INTERNATIONAL STANDARD

ISO 13347-4

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Industrial 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

Reference number
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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 13347-4 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. 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 textbooks.

This part of ISO 13347 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.

At a meeting of ISO/TC 117 in October 1997, it was resolved that the latest editions of ISO 9614-1 and AMCA 320 should be used as the basis for this part of ISO 13347.

This edition continues the original philosophy of the National Standards in combining the theoretical and the practical. Where there have been successful improvements in the state-of-the-art, full advantage is taken.

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

Part 4: Sound intensity method

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 the fan, which can be tested in accordance with this part of ISO 13347, are limited only by the practical aspects of the test installations.

This part of ISO 13347 determines sound power by using sound intensity measurements on a measurement surface which encloses the sound source. It provides guidelines on the acoustical environment, ambient noise, measurement surface, and number of measurements. The test set-ups are generally designed to represent the physical orientation of a fan installed in accordance with ISO 5801 and also used in ISO 13347-2.

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

ISO 9614-1:1993, *Acoustics — Determination of sound power levels of noise source 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 13347-1:2004, *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 13349:1999, *Industrial fans — Vocabulary and definitions of categories*

IEC 61094-2:1992, *Measurement microphones — Part 2: Primary method for pressure calibration of laboratory standard microphones by the reciprocity technique*

3 Instruments and methods of test

3.1 General

Full details of the instrumentation and its requirements are given in ISO 13347-1. Particular requirements for this part of ISO 13347 are given in the following subclauses.

3.2 Reference sound source (RSS)

The RSS shall 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. All requirements for the RSS are specified in ISO 13347-1.

NOTE 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 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.

Table 1 — Tolerances for the instrumentation system

One-third octave band centre frequency	Tolerance
Hz	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

3.3 Transducer and instrumentation system calibration checks

Before and after each sound power determination, the following calibration checks shall be performed. A calibration cheek 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 61094-2 and having an accuracy of ± 0,5 dB shall be used for this purpose. In conformance with IEC 61094-2, 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.

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 2 for the measuring equipment to be acceptable. The two sound intensities shall be of opposite sign.

Table 2 — 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

3.4 Performance verification

Periodically, the performance of the instrumentation system shall 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 3.

Table 3 — Tolerances for sound power level determined for reference sound source

Octave band centre frequency Hz	Tolerance dB
63	± 5,0
125	± 3,0
25 to 500	± 2,0
1 000 to 4 000	± 1,5
8 000	± 2,5

3.5 Test method

The basis of the test method originated in ISO 9614-1. The test method covers a wider frequency range and contains requirements somewhat more specific and restrictive than those of ISO 9614-1, and also provides for sound power level adjustments as described below. With the exception of the adjustments, however, measurements made in conformance with this test method will be in conformance with ISO 9614-1 over their common frequency range.

The basic requirement is the measurement of the sound intensity distribution around the fan. A measurement surface is defined which encloses the entire fan, fan inlet, or fan outlet, depending upon the objective of the test. A set of sound intensity measurements is made about this surface. The results of these measurements are compared with a set containing half the number of measurements, to ensure the adequacy of the number of measurements and the accuracy of the data. The sound power level is calculated using the surface area and the measured sound intensity data. Adjustments shall be made for duct-end corrections, if required, and based on measurements of a calibrated RSS.

Prior to sound intensity measurements on the source of interest, the sound intensity measurement instrumentation and personnel are to be qualified by conducting measurements about an RSS.

The sound power levels resulting from the test method can be expected to be identical to those that would be produced using ISO 13347-2, within the uncertainty of both methods, to the extent that each method is applicable and that the installations tested are identical. It should be noted that the present method differs substantially from ISO 13347-2 in both the test environment requirements and the measured quantities.

4 Equipment and test set-ups

4.1 Test environment

4.1.1 Background noise

Sound power determination using intensity measurements is inherently less sensitive to background noise than are methods based on sound pressure measurements (such as ISO 13347-2), although an excessive amount of background noise will not permit accurate sound power determination by any method. In general, background noise should not be a problem in using the present method provided that, on the measurement surface, the sound pressure level of background noise does not exceed the sound pressure level of direct sound from the fan equipment of interest.

If the background noise is excessive, sound power determination according to the procedures of this part of ISO 13347 may not be possible. The test environment shall be such that the background noise criterion of 6.2 is satisfied.

4.1.2 Nearby reflecting surfaces

Reflecting surfaces in the vicinity of the measurement surface can have an effect on the source sound power, and on the ability to accurately sample the sound intensity on the measurement surface. Nearby reflecting surfaces will tend to increase the sound power output of the fan equipment under test, and should be limited to those surfaces usually encountered in a typical installation of the fan. If a reflecting surface is part of the typical installation of the fan equipment, a similar surface shall be used during testing.

If the presence of a nearby reflecting surface interferes with sampling of sound intensity on the measurement surface, sound power determination according to the procedures of this standard may not be possible. To evaluate whether a nearby reflecting surface is in fact the cause of the difficulty, the procedure of Annex A is recommended.

