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Acoustics — Noise emitted by machinery and equipment — Guidelines for the use of basic standards for the determination of emission sound pressure levels at a work station and at other specified positions

Acoustique — Bruit émis par les machines et équipements — Guide d'utilisation des normes de base pour la détermination des niveaux de pression acoustique d'émission au poste de travail et en d'autres positions spécifiées

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Foreword

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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. www.iso.org/directives

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

This second edition cancels and replaces the first edition (ISO 11200:1995), which has been technically revised. It also incorporates the Technical Corrigendum ISO 11200:1995/Cor.1:1997.

Introduction

0.1 For many users of machinery and equipment, the control of noise is a major issue which requires effective exchange of acoustical information among the several parties concerned. These include the manufacturer, installer and user of the machinery or equipment. This acoustical information is obtained from measurements. The main flow of information goes from the manufacturer to the user.

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 carried out using standardized instruments.

Two quantities which complement one another can be used to describe the sound emission of machinery or equipment: the sound power level and the emission sound pressure level at a specified position. The International Standards which describe the basic methods of determining the sound power level are ISO 3740,[2] ISO 3741, ISO 3743 (all parts), ISO 3744, ISO 3745, ISO 3746 and ISO 3747 (determination from sound pressure level measurements), and ISO 9614-1, ISO 9614-2 and ISO 9614-3 (determination from sound intensity measurements). This International Standard introduces a group of five International Standards describing various methods for determining emission sound pressure levels of machinery and equipment taking into account possible situations for the source under test (mobile machine, fixed machine, various test rooms, various instrumentations, different kinds of work stations, etc.).

It is not the intention of this group of International Standards to describe procedures for measuring the occupational noise exposure of workers; for occupational noise exposure, see ISO 9612.[4]

0.2 Emission sound pressure levels in conjunction with sound power levels are used for declaration of the noise emitted under the 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 reduce the noise emission of machinery, and prediction of noise exposure at the specified positions.

Included in this group of International Standards are three, which describe procedures for measuring emission sound pressure levels directly, in different test environments (ISO 11201, ISO 11202 and ISO 11204), a fourth (ISO 11203), which gives procedures for determining emission sound pressure levels from the sound power level and a fifth (ISO 11205), which gives a procedure for determining the emission sound pressure level from measured values of the sound intensity level.

0.3 In general, these sound pressure levels are different from those which occur if the machinery or equipment operates in its installed surroundings, where the environment influences the sound pressure level at work stations or other specified positions. The selection of standards for the determination of the sound power level can, for practical reasons, have consequences on the selection of standards for the determination of the emission sound pressure level. It is preferable to make the choice of standards concurrently with respect to the two noise emission quantities.

0.4 Standards in the ISO 11201, ISO 11202, ISO 11203, ISO 11204 and ISO 11205 group are often used in practice through their reference in standardized noise test codes (see 3.25). If a particular noise test code exists for a family of machinery, it is intended that it be used. For drafting a noise test code, it is recommended to be familiar with ISO 12001.[6]

0.5 The reasons for revising the ISO 11201, ISO 11202, ISO 11203, ISO 11204 and ISO 11205 group were manifold:

— the need arose to introduce a grade 1 method into the group in order to enhance the similarity with the ISO 3741, ISO 3743 (all parts), ISO 3744, ISO 3745, ISO 3746 and ISO 3747 group of International Standards on the determination of sound power level;

— feedback from experience with the use of the group showed that the ISO 11202 method gave more precise results than initially thought, hence the introduction into ISO 11202 of the possibility to get grade 2 results;

— as source directivity plays a key role with regard to the emission sound pressure level, pragmatism led to introduce this parameter into the ISO 11202 and ISO 11204 methods;

— as measurement uncertainty was becoming a more and more central issue, the need arose to address the issue again in the light of the experience gained with the use of ISO/IEC GUIDE 98-3.

