INTERNATIONAL STANDARD

ISO 11203

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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 from the sound power level

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 à partir du niveau de puissance acoustique

Reference number
ISO 11203:1995(E)

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 11203 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

Annex A of this International Standard is for information only.

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Introduction

0.1 This International Standard specifies methods for determining the emission sound pressure levels at a work station and at other specified positions in the vicinity of machinery and equipment from the sound power level. In general, these sound pressure levels are different from those that would be observed when the machinery or equipment is operating in its normal surroundings where the environment may influence the emission sound pressure level.

0.2 This International Standard is one of a series (ISO 11200 to ISO 11204) which specifies various methods for determining the noise emissions of a piece of machinery or equipment, or a sub-assembly of such equipment (machine under test). ISO 11200 gives guidance on the choice of the method to be used to determine the emission sound pressure levels of machinery and equipment.

It also gives details of International Standards giving methods for the determination of sound power levels.

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

1 Scope

1.1 General

This International Standard specifies two methods for determining the emission sound pressure levels of machinery and equipment, at a work station and at other specified positions nearby, by calculation from the sound power level. The principal purpose of this determination is to permit comparison of the performance of different units of a given family of machinery or equipment, under defined environmental conditions and standardized mounting and operating conditions. The data obtained may also be used for the declaration and verification of emission sound pressure levels as specified in ISO 4871.

Emission sound pressure levels are determined with the same frequency weighting and time weighting, or in the same frequency bands, as those for which sound power levels have been determined.

NOTES

1 The contents of this and related International Standards are summarized in table 1 of ISO 11200:1995.

2 At any given position in relation to a particular machine, and for given mounting and operating conditions, the emission sound pressure levels determined by the method of this International Standard will in general be lower than the directly measured sound pressure levels for the same machine in the typical workroom where it is used. This is due to reverberation and the contributions of other machines. A method of calculating the sound pressure levels in the vicinity of a machine operating alone in a workroom is given in ISO 11690-3. Commonly observed differences are 1 dB to 5 dB, but in extreme cases the difference may be even greater.

1.2 Types of noise and noise sources

This International Standard is, in principle, applicable to moving or stationary machines, for indoor or outdoor use, particularly those machines which are mass-produced. The methods given in this International Standard are not applicable to highly directional sound sources used outdoors.

This International Standard is particularly applicable to machines whose largest dimension is less than or equal to 1 m. It is also applicable to larger machines in certain cases (see 6.2.3).

This International Standard is applicable to all types of noise as defined in ISO 2204 and ISO 12001 for which methods for determining the sound power level are available.

1.3 Test environment

The test environment to be used is that which is specified for the determination of the sound power level in accordance with the International Standards of the ISO 3740 or ISO 9614 series.

1.4 Specified positions

This International Standard is applicable to work stations and other specified positions in the vicinity of the source under test where emission sound pressure levels are to be determined. It is not applicable to work stations and other defined positions which are situated inside a cab or a cabin, or behind a screen.

A work station can be a single point, corresponding to the specified position of a standing or seated operator. It can also be a specified path.

NOTE 3 More detailed specifications regarding seated, standing, stationary or moving operators, as well as information concerning bystanders, are to be found in ISO 11201.

1.5 Specific field of application of each method

Specific information on the field of application of each of the two methods described in this International Standard is given in 6.2.2 and 6.2.3.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard 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 2204:1979, *Acoustics — Guide to International Standards on the measurement of airborne acoustical noise and evaluation of its effects on human beings.*

ISO 3741:1988, *Acoustics — Determination of sound power levels of noise sources — Precision methods for broad-band sources in reverberation rooms.*

ISO 3742:1988, *Acoustics — Determination of sound power levels of noise sources — Precision methods for discrete-frequency and narrow-band sources in reverberation rooms.*

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 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 3745:1977, *Acoustics — Determination of sound power levels of noise sources — Precision methods for anechoic and semi-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 9614-1:1993, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 1: Measurement at discrete points.*

ISO 9614-2:—[1], *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 2: Measurement by scanning.*

ISO 11200:1995, *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.*

ISO 12001:—[1], *Acoustics — Noise emitted by machinery and equipment — Rules for the drafting and presentation of a noise test code.*

IEC 651:1979, *Sound level meters.*

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

IEC 942:1988, *Sound calibrators.*

IEC 1260:—[2], *Electroacoustics — Octave-band and fractional-octave-band filters.*

3 Definitions

For the purposes of this International Standard, the following definitions apply. More detailed definitions may be found 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).

NOTE 4 Noise emission descriptors may be incorporated in a product label and/or product specification. The basic

1) To be published.

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

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: The sound pressure, at a 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. It 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, $p^2(t)$, to the square of the reference sound pressure, p_0^2, measured with a particular time weighting and a particular frequency weighting, selected from those defined in IEC 651. It is expressed in decibels. The reference sound pressure is 20 μPa.

NOTE 5 Examples include:

— maximum A-weighted emission sound pressure level with time-weighting F: L_{pAFmax};

— C-weighted peak emission sound pressure level: $L_{pC,peak}$.