4.1.3 Reverberation control

In addition to the difficulties associated with nearby reflecting surfaces, diffuse reverberant sound at the measurement surface can limit the accuracy of sound intensity measurements if this sound is excessive. In general, reverberant sound should not be a problem in using this standard provided that, on the measurement surface, the sound pressure level of reverberant sound does not exceed the sound pressure level of direct sound from the fan equipment of interest.

Excessive reverberation usually can be controlled by introducing a modest amount of sound absorbing material at the boundaries of an acoustically “hard” (reflective) room. Alternatively, it may be possible to reduce the relative strength of the reverberant sound by moving the measurement surface closer to the sound source of interest within the limits of this part of ISO 13347 i.e., increasing the direct sound from the source. Application of this standard in a reverberation chamber qualified for use with ISO 13347-2 is not recommended without use of supplemental absorption material, and/or special care in defining the measurement surface.

If reverberant sound is excessive, sound power determination according to the procedures of this part of ISO 13347 may not be possible. To evaluate whether excessive reverberant sound is in fact the cause of difficulty, the procedure of Annex A is recommended.

4.2 Fan installation

4.2.1 Set-up categories

A number of specific fan test set-ups are allowed. They are determined by the airflow direction and the particular mounting arrangement of the test device. These test set-ups fall into two general categories. The first category is for a free-standing unit that would be placed entirely in the test room (see Figure 1). Results of this arrangement yield the total sound power level ($L_{W\mathrm{m}}$ or L_W) of the test unit. The second category is for

those units that would be tested with a chamber or two-room system and where only the inlet or outlet would discharge sound into the test room (see Figures 2 or 3).

This arrangement results in ratings of inlet ($L_{W\mathrm{mi}}$ or $L_{W\mathrm{i}}$) or outlet ($L_{W\mathrm{mo}}$ or $L_{W\mathrm{o}}$) sound power level only. Note that the subscript «**m**» indicates that the sound power level is determined from measurements using a set-up not requiring an end correction adjustment, while values without the subscript «**m**» are determined by applying an end correction to measurements on a ducted test set-up.

The choice of which test set-up is used for a particular fan will depend on the way a product is expected to be rated and applied in the field.

4.2.2 Aerodynamic performance

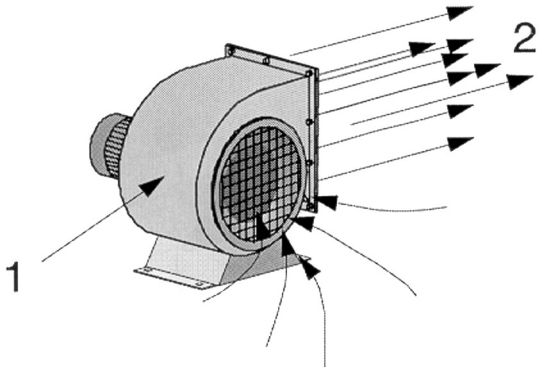
Where aerodynamic performance tests are necessary to determine the point of operation of the fan, these shall be performed as specified in ISO 5801.

4.2.3 Mounting methods

Vibration is known to influence airborne sound emission. Vibration effects may be minimised by resilient mounting of the fan and vibration isolation of any duct used.

The method of mounting fans, of connecting them to non-integral drivers, and of connecting them to aerodynamic performance test facilities is not specified. Any conventional method may be used, including vibration isolation devices and short flexible connectors. Other than these, sound and vibration absorptive material may not be incorporated in the test fan unless it is a standard part of the unit. Ducts shall be of metal or other rigid, dense non-absorptive material, and have no exposed sound absorption material on the interior or exterior surfaces.

The driving motor and drive, when not an integral part of the fan, may be damped or enclosed in any manner that does not expose sound absorption material within the measurement surface. When the driving motor and drive are an integral part of the test unit, they may not be treated in any manner, and normal belt tensions, bearings and lubricants shall be used.



Key

1 fan
2 airflow

Figure 1 — Fan total sound testing (A: free inlet, free outlet)

4.2.4 Duct length

The length of duct shown in Figures 2 and 3 is consistent with the procedures of ISO 5801. Care shall be exercised to ensure that no duct resonance exists in close proximity to specific frequencies of interest, e.g., blade passage frequency.

In chamber or two-room set-ups, the length of duct shall be consistent with acceptable practices from ISO 5801, which are necessary to accurately establish the point of rating.

4.2.5 Fan total sound testing (A: free inlet, free outlet)

Figure 1 shows the test configuration used with a free inlet/outlet fan arrangement to establish the fan's total sound power.

Installation type	E_W dB	Sound power level
A: Free inlet Free outlet	0	L_W(A,tot)

NOTE This test procedure and the above calculations are based on the following assumption: that resonances are not present on either the fan structure, supporting devices, or driving devices that provide any significant pure tones that may add to the fan recorded sound levels.

Appurtenances attached to the fan are considered as part of the fan and shall be contained within the test measurement surface.