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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/Corr.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

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

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]

3.25
noise test code
standard that is applicable to a particular class, family or type of machinery or equipment, which specifies all the information necessary to carry out efficiently the determination, declaration and verification of the noise emission characteristics under standardized conditions

[SOURCE: ISO 12001:1996, 3.2]

3.26
standard deviation of reproducibility of the method
σ_{R0}
<for a specified noise emission measurement method and for characterizing the measurement method> standard deviation of noise emission values obtained under reproducibility conditions (different environments, different operators, different instrumentation) for a sound source with constant noise emission

3.27
standard deviation due to operating and mounting conditions of the sound source
σ_{omc}
<for a specific set of operating and mounting conditions of a specified sound source> standard deviation of noise emission values obtained by repeating measurements according to the same noise emission measurement method under the same conditions (same environment, same operator, same instrumentation)

Note 1 to entry: This standard deviation characterizes the stability of the noise emitted by the source.

3.28
total standard deviation
σ_{tot}
square root of the sum of the squares of the standard deviation of reproducibility and the standard deviation due to operating and mounting conditions

$$\sigma_{\mathrm{tot}} = \sqrt{\sigma_{R0}^2 + \sigma_{\mathrm{omc}}^2}$$

Note 1 to entry: When a batch of identical sound sources is considered, the standard deviation of production should be taken into account by proper addition (see ISO 4871).[3]

3.29
typical distance
d
distance from the work station to the closest major sound source of the machine under test, without screening objects protruding into the line of sight between the major sound source and the work station

Note 1 to entry: In the case of extended sound-radiating areas, d is the length of the shortest possible line of sight between the source under test and the work station.

[SOURCE: ISO 11202:2010, 3.26]

4 Emission sound pressure level at work stations and other specified positions

4.1 Physical background

A microphone positioned at the work station or the specified position does not measure the emission sound pressure level only. It really measures the sound received directly from the machine (emission) combined with the sound coming from other noise sources present and the sound reflected by walls, floor, ceiling and obstacles in the room in which the machine is located.

The “emission” component shall be extracted from this total. Extraction is particularly difficult when the sound pressure level at the work station (or any other specified position) includes a strong

environmental component. This happens when the machine operates in a reverberant space and does not radiate its sound energy towards the work station. This extreme situation illustrates the important role that the directivity of the source plays in relation to the nature of the test environment (see 4.5) and explains why the determination of emission sound pressure levels is not straightforward and requires measurement methods that are more complex than expected.

At any given position in relation to a particular machine, and for given mounting and operating conditions, the emission sound pressure levels determined using any of the methods given in ISO 11201, ISO 11202, ISO 11203, ISO 11204 and ISO 11205 will in general be lower than the directly measured sound pressure levels for the same machine operating in its installed environment. This is due to the influence of the environment (reverberation) and the contributions of noise from 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/TR 11690-3.[5] Commonly observed differences are 1 dB to 5 dB, but in extreme cases the difference can be even larger.

The influence of this environment at the work station position or any other specified position is described by a local environmental correction K_3. Methods for determining K_3 are provided in ISO 11202 and ISO 11204. ISO 11201 does not consider K_3 because this standard covers the situation where the influence of the environment is negligible ($K_3 = 0$).

4.2 Difference between noise exposure level of persons and noise emission level

Noise exposure and noise emission are two very different concepts that have to be clearly distinguished. Noise exposure levels are different from noise emission levels. Noise exposure relates to a person in the actual environment. Noise emission relates to a source of sound independently of the environment in which it operates.

It is not the intent of the group of International Standards (i.e. ISO 11201, ISO 11202, ISO 11203, ISO 11204 and ISO 11205) to describe procedures for measuring the occupational noise exposure of workers. Emission sound pressure levels are not averages over a total working day during which the machinery might perform different functions, operate at different control settings, or undergo changes of workload. A method for determining the noise exposure of persons is given in ISO 9612.[4]

4.3 Difference between sound power level of machinery and sound pressure level

The sound power level characterizes the acoustic energy radiated in the air by a source for a given mounting and operating condition. It is an intrinsic feature of the source independent of the environment in which it operates.

As opposed to the sound power level, the sound pressure level characterizes the noise present at a particular point in space.

Just as for the sound power level, the emission sound pressure level at a work station or a specified position is an intrinsic characteristic of the machine.

4.4 Reasons for determining the emission sound pressure level

Examples of situations where the emission sound pressure level at the work station(s) of a source might be of interest are:

— manufacturer noise emission declaration according to regulations for machinery safety;

— customer need for input to sound exposure prediction models;

— customer need for data for comparing with competing machinery and equipment on the market (e.g. operator attended heavy machinery) to use “less noise emitted” as a purchasing parameter;

NOTE For some families of machines, e.g. information technology equipment, the preferred quantity on which to compare equipment on the market is the sound power level.

— requirements in a specification to check the noise level of equipment regardless of the environment in which it operates.

4.5 How the source directivity is handled in the ISO 11201, ISO 11202, ISO 11203, ISO 11204 and ISO 11205 group

ISO 11202 and ISO 11204 consider the directivity of the source.

ISO 11202 (method A.2) and ISO 11204 consider the directivity of the source by measuring the A-weighted sound pressure level at a set of microphone positions situated around the machine at a fixed distance from it in order to determine the directivity index. These levels describe the apparent work station directivity as they are contaminated by the sound energy coming from reflections within the environment where the machine operates. In ISO 11202 (method A.2), for the sake of simplicity, measurements are carried out on a path around the machine at a fixed distance above the ground to approximate the apparent directivity. In ISO 11204, measurements are carried out on a closed surface surrounding the machine. This requires more microphone positions, and greater measurement effort, but provides a more accurate directivity assessment.

The distance from these extra microphone positions to the machine for the determination of the directivity index is normally 1 m whatever the distance from the work station to the machine may be. The quantities specified in Annex A of ISO 11202:2010 and ISO 11204 necessary to calculate the local environmental correction, K_3, refer to the surface on which these extra measurement positions are located.

