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Test code for machine tools —

Part 5:
Determination of the noise emission

Code d'essai des machines-outils —

Partie 5: Détermination de l'émission sonore

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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 230-5 was prepared by Technical Committee ISO/TC 39, *Machine tools*, Subcommittee SC 6, *Noise of machine tools*.

This second edition cancels and replaces the first edition (ISO 230-5), of which has been technically revised.

ISO 230 consists of the following parts, under the general title *Test code for machine tools*:

— *Part 1: Geometric accuracy of machines operating under no-load or finishing conditions*

— *Part 2: Determination of accuracy and repeatability of positioning numerically controlled axes*

— *Part 3: Determination of thermal effects*

— *Part 4: Circular tests for numerically controlled machine tools*

— *Part 5: Determination of the noise emission*

— *Part 6: Diagonal displacement test*

Annexes A and B form a normative part of ISO 230. Annexes C and D are for information only.

Introduction

ISO/TC 39/SC 6 decided to revise and restructure this part of ISO 230 for the following reasons:

a) ISO 230-5 uses largely extracts of the standards ISO 3744, ISO 3746, ISO 11200, ISO 11202 and ISO 11204, which were revised themselves with important changes. Those changes have deep influence for the content of ISO 230-5.

b) Better integration of accuracy grade 2 (engineering grade).

Test code for machine tools —

Part 5:
Determination of the noise emission

1 Scope

This noise test code specifies all the information necessary to carry out efficiently and under standardized conditions the determination, declaration and verification of the noise emission characteristics of machine tools.

Noise emission characteristics include emission sound pressure levels at workstations and the sound power level. The determination of these quantities is necessary for:

- manufacturers to declare the noise emitted;
- comparing the noise emitted by machine tools in the family concerned;
- purposes of noise exposure risk assessment by the user of the machine tool.

The use of this noise test code ensures reproducibility of the determination of the noise emission characteristics within specified limits determined by the grade of accuracy of the basic noise measurement method used. Noise measurement methods referred to in this standard are accuracy grade 2 (engineering grade) or accuracy grade 3 (survey grade).

Accuracy grade 2 is preferred with the benefit of having a lower measurement uncertainty, accuracy grade 3 is allowed.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 354, *Acoustics — Measurement of sound absorption in a reverberation room*

ISO 3740, *Acoustics — Determination of sound power levels of noise sources — Guidelines for the use of basic standards*

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 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 4871:2009, *Acoustics — Declaration and verification of noise-emission values of machinery and equipment*

ISO 6926, *Acoustics — Requirements for the performance and calibration of reference sound sources used for the determination of sound power levels*

ISO 8525, *Airborne noise emitted by machine tools — Operating conditions for metal-cutting machines*

ISO 11200, *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 11202, *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 11204, *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*

IEC 61260:1995, *Electroacoustics — Octave-band and fractional-octave-band filters*

IEC 61672-1:2002, *Electroacoustics – Sound level meters – Part 1: Specification.*

IEC 60942, *Electroacoustics — Sound calibrators*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11200 and ISO 3740 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at https://www.iso.org/obp
- IEC Electropedia: available at http://www.electropedia.org/

Note 1 to entry In the following definitions and in the formulae throughout this part of ISO 230, the use of a prime ($L¢_p$ etc.) indicates measured values without any correction (K_{1A}, K_{2A}, K_{3A}).

Note 2 to entry The A-weighted sound pressure level $L'_{pA(ST)}$ indicates the level during operation of the machine tool under test, the A-weighted sound pressure level $L'_{pA(B)}$ indicates the level produces by the background noise.

Note 3 to entry More detailed definitions may be found in specific noise testoperating condition standards for specific types of machine tools and related equipment.

