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Airborne noise emitted by machine tools — Operating conditions for metal-cutting machines

Bruit aérien émis par les machines-outils — Conditions de fonctionnement des machines travaillant par enlèvement de métal

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

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Foreword

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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 8525 was prepared by Technical Committee ISO/TC 39, *Machine tools*, Subcommittee SC 6, *Noise of machine tools*.

Airborne noise emitted by machine tools — Operating conditions for metal-cutting machines

1 Scope

This International Standard describes, with reference to ISO 230-5, the mechanical and acoustical specifications necessary for a reproducible test method for the determination of airborne noise emitted by metal-cutting machines and related auxiliary equipment.

The purpose of this International Standard is to facilitate the obtention of comparable test results on the noise emission of similar machines. The results of the tests can be used for comparison, acceptance, maintenance or any other purpose.

This International Standard specifies, in particular, operating conditions for the measurement of noise emitted by metal cutting machines excluding any cutting process. These operating conditions are strictly the same for the determination of both sound power levels and emission sound pressure levels at specified positions.

It applies to:

— all kinds of turning machines, including numerical control (NC) turning machines and turning centres;

— all kinds of milling machines, including NC milling machines and machining centres.

For machine tools which enable milling and turning operations simultaneously, choose the suitable measurements of this International Standard.

Additional types will be covered in future editions of this International Standard.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 230-5:2000, *Test code for machine tools — Part 5: Determination of the noise emission*

ISO 3744, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering method in an essentially free field over a reflecting plane*

ISO 4871, *Acoustics — Declaration and verification of noise emission values of machinery and equipment*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 230-5:2000 and the following apply.

3.1
numerically controlled turning machine
machine tool in which the principal motion is the rotation of the workpiece against the stationary cutting tool(s) and where cutting energy is brought by the workpiece and not by tool

NOTE This machine is controlled by a numerical control (NC) providing automatic function and can be of a single spindle or multi-spindle type.

3.2
turning centre
numerically controlled turning machine equipped with power driven tool(s) and the capacity to orientate the work holding spindle around its axis

NOTE This machine may include additional features such as automatic tool changing from a magazine.

3.3
machining centre
numerically controlled machine tool capable of carrying out two or more of the operations of milling, boring, drilling and tapping on which tools can be changed automatically from a magazine or similar storage unit in accordance with a machining programme

NOTE Most machining centres have facilities for automatically changing the direction in which the workpieces are presented to the tool (e.g. turntables).

4 Preliminary remarks

4.1 Reference to ISO 230-5 and other standards

To apply ISO 8525, reference shall be made to ISO 230-5 for consideration of the test methods, measurement surface, measurement positions, corrections for both the acoustic environment and background noise and the recommended accuracy of testing equipment.

NOTE For more detailed information, the use of additional basic standards may be helpful (see Clause 2 and the Bibliography). Guidelines for the selection of the most appropriate basic standards are given in ISO 3740.

4.2 Tests to be performed

When testing a machine, it is not always necessary or possible to carry out all the tests described in ISO 8525. Depending upon the purposes the measurements are used for, the required tests may be chosen. Although prescribed metal cutting tests are excluded from this International Standard, specific cutting tests may be included where appropriate and desired.

5 Installation and mounting conditions

5.1 General

This clause gives general provisions for machine installation and operation. Detailed specifications for specific types of machining processes are given in the annexes.

The installation and mounting conditions shall be representative of the typical or normal use of the machine. These conditions shall be the same for the determination of both sound power levels and emission sound pressure levels at specified positions, and for declaration purposes.

Care shall be taken to ensure that any electrical conduits, piping or air ducts which are connected to the machinery do not radiate significant amounts of sound energy.

5.2 Machine installation

The machine shall be installed according to the manufacturer's instructions. If the manufacturer does not provide such instructions, this shall be stated in the test report, together with the installation method used. The machine shall be installed in such a way that access to all sides is possible.

The machine undergoing the test shall be placed on a reflecting (acoustically hard) plane. If the machine is to be installed on special foundations or in a pit, the measurements shall be made under these conditions, using the floor level outside the pit as a basis for the reference box and the measurement positions.

All protective devices and acoustic guards supplied with the machine shall be fitted and in operation during these tests.

5.3 Microphone positions

Microphone positions as specified in ISO 230-5 shall be used for determination of sound power level with accuracy grade 3.