5 Overview of the methods offered in the ISO 11201, ISO 11202, ISO 11203, ISO 11204 and ISO 11205 group for determining the emission sound pressure level at work stations and other specified positions

Overview of the methods offered in the ISO 11201, ISO 11202, ISO 11203, ISO 11204 and ISO 11205 group for determining the emission sound pressure level at work stations and other specified positions

ISO 11201 provides two measurement methods: a precision method (grade 1) and an engineering method (grade 2). Both are applicable in an essentially free field over a reflecting plane. No environmental corrections are applied.

ISO 11202 provides two measurement methods:

— A.1: for small sources or equipment which has a dominant source localizable;

— A.2: for other sources.

Each method provides grade 2 or grade 3 results. Approximate environmental corrections are applied.

NOTE 1 Method A.1 is based on the method given in the previous edition of ISO 11202.

ISO 11203 provides two alternative methods for determining emission sound pressure levels from the sound power level, leading to either grade 2 or grade 3 results.

ISO 11204 provides a measurement method that can lead to either grade 2 or grade 3 results. Accurate environmental corrections are applied.

ISO 11205 provides an engineering measurement method (grade 2) for determining the emission sound pressure level *in situ* from sound intensity measurements.

NOTE 2 For grades of accuracy, see ISO 12001.[6]

Table 1 gives an overview of the group of International Standards for determining emission sound pressure levels at work stations and other specified positions.

Annex A provides guidance about test site and environmental correction K_2.

Annex B provides case studies.

Table 1 — Overview of International Standards for the determination of emission sound pressure levels at the work station and at other specified positions

Parameter	ISO 11201 **measurement method** **grade 1 or 2**	ISO 11202 **measurement method** **grade 2 or 3** **Methods A.1 and A.2**	ISO 11203 **derivation from sound power level** **grade 2 or 3**	ISO 11204 **measurement method** **grade 2 or 3**	ISO 11205 **measurement method** **grade 2**
Test environment	Outdoors or indoors		Outdoors or indoors. In accordance with sound power level standard	Outdoors or indoors	
Criterion for suitability of test environment	**Indoor**: — hemi-anechoic room (grade 1) — $K_2 \leq 2$ dB (grade 2) **Outdoor**: — a plane area outdoors with hard ground and no reflecting objects in the near vicinity (grade 1) — on a reflecting plane ground at a specified distance from the nearest reflecting object (grade 2)	$K_{2A} \leq 7$ dB	In accordance with sound power level standard	$K_{2A} \leq 7$ dB	Any room — difference between pressure and intensity less than 10 dB(F_{pIxyz}) — intensity vector at measurement position shall point away from machine under test — if measurement position is between machine and wall, probe shall be at least 1 m from the wall
Limitation of local environmental correction K_3[a] and grade of accuracy	No determination of K_{3A} Environmental correction not allowed	Method A.1: $K_{3A} \leq 4$ dB (grade 2) 4 dB < $K_{3A} \leq 7$ dB (grade 3) Method A.2: K_3 and grade (grade 2 or grade 3) given as a function of K_2 and source directivity index	No determination of K_{3A}	$K_{3A} \leq 4$ dB (grade 2) 4 dB < $K_{3A} \leq 7$ dB (grade 3) K_3 given as a function of K_2 [or A/S (for explanation, see Note to Table 5 of 6.2)] and source directivity index	Not applicable

Table 1 *(continued)*

Parameter	ISO 11201 **measurement method** **grade 1 or 2**	ISO 11202 **measurement method** **grade 2 or 3** **Methods A.1 and A.2**	ISO 11203 **derivation from sound power level** **grade 2 or 3**	ISO 11204 **measurement method** **grade 2 or 3**	ISO 11205 **measurement method** **grade 2**
Size of sound source	No restriction; limited only by available test environment		Particularly appropriate for small machines (<1 m) and in some cases to large machines	No restriction; limited only by available test environment	
Character of noise	Any (steady, non-steady,fluctuating, isolated bursts of sound energy, etc.)		In accordance with sound power level standard	Any (steady, non-steady, fluctuating, isolated bursts of sound energy, etc.)	Stationary broadband noise with or without narrow band components
Limitation for background noise	$\Delta L \geq 10$ dB (grade 1)[b] $\Delta L \geq 6$ dB (grade 2)	$\Delta L \geq 6$ dB (grade 2) $\Delta L \geq 3$ dB (grade 3)	In accordance with sound power level standard	$\Delta L \geq 6$ dB (grade 2) $\Delta L \geq 3$ dB (grade 3)	ΔL intensity ≥ 10 dB
Points for which emission sound pressure levels are to be determined	Work stations and other specified positions		Work stations and other specified positions (but not in cabins or similar)	Work stations and other specified positions	
Microphone positions	At work stations (and other specified positions)	**Identifiable dominating source:** At work station (and/or other specified positions) **Dominating source not identifiable:** At least one microphone position on each side of the source under test (totalling four) and at work station and/or other specified positions	Not applicable	Same microphone positions as those used for the related sound power level standards (at least five for grade 3 and nine for grade 2) and at work station and/or other specified positions	At work stations (and other specified positions) in three orthogonal directions (the qualification of measurement on machines larger than 2 m may need measurement in a second set of three orthogonal directions)
Instrumentation system, including the microphones or probe, cables and windscreen, if used	Class 1 instrument in accordance with IEC 61672–1	Class 1 instrument in accordance with IEC 61672–1 or class 2 (grade 3)	Not applicable	Class 1 instrument in accordance with IEC 61672–1	Class 1 instrument in accordance with IEC 61043
Filters, if relevant	Class 1 instrument in accordance with IEC 61260		Not applicable	Class 1 instrument in accordance with IEC 61260	–
Sound calibrator	Class 1 instrument in accordance with IEC 60942		Not applicable	Class 1 instrument in accordance with IEC 60942	
Quantities to be obtained	L_{pA}, $L_{pC,peak}$; optional L_p in frequency bands		In accordance with sound power level standard	L_{pA}, $L_{pC,peak}$; optional L_p in frequency bands	L_{pA} with reduced frequency range: octaves 63 Hz to 8 kHz

