INTERNATIONAL STANDARD

ISO 11201

Second edition
2010-05-15

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

Acoustique — Bruit émis par les machines et équipements — Détermination des niveaux de pression acoustique d'émission au poste de travail et en d'autres positions spécifiées dans des conditions approchant celles du champ libre sur plan réfléchissant avec des corrections

Reference number
ISO 11201:2010(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 11201 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

This second edition cancels and replaces the first edition (ISO 11201:1995), which has been technically revised. It also incorporates the Technical Corrigendum ISO 11201:1995/Cor.1:1997.

Introduction

This International Standard specifies a method for determining the emission sound pressure levels at a work station and at other well defined positions, in the vicinity of a machine or piece of equipment, in an essentially free field over a reflecting plane. It is one of a series (ISO 11200[15] to ISO 11205[19]) which specifies various methods for determining the emission sound pressure level at a work station and at other specified positions of a machine or equipment. ISO 11200[15] gives guidance on the choice of the method to be used to determine the emission sound pressure levels of machinery and equipment.

The method specified in this International Standard differs from those in other International Standards in the ISO 11200[15] to ISO 11205[19] series in not applying any environmental correction. Requirements to be fulfilled by the environment are specified for accuracy grade 1 (precision) and grade 2 (engineering) measurements indoors and outdoors.

Precision measurements with accuracy grade 1 can generally be carried out in hemi-anechoic test rooms or outdoors provided that requirements on environmental conditions are met. With the specifications defined in the following it should be possible in some cases to provide such conditions in industrial ambience on larger plane areas outdoors free from reflecting objects.

ISO 11201:1995 provided results of accuracy grade 2 only. This edition of this International Standard provides a method of accuracy grade 2 that is essentially identical to that given in ISO 11201:1995. It also provides a more precise method of accuracy grade 1. Users and drafters of noise test codes referring to this International Standard should indicate clearly which method (accuracy grade 1 or accuracy grade 2) is used.

In general, the emission sound pressure levels are less than or equal to those that occur when the machinery or equipment is operating in its normal surroundings. This is because the sound pressure levels are determined by excluding the effects of background noise, as well as the effects of reflections other than those from the reflecting plane on which the machine under test is placed. For determination or calculation of the sound pressure level at the operator's position with the machine operating in a room, both sound power level and sound pressure level are required (as well as information on the room properties or reflections and noise from other sound sources or machines). A method of calculating the sound pressure levels in the vicinity of a machine operating alone in a workroom is given in ISO/TR 11690-3[20]. Commonly observed differences are 1 dB to 5 dB, but in extreme cases the difference may be even greater.

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

1 Scope

1.1 General

This International Standard specifies a method for determining the emission sound pressure levels of machinery or equipment, at a work station and at other specified positions nearby, in an essentially free field over a reflecting plane. A work station is occupied by an operator and may be located in open space, in the room where the source under test operates, in a cab fixed to the source under test, or in an enclosure remote from the source under test. One or more specified positions may be located in the vicinity of a work station, or in the vicinity of an attended or unattended machine. Such positions are sometimes referred to as bystander positions.

Emission sound pressure levels are determined as A-weighted levels. Additionally, levels in frequency bands and C-weighted peak emission sound pressure levels can be determined in accordance with this International Standard, if required.

NOTE 1 The contents of the series ISO 11200[15] to ISO 11205[19] are summarized in ISO 11200[15].

With the method specified in this International Standard, results of accuracy grade 1 (precision grade) or accuracy grade 2 (engineering grade) are obtained. Corrections are applied for background noise, but not for the acoustic environment. Instructions are given for the mounting and operation of the source under test and for the choice of microphone positions for the work station and for other specified positions. One purpose of the measurements is to permit comparison of the performance of different units of a given family of machines, under defined environmental conditions and standardized mounting and operating conditions.

NOTE 2 The data obtained can also be used for the declaration and verification of emission sound pressure levels as specified in ISO 4871[8].