If the determination of sound power level with accuracy grade 2 is desired, the microphone positions according ISO 3744 shall be used.

NOTE Practical knowledge shows that in typical workshops where machines are installed, accuracy grade 2 is not usually achievable.

6 Operating conditions

Noise measurements shall be made during idle running operations, accelerating and braking operations for slide rest and spindle, tool change operation and with the machine ready for service with the spindle stationary.

The operating conditions during measurement shall be representative of the use of the machinery. Tests according this International Standard are under no load conditions except where special work cycles have been agreed. The test conditions shall be those specified in the relevant annexes.

Machines with provisions for dust extraction shall be tested with the extraction system working.

General safety requirements shall take precedence over conditions specified in Annexes A and B.

For power driven tools, a noise measurement shall be made with the maximum speed under no load condition.

— If the drive of the machine is operated through a selective gear unit, a measurement shall be carried out at the maximum speed of each range.

— If several work spindles can operate independently, the measurement instructions in the following clauses apply to all work spindles where the maximum driving power is higher than half the driving power of the main spindle.

— If the machine is provided with a numerical control system which enables automatic operations, a representative test cycle shall be used for noise measurement. This should include movements and operations of all machine components that can be moved automatically, such as spindle(s), tool changer, workpiece changer, slide rest, etc. (see A.3.4 and B.3.3).

The noise emission during the test cycle specified in the annexes of this International Standard shall be measured under no load conditions. For the test cycle, each operation period and its duration shall be identified and recorded in the test report.

Prior to testing, the machine shall be run for at least 30 min at no less than 2/3 maximum spindle speed, or otherwise to the manufacturer's specifications to bring it up to normal operating conditions.

7 Measurement uncertainty

A single value of the sound power level of noise source determined according the procedures of this International Standard is likely to differ from the true value by an amount within the range of the measurement uncertainty. The uncertainty in determination of the sound power level arises from several factors which affect the result, some associated with environmental conditions of the place where the measurement is carried out. For more details of factors that may need to be taken into account, see ISO 230-5:2000, Clause 7.

8 Information to be recorded

The information to be recorded should be carried out according to ISO 230-5:2000, Clause 8. An example of information to be recorded is also to be found in ISO 230-5:2000, Annex D.

9 Information to be reported

For noise measurements that are made according to the specifications of this International Standard in addition to those specified in ISO 230-5, the following information shall be compiled as completely as possible and reported:

a) machine data:

   1) name and address of the supplier/manufacturer,

   2) year of construction,

   3) designation of series or type,

   4) serial/prototype number of the machine undergoing the test,

   5) designation of the machine configuration or identification of the machine components moving along the main linear axes,

   6) power of the spindle motor,

   7) maximum spindle speed,

   8) size of the tool (if one is used, e.g. machines with tool changing systems),

   9) working travels,

   10) rapid feed rates of the axes involved in the test,

   11) maximum programmable feed rates of the axes involved in the test;

b) installation and mounting:

   1) installation and mounting conditions,

   2) location of the machine under test, with respect to the reflecting plane,

   3) operating conditions including the test cycle description as defined in Annexes A and B of this standard;

c) measurement:

1) reference box and measurement surface, (by means of a sketch),

2) measurement positions including normal operator's position (by means of a sketch),

3) measurement time at each position;

d) results:

1) the background noise pressure levels, if the correction factor is required,

2) the A-weighted emission sound pressure level at the operator's position(s), with the relevant environmental correction factor,

3) the A-weighted sound power level (L_{WA}) emitted, with the relevant environmental correction factor, if determined,

4) the time-averaged A-weighted sound pressure level (L_{pAeqT} or L_{pA}) and the duration of period of time for measurement.

NOTE The above specifications are met if the data sheets given in Annex C are used.

10 Declaration and verification of noise-emission values

The noise declaration shall be made according to Clause 10 of ISO 230-5:2000. When required to meet legal regulations or user's specifications, the declaration of the noise-emission values of the machine is the responsibility of the supplier/manufacturer. The noise-emission declaration shall be made in such a way that the values can be verified according to ISO 4871 using the dual number presentation (measured noise-emission value, L, and uncertainty, K).

The noise-emission quantities to be declared by the supplier/manufacturer are those listed in Clause 9, from d 1) to d 4).