Table 1 *(continued)*

Parameter	ISO 11201 **measurement method** **grade 1 or 2**	ISO 11202 **measurement method** **grade 2 or 3** **Methods A.1 and A.2**	ISO 11203 **derivation from sound power level** **grade 2 or 3**	ISO 11204 **measurement method** **grade 2 or 3**	ISO 11205 **measurement method** **grade 2**
Standard deviation of reproducibility for L_{pA}	Equal to or less than approximately 0,5 dB (grade 1) or 1,5 dB (grade 2)	Equal to or less than approximately 1,5 dB (grade 2) or 3 dB (grade 3)	Equal to that associated with the sound power level determination method used	Equal to or less than approximately 1,5 dB (grade 2) or 3 dB (grade 3)	Equal to or less than approximately 1,5 dB
Related sound power level standards	ISO 3745 (grade 1) ISO 3744 (grade 2)	ISO 3744 (grade 2) ISO 3746 (grade 3)	ISO 3741, ISO 3743 (all parts), ISO 3744, ISO 3745, ISO 3746 and ISO 3747 group and the ISO 9614 series (see ISO 3740[2])	ISO 3744 (grade 2) ISO 3746 (grade 3)	ISO 9614 (all parts)
Correction for ambient conditions during measurements	**Grade 1**: Correction for static air pressure and temperature **Grade 2**: Altitudes ≤ 500 m: no correction Altitudes > 500 m: correction for static air pressure and temperature	**Grade 2**: Altitudes ≤ 500 m: no correction Altitudes > 500 m: correction for static air pressure and temperature **Grade 3**: Altitudes ≤ 800 m: no correction Altitudes > 800 m: correction for static air pressure and temperature	In accordance with sound power level standard	**Grade 2**: Altitudes ≤ 500 m: no correction Altitudes > 500 m: correction for static air pressure and temperature **Grade 3**: Altitudes ≤ 800 m: no correction Altitudes > 800 m: correction for static air pressure and temperature	No specifications

[a] K_3 tends to be larger than K_2 when the work station is shielded from the dominant noise source. K_3 tends to be smaller than K_2 when the dominant source radiates towards the work station.

[b] ΔL is the difference between the levels measured at the work station with the source under test in operation and switched off.

6 Selection of the most appropriate method from the group

6.1 Quantities to be measured and determined

ISO 11201, ISO 11202, ISO 11203, ISO 11204 and ISO 11205 are methods to determine emission sound pressure levels from measurements of sound pressure levels or by calculation from sound power level values. The emission levels may be time-averaged, peak, frequency-weighted, depending on the method and the purpose of this determination. Frequency weighting is usually A-weighting, except in the case of peak levels, where C-weighting is preferred.

6.2 Considerations affecting choice of method

Factors to be considered when selecting an International Standard from the ISO 11201, ISO 11202, ISO 11203, ISO 11204 and ISO 11205 group include:

a) existence of an applicable noise test code or procedure making reference to standard(s) in the ISO 11201, ISO 11202, ISO 11203, ISO 11204 and ISO 11205 group ;

b) the repeatability and reproducibility of sound pressure level measurements. Benefits of using a precise method are lost if repeatability is poor (see Figure 2);

c) the size and transportability of the machinery or equipment, affecting the practicability of setting it up in an acoustics test laboratory for the purpose of the noise measurements. Typically, hand-held tools are small enough to be transportable to an acoustics test laboratory;

d) whether or not particular work stations can be identified in relation to the machine. Typically, an air compressor used on construction sites has no work station;

e) the test environment available for the measurement (see Table 2). At the time of publication of this International Standard, noise emission from machinery for use outdoors is measured outdoors;

f) the grade of accuracy required. The generally recommended grade of accuracy for industrial applications is grade 2 “Engineering”;

g) the instrumentation available (see Table 3). The use of a class 1 instrument is recommended. Class 2 instruments provide only a rough estimation and grade 3 results with a large associated uncertainty;

h) the background noise level which cannot be avoided (see Table 4). When measuring indoors it might not be possible to switch off all ventilation devices or ancillary equipment, which might affect the sound pressure level measurements;

i) the way to determine the local environmental correction, K_3, and the grade of accuracy (see Table 5);

j) the instability of noise emission (see Table 6).

Table 2 — Applicability of different methods taking into account the test environment

Environment	Outdoor or hemi-anechoic room	Indoor		
Environmental correction, K_2, dB	K_2 approximately 0	$K_2 \leq 2$	$2 < K_2 \leq 7$	$K_2 > 7$
Standard	ISO 11201[a]	ISO 11201[a]	–[c]	–[c]
	ISO 11202[b]	ISO 11202[a]	ISO 11202[a]	–[c]
	ISO 11204[b]	ISO 11204[a]	ISO 11204[a]	–[c]
	ISO 11205[a]	ISO 11205[a]	ISO 11205[a]	ISO 11205[a]
NOTE ISO 11203 is preferred for sources without a defined work station. It is also possible to use it in any environment (according to the sound power standard).				
[a] Possible and preferred.				
[b] Allowed but not preferred.				
[c] Not possible.				

Table 3 — Applicability of different methods taking into account the instrumentation

Method	ISO 11201	ISO 11202	ISO 11203	ISO 11204	ISO 11205
Instrumentation	Class 1	Class 1 (grade 2) Class 2 (grade 3)	Class 1 (grade 1 and grade 2) Class 2 (grade 3) (according to the sound power standard)	Class 1	Class 1

Table 4 — Applicability of different methods taking into account the background noise level

$\Delta L \geq 10$ dB	6 dB $\leq \Delta L <$ 10 dB	3 dB $\leq \Delta L <$ 6 dB	$\Delta L <$ 3 dB
ISO 11201 grades 1 and 2[a]	ISO 11201 grade 2[a]	–[b]	–[b]
ISO 11202 grades 2 and 3[a]	ISO 11202 grades 2 and 3[a]	ISO 11202 grade 3[a]	–[b]
ISO 11203[ac]	ISO 11203[ad]	ISO 11203 grade 3[ae]	ISO 11203[af]
ISO 11204 grades 2 and 3[a]	ISO 11204 grades 2 and 3[a]	ISO 11204 grade 3[a]	–[b]
ISO 11205[ag]	–[b]	–[b]	–[b]
ΔL Difference in decibels between the sound pressure levels measured at the work station with the source under test in operation and switched off			
[a] Possible.			
[b] Not possible.			
[c] Based on a sound power standard providing grade 1 results.			
[d] Based on a sound power standard providing grade 2 results.			
[e] Based on a sound power standard providing grade 3 results.			
[f] Based on a sound power standard using intensity [specified in ISO 9614 (all parts)].			
[g] In ISO 11205, sound intensity levels are used instead of sound pressure levels, and ΔL is the difference in sound intensity levels.			

