INTERNATIONAL STANDARD

ISO 3747

Second edition
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Acoustics — Determination of sound power levels of noise sources using sound pressure — Comparison method *in situ*

Acoustique — Détermination des niveaux de puissance acoustique émis par les sources de bruit à partir de la pression acoustique — Méthode de comparaison in situ

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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 3747 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

This second edition cancels and replaces the first edition (ISO 3747:1987), which has been technically revised.

Annex A forms a normative part of this International Standard. Annex B is for information only.

Introduction

This International Standard is one of the ISO 3740 series which, together with ISO 9614, specifies various methods for determining sound power levels of machines, equipment and sub-assemblies thereof. When selecting one of the methods of the 3740 series, it is necessary to decide which one is most appropriate for the conditions and purposes of the test. General guidelines to assist in the selection are provided in ISO 3740. Insofar as the operating and mounting conditions of the machine or equipment under test are concerned, only general principles are given in the ISO 3740 series. Reference should be made to the test code for a specific type of machine or equipment, if available, for specifications on mounting and operating conditions.

Acoustics — Determination of sound power levels of noise sources using sound pressure — Comparison method *in situ*

1 Scope

1.1 This International Standard specifies a method for determining the sound power levels of sound sources *in situ*, especially if non-movable. A comparison method is used and all measurements are carried out in octave bands. The measurement uncertainty depends on the test environment. The measurement uncertainty is evaluated by comparing with an indicator describing the spatial sound distribution. The accuracy will either be that of an engineering method or a survey method.

The sound power level of the source under test is calculated from the measured values of the sound pressure levels produced at specified measurement points by the source and by a reference sound source, respectively. The sound power level is calculated using the calibrated values of the reference sound source and the differences between the values obtained with the source under test and those of the reference sound source. All calculations are carried out in octave bands, from which the A-weighted sound power level is determined.

NOTE For noise sources which can be moved, other relevant standards in the ISO 3740 series may be used.

1.2 This International Standard is applicable to all kinds of test environments which are to be found outside a laboratory environment, provided that the background noise level is sufficiently low and the sound pressure level at the microphone positions depends mainly on reflections from the room surfaces.

NOTE ISO 3744 or ISO 9614 may provide alternative methods.

1.3 This International Standard is primarily applicable to sources which radiate broad-band noise. It may, however, also be used for sources which radiate narrow-band noise or discrete tones, although the measurement uncertainty might then become larger than stated herein.

NOTE For noise sources emitting stationary noise, ISO 9614 may be used as an alternative.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

ISO 7574-1, *Acoustics — Statistical methods for determining and verifying stated noise emission values of machinery and equipment — Part 1: General considerations and definitions*.

IEC 60942, *Electroacoustics — Sound calibrators*.

IEC 61260:1995, *Electroacoustics — Octave-band and fractional-octave band filters*.

IEC 61672-1, *Electroacoustics — Sound level meters — Part 1: Specifications*.[1)]

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

3.1
reference sound source
RSS
stable and steady source emitting constant broad-band noise with an adequate sound power level, in conformance with and calibrated according to ISO 6926

3.2
calibration position
position, well-defined relative to reflecting surfaces, in which the reference sound source has been calibrated

3.3
reference box
hypothetical surface which is the smallest rectangular parallelepiped that just encloses the source and terminates on the reflecting plane(s)

3.4
reverberant sound field
that portion of the sound field in the test room over which the influence of sound received directly from the source is negligible

3.5
measurement distance
d_m
closest distance from the reference box to a microphone position

3.6
background noise
noise from all sources other than the source under test

NOTE Background noise may include contributions from airborne sound, structure-borne vibration, and electrical noise in instrumentation.