1.2 Types of noise and noise sources

The method specified in this International Standard is suitable for all types of noise (steady, non-steady, fluctuating, isolated bursts of sound energy, etc.) defined in ISO 12001.

The method specified in this International Standard is applicable to all types and sizes of noise sources.

NOTE Throughout this International Standard the words “machine” and “source under test” are used to represent either a machine or a piece of equipment.

1.3 Test environment

The type of test environment influences the accuracy of the determination of emission sound pressure levels. For the application of this International Standard, an essentially free field over a reflecting plane (indoors or outdoors) is required.

1.4 Work station and other specified positions

This International Standard is applicable to work stations and other specified positions where emission sound pressure levels are to be determined.

Appropriate positions where measurements may be made include the following:

a) work station located in the vicinity of the source under test; this is the case for many industrial machines and domestic appliances;

b) work station within a cab which is an integral part of the source under test; this is the case for many industrial trucks and earth-moving machines;

c) work station within a partial or total enclosure (or behind a screen) supplied by the manufacturer as an integral part of the source under test;

d) work station partially or totally enclosed by the source under test — this situation may be encountered with some large industrial machines;

e) bystander positions occupied by individuals not responsible for the operation of the source under test, but who may be in its immediate vicinity, either occasionally or continuously;

f) other specified positions, not necessarily work stations or bystander positions.

The work station may also lie on a specified path along which an operator moves (see 9.4).

2 Normative references

The following referenced documents are indispensable for the application 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, *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, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Precision methods for anechoic and hemi-anechoic rooms*

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

ISO 5725 (all parts), *Accuracy (trueness and precision) of measurement methods and results*

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

IEC 60942:2003, *Electroacoustics — Sound calibrators*

IEC 61260:1995, *Electroacoustics — Octave-band and fractional-octave-band filters* (amended by IEC 61260/Amd.1:2001)

IEC 61672-1:2002, *Electroacoustics — Sound level meters — Part 1: Specifications*

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement* (*GUM:1995*)

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply. More detailed definitions can be found in noise test codes for specific types of machines.

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

NOTE 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.

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 Emission sound pressure is expressed in pascals.

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

$$L_p = 10 \lg \frac{p^2}{p_0^2} \text{ dB} \tag{1}$$

where the reference value, p_0, is 20 µPa

NOTE 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 ISO 11200[15] to ISO 11205[19] series.

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

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

where the reference value, p_0, is 20 µPa

NOTE 1 Adapted from ISO/TR 25417:2007[21], 2.3, “time-averaged sound pressure level”.

NOTE 2 For simplicity of notation, the subscript T is omitted throughout the following text.

NOTE 3 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 emission sound pressure level.

NOTE 4 Equation (2) 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.

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

NOTE 1 Peak emission sound pressure is expressed in pascals.

NOTE 2 A peak emission sound pressure may arise from a positive or negative sound pressure.

3.6
peak emission sound pressure level
$L_{p,\mathrm{peak}}$
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

$$L_{p,\mathrm{peak}} = 10\lg\frac{p_{\mathrm{peak}}^2}{p_0^2}\ \mathrm{dB} \tag{3}$$

where the reference value, p_0, is 20 µPa

NOTE The peak emission sound pressure level is usually C-weighted and denoted by $L_{p\mathrm{C,peak}}$.

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

$$\begin{aligned} L_E &= 10\lg\left[\frac{1}{T_0}\int_{t_1}^{t_2}\frac{p^2(t)}{p_0^2}\mathrm{d}t\right]\mathrm{dB} \\ &= L_{p,T} + 10\lg\frac{T}{T_0}\ \mathrm{dB} \end{aligned} \tag{4}$$

NOTE Equation (4) is equivalent to that for the environmental noise descriptor “sound exposure level” (ISO/TR 25417:2007[21], 2.7). 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.

