INTERNATIONAL STANDARD

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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

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 en appliquant des corrections d'environnement approximatives

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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 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 11202 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

This second edition cancels and replaces the first edition (ISO 11202:1995), which has been technically revised.

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 situ*. 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 of ISO 11201[16] in determining and applying a local environmental correction. It differs from ISO 11204[18] by using an approximate method to determine the directivity of the sound radiation of a machine with a reduced number of measurement positions or even with no additional measurement. The acoustical properties of the room have to be determined to qualify the test environment and to determine a correction for local environmental influences applied to the measured sound pressure levels. With the method specified in this International Standard, results of accuracy grade 2 (engineering grade) or accuracy grade 3 (survey grade) are obtained.

For the determination of the local environmental correction two procedures are specified in this International Standard.

The first procedure (see A.1) is based on the assumption that a well-defined part of the machine, visible from and with free propagation conditions to the work station or the specified position, radiates the sound responsible for the sound pressure level at this position. With this assumption, only a sound pressure measurement at the work station and an acoustical qualification of the room are necessary to determine the local environmental correction.

The second procedure (see A.2) is generally applicable. No assumptions about the directivity of the radiation or the source location are necessary, because this directivity is determined using an approximate method with few additional measurement positions. The approximate character of this method is taken into account in qualifying the grade of accuracy of the result.

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 applying approximate 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 situ*. 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].

Methods are given for determining a local environmental correction (subject to a specified limiting maximum value) to be applied to the measured sound pressure levels in order to eliminate the influence of reflecting surfaces other than the plane on which the source under test is placed. This correction is based on the equivalent sound absorption area of the test room and on radiation characteristics (source location or directivity at the work station).

With the method specified in this International Standard, results of accuracy grade 2 (engineering grade) or accuracy grade 3 (survey grade) are obtained. Corrections are applied for background noise and, as described above, 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[9].

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 this International Standard, any room meeting prescribed requirements is applicable. These requirements on the room are less strict than those of ISO 11201[16], in particular regarding the acoustical quality of the environment.

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 10.4).

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 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

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

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

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

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

where the reference value, p_0, is 20 µPa

NOTE 1 For simplicity of notation, the subscript T is omitted throughout the following text.

NOTE 2 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 3 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 sound pressure is expressed in pascals.

NOTE 2 A peak 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 obstacles

3.9
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[10], 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.

3.10
work station
operator's position
position in the vicinity of the machine under test which is intended for the operator

3.11
operator
individual whose work station is in the vicinity of a machine and who is performing a work task associated with that machine

3.12
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 word “work station” applies to any possible specified positions listed in 1.4.

3.13
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.

3.14
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.

3.15
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

3.16
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

3.17
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.

3.18
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.

3.19
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

3.20
reference measurement surface
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

NOTE 1 The “equal distance” is preferably 1 m.

NOTE 2 The work station does not have to be located on the reference measurement surface.

3.21
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.

3.22
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

$$D_{\mathrm{I,op}} = L_p - \overline{L_p} \tag{5}$$

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 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.

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

$$D^*_{\mathrm{I\,op}} = L^*_p - \overline{L^*_p} \tag{6}$$

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

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

$$D^*_{\mathrm{I\,op,approx}} = L^*_p - \overline{L^*_{p,\mathrm{approx}}} \tag{7}$$

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