
**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 — Guide pour l'utilisation des normes de base*

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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 3740 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

This second edition cancels and replaces the first edition (ISO 3740:1980), which has been technically revised.

Annex A forms a normative part of this International Standard. Annexes B to D are for information only.

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Introduction

0.1 General

The series of International Standards, for which this International Standard serves as a guideline for use, comprises ISO 3741, ISO 3743-1, ISO 3743-2, ISO 3744, ISO 3745, ISO 3746, ISO 3747, ISO 9614-1 and ISO 9614-2. In principle, the methods of determining sound power levels described in ISO 3741 to ISO 3747 and ISO 9614-1 and ISO 9614-2 cover all types of machinery and equipment.

ISO 3741 to ISO 3747, ISO 9614-1 and ISO 9614-2 make up a set of basic International Standards which specify the acoustical conditions and instrumentation to be used, describe the procedures to be followed, and give general information on the mounting and operation of the machine under test in order to determine sound power levels.

The selection of standards for the determination of sound power levels can, for practical reasons, have consequences for the selection of standards for the determination of the emission sound pressure levels (see ISO 11200) and vice versa. It is beneficial to make the choice of standards concurrently with respect to the two noise emission quantities.

0.2 Relationships to other standards

This International Standard is one of a series which specifies various methods for determining the noise emission of a piece of machinery or equipment, or a sub-assembly of such equipment (referred to throughout this International Standard as the "machine under test"). Standards in this series are grouped in three categories.

a) Methods for the determination of sound power levels

This category includes the following standards (see Table 1):

- ISO 3741 to ISO 3747 give methods with precision grade, engineering grade or survey grade of accuracy for determining sound power levels of machinery and equipment using sound pressure level measurements in different types of environments;
- ISO 9614-1 and ISO 9614-2 describe methods for determining the sound power levels of machinery and equipment using sound intensity level measurements.

b) Methods for the determination of emission sound pressure levels at work stations and at other specified positions

This category includes the following standards:

- ISO 11200 gives guidelines for the choice of the method to be used;
- ISO 11201, ISO 11202 and ISO 11204 give methods for determining emission sound pressure levels of machinery and equipment from measured sound pressure levels;
- ISO 11203 gives methods for determining the emission sound pressure levels of machinery and equipment from the sound power levels.

c) Noise test codes

For a particular family of machinery or equipment, a noise test code specifies the following:

- the methods and instruments to be used for the determination of the sound power level;
- the method to be used for the determination of emission sound pressure levels at work stations and/or at other specified positions;
- the positions of the work stations;
- the mounting and operating conditions of the machine under test for the purpose of determining the noise emission quantities;
- the method to be used for verifying declared noise emission quantities.

ISO 12001 gives rules for the drafting and presentation of a noise test code.

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

1 Scope

This International Standard gives guidance for the use of a series of nine International Standards describing various methods for determining the sound power levels from all types of machinery and equipment. It provides:

- brief summaries of these basic International Standards;
- guidance on the selection of one or more of these standards which are appropriate to any particular type (see clause 5 and annex D). The guidance given applies only to airborne sound. It is for use in the preparation of noise test codes (see ISO 12001) and also in noise testing where no specific noise test code exists.

This International Standard is not intended to replace any of the details of, or add any additional requirements to, the individual test methods in the other basic standards referred to.

These basic standards specify the acoustical requirements for measurements appropriate for different test environments and accuracies.

It is important that specific test codes for various types of machinery and equipment be established and used in accordance with the requirements of these basic International Standards. Such standardized noise test codes will recommend the basic International Standard(s) to be used and will give detailed requirements on mounting and operating conditions for a particular family to which the machine under test belongs.

If no specific noise test code exists for a particular type of machinery, this International Standard is of use for the choice of the most suitable of the basic standards. In all cases, the mounting and operating conditions of the machine under test should be in accordance with the general principles given in the basic standards.

NOTE Two quantities which complement each other can be used to describe the sound emission of machinery or equipment. 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 the work station and at other specified positions are the series ISO 11200 to ISO 11204.