Table 5 — Steps for the determination of the local environmental correction, K_3, and of the grade of accuracy

Steps	ISO 11201	ISO 11202	ISO 11202	ISO 11204	ISO 11205
Step 1 **Size of source**	Any size of source under test	Method A.1: Any size of source under test **but** small dominant sound-radiating area	Method A.2: Any size of source under test	Any size of source under test	
Step 2 **Measurement**	Measurement at one point (work station or other specified position)		Measurement at points on a path half height of source or height = 1,55 m ± 0,075 m	Measurement at points on a closed surface (five sides preferably in accordance with ISO 3744 or ISO 3746)	Measurement at one point
Step 3 **Correction** K_2	Determination of K_2	Determination of A	Determination of K_2 and $D_I{}^*_{op,approx}$	Determination of K_2 (or A/S) and $D_I{}^*_{op}$	No consideration of K_2
Step 4 **Correction** K_3	No consideration of K_3	$K_3 = 10 \lg (1 + 4S/A)$ dB	Determination of K_3 using K_2 and $D_I{}^*_{op,approx}$	Determination of K_3 using K_2 (or A/S_M) and $D_I{}^*_{op}$	No consideration of K_3
Step 5 **Grade**	Grade 1 or grade 2	Grade 2 if $K_{3,max} \leq 4$ dB Grade 3 if $K_{3,max} > 4$ dB	Grade 2 or grade 3		Grade 2

NOTE Regarding ISO 11202 and ISO 11204, A is the equivalent sound absorption area of the test room. Methods for determining A are provided in the sound power standards, e.g. ISO 3744. Regarding ISO 11202, the surface on which the measurement is taken, S is a typical surface easy to determine if the location of the major sound source of the machine under test is easily identifiable. Regarding ISO 11204, S_M is the area of the reference measurement surface surrounding the source under test on which the surface sound pressure level is determined.

Table 6 — Influence of the stability of noise emission on the total uncertainty — Examples of calculated total standard deviations, σ_{tot} , for three different cases

Standard deviation of reproducibility of the method σ_{R0} dB	**Operating and mounting conditions**		
	stable	unstable	very unstable
	Standard deviation, σ_{omc} , in dB		
	0,5	2	4
	Total standard deviation, σ_{tot} , in dB		
0,5 (accuracy grade 1)	0,7	2,1	4,0
1,5 (accuracy grade 2)	1,6	2,5	4,3
3 (accuracy grade 3)	3,0	3,6	5,0

6.3 Considerations for the selection of the most appropriate method

Attention is drawn to the following considerations that might help with the choice of the most appropriate method to be used.

a) Facts relating to the grade of accuracy:

- the preferred grade of accuracy for purposes of noise declaration is grade 2 (engineering methods). Whatever the room, if the work station is close to the dominating sound source and background noise is low, ISO 11202 or ISO 11204 almost always provides a grade 2 result;
- among the measurement methods, only those provided in ISO 11202 allow the use of class 2 instruments, resulting in grade 3 measurements even though grade 2 requirements are otherwise fulfilled;
- when using ISO 11202 or ISO 11204, the grade of accuracy of the result is not a priori defined but is known once the measurements are performed;
- when using ISO 11202 or ISO 11204, the grade of accuracy and, consequently the uncertainty associated to the value of the emission sound pressure level might not be the same for all work stations or other specified positions on a machine.

b) Facts relating to the measurement effort:

- ISO 11201 (outdoors) and ISO 11202, method A.1 only require a single measurement at the work station;
- the measurement effort when using ISO 11204 is equivalent to that required by the measurement of the sound power level. Consequently, if the sound power level is to be determined or is known, the additional measurement effort when using ISO 11204 is minimal;
- for outdoor measurements, grade 2 results (even grade 1 results) are facilitated;
- for measurements carried out according to ISO 11202, method A.2, or ISO 11204, it is always necessary to carry out at least five measurements around the machine (in order to assess the directivity of the source).

c) Facts relating to method applicability:

- method A.1 of ISO 11202 only applies to machines having a dominant sound-radiating area that is small compared to its distance from the measurement point. This is the case for small-sized machines and machines with a clearly identifiable localized major sound source of small volume;
- if emission sound pressure levels are to be determined at points on a path around the machine, ISO 11202 might be the most appropriate method (unless ISO 11203 is applicable).

6.4 Synopses

6.4.1 Procedure for selection

ISO 11201, ISO 11202, ISO 11203, ISO 11204 and ISO 11205 are applicable to all kinds of machinery and equipment. The choice of method is governed by technical and practical limitations which are given below (in this subclause and in 6.4.2). A guide to the choice between the different methods is illustrated by the flow charts of Figures 1, 2 and 3. Unless ISO 11203 can be used (see Figure 1), study first the repeatability (see Figure 2) and then go to the "START" box in Figure 3.

