SLOVENSKI STANDARD
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Acoustique - Détermination des niveaux de puissance et d'énergie acoustiques émis par les sources de bruit à partir de la pression acoustique - Méthodes d'expertise pour des conditions approchant celles du champ libre sur plan réfléchissant (ISO/DIS 3744:2023)

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Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering methods for an essentially free field over a reflecting plane

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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.

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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 43, *Acoustics,* Subcommittee SC 1, *Noise*.

This fourth edition of ISO 3744 constitutes a merger and a technical revision of and cancels and replaces the third edition (ISO 3744:2010), second edition (ISO 3744:1994) and the first edition of this test method which was issued as ISO 4872:1978.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document is one of the series ISO 3741 to ISO 3747,[2-6] which specify various methods for determining the sound power levels of noise sources including machinery, equipment and their sub-assemblies. General guidelines to assist in the selection are provided in ISO 3740.[1] The selection depends on the available test environment and on the precision of the sound power level values required. A noise test code can be established (see ISO 12001) for the individual noise source in order to select the appropriate sound measurement surface and microphone array from among those allowed in each member of the ISO 3741[2] to ISO 3747[6] series, and to give requirements on test unit mounting, loading and operating conditions under which the sound power levels are to be obtained. The sound power emitted by a given source into the test environment is calculated from the mean square sound pressure that is measured over a hypothetical measurement surface enclosing the source, and the area of that surface.

The methods specified in this document permit the determination of the A-weighted sound power level and optionally the sound power level in octave or 1/3-octave frequency bands.

The main body of this document defines test environment qualification criteria, testing procedures and the associated measurement uncertainties for basic compliance with the method. Annex I outlines additional requirements that may be applied by testing laboratories to reduce measurement uncertainty. For applications where even greater accuracy is required, reference can be made to ISO 3745, ISO 3741[2] or ISO 9614.[13,14,15] If the relevant criteria for the measurement environment specified in this document are not met, it might be possible to refer to another standard from this series, or to ISO 9614[13,14,15].

This document describes methods of accuracy grade 2 (engineering grade) as defined in ISO 12001, when the measurements are performed in a space that approximates an acoustically free field over a reflecting plane. Such an environment can be found in a specially designed room, or within industrial buildings or outdoors. Ideally, the test source should be mounted on a sound-reflecting plane located in a large open space. For sources normally installed on the floor of machine rooms, corrections are defined to account for undesired reflections from nearby objects, walls and ceiling, and for background noises.

This test method was originally issued as ISO 4872 in 1978. It was first released as ISO 3744 in 1994. A brief history of the technical requirements associated with the revisions of this test method follows.

ISO 3744:1994 required a test environment with a $K_{2f} \leq 2\,\text{dB}$ in all frequency bands of interest and required measurements to be conducted in octave or one-third octave bands, with A-weighted levels being calculated from the band level data over the frequency range of interest.

ISO 3744:2010 relaxed the requirements on the test environment to require $K_{2\text{A}} \leq 4\,\text{dB}$ and allowed A-weighted levels to be determined either by calculation from frequency band level measurements or by direct measurement using an A-weighted filter. These changes to the requirements for the test environment and instrumentation were made to facilitate in-situ and field sound power level determinations using equipment without proportional octave band filtering for evaluation of compliance with regulatory requirements. Round robin studies were conducted to verify that the stated measurement uncertainties associated with the method could be maintained using these requirements[26].

In addition, the 2010 revision added methods for sound energy level determination of short duration transient events, a number of special case sound power level determination conditions to the main body of the standard and several new measurement parameters.

This revision of ISO 3744 removes sound energy level determination due to lack of use and because it was highly duplicative of other text in the method. Those users with an interest in sound energy level can continue to refer to ISO 3744:2010 until this working group develops an independent test method on sound energy level determination. Also, this revision moves many of the special case measurement conditions and measurement parameters into Annexes to simplify the main body of the standard to focus on the basic sound power level determination method for typical sources and test environments.

In addition, a new Annex I outlines procedures that testing laboratories may apply to reduce measurement uncertainties associated with the test method.

Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering methods for an essentially free field over a reflecting plane

1 Scope

1.1 General

This document specifies methods for determining the sound power level of a noise source from sound pressure levels measured on a surface enveloping the noise source (machinery or equipment) in an environment that approximates to an acoustic free field near one or more reflecting planes. The sound power level produced by the noise source, in frequency bands or with A-weighting applied, is calculated using those measurements.

NOTE Differently shaped measurement surfaces can yield differing estimates of the sound power level of a given noise source which are accounted for in the uncertainty associated with this test method, or a noise test code that refers to this method. An appropriately drafted noise test code (see ISO 12001) gives detailed information on the selection of the surface.