3.7
frequency range of interest
for general purposes, the frequency range of interest includes the octave bands with midband frequencies from 125 Hz to 8 000 Hz

NOTE 1 For special purposes, it is permissible to extend or reduce the frequency range of interest at either end, provided that the test environment, reference sound source and instrument accuracy are satisfactory for use over the extended or reduced frequency range. For sources which radiate predominantly high (or low) frequency sound, it is permissible to extend or reduce the frequency range of interest in order to optimize the test procedures.

NOTE 2 For determination of A-weighted sound power levels (or other frequency-weighted levels), frequency components within the range which do not contribute to the A-weighted sound power level may be disregarded.

1) To be published. (Revision of IEC 60651 and IEC 60804)

3.8
comparison method
method in which the sound power level is calculated by comparing the measured sound pressure levels produced by the source under test in an environment with the sound pressure levels produced in the same environment by a reference sound source of known sound power output

3.9
excess of sound pressure level at a given distance
ΔL_f
difference, in decibels, for a reference sound source with a reference calibration, at a given distance, between the spatial sound distribution curve of the room and the spatial sound distribution curve for a free field (6 dB per distance doubling) according to annex A

NOTE This term and its definition differ from that of ISO 14257 which relates to an *average* difference over a given distance range.

4 Test methodology

4.1 General

The test method is a comparison method, that is the sound power output of the source under test is compared with that of a reference sound source with known sound power level. In order to obtain a good comparison, at least the following condition must be fulfilled:

— the test environment is sufficiently reverberant to cause the directivity of the source under test to have only an insignificant influence on the measured sound pressure levels.

The better the above condition is fulfilled, the lower the measurement uncertainty will be. To make an objective evaluation of the measurement conditions, it is necessary to determine one indicator, ΔL_f, for the test environment. Further information about this indicator is given in annex A.

4.2 Accuracy

ΔL_f will be influenced by the selection of the reference sound source and the microphone positions. Thus it may, in some cases, be possible to improve the measurement accuracy from that of a survey method to that of an engineering method by changing these positions; see annex A.

5 Measurement uncertainty

A single value of the sound power level of a sound source determined according to the procedures of this International Standard is likely to differ from the true value by an amount within the measurement uncertainty. The uncertainty in determinations of the sound power level arises from several factors which affect the results, some associated with environmental conditions in the test environment and others with experimental techniques and the directional characteristics of the sound source under test.

If a particular source were to be transported to each of a number of different test environments and if, in each environment, the sound power level of that source were to be determined in accordance with the provisions of this International Standard, the results would show a scatter. The standard deviations of the measured octave band values could be calculated (examples are given in ISO 7574-4:1985, annex B) and would vary. These standard deviations would, with few exceptions, not exceed those listed in Table 1 for the A-weighted sound power level. The standard deviation will depend on the indicator ΔL_f. If this indicator is not evaluated, the default standard deviation of reproducibility, s_R, is 4,0 dB.

Table 1 — Estimated upper values of the standard deviation of reproducibility, s_R, of A-weighted sound power levels of sound sources determined according to this International Standard

Indicator values	Upper values of standard deviation of reproducibility for the A-weighted sound power level	Grade of accuracy
$\Delta L_{fA} \geqslant 7$ dB [a]	1,5 dB	Grade 2
$\Delta L_{fA} < 7$ dB or not determined	4,0 dB	Grade 3

[a] To be met by all microphone positions.

NOTE 1 The standard deviations given in Table 1 might become larger for sources that radiate narrow-band noise, discrete tones and combinations of these. In these cases the engineering grade of accuracy might not be achieved.

The values given in Table 1 are standard deviations of reproducibility, s_R, as defined in ISO 7574-1. The values of Table 1 take into account the cumulative effects of measurement uncertainty in applying the procedures of this International Standard, but exclude variations in the sound power output caused by changes in operating conditions (e.g. rotational speed, line voltage) or mounting conditions.

