INTERNATIONAL STANDARD

ISO 3740

Third edition
2019-02

Acoustics — Determination of sound power levels of noise sources — Guidelines for the use of basic standards

Acoustique — Détermination des niveaux de puissance acoustique émis par les sources de bruit — Lignes directrices pour l'utilisation des normes de base

Reference number
ISO 3740:2019(E)

Contents

Page

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 third edition cancels and replaces the second edition (ISO 3740:2000), which has been technically revised. The main change compared to the previous edition is as follows:

— All of the basic standards covered by this document with the exception of the ISO 9614 series have been revised.

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

For many users of machinery, equipment and products, the control of noise is a major issue which requires effective exchange of acoustical information. In this context, the main flow of information goes from the manufacturer to the purchaser, installer or user of the machines and products to describe the generated sound. In particular, information on source airborne noise emission is desired. Therefore, the sound power level, as the major parameter characterising airborne noise emission of sound sources, needs to be determined by measurement.

However, such measurements are only useful if the conditions under which they are carried out are specified; they yield defined acoustical quantities, and they are taken with standardized instruments.

Sound power levels are used for

— declaration of the noise emitted under defined conditions,

— verification of declared values,

— comparison of the noise emitted by machinery of various types and sizes,

— comparison with limits specified in a purchasing contract or a regulation,

— engineering work to control the noise emission of machinery,

— prediction of noise exposure of workers in indoor or outdoor work shops,

— prediction of noise in the environment.

International Standards describing basic methods for determining sound power level are

— ISO 3741 to ISO 3747 (sound power level determination using sound pressure level measurements),

— ISO 9614-1 to ISO 9614-3 (sound power level determination using sound intensity measurements),

— ISO/TS 7849-1 and ISO/TS 7849-2 (sound power level determination using vibration measurements).

These standards specify different methods for determination of sound power level and the achievable accuracy, characterized by the standard deviation of reproducibility of the method. Operating and mounting conditions, and the uncertainty associated with these conditions, are dealt with only in a very general manner. Specific and detailed requirements on the machinery or equipment under test are given in noise test codes prepared by machinery specific standards committees. They not only provide the necessary detailed information on the operating, installation and mounting conditions but also identify basic measurement standards that can be used and how a noise emission declaration and verification is made.

The standards mentioned above differ in their range of applications and their requirements with regard to the test environment. In practice, procedures that do not require special laboratory environments and additionally meet class 2 accuracy are particularly advantageous, especially to meet legal requirements. These include the procedures in standards ISO 3744, ISO 3747 and methods in ISO 9614-2.

To help technical committees in drafting noise test codes or to assist manufacturers of machines and equipment in determining the sound power level if a noise test code is not currently available, ISO 3740 introduces the set of twelve International Standards describing various methods for determining sound power levels of machinery, equipment and products taking into account the broad variety of practical situations for the sources under test (types of machinery, equipment and products), test environments, measurement instruments and the accuracy desired.

Some machinery, equipment and products emit high-frequency noise, which can be broad-band noise, narrow-band noise or discrete tones. ISO 9295 specifies four methods for the determination of sound power levels emitted by machinery, equipment and products in the frequency range covered by the 16 kHz octave band. In 5.6, ISO 9295 is briefly described.

More detailed definitions than those specified in this document can be found in ISO 3741, ISO 3743-1, ISO 3743-2, ISO 3744, ISO 3745, ISO 3746 and ISO 3747, in ISO 9614-1 to ISO 9614-3, ISO/TS 7849-1, ISO/TS 7849-2, and in noise test codes for specific types of machinery, equipment and products.

Acoustics — Determination of sound power levels of noise sources — Guidelines for the use of basic standards

1 Scope

This document gives guidance for the use of a set of twelve basic International Standards (see Tables 1, 2 and 3) describing various methods for determining sound power levels from all types of machinery, equipment and products. It provides guidance on the selection of one or more of these standards, appropriate to any particular type of sound source, measurement environment and desired accuracy. The guidance given applies to airborne sound. It is for use in the preparation of noise test codes (see ISO 12001) and also in noise emission testing where no specific noise test code exists. Such standardized noise test codes can recommend the application of particular basic International Standard(s) and give detailed requirements on mounting and operating conditions for a particular family to which the machine under test belongs, in accordance with general principles given in the basic standards.