The noise declaration shall explicitly state that the noise-emission values have been obtained according to this International Standard and to basic noise test codes. If necessary, the noise declaration shall clearly indicate what the deviations are from the basic standard(s).

Possible verifications shall be carried out by using the same mounting, installation and operating conditions as those used for the initial determination of noise-emission values.

An example of a noise-emission declaration is given in Annex E of ISO 230-5:2000.

Annex A
(normative)

Operating conditions for turning machines

A.1 General

This annex specifies, with reference to ISO 230-5, operating conditions to be applied in connection with measurement of noise from all kinds of turning machines with/without tailstocks, standing alone or integrated in flexible manufacturing systems.

For machines provided with a numerical control system which enables automatic operations, a representative test cycle shall be used for noise measurement according to A.3.4.

A.2 Preliminary operations

A.2.1 Identification of the machining volume

In order to specify standard travels of the movable components during the noise test, the machining volume shall be identified by means of the working travels of the main coordinate axes, excluding those parts of their travels used for tool change or pallet change only. In order to identify the machining volume, it is therefore necessary to specify the maximum and minimum parameters, e.g.

$$X_{min},\quad X_{max},\quad Y_{min}\ ^{1)},\quad Y_{max}\ ^{1)},\quad Z_{min}, \text{ and } Z_{max}$$

the centre of the machining volume is then defined by the following parameters:

$$X_{mean}, Y_{mean}\ ^{1)} \text{ and } Z_{mean}$$

which correspond respectively to the mean values of the above pairs of parameters.

A.2.2 Supplementary components

Movable components other than the main coordinate axes, such as sliding spindles, quills or rams, shall be retained in the home position.

No universal accessory heads are to be used.

If the machine is fitted with an integral universal head, the spindle shall be oriented in the position allowing the shortest tool change time.

A.3 Noise measurement

A.3.1 General

In every case, for the operating conditions described in A.3.3 and the test cycle described in A.3.4, the maximum A-weighted sound pressure level ($L_{p\mathrm{Amax}}$) and the time-averaged A-weighted sound pressure level ($L_{p\mathrm{Aeq}T}$) shall be measured. Additionally, the A-weighted sound power level ($L_{W\mathrm{A}}$) is to be determined with the relevant environmental correction factor.

1) Only when applicable.

A.3.2 Start conditions

A.3.2.1 Coordinate axes

The three main coordinate axes shall be in the centre of the machining volume, i.e. in the following positions:

$$X_{mean},\ Y_{mean}\ ^{2)}\ \text{and}\ Z_{mean}$$

A.3.2.2 Workpieces and tools

A short part blank shall be clamped in the chuck of the work-holding spindle;

For machines without tool changing systems, no tool is required.

For machines with tool changing systems:

a) for random position tool stores, one tool holder shall be ready in the store slot nearest to the tool changer and a second one in the next slot;

b) for fixed position tool stores with bi-directional search, one tool holder shall be ready in the nearest slot for the change and a second one in the next slot;

c) for fixed position tool stores with unidirectional search, one tool holder shall be ready in the nearest slot for the change and two others in the next slots.

A.3.3 Operating conditions

A.3.3.1 General

Noise emission shall be recorded for each of the operating conditions in the sub-clauses below.

A.3.3.2 Machine ready for service

For this test, all movable elements (slides, spindle, etc.) should be at rest, but with all ancillary devices (such as swarf conveyor, coolant, hydraulics and lubrication systems) activated.

A.3.3.3 Operation of the slide rest

Operation of the slide rest can also produce a high noise emission. Therefore, noise measurement should be evaluated by the following test.

The slide rest moves over 80 % of the maximum moving range of the X-axis and the Z-axis, separately, in both directions at maximum travel speed.

A.3.3.4 Operation of the spindle

The spindle is accelerated from zero to the maximum spindle speed and decelerated to standstill again. During this measurement, the lathe chuck should be removed. If this is not possible, the jaws should be in the closed position and this should be recorded in the test report.

A.3.3.5 Operation of the tool change

If the turning machine to be measured is equipped with tool changing devices, a full tool change cycle including the cleaning procedure (e.g. air blast) shall be carried out.

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2) Only when applicable.

A.3.3.6 Workpiece changing

If the machine is equipped with an automatic workpiece changing device, additional measurements during the workpiece changing operation should be carried out using a short part blank according to A.3.2.2. The time of measurement corresponds with the period of the workpiece changing operation.