The emission sound pressure level shall be determined at a specified position in accordance with either a test code for a specific family of machines or, if no test code exists, a method that complies with the ISO 11200 series.

3.3.1 time-averaged emission sound pressure level, L_{peqT}: Emission 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.

It is expressed in decibels and is given by the following equation:

$$L_{peqT} = 10 \lg \frac{1}{T} \int_0^T \frac{p^2(t)}{p_0^2} \mathrm{d}t \ \mathrm{dB} \qquad \ldots (1)$$

A-weighted time-averaged emission 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 804.

NOTES

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

7 Equation (1) is identical to that for the familiar ISO environmental noise descriptor "equivalent continuous sound pressure level" defined in ISO 1996-1. However, the emission quantity defined above is used to characterize the noise emitted by a machine under test and assumes that standardized measurement and operating conditions as well as a controlled acoustical environment are used for the measurements.

3.3.2 peak emission sound pressure level, $L_{p,peak}$: Highest instantaneous value of the emission sound pressure level determined over an operational cycle. It is expressed in decibels.

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

It is expressed in decibels and is given by the following equation:

$$L_{p,1s} = 10 \lg \frac{1}{T_0} \int_0^T \frac{p^2(t)}{p_0^2} \mathrm{d}t \ \mathrm{dB} \qquad \ldots (2)$$

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

NOTE 8 The above equation is identical to that for the familiar ISO environmental noise descriptor "sound exposure level". However, the emission quantity defined above is used to characterize a noise source and assumes that a controlled environment is used for the measurements.

3.4 sound power, W: The rate per unit time at which airborne sound energy is radiated by a source. It is expressed in watts.

3.5 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. It is expressed in decibels.

The frequency weighting or the width of the frequency band used shall be indicated. The reference power is 1 pW (1 pW = 10^{-12} W).

NOTE 9 For example, the A-weighted sound power level is L_{WA}.

3.6 free field over a reflecting plane: Sound field in a homogeneous, isotropic medium in the half space

above an infinite, rigid plane surface on which the source is located.

3.7 reference box: Hypothetical surface which is the smallest rectangular parallelepiped that just encloses the source and terminates on the reflecting plane.

3.8 work station; operator's position: Position in the vicinity of the machine under test which is intended for the operator.

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.

3.10 specified position: Position defined in relation to a machine, including, but not limited to, an operator's position. 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 any exists.

NOTE 10 Positions located in the vicinity of a work station, or in the vicinity of an unattended machine, may be identified as "bystander positions".

3.11 operational period: Interval of time during which a specified process is accomplished by the machine under test (e.g. for a dishwasher when washing or rinsing or drying).

3.12 operational cycle: Specific sequence of operational periods occurring while the machine under test performs a complete work cycle. Each operational period is associated with a specific process that may occur only once, or may be repeated, during the operational cycle (e.g. for a dishwasher when washing *and* rinsing *and* drying).

4 Measurement uncertainty

Emission sound pressure levels at work stations and at other specified positions which are calculated from values of the sound power level are approximations of the levels that would be directly measured under environmental conditions approximating a free field over a reflecting plane.

The uncertainties, as expressed by the standard deviations of reproducibility, of the determination of the emission sound pressure level according to the two methods given in this International Standard are numerically equal to those associated with the method used for determining the sound power level. The uncertainties of sound power level determination are given in the ISO 3740 and ISO 9614 series.

5 Quantities to be determined

The methods given in this International Standard apply to A-weighted emission sound pressure levels, L_{pA}. Levels in frequency bands may be calculated from the corresponding sound power levels, if they are available.

Reference should be made to the other International Standards of the ISO 11200 series for determinations of quantities describing time characteristics of the noise emission at work stations (for example, peak C-weighted sound pressure levels, $L_{pC,peak}$, or single-event sound pressure levels, $L_{p,1s}$).

NOTE 11 Optionally, quantities describing time characteristics of the noise emission (for example, $L_{pC,peak}$ and $L_{p,1s}$) may be determined in isolated, specified positions *in situ* in the actual measurement environment.

6 Procedures

6.1 General

The two methods described below do not require any specific measurement. They only assume that the sound power level of the machine under test has been determined in accordance with one of the methods given in the ISO 3740 or ISO 9614 series, or in a noise test code which is consistent with these basic standards.

6.2 Methods

6.2.1 General calculation procedure

The emission sound pressure level at a specified position, L_p, is calculated from the sound power level, L_W, of the machinery or equipment using the following general equation:

$$L_p = L_W - Q \qquad \ldots (3)$$

In this equation, the quantity Q is either determined experimentally ($Q = Q_1$, see 6.2.2) or calculated from a measurement surface surrounding the machine under test ($Q = Q_2$, see 6.2.3).

In equation (3), the time averaging, frequency weighting and frequency bands applicable to L_p are the same as those applicable to L_W.