The measurement uncertainty depends on the standard deviation of reproducibility tabulated in Table 1, the systematic errors discussed below, and the degree of confidence that is desired. As examples, excluding the systematic errors, there is a 90 % confidence that the expected value of the sound power level of a source lies within the range $\pm$ 1,645s_R, of the measured value and a 95 % confidence that it lies within the range $\pm$ 1,96s_R. For further examples, see ISO 7574-4.

NOTE 2 Where s_R exceeds 2 dB, the ranges of confidence intervals may not apply.

Normally the A-weighted sound power level is mainly influenced by the levels in the 250 Hz to 4 000 Hz octave bands. The A-weighted sound power level is determined with a standard deviation which varies with the indicator values as shown in Table 1. If frequencies lower than 500 Hz are very important for the A-weighted level, the standard deviation will become higher. If frequencies higher than 2 000 Hz are important the source may be highly directional. If, in such cases, there are strongly absorbing surfaces close to the machine under test (e.g. an absorbing ceiling), the measurement uncertainty may become greater.

NOTE 3 One reason, specific for this International Standard, for increased measurement uncertainty at low frequencies is that the reference sound source is not always used in calibrated positions. Thus calibration errors are introduced. These errors occur at low frequencies where the RSS is located at distances in relation to nearby reflecting surfaces which are different from the ones used during the calibration.

6 Instrumentation

6.1 Instrumentation system

The instrumentation system, including the microphone and cable, shall meet the requirements for a class 1 instrument specified in IEC 61672-1. The calibrator shall meet the requirements for class 1 specified in IEC 60942.

For measurements in octave bands, the instrumentation system shall meet the requirements of IEC 61260.

6.2 Calibration

6.2.1 Measuring system

During each series of measurements, apply the sound calibrator to the microphone for checking the calibration of the entire measuring system at one or more frequencies over the frequency range of interest.

Verify the compliance of the calibrator with the requirements of IEC 60942 once a year and the compliance of the instrumentation system with the requirements of IEC 61672-1 at least every two years in a laboratory making traceable calibrations.

Record the date of the last check and confirmation of the compliance with the relevant IEC standard.

6.2.2 Reference sound source

The reference sound source shall be in conformance with and calibrated according to ISO 6926.

NOTE Normally this calibration is valid only for positions away from walls with the reference sound source either directly on the floor or on a stand at a specified elevation above the floor. If the RSS is used in other positions, unless it has been calibrated specifically in these positions, systematic errors may occur at low frequencies.

7 Operating conditions of the source under test

During the measurements use the operating conditions specified in the relevant test code, if one exists for the particular type of machinery or equipment under test. If there is no test code, operate the source, if possible, in a manner which is typical of normal use. In such cases, one or more of the following operating conditions shall be selected:

— device under specified load and operating conditions;

— device under full load (if different from above);

— device under no load (idling);

— device under operating condition corresponding to maximum sound generation representative of normal use;

— device with simulated load operating under carefully defined conditions;

— device under operating condition with characteristic work cycle.

The sound power level of the source may be determined for any desired set of operating conditions (i.e. loading, device speed, temperature, etc.). These test conditions shall be selected beforehand and shall be held constant during the test. The source shall be in the desired operating condition before any noise measurements are made.

If the noise emission depends on secondary operating parameters, such as the type of material being processed or the type of tool being used, as far as practicable, those parameters shall be selected that give rise to the smallest variations and that are typical of the operation. The noise test code for a specific family of machines shall specify the tool and the material for the test.

For special purposes it is appropriate to define one or more operating conditions in such a way that the noise emission of machines of the same family is highly reproducible and that the operating conditions which are most common and typical for the family of machines are covered. These operating conditions shall be defined in specific test codes.

If simulated operating conditions are used, they shall be chosen to give sound power levels representative of normal use of the source under test.

If appropriate, the results for several separate operating conditions, each lasting for defined periods of time, shall be combined by energy-averaging to yield the result for a composite overall operating procedure.

The operating conditions of the source during the acoustical measurements shall be fully described in the test report.