3.1
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 $P_0{}^2(t)$, measured with a particular time weighting and a particular frequency weighting, selected from those defined in IEC 61672-1

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

Note 1 to entry: The emission sound pressure level is determined at a specified position and is expressed in decibels. The reference sound pressure is 20 µPa

Note 2 to entry: For example, the A-weighted sound pressure is $L_{pA.}$

3.1.1
Time-averaged emission sound pressure level

$L_{peq,T}$

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.

Note 1 to entry: The time-averaged emission sound pressure level is expressed in decibels and is given by the following equation:

$$L_{p,T} = 10\lg\left[\frac{1}{T}\int_0^T \frac{p^2(t)}{p_0^2}dt\right] \text{ dB} \quad (2)$$

Note 2 to entry: L_{pT} shall be measured with an instrument which complies with the requirements of IEC 61672-1.

Note 3 to entry: The A-weighted time-averaged emission sound pressure levels are noted by L_{pAT}, usually abbreviated to L_{pA}.

Note 4 to entry: In general, the subscripts T is omitted since time-averaged emission sound pressure levels are necessarily determined over a certain measurement time interval.

Note 5 to entry: Equation (1) is identical to that for the familiar ISO environmental noise descriptor, equivalent continuous sound pressure level" defined in ISO1996-1 and ISO1999. 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.

3.1.2
C-weighted peak emission sound pressure level
$L_{pC,peak}$
highest instantaneous value of the C-weighted emission sound pressure level determined over an operational cycle

Note 1 to entry: The C-weighted peak emission sound pressure level is expressed in decibels.

3.2
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 machine tool under test is located

3.3
Reference box

hypothetical surface which is the smallest rectangular parallelepiped that just encloses the source and terminates on the reflecting plane or planes

3.4
Measurement surface
hypothetical surface, of area S, enveloping the source on which the measurement points are located

Note 1 to entry: The measurement surface terminates on one or more reflecting planes, i.e. the reflecting plane(s) are not included in the area of the measurement surface.

3.5
Surface sound pressure level
$\overline{L_{pf}}$
energy-average of the time-averaged sound pressure levels at all the microphone positions on the measurement surface, with the background noise correction and the environmental correction K_{2A} applied

Note 1 to entry: The surface sound pressure level is expressed in decibels.

3.6
Sound power level
L_W
ten times the logarithm to the base 10 of the ratio of the sound power radiated by the sound source under test to the reference sound power

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

Note 2 to entry: The frequency weighting or the width of the frequency band used should be indicated.

Note 3 to entry: For example, the A-weighted sound power level is L_{WA}.

3.7
Measurement distance
d
the distance from the reference box to a box-shaped measurement surface

Note 1 to entry: The measurement distance is expressed in metres.

4 Measuring equipment

4.1 General

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

A class 2 sound level meter can be used with achieving accuracy grade 3.

4.2 Calibration

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

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

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

4.3 Adverse environmental conditions

Environmental conditions having an adverse effect on the microphone used for the measurements (for example, strong electric or magnetic fields, wind, impingement of air discharge from the machine tool under test, high or low temperature) shall be avoided by proper selection or positioning of the microphone. The instructions of the manufacturers of the measurement instruments regarding adverse environmental conditions shall be followed.

5 Installation and operation of the machine tool under test

5.1 General

The manner in which the machine tool under test is installed and operated can have a significant influence on the noise emission. This clause specifies conditions that are intended to minimize variations in the noise emission due to the installation and operating conditions of the machine tool under test. Relevant instructions of noise-test standards for individual types of machine tools, if they exist for the family to which the machine tool under test belongs, shall be followed. The same installation and operating conditions of the machine tool under test shall be used for the determination of emission sound pressure levels, sound power levels, and for declaration purposes.

The specific noise-test standards to which reference is made in this sub clause, and in further places in this part of ISO 230, are e.g.:

— ISO 8525 for metal cutting machines.