6.2.2 Method with Q determined experimentally ($Q = Q_1$)

This method is only applicable if a noise test code exists for the family of machinery or equipment to

which the machine under test belongs and if the noise test code calls explicitly for this method. In this case, the noise test code shall give the values of Q_1. These values will have normally been determined from initial experimental investigations carried out when the noise test code was prepared.

A value of Q_1 is associated with a specified position where the emission sound pressure level is to be determined and is only valid for that position.

Specified positions to which this method is applicable are in principle any of the work stations and other specified positions defined in 1.4 as long as adequate experimental investigations show that a high correlation exists between the sound power level and the emission sound pressure level at the specified position for the family of machines under consideration.

This method is particularly suitable for small machines which radiate omnidirectionally, for example most hand-held machines.

NOTE 12 For hand-held machines, typical values for Q_1 lie in the range of 4 dB to 12 dB depending upon the size of the machine.

6.2.3 Method with Q calculated ($Q = Q_2$)

In the following cases, Q_2 is calculated from equation (4). For cases a) and b) below, this method is only applicable if a noise test code exists for the family of machinery or equipment to which the machine under test belongs and if the noise test code calls explicitly for this method.

This method is suitable for

a) machines with work stations or other specified positions at a distance d from the reference box which radiate sound omnidirectionally;

b) machines with work stations or other specified positions at a distance d from the reference box which are normally located close to a wall from which sound energy is reflected to the work station or other specified position;

c) machines for which the operator moves around at a distance d from the reference box; or

d) machines without a specified work station, but for which an average sound pressure level over a measurement surface at a fixed distance (e.g. 1 m) from the reference box can be assumed to be representative:

$$Q = 10 \lg \frac{S}{S_0} \text{ dB} \qquad \ldots (4)$$

where

S is the area, in metres, of a box-shaped surface enveloping the source at a given measurement distance d from the reference box (see 3.7) on which the work station or other specified position lies;

S_0 $= 1 \text{ m}^2$

Detailed information on the reference box is given in ISO 3744 and ISO 3746. Typical values of the measurement distance d are in the range 0,3 m to 1,0 m. The value of d for which Q_2 and S are determined shall be as given in the noise test code, if any exists.

The value of S differs from one specified position to another since it depends mainly on the distance d of the specified position from the source under consideration.

This method is, in principle, applicable to units of a given family of machinery or equipment with different sizes.

The emission sound pressure level obtained with this method represents the average sound pressure level over the surface of area S in environmental conditions approximating to a free field over a reflecting plane.

7 Information to be recorded

The following information, when applicable, shall be compiled and recorded.

7.1 Sound source

Description of the sound source, including its

— type,

— technical data,

— dimensions,

— manufacturer,

— machinery or equipment serial number, and

— year of manufacture.

7.2 Conditions under which the sound power level has been determined

a) Reference to the International Standard used, with indication of the grade of accuracy.

b) Precise quantitative description of operating conditions and, if relevant, operational periods and cycle.

c) Mounting conditions.

d) Description and location in the test environment of auxiliary equipment, if any.

7.3 Location(s) of specified positions

Precise quantitative descriptions of the work station location(s) and the location(s) of other specified positions where emission sound pressure levels have been calculated.

7.4 Method used

The method used shall be recorded, with reference to the noise test code, if any exists, together with the value of Q_1 or Q_2.

7.5 Noise data

a) Emission A-weighted sound pressure levels at work station(s) and/or at other specified positions.

b) When applicable, emission sound pressure levels with various frequency and/or time weightings, or in frequency bands.

c) Date of sound power level determination and name of person responsible for the calculation.

8 Information to be reported

Only those recorded data (see clause 7) are to be reported which are required for the purpose of the calculation. If a standardized noise test code exists for the machinery or equipment under test, the code will specify the data that are to be reported.

The report shall include:

a) the method used for the initial determination of the sound power level and the grade of accuracy;

b) the sound power level data that were used in the calculations;

c) the origin of the sound power level data;

d) of the two methods described in this International Standard, reference to the one that has been used to calculate the emission sound pressure levels;

e) the value of Q_1 or Q_2;

f) reference to the noise test code used, if any exists.

The report shall state whether or not the reported emission sound pressure levels have been obtained in full conformity with the requirements of this International Standard. Deviations, if any, shall be described precisely and justified in the test report. The report shall include the date on which the sound power levels used in the calculations were determined, and the name(s) of the person(s) responsible for the calculations.

Emission sound pressure levels at work station(s) and/or at other specified positions shall be reported to the nearest 0,5 dB.

Annex A
(informative)

Bibliography

[1] ISO 1996-1:1982, *Acoustics — Description and measurement of environmental noise — Part 1: Basic quantities and procedures.*

[2] ISO 3740:1980, *Acoustics — Determination of sound power levels of noise sources — Guidelines for the use of basic standards and for the preparation of noise test codes.*

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

[4] ISO 4871:—[3], *Acoustics — Declaration and verification of noise emission values of machinery and equipment.*

[5] ISO 7779:1988, *Acoustics — Measurement of airborne noise emitted by computer and business equipment.*

[6] 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.*

[7] 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.*

[8] 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.*

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