This document is not intended to replace any of the details of, or add any additional requirements to, the individual test methods in the basic International Standards referenced.

NOTE 1 Two quantities which complement each other can be used to describe the noise emission of machinery, equipment and products. One is the emission sound pressure level at a specified position and the other is the sound power level. The International Standards which describe the basic methods for determining emission sound pressure levels at work stations and at other specified positions are ISO 11200 to ISO 11205 (References [20] to [25]).

NOTE 2 The sound energy level mentioned in ISO 3741 to ISO 3747 is not addressed in this document as it is not mentioned in any legal requirement. Its application is limited to very special cases of a single burst of sound energy or transient sound defined in ISO 12001.

2 Normative references

There are no normative references in this document.

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 http://www.electropedia.org/

3.1
emission
<acoustics> airborne sound radiated by a well-defined noise source (e.g. the machine under test) under specified operating and mounting conditions

Note 1 to entry: Emission values may be incorporated into a product noise declaration, product label and/or product specification. The basic noise emission quantities are the sound power level of the source itself and the emission sound pressure levels at the work station and/or at other specified positions (if any) in the vicinity of the source.

[SOURCE: ISO 12001:1996, 3.3, modified — Note 1 to entry "product noise declaration" added.]

3.2
sound power
P
through a surface, product of the sound pressure, *p*, and the component of the particle velocity, u_n, at a point on the surface in the direction normal to the surface, integrated over that surface

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

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

[SOURCE: ISO 80000-8:2007, 8-16, modified — Notes 1 and 2 to entry added.]

3.3
sound power level
L_W
ten times the logarithm to the base 10 of the ratio of the *sound power*, *P* (3.2), of a source to a reference value, P_0, expressed in decibels

$$L_W = 10 \lg \frac{P}{P_0} \text{dB}$$

where the reference value, P_0, is 1 pW

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_{WA} denotes the A-weighted sound power level.

Note 2 to entry: This definition is technically in accordance with ISO 80000-8:2007, 8-23.

Note 3 to entry: lg ( ) = $\lg_{10}$ ( ) in all relevant parts of the standard.

[SOURCE: ISO/TR 25417:2007, 2.9, modified — Note 3 to entry added.]

3.4
structure vibration generated sound
airborne sound caused by structural vibration in the audible frequency range

Note 1 to entry: In the ISO/TS 7849 series, structure vibration generated sound is determined either from the vibratory velocity or from the vibratory acceleration of the surface of the solid structure.

[SOURCE: ISO/TS 7849-1:2009, 3.1, modified — Expression "In the ISO/TS 7849 series" used for clarification instead of "For the purpose of this part of ISO/TS 7849".]

3.5
sound pressure level
L_p
ten times the logarithm to the base 10 of the ratio of the square of the sound pressure, *p*, to the square of a reference value, p_0, expressed in decibels

$$L_p = 10 \lg \frac{p^2}{p_0^2} \text{dB}$$

where the reference value, p_0, is 20 µPa

[SOURCE: ISO/TR 25417:2007, 2.2, modified — Notes 1 and 2 deleted.]

3.6
time-averaged sound pressure level
$L_{p,T}$
ten times the logarithm to the base 10 of the ratio of the time average of the square of the sound pressure, p, during a stated time interval of duration, T (starting at t_1 and ending at t_2), to the square of a reference value, p_0, expressed in decibels

$$L_{p,T} = 10\lg\left[\frac{\frac{1}{T}\int_{t_1}^{t_2} p^2(t)\mathrm{d}t}{p_0^2}\right]\mathrm{dB}$$

where the reference value, p_0, is 20 µPa

Note 1 to entry: In general, the subscript "T" is omitted since time-averaged sound pressure levels are necessarily determined over a certain measurement time interval.

