

INTERNATIONAL
STANDARD

ISO
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**Acoustics — Determination of sound
insulation performances of enclosures —**

Part 2:

Measurements *in situ* (for acceptance and
verification purposes)

*Acoustique — Détermination de l'isolement acoustique des
encoffrements —*

Partie 2: Mesurages sur site (aux fins d'acceptation et de vérification)



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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.

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.

International Standard ISO 11546-2 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

ISO 11546 consists of the following parts, under the general title *Acoustics — Determination of sound insulation performances of enclosures*:

- *Part 1: Measurements under laboratory conditions (for declaration purposes)*
- *Part 2: Measurements in situ (for acceptance and verification purposes)*

Annex A forms an integral part of this part of ISO 11546. Annexes B, C, D and E are for information only.

Acoustics — Determination of sound insulation performances of enclosures —

Part 2:

Measurements *in situ* (for acceptance and verification purposes)

1 Scope

This part of ISO 11546 specifies *in situ* methods for the determination of the sound insulation performance (insertion loss) of machine enclosures.

It applies to a total enclosure only and not to the individual panels from which the enclosure is made.

NOTES

1 Sound insulation for enclosure panels such as wall elements, doors, windows, silencers, etc. should be measured in accordance with other relevant standards.

2 Related standards concern noise-attenuation measurements of enclosures under laboratory conditions (ISO 11546-1) and cabins (ISO 11957).

The measurement methods specified in this part of ISO 11546 are based on International Standards in the series ISO 3740, ISO 9614 and ISO 11200 (see table 1). Depending on the method chosen, the sound insulation performance (insertion loss) of the enclosure is determined in terms of the reduction of sound power level or sound pressure level. Methods are given for measurements where the enclosure surrounds the actual sound source (machine). When these methods are not practicable, alternative measurements can be performed with an artificial sound source. Such methods are also described in this part of ISO 11546.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 11546. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 11546 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 140-6:1978, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 6: Laboratory measurements of impact sound insulation of floors.*

ISO 717-1:—¹⁾, *Acoustics — Rating of sound insulation in buildings and of building elements — Part 1: Airborne sound insulation.*

ISO 3743-1:1994, *Acoustics — Determination of sound power levels of noise sources — Engineering methods for small, movable sources in reverberant fields — Part 1: Comparison method for hard-walled 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.*

1) To be published. (Revision of ISO 717-1:1982 and ISO 717-3:1982)

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 3747:1987, *Acoustics — Determination of sound power levels of noise sources — Survey method using a reference sound source.*

ISO 4871:—²⁾, *Acoustics — Declaration and verification of noise emission values of machinery and equipment.*

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:—³⁾, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 2: Measurement by scanning.*

ISO 11201:1995, *Acoustics — Noise emitted by machinery and equipment — Measurement of emission sound pressure levels at a work station and at other specified positions — Engineering method in an essentially free field over a reflecting plane.*

ISO 11202:1995, *Acoustics — Noise emitted by machinery and equipment — Measurement of emission sound pressure levels at a work station and at other specified positions — Survey method in situ.*

ISO 11204:1995, *Acoustics — Noise emitted by machinery and equipment — Measurement of emission sound pressure levels at a work station and at other specified positions — Method requiring environmental corrections.*

IEC 651:1979, *Sound level meters.*

IEC 804:1985, *Integrating-averaging sound level meters.*

IEC 942:1988, *Sound calibrators.*

IEC 1260:—⁴⁾, *Electroacoustics — Octave-band and fractional-octave-band filters.*

3 Definitions

For the purposes of this part of ISO 11546, the following definitions apply.

2) To be published. (Revision of ISO 4871:1984)

3) To be published.

4) To be published. (Revision of IEC 225:1966)

3.1 A-weighting: Frequency weighting as defined in IEC 651.

3.2 enclosure: A structure enveloping a noise source (machine), designed to protect the environment from this noise source (machine).

NOTE 3 An enclosure can be, for example, a freestanding structure terminated on the floor or a structure more or less fixed to the machine. (Concerning enclosures fixed to the machine, see clause 4.)

3.3 sound pressure level, L_p : Ten times the logarithm to the base 10 of the ratio of the square of the sound pressure of a sound to the square of the reference sound pressure. Sound pressure levels are expressed in decibels. The reference sound pressure is 20 μ Pa (2×10^{-5} Pa).

3.4 average sound pressure level, \bar{L}_p : Mean-square of the sound pressure levels:

$$\bar{L}_p = 10 \lg \left(\frac{10^{0,1L_{p1}} + 10^{0,1L_{p2}} + \dots + 10^{0,1L_{pn}}}{n} \right) \text{ dB}$$

where $L_{p1}, L_{p2}, \dots, L_{pn}$ are the sound pressure levels, in decibels, to be averaged.

