this part of ISO 13347 or to ISO 10302, according to usage).

The test arrangements in this part of ISO 13347 establish the laboratory conditions necessary for a successful test. Rarely will it be possible to meet these requirements in situ and this part of ISO 13347 is not intended for field measurements. Intending users are reminded that, in these situations, there may well be additional acoustic system effects where inlet and outlet conditions at the fan are less than ideal.

The enveloping surface methods may be used for the determination of open inlet and/or open outlet sound power level of fans for the standardized installation types given in 3.1.

An estimation (with increased uncertainty) of ducted sound power for fans too small, or otherwise inconvenient, for testing by the in-duct method described in ISO 5136 may also be obtained by the addition of end reflection corrections (see Annex C of ISO 13347-1:2004).

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 3744, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering method in an essentially free field over a reflecting plane*

ISO 5136, *Acoustics — Determination of sound power radiated into a duct by fans and other air-moving devices — In-duct method*

ISO 5801:1997, *Industrial fans — Performance testing using standardised airways*

ISO 10302, *Acoustics — Method for the measurement of airborne noise omitted by small air-moving devices*

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

ISO 13349, *Industrial fans — Vocabulary and definitions of categories*

3 Acoustic environment and ducting

3.1 General

The fan installation conditions conform to the four categories of installation types specified in ISO 5801:

— type A: free inlet, free outlet;

— type B: free inlet, ducted outlet;

— type C: ducted inlet, free outlet;

— type D: ducted inlet, ducted outlet, (casing breakout noise may also be determined for type D ducted inlet, ducted outlet).

The test environments that are suitable for measurements according to this procedure are specified in detail in ISO 3744. They can be outdoors or indoors.

For fans generating large flowrates, it is preferable that measurements are undertaken in a large space to minimise the recalculation of turbulent airflow through the fan and to ensure that microphones are not positioned in high velocity flowrates.

Care should be taken to conduct outdoor tests on still calm days where the effects of the wind on fan aerodynamic and/or noise performance may be discounted. A maximum wind speed of 3 m/s is recommended.

During the period of the tests, the variation in the ambient air temperature and in relative humidity should not exceed ± 5 %.

For tests according to this procedure, the environment correction K_2 should be less than or equal to 2 dB in any one-third octave band (see Annex A). In practice, this limit of 2 dB may be difficult to obtain in a real-world test area, but it has been shown that this limit is not actually required to achieve good repeatability in fan noise measurement [1].

3.2 Test installation

3.2.1 General

The test installation shall comply with the general requirements of this clause and with the requirements given in ISO 13347-1:2004, Clause 6, as appropriate.

The ducting and anechoic termination and flow measurement and control device, when necessary, fitted to the fan for tests for installation types B, C and D shall be as specified in ISO 5136 and ISO 5801. Simplified anechoic termination shall be fitted, see also ISO 13347-1.

The appropriate operating condition shall be determined from a measurement of the air volume flowrate and fan pressure in accordance with ISO 5801.

The sound pressure level in the test area due to the noise generated by the flow measurement or control device shall be at least 10 dB below the measured sound pressure level from the fan under test.

When an air vent is necessary for air to recirculate into or out of the test area, it shall be silenced and placed on the room surface. It may also be used to regulate the air flow.

If practicable, all auxiliary equipment necessary for the fan under test shall be located outside the test area which shall be cleared of all objects which may interfere with the measurements.

Care should be taken to ensure that any electrical conduits and fittings, piping, or air ducts connected to the equipment do not radiate significant amounts of sound energy into the test area.

3.2.2 Type A installation

The fan shall be placed over an aperture in the reflecting plane such that the fan inlet or outlet orifice (as appropriate) is axially located in relation to the reflecting plane in a manner representative of its recommended installation. The fan orifice shall be placed coaxially with the wall aperture, and, to ensure satisfactory air flow conditions, the aperture shall be larger all round than the fan orifice by an amount at least as great as the thickness of the reflecting plane structure, and the intervening gap shall be sealed by a panel. Provision shall be made for determining and adjusting the fan air flowrate.

Care should be taken to avoid vibration of the sealing panel.

NOTE The reverberant conditions of the non-measured side may affect the measurements made on the measured side of the fan. Highly reverberant conditions on the non-measured side may lead to higher levels of sound power level being determined than if free field conditions existed on the non-measurement side.

3.2.3 Type B installation

The inlet of the fan shall be placed in the vicinity of the centre of the test area. Ducting connected to the fan discharge shall either be of sufficiently massive construction or be treated externally so as to avoid transmission of undesired noise from within the duct.

The duct shall be terminated with a simplified anechoic device as described in ISO 13347-1. The outlet duct shall comprise an intermediate duct, a transition duct if necessary, a test duct or terminating duct and an anechoic termination (see Annex D of ISO 13447-1:2004).

Precautions should be taken to ensure that noise from the flow control or flow measurement device does not interfere with noise from the fan at any of the measurement locations.

NOTE Unless precautions are made to ensure otherwise, the sound pressure levels measured will include noise radiated from the fan casing and the fan drive motor (see ISO 13347-1).

3.2.4 Type C installation

The outlet of the fan shall be placed in the vicinity of the centre of the test area. Ducting connected to the fan inlet shall either be of sufficiently massive construction or be treated externally so as to avoid transmission of undesired noise from within the duct.