The time-averaged sound pressure level and the time-averaged sound power level resulting from the measurement period and the peak sound pressure level at the operator's position shall be recorded. In addition, the maximum measured values and the time period of the workpiece changing operation shall be recorded.

If possible, the sound pressure level at the operator's position during the workpiece changing operation should be measured and presented as a graph against time, in addition to the report.

A.3.4 Test cycles

A.3.4.1 Standard work cycle

The work cycle of the machine undergoing the test is specified as follows. Each operational period which is part of this test cycle has been identified. The duration of each period is specified by the machine features, such as the travels defined in A.2.1, the maximum spindle speed of the machine, the rapid feed rates and the maximum working feed rates of the linear axes. Noise-emission values (averaged emission sound pressure levels and sound power levels) shall be determined for a complete test cycle at each measuring point.

Starting from the conditions specified in A.3.3, the following test cycle shall be carried out:

a) load/index the nearest tool into the active cutting position (see A.3.2.2);

b) move back the two or three main axes[1)] to the centre of the machining volume (see A.2.1);

c) start the spindle at maximum speed;

d) move all main axes simultaneously first to their maximum positions (X_{max}, Y_{max} [3)], and Z_{max}), then to their minimum positions (X_{min}, Y_{min} [3)], and Z_{min}), and finally back to the centre (X_{mean}, Y_{mean} [3)], and Z_{mean}) at the maximum programmable feed rate;

e) stop the spindle rotation;

f) change/index the tool with the nearest one (see A.3.2.2) [4)];

g) if necessary move back the main axes to the centre of the machining volume (see A.2.1);

h) start the spindle at maximum speed;

i) move all main axes simultaneously first to their maximum positions (X_{max}, Y_{max}[3)], and Z_{max}), then to their minimum positions (X_{min}, Y_{min}[3)], and Z_{min}), and finally back to the centre (X_{mean}, Y_{mean}[3)], and Z_{mean}) at the maximum programmable feed rate;

j) stop the spindle rotation;

k) change/index the tool with the nearest one (see A.3.2.2) [4)];

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3) Only when applicable.

4) Only for machines with automatic tool changing systems.

l) move back the main axes to the centre of the machining volume (see A.2.1);

m) start the spindle at maximum speed;

n) move all main axes simultaneously first to their maximum positions (X_{max}, Y_{max}[3)], and Z_{max}), then to their minimum positions (X_{min}, Y_{min}[3)], and Z_{min}), and finally back to the centre (X_{mean}, Y_{mean}[3)], and Z_{mean}) at the maximum programmable feed rate;

o) stop the spindle rotation;

p) unload the tool;

q) if necessary, move back the main axes to the centre of the machining volume (see A.2.1).

A.3.4.2 Special work cycle

A special work cycle defined and agreed between user and supplier may be used as an alternative to the standard cycle described above. The noise-emission test would follow the same procedure as in the standard work cycle. This may also include cutting operations as required.

Annex B
(normative)

Operating conditions for milling machines

B.1 General

This annex contains a series of operating conditions to be applied in connection with measurement of noise emission from milling machines.

These test conditions shall be complied with as closely as possible. If in a specific situation, it is necessary to deviate from these test conditions, the actual condition applied for the test shall be recorded.

Mandatory and standard safety attachments shall be mounted and in use during the tests. This annex may also serve as a data sheet on which measurement information can be recorded.

This annex is applicable for

— face milling machines,

— knee- and column-type milling machines,

— plano milling machines,

— milling and boring machines,

— machining centres with linear axes up to 2 000 mm.

This annex may also be applied for measurement of noise from special purpose machines having a similar construction and function.

For machines provided with a numerical control system which enables automatic operations (e.g. machining centres), a representative test cycle according to B.3.3 should be used for noise measurement.

B.2 Preliminary operations

B.2.1 Identification of the machining volume

In order to specify standard travels of the movable components during the noise test, the machining volume shall be identified by means of the working travels of the three main coordinate axes, excluding those parts of their travels used for tool change or pallet change only. In order to identify the machining volume, it is therefore necessary to specify the following parameters:

$$X_{min},\ X_{max},\quad Y_{min},\ Y_{max},\quad Z_{min}, \text{ and } Z_{max}$$

The centre of the machining volume is then defined by the following parameters:

$$X_{mean},\ Y_{mean},\ \text{and}\ Z_{mean}$$

which correspond respectively to the mean values of the above pairs of parameters.