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 3741:1999, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Precision methods for reverberation rooms.*

ISO 3743-1, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering methods for small, movable sources in reverberant fields — Part 1: Comparison method for hard-walled test rooms.*

ISO 3740:2000(E)

ISO 3743-2:1994, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering methods for small, movable sources in reverberant fields — Part 2: Methods for special reverberation test rooms.*

ISO 3744:1994, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering method in an essentially free field over a reflecting plane.*

ISO 3745:—¹⁾, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Precision methods for anechoic and hemi-anechoic rooms.*

ISO 3746:1995, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Survey method using an enveloping measurement surface over a reflecting plane.*

ISO 3747, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Comparison method in situ.*

ISO 9614-1:1993, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 1: Measurement at discrete points.*

ISO 9614-2:1996, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 2: Measurement by scanning.*

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

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

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3 Terms and definitions

ISO 3740:2000

For the purposes of this International Standard, the following terms and definitions apply. More detailed definitions may be found in the ISO 3740 series (which includes ISO 3741 through ISO 3747), in ISO 9614-1 and ISO 9614-2 and in noise test codes for specific types of machinery and equipment.

3.1

emission

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

NOTE Emission values may be incorporated in a 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.

[ISO 12001]

3.2

sound power

W

rate per unit time at which airborne sound energy is radiated by a source

NOTE It is expressed in watts.

[ISO 12001]

1) To be published. (Revision of ISO 3745:1977)

3.3 sound power level

L_W

ten times the logarithm to the base 10 of the ratio of the sound power radiated by the source under test to the reference sound power [$W_0 = 1 \text{ pW}$ (10^{-12} W)]

NOTE 1 It is expressed in decibels.

NOTE 2 The frequency weighting or the width of the frequency band used should be indicated; for example A-weighted sound power level (L_{WA}).

NOTE 3 Adapted from ISO 12001.

3.4 sound pressure level

L_p

ten times the logarithm to the base 10 of the ratio of the square of the sound pressure to the square of the reference sound pressure [$p_0 = 20 \text{ } \mu\text{Pa}$ ($2 \times 10^{-5} \text{ Pa}$)]

NOTE 1 It is expressed in decibels.

NOTE 2 The frequency weighting or the width of the frequency band used, and the time weighting (S, F or I, see IEC 61672-1) should be indicated.

NOTE 3 Adapted from ISO 3744.

3.5 time-averaged sound pressure level (standards.iteh.ai)

L_{peqT}

sound pressure level of a continuous steady sound that, within a measurement time interval T , has the same mean-square sound pressure as a sound under consideration which varies with time:

$$L_{peqT} = 10 \lg \left[\frac{1}{T} \int_0^T \frac{p^2(t)}{p_0^2} dt \right] \text{ dB} \quad (1)$$

NOTE 1 It is expressed in decibels.

NOTE 2 A-weighted time-averaged sound pressure levels are denoted by L_{pAeqT} , which is usually abbreviated to L_{pA} . L_{pAeqT} shall be measured with an instrument which complies with the requirements of IEC 61672-1.

NOTE 3 In general, the subscripts "eq" and "T" are omitted since time-averaged sound pressure levels are necessarily determined over a certain measurement time interval.

NOTE 4 Adapted from ISO 12001.

3.6 sound energy level

L_J

ten times the logarithm to the base 10 of the ratio of the sound energy E (in joules) of the single burst of sound or transient sound radiated by the sound source under test to the reference sound energy [$E_0 = 1 \text{ pJ}$ (10^{-12} J)]:

$$L_J = 10 \lg(E/E_0) \text{ dB} \quad (2)$$

NOTE 1 It is expressed in decibels.

NOTE 2 The frequency weighting or the width of the frequency band used should be indicated.

3.7
single-event sound pressure level

$L_{p,1s}$
time-integrated sound pressure level of an isolated single sound event of specified duration T (or specified measurement time T) normalized to $T_0 = 1$ s:

$$L_{p,1s} = 10 \lg \left[\frac{1}{T_0} \int_0^T \frac{p^2(t)}{p_0^2} dt \right] \text{ dB}$$
$$= L_{peqT} + 10 \lg \left[\frac{T}{T_0} \right] \text{ dB} \tag{3}$$

NOTE 1 It is expressed in decibels.

NOTE 2 Adapted from ISO 3744.

3.8
sound intensity

\vec{I}
product of the sound pressure at a point and the associated particle velocity

NOTE It is a vectorial quantity.

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3.9
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.

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[ISO 3744]

3.10
background noise level

sound pressure level measured when the source under test is not operating

NOTE It is expressed in decibels.

3.11
background noise correction

K_1
correction term to account for the influence of background noise on the surface sound pressure level

NOTE 1 K_1 is frequency dependent and is expressed in decibels.

NOTE 2 The correction in the case of A-weighting is denoted K_{1A} .