Note 2 to entry: Time-averaged sound pressure levels are often A-weighted, in which case they are denoted by $L_{p\mathrm{A},T}$, which is usually abbreviated to $L_{p\mathrm{A}}$.

Note 3 to entry: Adapted from ISO/TR 25417:2007, 2.3.

[SOURCE: ISO 3744:2010, 3.3]

3.7
single event time-integrated sound pressure level
L_E
ten times the logarithm to the base 10 of the ratio of the integral of the square of the sound pressure, p, of an isolated single sound event (burst of sound or transient sound) over a stated time interval T (starting at t_1 and ending at t_2), to a reference value, E_0, expressed in decibels

$$L_E = 10\lg\left[\frac{\int_{t_1}^{t_2} p^2(t)\mathrm{d}t}{E_0}\right]\mathrm{dB}$$

where the reference value, E_0, is $(20\ \mu\mathrm{Pa})^2\ \mathrm{s} = 4 \times 10^{-10}\ \mathrm{Pa}^2\ \mathrm{s}$

Note 1 to entry: This quantity can be obtained by

$$L_{p,T} + 10\lg\left[\frac{T}{T_0}\right]\mathrm{dB}$$

where T_0 = 1 s.

Note 2 to entry: When used to measure sound immission, this quantity is usually called "sound exposure level" (see ISO/TR 25417:2007).

[SOURCE: ISO 3744:2010, 3.4]

3.8
sound intensity
$\vec{I}$

$$\vec{I} = p \cdot \vec{u}$$

where

p is the sound pressure, in Pa;

$\vec{u}$ is the sound particle velocity, in m/s.

Note 1 to entry: $\vec{u}$ and $\vec{I}$ are vectorial quantities.

3.9
vibratory velocity
v
root-mean square (RMS) value of the component of the velocity of a vibrating surface in the direction normal to the surface

Note 1 to entry: In ISO/TS 7849-1, the vibratory velocity is applied with an A-weighting, denoted v_A.

[SOURCE: ISO 7849-1:2009, 3.3, modified — Former Note 1 to entry deleted, expression "In ISO/TS 7849-1" used for clarification instead of "In this part of ISO/TS 7849" in former Note 2, now Note 1.]

3.10
vibratory velocity level
L_v
ten times the logarithm to the base 10 of the ratio of the square of the RMS value of the vibratory velocity, v, to the square of a reference value, v_0, expressed in decibels:

$$L_v = 10\lg\frac{v^2}{v_0^2}\,\text{dB}$$

where

v is the RMS value of the vibratory velocity, in metres per second;

v_0 is the reference value for the velocity and is equal to 5×10^{-8} m/s.

Note 1 to entry: For airborne and structure vibration generated sound, the reference value, v_0 = 50 nm/s has the property that it leads, together with $p_0 = 2 \times 10^{-5}$ Pa, to the reference value of the intensity level $I_0 = 1 \times 10^{-12}$ W/m^2 and to a characteristic impedance of air of p_0/v_0 = 400 Pa·s/m.

Note 2 to entry: In ISO/TS 7849-1, the vibratory velocity level is applied as A-weighted vibratory velocity level, L_{vA}, by substituting v^2 for the A-weighted RMS $v_A{}^2$ in ISO/TS 7849-1:2009, Formula (6).

Note 3 to entry: In ISO 1683, two reference values for the velocity level are mentioned: $v_0 = 10^{-9}$ m/s and 5×10^{-8} m/s. The latter is intended for cases of airborne and structure vibration generated sound and is therefore used in ISO/TS 7849-1 and ISO/TS 7849-2. A choice of $v_0 = 10^{-9}$ m/s results in a vibratory velocity level which is 34 dB higher than the level used in both parts of ISO/TS 7849. Therefore, if $v_0 = 10^{-9}$ m/s is used, subtract 34 dB from the right-hand sides of the first formula in 3.10.

3.11
radiation factor
ε
factor expressing the efficiency of airborne *sound power* (3.2) radiation from the vibrating surface

Note 1 to entry: See ISO/TS 7849-1:2009, 4.4.1 to 4.4.4.