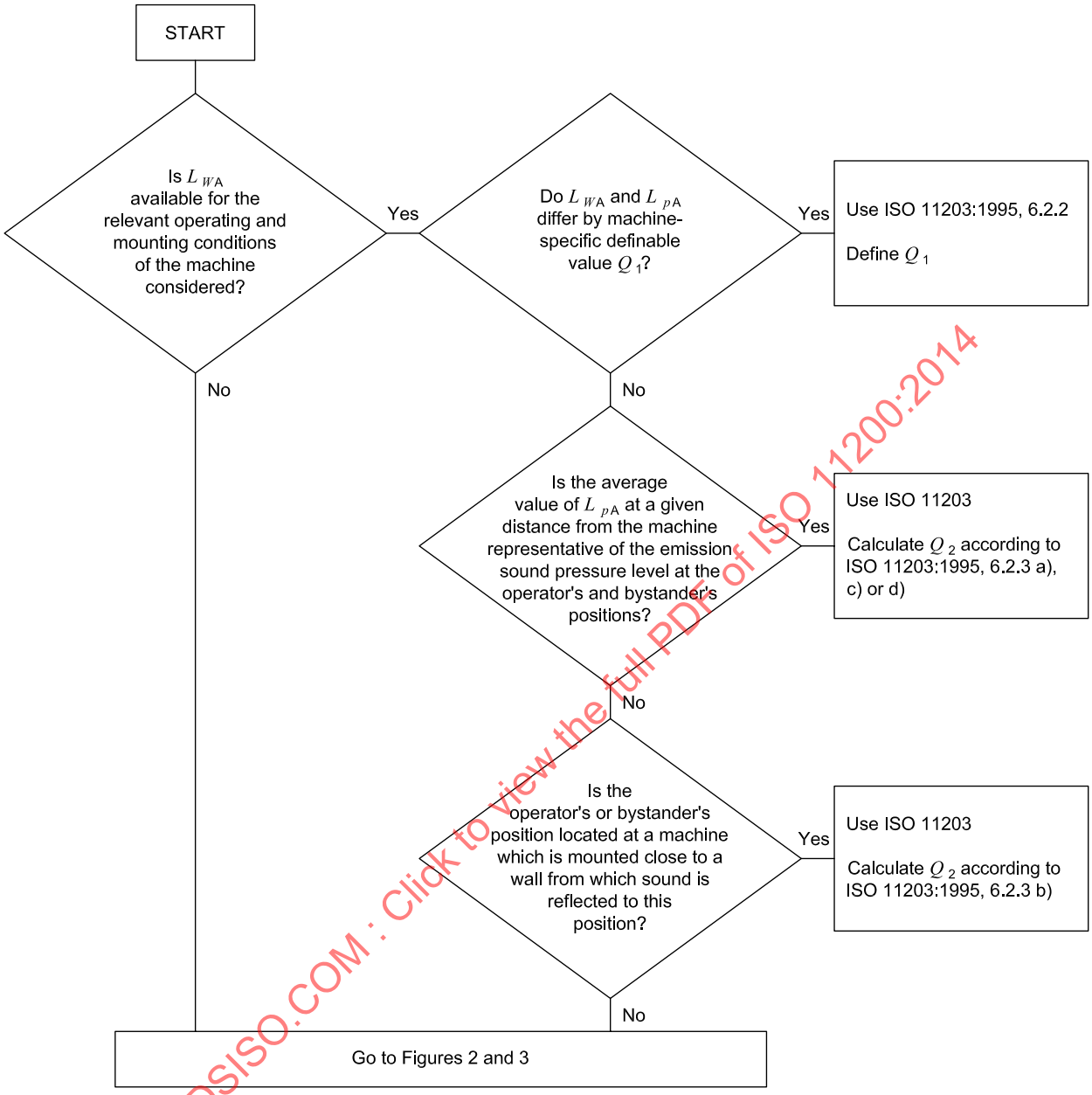


Figure 1 — Determination of the emission sound pressure level, L_p, from the sound power level, L_W, using ISO 11203 (without any additional measurement)