3.5 sound power level, L_w : Ten times the logarithm to the base 10 of the ratio of a given sound power to the reference sound power. It is expressed in decibels. The reference sound power is 1 pW (10^{-12} W).

3.6 average sound power level, \bar{L}_w : Mean-square of the sound power levels:

$$\bar{L}_w = 10 \lg \left(\frac{10^{0,1L_{w1}} + 10^{0,1L_{w2}} + \dots + 10^{0,1L_{wn}}}{n} \right) \text{ dB}$$

where $L_{w1}, L_{w2}, \dots, L_{wn}$ are the sound power levels, in decibels, to be averaged.

3.7 sound power insulation, D_w : Reduction in sound power level obtained due to the enclosure (octave bands or one-third-octave bands). It is expressed in decibels.

3.8 A-weighted sound power insulation, D_{wA} : Reduction in the A-weighted sound power level obtained due to the enclosure for the actual sound source spectrum. It is expressed in decibels.

3.9 sound pressure insulation, D_p : Reduction in the sound pressure level at a specified position due to the

enclosure (octave bands or one-third-octave bands). It is expressed in decibels.

3.10 A-weighted sound pressure insulation, D_{pA} : Reduction in A-weighted sound pressure level at a specified position due to the enclosure for the actual sound source spectrum. It is expressed in decibels.

3.11 estimated noise insulation due to the enclosure, $D_{WA,e}$ or $D_{pA,e}$: Calculated reduction in A-weighted sound power or sound pressure level obtained from D_W or D_p , measured in accordance with this part of ISO 11546, and a specific noise spectrum. (See annex C.) It is expressed in decibels.

3.12 weighted sound power insulation, $D_{W,w}$: Single-number value determined in accordance with the method stated in ISO 717-1 except that the sound reduction index is replaced by the sound power insulation, D_W . It is expressed in decibels.

3.13 fill ratio, ϕ : Ratio of the volume of the source in an enclosure to the interior volume of that enclosure.

In cases where the shape of the source complicates calculation of the source volume, the volume of a reference box determined in accordance with ISO 3744 or ISO 3746 can be used.

3.14 leak ratio, θ : Ratio between the area of all openings of the enclosure and the total interior surface area of the enclosure (including openings).

NOTES

4 Openings provided with sufficiently efficient sound-attenuating silencers are not regarded as openings with respect to the leak ratio.

5 The reciprocal value of the leak ratio is designated the seal ratio, Ψ ($\Psi = 1/\theta$).

4 Choice of measurement method

Accurate values of the sound insulation performance of an enclosure can only be obtained when the measurements take place with the actual sound source for which the enclosure is designed. Thus, whenever practicable, methods using the real source shall be used. If the enclosure is fixed or otherwise connected to the sound source, the sound insulation performance can only be determined with the actual sound source.

NOTE 6 The result of an *in situ* measurement depends on the enclosure construction and the workmanship when installed.

In some specific cases, an artificial sound source can be used instead of the sound source, for which the enclosure is intended. This method may, for example, be used in cases where the actual sound source (machine) cannot work without auxiliary equipment with a high noise level. Furthermore, an artificial sound source may be used in cases where it is impossible to achieve identical operating conditions for the machine during measurements with and without an enclosure, respectively.

The leak ratio of an enclosure measured in accordance with this part of ISO 11546 with an artificial sound source should be small (θ preferably less than 2 %) and the interior surfaces of the enclosure should be sound absorbing.

NOTE 7 The more the enclosure deviates from these ideal conditions regarding leak ratio and absorption, the more there is a need to take measurements using the actual sound source.

In cases where a single-number value is wanted based on measurements carried out with the artificial sound source method, the weighted sound power insulation, $D_{W,w}$, is the preferred quantity (see definition 3.12). The weighted sound power insulation is a practicable single-number value to be used for a rough comparison of different enclosures. However, this quantity must not be taken as a general measure of the sound insulation performance of the enclosure, as the performance in actual situations strongly depends on the spectrum of the actual noise.

This part of ISO 11546 is intended for use together with a relevant International Standard for the determination of sound power level or measurement of sound pressure level. The applicability of the different methods described is summarized in table 1 and in annex C.

The requirement concerning the maximum volume of the enclosure, as given by the relevant International Standard selected from table 1, shall be fulfilled.

If the actual noise spectrum is known or can be assumed, the reduction in A-weighted noise level due to the enclosure can be estimated according to the method given in annex D.

NOTE 8 Measurement data obtained using the actual sound source are not necessarily comparable with data obtained using an artificial sound source. In cases where the actual sound source is connected to the enclosure, structure-borne sound may influence the measurement result.