3.12
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.

[SOURCE: ISO 3744:2010, 3.15]

3.13
background noise level
sound pressure level (3.5) measured when the source under test is not operating

Note 1 to entry: It is expressed in decibels.

3.14
extraneous vibratory velocity level
vibratory velocity level (3.10) caused by all sources other than the source under test

Note 1 to entry: Extraneous vibratory velocity levels originate, for example, from coupled assemblies.

[SOURCE: ISO/TS 7849-1:2009, 3.9]

3.15
background noise correction
K_1
correction applied to the mean (energy average) of the *time-averaged sound pressure levels* (3.6) over all the microphone positions on the measurement surface, to account for the influence of *background noise* (3.12)

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

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

[SOURCE: ISO 3744:2010, 3.16]

3.16
environmental correction
K_2
correction applied to the mean (energy average) of the *time-averaged sound pressure levels* (3.6) over all microphone positions on the measurement surface, to account for the influence of reflected or absorbed sound

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 A-weighting is denoted K_{2A}.

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

[SOURCE: ISO 3744:2010, 3.17]

3.17
systematic deviation
Δ_{sy}
deviation to account for a systematic difference between *sound power levels* (3.3) obtained using basic standards based on different physical rules

Note 1 to entry: Δ_{sy} is not covered in the basic standards. See 4.4 and Annex C.

Note 2 to entry: $\Delta_{sy,pI}$ describes specifically the systematic deviation between the sound power level yielded by the intensity method, $L_{W,I}$, compared with the result from free field sound pressure measurements, $L_{W,p}$: $\Delta_{sy,pI} = L_{W,p} - L_{W,I}$; otherwise $\Delta_{sy,pI}$ is also designated as near field error.

Note 3 to entry: Systematic deviations can also appear when environmental correction, K_2, is determined according to different procedures from the basic standards.

3.18
background noise index
ΔL_p
index denoting the difference, in decibels, between the *sound pressure levels* (3.5) from the noise source under test in operation and the sound pressure levels of the *background noise* (3.12), both measured using an array of microphone positions over the measurement surface

3.19
dynamic capability index
L_d
index given by

$$L_\mathrm{d} = \delta_{pI_0} - K$$

where

δ_{pI_0} is the pressure-residual intensity index, in decibels;

K is the bias error, in decibels.

Note 1 to entry: The dynamic capability index is expressed in decibels.

Note 2 to entry: The dynamic capability index describes the quality of the intensity measurement system to suppress unwanted background noise. It is used to check the attainment of the desired accuracy level, where K is selected to be 10 dB for grade 1 and 2 measurements and 7 dB for grade 3 measurements.

3.20
standard deviation of reproducibility of the method
σ_{R0}
uncertainty associated with a *sound power* (3.2) measurement method excluding the uncertainty due to the instability of the sound power of the source under test

Note 1 to entry: σ_{R0} is determined from round robin tests on an extreme stable source. It does not include uncertainty components like σ_omc and Δ_sy and consequently does not represent the total uncertainty.

3.21
standard deviation due to operating and mounting conditions of the sound source
σ_omc
uncertainty associated with the instability of the operating and mounting conditions for the particular source under test

3.22
total standard deviation
σ_tot
square root of the sum of the squares of the *standard deviation of reproducibility of the method* (3.20) and the *standard deviation due to operating and mounting conditions* (3.21)

$$\sigma_\mathrm{tot} = \sqrt{\sigma_{R0}^2 + \sigma_\mathrm{omc}^2}$$

3.23
accuracy grade
grade characterising three different classes of uncertainty in determining *sound power levels* (3.3) based on the *standard deviations of reproducibility of the method*, σ_{R0} (3.20)

Note 1 to entry: The grade classification provides an indication of the required measurement effort.

Note 2 to entry: It is described by typical upper bound values.

Note 3 to entry: σ_{R0} does not include uncertainty components like σ_omc and Δ_sy and consequently does not represent the total uncertainty.