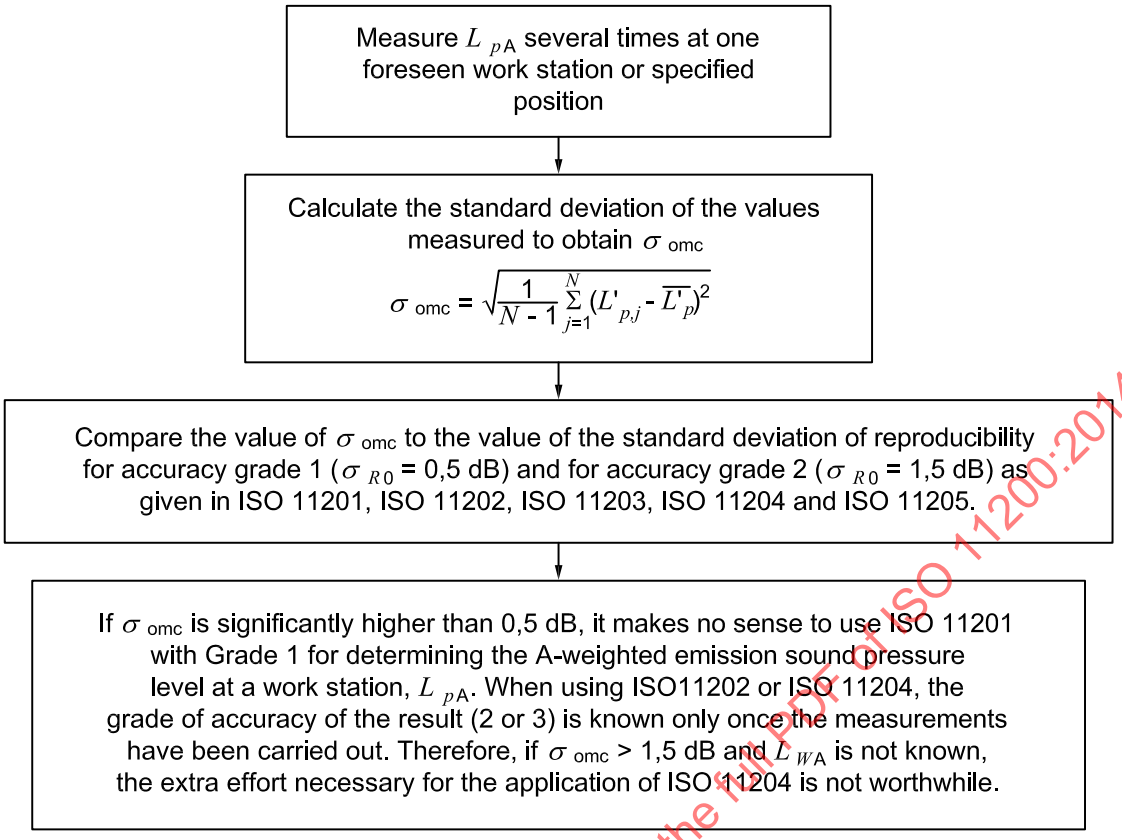


Figure 2 — Determination by measurement — Initial repeatability test

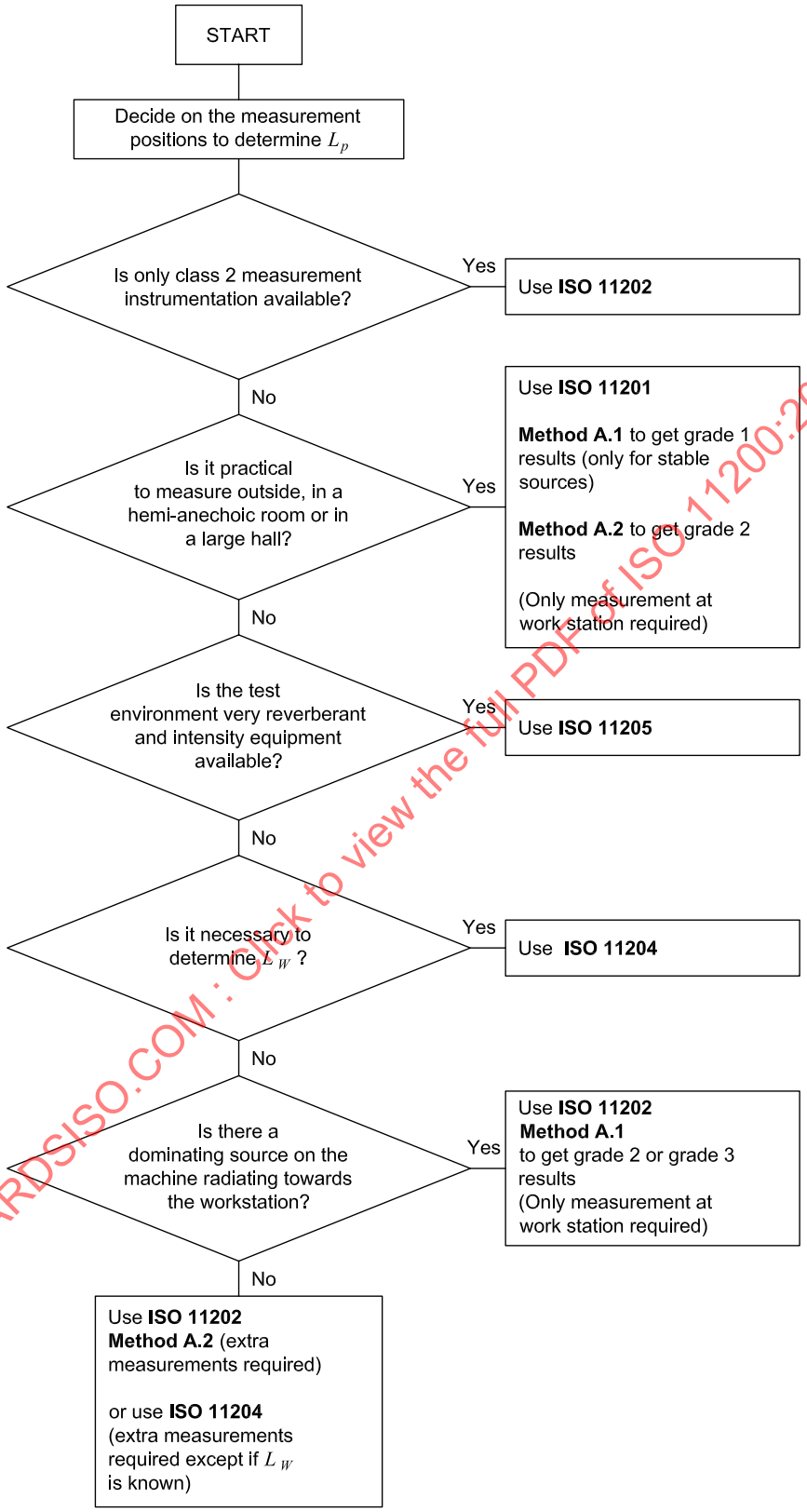


Figure 3 — Determination by measurement — Choice of the International Standard to be used (i.e. ISO 11201, ISO 11202, ISO 11204 or ISO 11205)

6.4.2 Benefits and constraints of each method

Table 7 gives a synthesis of benefits and constraints associated to each standard.

Table 7 — Benefits and constraints related to each International Standard for determination of emission sound pressure levels at the work station and at other specified positions

International Standard	Benefit	Constraint
ISO 11201	It is easy to use outdoors. Grade 1 allows a measurement with a small uncertainty.	ISO 11201 does not allow any K_3 correction. It has more stringent requirements on the test environment in order to provide grade 1 results.
ISO 11202 method A.1	It is easy to apply. K_3 correction is permitted. There is no need for an acoustically treated (low reverberation) test site to reach a grade 2 result.	The scope is limited to machines with a small dominating sound-radiating area.
ISO 11202 method A.2	K_3 correction is permitted. There is no need for an acoustically treated (low reverberation) test site to reach a grade 2 result.	It requires additional measurement points.
ISO 11203	If the sound power level is known, there is no need for any additional measurements. If there are other sources (e.g. a power source) which might contaminate the L_p measured, this standard might provide the only procedure that can be used.	It requires measurement of the sound power level. If the machine has a work station, it requires a correlation between emission sound pressure and sound power. It provides a mean value of the sound pressure level around the machine.
ISO 11204	It is more precise than ISO 11202. There is no need for an acoustically treated (low reverberation) test site to reach a grade 2 result.	This fact is not systematically reflected in the grade of accuracy obtained. It requires many measurement points (similar to a sound power level measurement) without guaranteeing a better precision.
ISO 11205	In principle, it provides good results in particular for machines which cannot be moved. It is the only possible method in a highly reverberant environment.	It requires sound intensity measuring instrument and a good know-how in intensity measurement.

7 Selection of specified positions

The ISO 11201, ISO 11202, ISO 11203, ISO 11204 and ISO 11205 group deals with the following situations: seated, standing, stationary operator, operator moving along a specified path. The group also applies to enclosed work station positions, bystanders and unattended machines (see Clause 10 of ISO 11201:2010, ISO 11202:2010 and ISO 11204:2010, 1.4 of ISO 11203:1995 or 3.7 of ISO 11205:2003) with the following restriction: ISO 11203 is not applicable to workstations or other specified positions situated in a cab or a cabin, or behind a screen.