5.2 Machine tool location

Whenever possible, the machine tool under test shall be installed with respect to the reflecting plane as if it were being installed for normal usage. In the manufacturers' assembly shops, this is not always possible for machine tools such as large power presses, large boring machine tools, large press brakes, etc., which are often assembled in large pits or totally over the floor, at a different height from the reflecting plane, compared to the final installation in the user's workshop.

If the location of the machine tool within the test environment can be selected, sufficient space shall be allowed so that the measurement surface can envelop the machine tool under test in accordance with the requirements of 12.2.1.

5.3 Machine tool mounting

In many cases, the noise emission of the machine tool under test will depend upon the support or mounting conditions of the machine tool. Whenever a typical mounting condition exists for a machine tool, that condition shall be used or simulated, if feasible.

If a typical mounting condition does not exist or cannot be utilized for the test, care shall be taken to avoid changes in the sound emission of the machine tool caused by the mounting system used for the test. Steps shall be taken to reduce any sound radiation from the structure on which the machine tool is mounted.

5.4 Auxiliary equipment

Care shall be taken to ensure that any electrical conduits, piping or air ducts connected to the machine tool under test do not radiate significant amounts of sound energy into the test environment.

Whenever possible, the auxiliary equipment supplied with the machine tool shall be included in the reference box and its operating conditions described in the test report.

When the auxiliary equipment necessary for the operation of the machine tool under test is not supplied with the machine tool, it shall be located outside the test environment.

5.5 Operation of the machine tool during test

During the noise measurements, the operating conditions specified in the relevant noise-test standards shall be used, if they exist for the particular family of machine tools to which the machine tool under test belongs.

If there are no specific noise-test standards, the machine tool under test shall be operated as follows:

- most common and typical for the family of machine tools;
- in a manner which is typical of normal use;
- highly reproducible noise emission.

The results for several separate operating conditions, each lasting for defined periods of time, shall be combined by energy-averaging to yield the result for a composite overall operating procedure.

The operating conditions of the machine tool under test during noise measurements shall be fully described in the test report.

NOTE Additional topics can be agreed upon between manufacturer and customer.

6 Measurement procedure

Take readings of the A-weighted sound pressure level and C-weighted peak sound pressure level at each microphone position, as indicated in 11.2 and 12.2.2. The sound pressure level shall be observed over a typical period of operation of the machine tool.

Determine the following:

a) the A-weighted sound pressure levels $L'_{pA(ST)}$ during operation of the machine tool under test;

b) the A-weighted sound pressure levels $L'_{pA(B)}$ produced by the background noise;

c) the C-weighted peak sound pressure level, $L_{p\mathrm{C,peak}}$, at the positions specified in 11.2 (for the purposes of clause 11 only).

The machine tool under test shall be in the desired operating condition before any noise measurements are made.

The period of observation shall be at least 10 s. For noise that varies in time, it is important to specify carefully the period of observation, in order to achieve a stabilized time-averaged value, according to the purpose of the measurements. For a machine tool with modes of operation having different noise levels, select an appropriate measuring period for each mode and state this in the test report.

7 Measurement uncertainty

The measurement uncertainty (K) depends on the standard deviation of reproducibility (see annex A of ISO 4871:2009). For determining the sound power level and the emission sound pressure level at a work station in compliance with the series of International Standard of which ISO 11200 forms the introduction, maximum values of standard deviations of reproducibility are given (excluding variation in operating conditions) for accuracy grade 2 (engineering grade) and 3 (survey grade). However, the standard deviation of reproducibility is much smaller and varies considerably among the many different types of machine tools and equipment to which this part of ISO 230 is applicable.

Uncertainty depends on the environmental conditions, background noise, microphone array on the measurement surface.

8 Information to be recorded

8.1 Test data

a) Place and date when the measurements were performed, and

b) person responsible for the test.

8.2 Machine tool under test

Description of the machine tool, including its

— type,

— technical data,

— dimensions,

— manufacturer,

— machine tool serial number, and

— year of manufacture.