No research was carried out in order to revise the ISO 11201, ISO 11202, ISO 11203, ISO 11204 and ISO 11205 group. Only existing knowledge was used.

Acoustics — Noise emitted by machinery and equipment — Guidelines for the use of basic standards for the determination of emission sound pressure levels at a work station and at other specified positions

1 Scope

This International Standard is the frame standard introducing the basic group, ISO 11201, ISO 11202, ISO 11203, ISO 11204 and ISO 11205, on the determination of emission sound pressure levels at work stations and other specified positions. It gives guidance for:

— facilitating the writing of noise test codes;

— providing physical explanations of this noise emission quantity compared to other noise quantities (see 4.1 to 4.3);

— comparing the different measurement methods offered by the group (see Table 1);

— facilitating the choice of the most appropriate method(s) in typical practical situations (Clause 6).

This International Standard is largely based on flow charts and tables. Case studies are described.

The guidance given applies to airborne sound only. It is for use in noise testing, in general, and in the preparation of noise test codes, in particular.

A standardized noise test code is intended to select standards from the ISO 11201, ISO 11202, ISO 11203, ISO 11204 and ISO 11205 group, which are the most appropriate to the machinery family it covers, and which give detailed requirements on mounting and operating conditions for the particular family, as well as the location of the work station(s) and other specified positions as prescribed in these International Standards.

The data so obtained can be used for the declaration and verification of emission sound pressure levels, e.g. as specified in ISO 4871.[3]

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3741, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Precision methods for reverberation test rooms*

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

ISO 3743-2, *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, *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 3746, *Acoustics — Determination of sound power levels and sound energy 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 and sound energy levels of noise sources using sound pressure — Engineering/survey methods for use in situ in a reverberant environment*

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

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

ISO 9614-3, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 3: Precision method for measurement by scanning*

ISO 11201:2010, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions in an essentially free field over a reflecting plane with negligible environmental corrections*

ISO 11202:2010, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions applying approximate environmental corrections*

ISO 11203, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions from the sound power level*

ISO 11204:2010, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions applying accurate environmental corrections*

ISO 11205, *Acoustics — Noise emitted by machinery and equipment — Engineering method for the determination of emission sound pressure levels in situ at the work station and at other specified positions using sound intensity*

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 61043, *Electroacoustics — Instruments for the measurement of sound intensity — Measurement with pairs of pressure sensing microphones*

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

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

3 Terms and definitions

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

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

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

[SOURCE: ISO 11201:2010, 3.1]

3.2
emission sound pressure
p
sound pressure, at a work station or another specified position near a noise source, when the source is in operation under specified operating and mounting conditions on a reflecting plane surface, excluding the effects of background noise as well as the effects of reflections other than those from the plane or planes permitted for the purpose of the test

Note 1 to entry: Emission sound pressure is expressed in pascals.

[SOURCE: ISO 11201:2010, 3.2]

3.3
emission sound pressure level
L_p
ten times the logarithm to the base 10 of the ratio of the square of the emission 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

Note 1 to entry: The emission sound pressure level is determined at a work station or another specified position in accordance with either a noise test code for a specific family of machines or, if no noise test code exists, one of the standards of the group (i.e. this International Standard along with ISO 11201, ISO 11202, ISO 11203, ISO 11204 and ISO 11205).

[SOURCE: ISO 11201:2010, 3.3, modified — In Note 1, the reference numbers of the group of standards have been written in full.]

3.4
time-averaged emission 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 emission 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

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

where the reference value, p_0, is 20 µPa

Note 1 to entry: For simplicity of notation, the subscript T is omitted throughout the following text.

Note 2 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_{pA} denotes the A-weighted emission sound pressure level.

Note 3 to entry: The formula is equivalent to that for the environmental noise descriptor "equivalent continuous sound pressure level" (ISO 1996-1[1]). However, the emission quantity defined above is used to characterize the noise emitted by a source under test and assumes that standardized measurement and operating conditions as well as a controlled acoustical environment are used for the measurements.