[ISO 3744]

3.12
environmental correction

K_2
correction term to account for the influence of reflected or absorbed sound on the surface sound pressure level

NOTE 1 K_2 is frequency dependent and is expressed in decibels.

NOTE 2 The correction in the case of A-weighting is denoted K_{2A} .

[ISO 3744]

NOTE 3 K_2 is used in standards of the ISO 3740 series employing an enveloping measurement surface.

4 Determination of sound power levels

4.1 Reasons for the determination of sound power levels

The effective exchange of acoustical information among the several parties concerned is usually needed to control the noise from machinery and equipment. These include the manufacturer, installer, and user of the machinery or equipment. This acoustical information is obtained from measurements. These measurements are useful only if the conditions under which they are carried out are specified, if they yield defined acoustical quantities, and if they are made using standardized instruments.

Sound power levels may be used for different purposes:

- declaration of the noise emitted under defined conditions (see clause 5);
- 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 reduce the noise emission of machinery;
- prediction of noise levels in work places; [ISO 3740:2000](https://standards.iteh.ai/catalog/standards/sist/efe7e426-e390-4bf0-8641-7b5a202a1861/iso-3740-2000)
- establishment of a list of requirements from the client to the supplier and/or elaboration of a contract with reference to a standardized method; <https://standards.iteh.ai/catalog/standards/sist/efe7e426-e390-4bf0-8641-7b5a202a1861/iso-3740-2000>
- characterization and description of the source.

The sound power level data determined according to one of the basic International Standards are essentially independent of the environment in which the data are obtained or in which the machinery or equipment is to be installed. This is one of the reasons for using sound power levels to characterize the noise emitted by various types of machinery and equipment.

4.2 Methodology

The two main principles for the determination of the sound power level of a machine or equipment applied in the ISO 3740 and ISO 9614 series are:

- evaluation of the spatial mean-squared sound pressure built up in a highly reflective environment (measurements in a reverberant field);
- evaluation of the flow of sound energy emitted by the source, with measurements using an enveloping surface (measurements in a free field or in a free field over a reflecting plane or in a more or less free field over a reflecting plane).

Two basic quantities can be measured to determine the sound power level of a machine or equipment, i.e. sound pressure levels or sound intensity levels. Seven International Standards in the ISO 3740 series describe procedures for determining sound power levels from measured sound pressure levels, in different test environments. ISO 9614-1 and ISO 9614-2 give procedures for determining sound power levels from measured values of the sound intensity components in the vicinity of the machine under test.

5 Noise declaration according to ISO 4871

The sound power level determined according to one of the methods described in this International Standard and the related uncertainty are two quantities that are used by manufacturers of machinery and equipment when preparing the noise declaration according to ISO 4871. Values of the uncertainty are normally given in the relevant noise test code. If no specific noise test code exists, values given in annex A of ISO 4871:1996 can be used.

6 Selection of the appropriate International Standard for determination of sound power levels

6.1 Quantities to be measured and determined

Methods are specified in ISO 3741 to ISO 3747 for determining sound power levels by measuring sound pressure levels. Methods are specified in ISO 9614-1 and ISO 9614-2 for determining sound power levels by measuring sound intensity levels.

The levels may be time-averaged, frequency-weighted, in frequency bands, or time-weighted. The preferred frequency weighting is A-weighting.

6.2 Considerations affecting choice of method

Factors to be considered when selecting a standard from this series of International Standards include the following:

- a) the grade of accuracy required (see ISO 12001 for the definition);
- b) the size and transportability of the machinery or equipment, affecting the practicability of setting it up in an acoustical test laboratory for the purpose of the noise measurements;
- c) the test environment available for the measurements;
- d) the background noise level;
- e) the character of the noise produced by the source (e.g. broad-band, narrow-band, discrete-frequency; steady, non-steady, impulsive);
- f) the acoustical instrumentation available;
- g) the type of sound power level required (frequency-weighted or in frequency bands, frequency range of interest);
- h) other acoustical information desired (e.g. directivity of source, temporal pattern).

NOTE 1 The preferred grade of accuracy for purposes of noise declaration is engineering (grade 2).

NOTE 2 All standards within a specific grade imply the same level of accuracy.

6.3 Synopses

Synopses of ISO 3741 to ISO 3747 and ISO 9614-1 and ISO 9614-2 are given in annex A. Table 1 gives an overview of these International Standards.

6.4 Test environments

Annex B describes the different test environments considered in ISO 3741 to ISO 3747, and ISO 9614-1 and ISO 9614-2.