3.8
acoustic free field over a reflecting plane
sound field in a homogeneous, isotropic medium in the half space above an infinite reflecting plane, in the absence of any other obstacles

3.9
essentially free field over a reflecting plane
environment approximating an acoustic free field over a reflecting plane on which the noise source under test is located

NOTE The requirements on the environment are specified in 5.2.

3.10
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 or the one-third octave bands with nominal mid-band frequencies from 100 Hz to 10 000 Hz

NOTE 1 Adapted from ISO 6926:1999[9], 3.10.

NOTE 2 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 should be made clear in the test report. For sources which emit sound at predominantly high or low frequencies, the frequency range of interest should be extended to include these frequencies.

3.11
work station
operator's position
position in the vicinity of the machine under test which is intended for the operator

3.12
operator
individual whose work station is in the vicinity of a machine and who is performing a work task associated with that machine

3.13
specified position
position defined in relation to a machine, including, but not limited to, an operator's position

NOTE 1 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 Positions located in the vicinity of a work station, or in the vicinity of an unattended machine, are identified as “bystander positions”.

NOTE 3 Throughout the text of this International Standard, the term “work station” applies to any possible specified position listed in 1.4.

3.14
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.

3.15
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.

3.16
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

3.17
time history
continuous recording of the emission sound pressure level, as a function of time, which is obtained during one or more operational periods of an operational cycle

3.18
background noise
noise from all sources other than the source under test

NOTE Background noise can include contributions from airborne sound, noise from structure-borne vibration, and electrical noise in instrumentation.

3.19
background noise correction
K_1
correction applied to the measured sound pressure levels to account for the influence of background noise

NOTE 1 Background noise correction is expressed in decibels.

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

3.20
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

3.21
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

3.22
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 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}.

NOTE 2 For the purposes of this International Standard, the environmental correction, K_2, is only used as an indicator to qualify the environment and is determined for the reference measurement surface.

3.23
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 In the case of A-weighting, it is denoted K_{3A}.

NOTE 2 The local environmental correction is not applied in this International Standard, but appears in other standards of this series (ISO 11202[16], ISO 11204[18]).

4 Instrumentation

4.1 General

The instrumentation system, including the microphones, cables, and windscreen if used, shall meet the requirements of IEC 61672-1:2002, class 1, and the filters shall meet the requirements of IEC 61260:1995, class 1.

4.2 Calibration

Before and after each series of measurements, a sound calibrator meeting the requirements of IEC 60942:2003, class 1, shall be applied to each microphone to verify the calibration of the entire measuring system at one or more frequencies within the frequency range of interest. Without any further adjustment, the difference between the readings at each end of the series of measurements shall be less than or equal to 0,5 dB. If the difference exceeds 0,5 dB, the results of the series of measurements shall be discarded.

The sound calibrator shall be calibrated, and the compliance of the instrumentation system with the requirements of IEC 61672-1 shall be verified at intervals in a laboratory making calibrations traceable to appropriate standards.

Unless national regulations dictate otherwise, the sound calibrator should be calibrated annually, and the compliance of the instrumentation system with the requirements of IEC 61672-1 should be verified at intervals not exceeding 2 years.

5 Test environment

5.1 General

This International Standard allows the determination of the emission sound pressure level with accuracy grade 1 (precision) and grade 2 (engineering) in a test environment under essentially free-field conditions over a reflecting plane, where no correction for environmental influence is necessary and permitted.

The user of this International Standard shall choose between these two grades of accuracy. The accuracy grade used shall be recorded and reported.

The test environment, therefore, has to meet strict requirements which are often impossible to comply with for installations *in situ*.

Determinations of the emission sound pressure level with accuracy grade 1 (precision) or accuracy grade 2 (engineering) is possible in a hemi-anechoic room as well as outdoors on a reflecting plane, with no reflecting objects influencing the result of the measurement.

Determinations of accuracy grade 2 in accordance with this International Standard are possible indoors and outdoors if background noise and influence from reflected sound do not exceed certain limits.