1.2 Types of noise and noise sources

The methods specified in this document are suitable for all types of noise (steady, non-steady, and fluctuating) as defined in ISO 12001, except for short duration, impulsive events.

This document is applicable to all types and sizes of noise source (e.g. stationary or slowly moving component or sub-assembly), provided the conditions for the measurements can be met.

NOTE It is possible that the conditions for measurements given in this document are impracticable for very tall or very long sources such as chimneys, ducts, conveyors and multi-source industrial plants. A noise test code for the determination of noise emission of specific sources can provide alternative methods in such cases.

1.3 Test environment

The test environments that are applicable for measurements made in accordance with this document can be located indoors or outdoors, with one or more sound-reflecting planes present on or near which the noise source under test is mounted. The ideal environment is a completely open space with no bounding or reflecting surfaces other than the reflecting plane(s) (such as that provided by a qualified hemi-anechoic chamber), but procedures are given for applying corrections (within limits that are specified) in the case of environments that are less than ideal. Annex A or ISO/DIS 26101-2:—[1] defines methods for determining the adequacy of the test environment and for determination of corrections to be applied to account for the effect of the test environment.

1.4 Measurement uncertainty

Information is given on the uncertainty of the sound power levels determined in accordance with this document, for measurements made in limited bands of frequency and with frequency A-weighting applied. Annex I outlines procedures for testing laboratories that can be used to reduce measurement uncertainty. The uncertainty conforms to ISO 12001, accuracy grade 2 (engineering grade). General information on measurement uncertainty is provided in this document and additional information can be found in ISO/DIS 5114-1:—[2].

1) Under preparation Stage at the time of the ballot: ISO/DIS 26101-2:2022

2) Under preparation. Stage at the time of the ballot: ISO/DIS 5114-1:2022

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 3744:2010, *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*

ISO 3745, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Precision methods for anechoic rooms and hemi-anechoic rooms*

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

ISO 26101-1, *Acoustics — Test methods for the qualification of the acoustic environment — Part 1: Qualification of free-field environments*

ISO/DIS 26101-2:—, *Acoustics — Test methods for the qualification of the acoustic environment— Part 2: Determination of the environmental correction*

ISO 12001, *Acoustics — Noise emitted by machinery and equipment — Rules for the drafting and presentation of a noise test code*

ISO/DIS 5114-1:—, *Acoustics — Determination of uncertainties associated with sound emission measures — Part 1: Sound power levels determined from sound pressure measurements*

ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

IEC 60942, *Electroacoustics — Sound calibrators*

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

IEC 61672-1, *Electroacoustics — Sound level meters — Part 1: Specifications*

IEC 61672-3, *Electroacoustics — Sound level meters — Part 3: Periodic Testing*

IEC 61183, *Electroacoustics — Random-incidence and diffuse-field calibration of sound level meters*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
sound pressure
p
difference between instantaneous total pressure and static pressure

Note 1 to entry: Sound pressure is expressed in pascals.

[SOURCE: ISO 80000-8:2020, 8-2.2, modified, Note 1 added.]

3.2
sound pressure level
L_p
quantity given by:

$$L_p = 10 \lg \frac{p_{\mathrm{rms}}^2}{p_0^2} \mathrm{dB}$$

where p_{rms} is the root-mean-square sound pressure in the time domain and p_0 is the reference value if sound pressure

$$p_{\mathrm{rms}}^2 = \frac{1}{T} \int_{t_1}^{t_2} p^2(t) \mathrm{d}t$$

and $p_0 = 20\,\mu\mathrm{Pa}$ is the reference value of sound pressure

Note 1 to entry: If specific frequency and time weightings as specified in IEC 61672-1 and/or specific frequency bands are applied, this is indicated by appropriate subscripts; e.g. $L_{p\mathrm{A}}$ denotes the A-weighted sound pressure level.

Note 2 to entry: In this version “sound pressure level” is the same definition as “time-average sound pressure level” in ISO 3744:2010, the changes were made to be consistent with ISO 80000-8:2020.

[SOURCE: ISO 80000-8:2020, table 1, 8-14, modified: deleted remarks and added instead Note 1 to entry and Note 2 to entry.]

3.4
measurement time interval
T
portion or a multiple of an operational period or operational cycle of the noise source under test for which the sound pressure level is determined

Note 1 to entry: Measurement time interval is expressed in seconds.

3.5
acoustic free field
sound field in a homogeneous, isotropic medium free of boundaries

Note 1 to entry: In practice, an acoustic free field is a field in which the influence of reflections at the boundaries or other disturbing objects is negligible over the frequency range of interest.