Note 4 to entry: ISO 11205 uses L_I instead of $L_{p,T}$ and replaces p^2 by the magnitude of the intensity vector, $|\vec{I}|$, and p_0^2 by $I_0 = 10^{-12}$ W/m^2.

[SOURCE: ISO 11201:2010, 3.4, modified — Notes 1 to 3 have been renumbered; Note 4 has been added.]

3.5
peak emission sound pressure
p_{peak}
greatest absolute emission sound pressure during a stated time interval

Note 1 to entry: Peak emission sound pressure is expressed in pascals.

Note 2 to entry: A peak emission sound pressure may arise from a positive or negative sound pressure.

[SOURCE: ISO 11201:2010, 3.5]

3.6
peak emission sound pressure level
$L_{p,peak}$
ten times the logarithm to the base 10 of the ratio of the square of the peak emission sound pressure, p_{peak}, to the square of a reference value, p_0, expressed in decibels

$$L_{p,\mathrm{peak}} = 10 \lg \frac{p_{\mathrm{peak}}^2}{p_0^2} \mathrm{dB}$$

where the reference value, p_0, is 20 µPa

Note 1 to entry: The peak emission sound pressure level is usually C-weighted and denoted by $L_{pC,peak}$.

[SOURCE: ISO 11201:2010, 3.6]

3.7
single event emission sound pressure level
L_E
ten times the logarithm to the base 10 of the ratio of the integral of the square of the emission sound pressure, p, of an isolated single sound event (burst of sound or transient sound) of specified duration, T (or specified measurement time interval $T = t_2 - t_1$ covering the single event), to the square of a reference value, p_0, normalized to reference time interval $T_0 = 1$ s, expressed in decibels

$$L_E = 10 \lg \left[\frac{1}{T_0} \int_{t_1}^{t_2} \frac{p^2(t)}{p_0^2} \mathrm{d}t \right] \mathrm{dB}$$

$$= L_{p,T} + 10 \lg \frac{T}{T_0} \mathrm{dB}$$

Note 1 to entry: This formula is equivalent to that for the environmental noise descriptor “sound exposure level”. However, the emission quantity defined above is used to characterize the noise emitted by a source under test and assumes that standardized measurement, mounting, and operating conditions as well as a controlled acoustical environment are used for the measurements.

[SOURCE: ISO 11201:2010, 3.7, modified — The source of “sound exposure level” has been deleted from Note 1.]

3.8
work station
operator’s position
position in the vicinity of the machine under test which is intended for the operator

[SOURCE: ISO 11201:2010, 3.11]

3.9
operator
individual whose work station is in the vicinity of a machine and who is performing a work task associated with that machine

[SOURCE: ISO 11201:2010, 3.12]

3.10
specified position
position defined in relation to a machine, including, but not limited to, an operator's position

Note 1 to entry: The position can be a single, fixed point, or a combination of points along a path or on a surface located at a specified distance from the machine, as described in the relevant noise test code, if one exists.

Note 2 to entry: Positions located in the vicinity of a work station, or in the vicinity of an unattended machine, are identified as "bystander positions".

[SOURCE: ISO 11201:2010, 3.13, modified — Note 3 has been deleted.]

3.11
operational period
interval of time during which a specified process is accomplished by the source under test

EXAMPLE For a dishwasher, when washing or rinsing or drying.

[SOURCE: ISO 11201:2010, 3.14]

3.12
operational cycle
specific sequence of operational periods occurring while the source under test performs a complete work cycle, where each operational period is associated with a specific process that may occur only once, or may be repeated, during the operational cycle

EXAMPLE For a dishwasher, when washing and rinsing and drying.