8 Treatment of measurement uncertainty in ISO 11201, 11202 and 11204

Measurement uncertainty is dealt with in a much more detailed manner in ISO 11201, ISO 11202 and ISO 11204 as compared with their previous editions. The intention was:

— to take ISO/IEC Guide 98-3 into consideration;

— to distinguish between two main components of measurement uncertainty, i.e. the uncertainty associated with the method (expressed in term of the standard deviation of reproducibility σ_{R0}) and the uncertainty due to the possible instability of mounting and operating conditions of the machine under test (expressed in terms of a standard deviation σ_{omc}).

The general approach remained unchanged:

— the use of accuracy grades 1 to 3 is defined on the basis of the uncertainty of the method;

— upper values of the uncertainty of the method, to be used when no data specific to a particular family of machines is available, are provided.

ISO 11201, ISO 11202 and ISO 11204 contain a clause on uncertainty in their main bodies supplemented by an annex, which gives guidelines on the development of data on uncertainty. In particular, this annex lists all identified components of the uncertainty associated with the method (the so-called uncertainty budget). Wherever possible, it gives quantitative estimations for each component.

A methodology to determine the magnitude of σ_{R0} and σ_{omc} is provided. When drafting a noise test code, appropriate measurements should be carried out so that values of σ_{R0} and σ_{omc} specific to the machinery family concerned can be derived.

Annex A
(informative)

Test site and environmental correction K_2 — Some guidance

A.1 ISO 11201

Indoor:

— laboratory hemi-anechoic room (grade 1);

— $K_2 \leq 2$ dB (grade 2); this requirement is generally met in a machinery room with minimum width and length at least eight times the largest machine dimension. The ceiling height should be four times the largest machine dimension. In addition, there should be a clear space around the machine with a radius of at least twice the largest machine dimension. For small machines, the minimum room dimension should generally be at least 16 m with a ceiling height greater than 4 m, and there should be 4 m of clear space around the machine.

Outdoor:

— a plane area outdoors with hard ground and no reflecting objects in the near vicinity (grade 1);

— on a reflecting plane ground at a specified distance from the nearest reflecting object (grade 2). In general, there should be a clear space around the machine with a radius of at least twice the largest machine dimension. For small machines, there should be 4 m of clear space around the machine.

A.2 ISO 11202

Indoor:

$K_{2A} < 7$ dB; this requirement is generally met in a machinery room with width and length of at least three times the largest machine dimension. The ceiling height should be 1,5 times the largest machine dimension. In addition, there should be a clear space around the machine with a radius at least equal to the largest machine dimension. For small machines, the minimum room dimension should generally be at least 6 m, ceiling height of at least 3 m and there should be 2 m of clear space around the machine.

Outdoor:

— a plane area outdoors with hard ground and no reflecting objects in the near vicinity;

— on a reflecting plane ground. In general, there should be a clear space around the machine with a radius at least equal to the largest machine dimension.

A.3 ISO 11204

See ISO 11202.

A.4 ISO 11205

If the measurement position is between the machine and the wall, the probe shall be at least 1 m from the wall.

Indoor:

$F_{pI,xyz}$ < 10 dB; this requirement is generally met in a machinery room with minimum room dimension at least twice the largest machine dimension.

Outdoor:

on a reflecting plane ground. Measurements should only be taken in calm winds.

Annex B
(informative)

Case studies

B.1 General

This annex gives an example of practical application of each of the methods in the ISO 11201, ISO 11202, ISO 11203 and ISO 11204 group.

B.2 Example 1

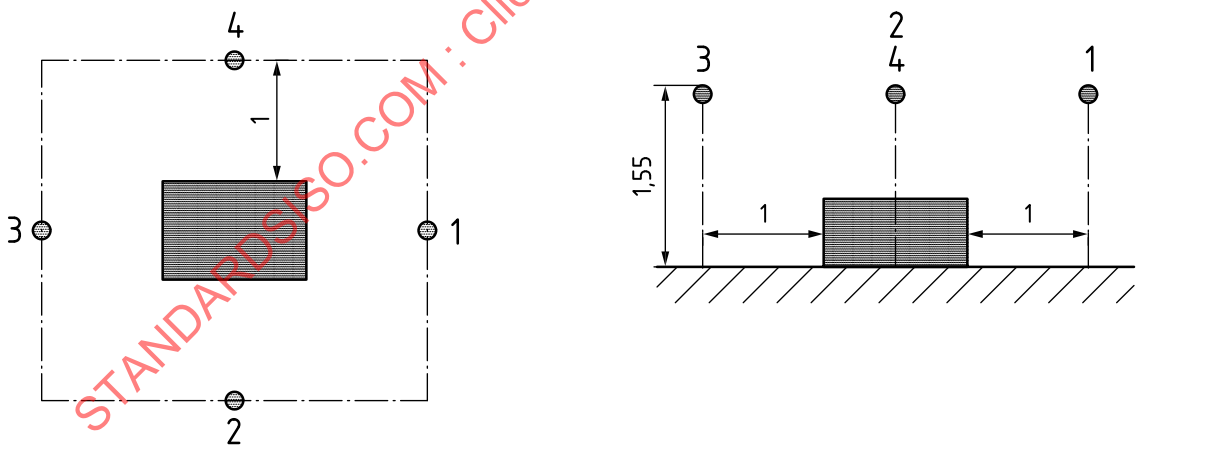
Example 1 Use of ISO 11201 for a small movable machine

Objective: to determine the A-weighted emission sound pressure level of a small movable machine without work station for the purpose of noise emission declaration. A noise test code exists for the family to which the machine belongs.

As the machine is small and movable, it can be easily installed outdoors. Therefore, ISO 11201 is the most favourable method to be used. As the purpose of the determination is noise declaration, the method specified in ISO 11201, which provides grade 2 results is adequate. This is one of the methods allowed by the noise test code.

As the machine has no work station, four measurement positions, one on each side of the machine, are specified by the noise test code (see Figure B.1 and Table B.1).

Dimensions in metres



a) Top view **b) Side view**

Key

● microphone positions

The grey box depicts the reference box.