The duct shall be terminated with a simplified anechoic device as described in ISO 13347-1. The inlet duct shall comprise an intermediate duct, a transition duct if necessary, a test duct or terminating duct and an anechoic termination (see Annex D of ISO 13347-1:2004).

Precautions should be taken to ensure that noise from the flow control or flow measurement devices does not interfere with noise from the fan at any of the measurement locations.

NOTE Unless precautions are made to ensure otherwise, the sound pressure levels measured will include noise radiated from the fan casing and the fan drive motor (see ISO 13347-1).

3.2.5 Casing sound power, type D installation

The sound power radiated from the external surface of the fan casing and, if appropriate, from the drive, may be determined by this method provided that noise radiated from the associated ducting is minimal. The ducting connected to the fan inlet or outlet shall be terminated with a simplified anechoic device as described in ISO 13347-1 to ensure that the reflection coefficients are within the limits specified in Table 4 of ISO 13347-1:2004 and shall also comply with 3.2.1, 3.2.3 and 3.2.4 of this part of ISO 13347.

3.2.6 Ducted small fans

Fans with test ducts smaller in diameter than those specified in Clause 8 of ISO 13347-1:2004 cannot be tested by the in-duct method.

If an indication of the in-duct sound power level is required, it may be obtained for these fans by applying the end reflection correction to the sound pressure level determined in the room. This resultant sound power level is not a true in-duct sound power level, but may be taken as a characteristic in-duct sound power level for small fans for the purposes of noise control calculations. The end reflection correction E may be found from Figure C.1 of ISO 13347-1:2004.

$$L_W \text{ in-duct} = L_W + E$$

3.3 Fan-powered exhaust ventilators

Fan-powered exhaust ventilators may be tested by the free field method. When it is not possible to mount a unit with gravity controlled shutters in its correct mounting attitude, the shutters shall be locked in the correct mounting operating position. The units shall be mounted in as representative a manner as possible with only that degree of vibration isolation recommended for a normal site installation. The opening in the test room shall be dimensionally similar to the recommended opening for the installed unit. The powered ventilator shall not be separated from the external face of the test room by a connecting duct but additional fittings may be used to simulate accurately the mounting conditions specified by the manufacturer.

3.4 Drive and transmission noise

In cases where the fan drive and its inlet and outlet are in the same measurement space, the noise will be partly aerodynamic and partly due to the drive and transmission. If the drive is representative of that supplied with the fan, this noise shall be taken to be the noise from the fan assembly. In cases where drive and transmission are not supplied as standard, the contribution to the noise made by these shall be checked by removing the fan impeller and substituting an equal and smooth surfaced mass. The noise thus obtained shall be measured. If this is 10 dB or more below the level in any octave band due to the complete assembly, transmission noise may be ignored. For differences between 6 dB and 10 dB, background noise corrections in accordance with ISO 3744 shall be made. Otherwise, some action shall be taken to reduce noise from this source. If the drive and transmission are considered to make a significant contribution to the total noise, this fact shall be included in the test report.

4 Determination of measurement surface

4.1 General

This part of ISO 13347 recognises a number of different methods for defining the positions at which microphones shall be placed for measuring the fan noise. The general principle is to define a hypothetical surface enveloping some or all of the source, or if there is a reflecting plane, enveloping the source and terminating on the reflecting plane.

4.2 Measurement surfaces

The different measurement surfaces are as follows.

4.2.1 A rectangular parallelepiped enclosing the sound source as shown in Figure 1. This surface is easily and accurately measured. It may include part of the casing radiated noise, in which case this shall be clearly identified. Directivity of the noise is not easily deduced.

4.2.2 A sphere, or hemisphere over a reflecting plane, as shown in Figures 2, 3 and 4. This surface conveniently requires the use of a rotating boom if the positions are to be easily reproduced. Directivity of the sound may be deduced by plotting curves of equal dB value through the levels at the measuring points.

4.2.3 A small-radius hemisphere, the centre of which is located at the intersection of the axis of symmetry of the inlet(s) and of the plane normal to this axis at the inlet under consideration, as shown in Figure 5. This method is suitable for use in more restricted spaces, but is generally confined to the measurement of inlet noise on fans having a ducted outlet. For absolute comparisons, the use of a Reference Sound Source is necessary.

4.3 Arrangement of measuring points (rectangular parallelepiped)

A hypothetical reference surface in the form of a rectangular parallelepiped (reference box) shall enclose the fan, any protruding elements which are not significant radiators of sound energy being disregarded.

For the determination of sound power level L_W(B,in + cas) or L_W(B,out) the reference box shall be selected in such a way that it encloses a portion of the space at the orifice, and in the case of outlet orifices, a portion of the discharge flow, and that it terminates, if required, on the reflecting plane(s). The dimensions of the reference box are functions of the diameter of the orifice, D, and of its height above the reflecting floor, h (see Figure 1).

The measuring points shall lie on the measurement surface enclosing the object under test or the reference box at the measurement distance, d, and terminating on sound reflecting boundary surfaces of the installation site (e.g. on a floor) or of the fan.

NOTE 1 If only one reflecting plane is present (e.g. outdoors) on which the fan is placed, to which it is attached or which incorporates the inlet or outlet orifice, a hemispherical measurement surface as specified in 3.3 may be used as an alternative (e.g. for table and ceiling fans). This is particularly the case if the directivity of the fan is to be determined and if the wind speed at the microphone does not exceed 5 m/s.

NOTE 2 See also Table 1 which includes further necessary information to determine microphone positions.