[SOURCE: ISO 11201:2010, 3.15]

3.13
measurement time interval
portion or a multiple of an operational period or operational cycle of the source under test, for which the time-averaged emission sound pressure level is determined or over which the maximum emission sound pressure level is sought

[SOURCE: ISO 11201:2010, 3.16]

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

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

[SOURCE: ISO 11201:2010, 3.18]

3.15
background noise correction
K_1
correction applied to the measured sound pressure levels to account for the influence of background noise

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

Note 2 to entry: Background noise correction is frequency dependent. In the case of A-weighting, the correction, K_{1A}, is determined from A-weighted measured values.

[SOURCE: ISO 11201:2010, 3.19]

3.16
reference box
hypothetical rectangular 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 may be mounted

[SOURCE: ISO 11201:2010, 3.20]

3.17
reference measurement surface
S_M
hypothetical surface defined by a rectangular parallelepiped enveloping the noise source under test, terminating on the reflecting plane(s) on which the source is located, and having sides parallel to those of the reference box with each side spaced at equal distance from the corresponding side of the reference box

[SOURCE: ISO 11201:2010, 3.21]

3.18
sound power
P
rate over given time interval at which airborne sound energy is radiated by a source

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

3.19
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

Note 1 to entry: Sound power level is expressed in decibels.

Note 2 to entry: The reference sound power is 1 pW (10^{-12} W).

[SOURCE: ISO 3744:2010, 3.21, modified — The definition and Notes 1 and 2 have been changed.]

3.20
environmental correction
K_2
term to account for the influence of reflected sound on the mean sound pressure level on the reference measurement surface, expressed in decibels

Note 1 to entry: K_2 is frequency dependent and can be determined in accordance with ISO 3744 or ISO 3746. In the case of A-weighting, it is denoted K_{2A}.

[SOURCE: ISO 11201:2010, 3.22]

3.21
local environmental correction
K_3
correction applied to the measured sound pressure levels at the work station to account for the influence of reflected sound, expressed in decibels

Note 1 to entry: The local environmental correction is frequency dependent. In the case of A-weighting, it is denoted K_{3A}.

Note 2 to entry: K_3 is only obtained on completion of testing.

[SOURCE: ISO 11202:2010, 3.25, modified — Note 2 has been added.]

3.22
work station directivity index
$D_{\mathrm{I,op}}$
measure of the extent to which a source under test radiates sound in the direction of the work station (operator's position), relative to the mean sound radiation over the reference measurement surface, expressed in decibels

$$D_{\mathrm{I,op}} = L_p - \overline{L_p}$$

where

L_p is the emission sound pressure level;

$\overline{L_p}$ is the surface sound pressure level (in accordance with ISO 3744) on the reference measurement surface

Note 1 to entry: These levels are determined in an essentially free field over a reflecting plane and have been corrected for background noise and for environmental influences, if relevant.

[SOURCE: ISO 11202:2010, 3.22]

3.23
apparent work station directivity index
$D^*_{\mathrm{I\,op}}$

$$D^*_{\mathrm{I\,op}} = L^*_p - \overline{L^*_p}$$

where

L^*_p is the sound pressure level measured at the work station, corrected for background noise, but not for the influence of the environment;

$\overline{L^*_p}$ is the sound pressure level averaged over the reference measurement surface, corrected for background noise, but not for the influence of the environment

[SOURCE: ISO 11202:2010, 3.23]

3.24
approximate apparent work station directivity index
$D^*_{\mathrm{I\,op,approx}}$

$$D^*_{\mathrm{I\,op,approx}} = L^*_p - \overline{L^*_{p,\mathrm{approx}}}$$

where

L^*_p is the sound pressure level measured at the work station, corrected for background noise, but not for the influence of the environment;

$\overline{L^*_{p,\mathrm{approx}}}$ is the sound pressure level averaged over the reference measurement surface, corrected for background noise but not for the influence of the environment, measured with a reduced number of microphone positions

[SOURCE: ISO 11202:2010, 3.24]