3.6
acoustic free field over a reflecting plane
essentially acoustic free field over a reflecting plane in the absence of any other obstacles

3.7
reflecting plane
sound reflecting planar surface on which the noise source under test is located

3.8
frequency range of interest
for general purposes, the frequency range of octave bands with nominal mid-band frequencies from 125 Hz to 8 000 Hz (including one-third octave bands with mid-band frequencies from 100 Hz to 10 000 Hz)

Note 1 to entry: For special purposes, the frequency range may be extended or reduced, provided that the test environment and instrument specifications are satisfactory for use over the modified frequency range. Changes to the frequency range of interest shall be included in the test report.

3.9
reference box
hypothetical right parallelepiped terminating on the reflecting plane(s) on which the noise source under test is located, that just encloses the source including all the significant sound radiating components and any test table on which the source is mounted

Note 1 to entry: If required, the smallest possible test table may be used for compatibility with emission sound pressure measurements at bystander positions in accordance with, for example, ISO 11201[18].

3.10
characteristic source dimension
d_0
distance from the origin of the co-ordinate system to the farthest corner of the reference box

Note 1 to entry: Characteristic source dimension is expressed in metres.

3.11
measurement distance
d
distance from the reference box to a parallelepiped measurement surface

Note 1 to entry: Measurement distance is expressed in metres.

3.12
measurement radius
r
radius of a hemispherical, half-hemispherical or quarter-hemispherical measurement surface

Note 1 to entry: Measurement radius is expressed in metres.

3.13
measurement surface
hypothetical surface of area, S, on which the microphone positions are located at which the sound pressure levels are measured, enveloping the noise source under test and terminating on the reflecting plane(s) on which the source is located

3.14
background noise
noise from all sources other than the noise source under test

Note 1 to entry: Background noise includes contributions from airborne sound, noise from structure-borne vibration, and electrical noise in the instrumentation.

3.15
background noise correction
K_1
correction applied to the mean (energy average) of the sound pressure levels over all the microphone positions on the measurement surface, to account for the influence of background noise

Note 1 to entry: Background noise correction is expressed in decibels.

Note 2 to entry: The background noise correction is frequency dependent; the correction in the case of a frequency band is denoted K_{1f}, where f denotes the relevant mid-band frequency, and that in the case of A-weighting is denoted K_{1A}.

3.16
environmental correction
K_2
correction applied to the mean (energy average) of the sound pressure levels over all the microphone positions on the measurement surface, to account for the influence of reflected or absorbed sound, determined as described in Annex A or in ISO/DIS 26101-2:—.

Note 1 to entry: Environmental correction is expressed in decibels.

Note 2 to entry: The environmental correction is frequency dependent; the correction in the case of a frequency band is denoted K_{2f}, where *f* denotes the relevant mid-band frequency, and that in the case of overall A-weighting is denoted $K_{2\mathrm{A}}$,which is determined from A-weighted sound pressure level measurements.

Note 3 to entry: In general, the environmental correction depends on the area of the measurement surface and usually K_2 increases with S.

Note 4 to entry: In practice, the K_2 value determined will be a function of both the reflected sound from the test environment and the shape and arrangement of microphone on the measurement surface used for the K_2 determination. For the purpose of this standard the differences between K_2 values determined with different measurement surfaces are assumed to be included in the stated measurement uncertainty for the test method.

3.17
surface sound pressure level
$\overline{L_p}$
mean (energy average) of the sound pressure levels over all the microphone positions, or traverses, on the measurement surface, with the background noise correction, K_1, and the environmental correction, K_2, applied

Note 1 to entry: Surface sound pressure level is expressed in decibels.

3.18
sound power
P
integral over a surface of the product of sound pressure, p, and the component un of the particle velocity in the direction normal to the surface, at a point on the surface

Note 1 to entry: Sound power is expressed in watts.

Note 2 to entry: The quantity relates to the rate per time at which airborne sound energy is radiated by a source.

[SOURCE: ISO 80000-8:2020,[21] 8-9, modified: Abbreviation *W* deleted, Note 1 and 2 to entry added.]

3.19
sound power level
L_W
quantity given by:

$$L_W = 10 \lg \frac{P_\mathrm{m}}{P_0} \mathrm{dB}$$

where P_m is the magnitude of the sound power and $P_0 = 1\,\mathrm{pW}$ is the reference value of sound power

Note 1 to entry: If a specific frequency weighting as specified in IEC 61672-1 and/or specific frequency bands are applied, this is indicated by appropriate subscripts; e.g. $L_{W\mathrm{A}}$ denotes the A-weighted sound power level.

[SOURCE: ISO 80000-8:2020[21], 8-15, modified: Note 1 to entry added.]