Figure B.1 — Top and side views of machine and microphone positions

Table B.1 — Example 1: case study using ISO 11201

Initial repeatability test		
Measurement of the A-weighted sound pressure level (with negligible background noise) at microphone position 1 is repeated three times for the operating and mounting conditions specified in the relevant noise test code	94,5 dB; 94,3 dB; 93,8 dB	
Standard deviation of the three values measured, σ_{omc}	0,3 dB	
Conclusion	The noise emission is stable and it makes sense to use a grade 2 method	
Basic standard	ISO 11201 - engineering method	
Type of source	Small movable machine without work station	
Location of source	Over a reflecting plane (concrete or sealed asphalt)	
Environment	Free field over a reflecting plane (outdoors)	
Operating and mounting conditions	According to the relevant noise test code	
Dimensions of the source	Length: 0,8 m Width: 0,5 m Height: 0,6 m	
Four microphone positions	Distance from machine: 1 m Height: 1,55 m	
Measuring instrument	Class 1 sound level meter	
K_1 determination		
Background noise level, $L_{pA(B)}$ Background noise correction, K_{1A}	<60 dB 0 dB	
Measurement results		
A-weighted sound pressure level, L_{pA}, at each microphone position corrected for background noise. Measurements are repeated three times at each microphone position (this is a requirement of the relevant noise test code).	Point 1	94,5 dB; 94,3 dB; 93,8 dB
	Point 2	93,5 dB; 93,1 dB; 93,3 dB
	Point 3	93,6 dB; 93,0 dB; 93,4 dB
	Point 4	93,4 dB; 92,6 dB; 92,8 dB
Mean A-weighted sound pressure level L_{pA} (here the arithmetic mean of the two highest values is taken as this is a requirement of the relevant noise test code)	Point 1	94,4 dB
	Point 2	93,4 dB
	Point 3	93,5 dB
	Point 4	93,1 dB
Final result: the highest mean value (this is a requirement of the relevant noise test code)	The value of the A-weighted emission sound pressure level is 94,4 dB	
Uncertainty		
Standard deviation of reproducibility, σ_{R0}, taken as the value offered in ISO 11201 for grade 2 (as the relevant noise test code does not specify another value)	1,5 dB	
Total standard deviation, σ_{tot}	1,5 dB	
Expanded uncertainty, U, with a coverage factor k = 1,6	2,4 dB	

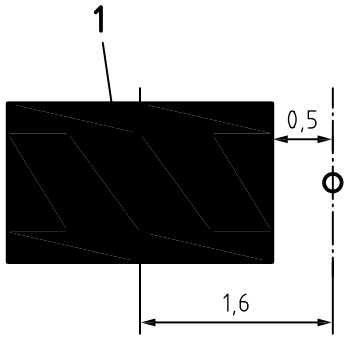
B.3 Example 2

Example 2 Use of ISO 11202, method A.1, for a machine with a clearly identifiable dominating sound source

Objective: during the process of designing a machine, a manufacturer wishes to determine the A-weighted emission sound pressure level of a prototype. The machine has a defined work station. No noise test code exists for the family of machines.

The machine can only operate in the manufacturer assembly workshop. It has a clearly identifiable dominating sound source. Therefore, the adequate method is that provided by ISO 11202, method A.1. ISO 11202, method A.2, and ISO 11204 could also have been used, but with a greater measurement effort (see Figure B.2 and Table B.2).

Dimensions in metres



Key

1 dominating source

O microphone position at the work station

The light grey box depicts the reference box.

Figure B.2 — Top view of the machine showing the work station position

Table B.2 — Example 2: case study using ISO 11202

Basic standard used	ISO 11202, method A.1
Type of source	Small machine
Location of source	Over a reflecting plane (concrete)
Environment	Assembly workshop
Operating and mounting conditions	Defined by the manufacturer
Dimensions of the source	Length: 2 m Width: 0,98 m Height: 1,10 m
Microphone positions	Work station at one end of the machine
	Distance from the machine: 0,5 m
	Height: 1,55 m
Measuring instrument	Class 1 sound level meter
Dominating source dimensions	0,5 m × 0,4 m × 0,2 m
Distance, d, from the measurement point to the dominating source	1,6 m
K_3 determination	

Table B.2 *(continued)*

Measured reverberation time, T_r	1,2 s
Dimensions of the room	11 m × 8 m × 4 m
Volume of the room	352 m^3
Equivalent sound absorption area of the room, A, $A = 0{,}16\frac{V}{T_r}$	47 m^2
$S = 2\pi d^2$	16 m^2
$K_{3A} = 10\lg\left[1 + 4\frac{S}{A}\right]$	3,7 dB (less than 4 dB, therefore a grade 2 result is obtained)
K_1 determination	
Background noise level, $L_{pA(B)}$	<60 dB
Background noise correction, K_{1A}	0 dB
Results	
Five repeated measurements of the A-weighted sound pressure level at the work station, $L'_{pAeq,30s}$	77,5 dB; 76,0 dB; 77,2 dB; 77,7 dB; 75,9 dB
Mean A-weighted sound pressure level, L'_{pA} (taken as the energy average)	76,9 dB
A-weighted emission sound pressure level at the work station, L_{pA} (mean value minus K_{3A})	73,2 dB
Uncertainty	
Standard deviation due to operating and mounting conditions (determined from the five repeated measurements), σ_{omc}	1 dB (noise emission is therefore fairly stable and it makes sense to use a grade 2 method)
Standard deviation of reproducibility, σ_{R0} (the value offered in ISO 11202 for grade 2 as the manufacturer has no knowledge allowing him/her to choose another value)	1,5 dB
Total standard deviation, σ_{tot}	1,8 dB
Expanded uncertainty, U, with a coverage factor of k = 1,6	2,9 dB

B.4 Example 3

Example 3 Use of ISO 11202 method A.2 for a machine that has no identifiable dominating sound source and no strong radiation upwards

Objective: to determine the A-weighted emission sound pressure level of a machine that has one work station and is covered by a noise test code.

The noise test code allows ISO 11202 and ISO 11204 to be used. ISO 11201 is not allowed because the machine cannot operate outdoors.