B.2.2 Supplementary components

Movable components other than the three main coordinate axes, such as sliding spindles, rotary and swivelling tables, quills or rams, shall be held in the home position and holding mode.

No universal accessory heads are to be used.

If the machine is fitted with an integral universal head, the spindle shall be oriented in the position allowing the shortest tool change time.

B.3 Noise measurements

B.3.1 Start conditions

B.3.1.1 Coordinate axes

The three main coordinate axes shall be in the centre of the machining volume as defined in B.2.1, i.e. in the following positions:

$$X_{mean},\ Y_{mean} \text{ and } Z_{mean}$$

B.3.1.2 Tools

For tools, the following requirements apply.

a) No tool holder shall be placed in the spindle.

b) For random position tool stores with tool changer, one tool holder shall be ready in the store slot nearest to the tool changer and a second one in the next slot.

c) For fixed position tool stores with bi-directional search, one tool holder shall be ready in the nearest slot for the change and a second one in the next slot.

d) For fixed position tool stores with unidirectional search, one tool holder shall be ready in the nearest slot for the change and two others in the next slots.

B.3.1.3 Pallets

For pallets, the following requirements apply.

a) One empty pallet shall be clamped on the receiver.

b) For random position pallet stores with pallet changer, one empty pallet shall be ready in the waiting position of the pallet changer.

c) For fixed position pallet stores with bi-directional search, one empty pallet shall be ready in the nearest slot for the change.

d) For fixed position pallet stores with unidirectional search, one empty pallet shall be ready in the nearest slot for the change and a second one in the next slot.

B.3.2 Operating conditions

B.3.2.1 General

Noise emission shall be recorded for each of the operating conditions in the sub-clauses below.

B.3.2.2 Machine ready for service

During this measurement, the sound power level shall be determined. There should be no movement (of a spindle, the table, the knee or any other part of the machine), but all ancillary devices (such as the chip conveyor, coolant, hydraulics and lubrication systems) shall be in operation.

The emission sound pressure level at the operator's position and the sound power level shall be recorded.

B.3.2.3 Operation of the movable elements

The noise emission of a milling machine during the operation of the movable elements (knee, table, etc.) with maximum speed shall be carried out under the following operating conditions:

The movable elements should move in both directions over 80 % of the maximum moving range of the X-, Y- and Z-axis with maximum motion speed.

The time-averaged sound pressure level and the time-averaged sound power level resulting from the measurement period and the peak sound pressure level at the operator's position and the motion feedrate shall be recorded.

B.3.2.4 Operation of the spindle

A face-milling-cutter with a diameter of about 80 % of the maximum possible diameter shall be fitted into the tool receiver. Attention shall be taken that the test-tool is suitable for the maximum spindle speed of the machine.

For this measurement, the spindle is accelerated from zero to the maximum spindle speed and braked to standstill again.

The increase of the sound pressure level at the operator's position in relation to the sound pressure level at maximum speed during spindle accelerating and braking should be measured. The time interval of the spindle accelerating and braking shall be recorded.

If possible, the sound pressure level at the operator's position during accelerating and braking should be measured and presented as a graph against time in addition to the test report.

B.3.2.5 Operation of the tool change

If the machine to be measured is equipped with tool changing devices, a full tool change cycle including the cleaning procedure (e.g. air blast) shall be carried out.

Two tool changing operations between two adjacent tools in the magazine shall be measured: 1) one shank-type milling cutter; and 2) one face-milling-cutter with a diameter of about 80 % of the maximum possible diameter.

In addition to the tool changing operation, the cleaning operation of the tool receiver and the shank shall be measured during the measuring time period.

The time-averaged sound pressure level and the time-averaged sound power level resulting from the measurement period and the peak sound pressure level at the operator's position shall be recorded.

In addition, the maximum measured values and the time period of the tool changing operation shall be recorded.

If possible, the sound pressure level at the operator's position during the tool changing operation should be measured and presented as a graph against time additionally to the report.

B.3.2.6 Workpiece/pallet change

If the machine is equipped with an automatic workpiece/pallet changing device, additional measurements during the workpiece/pallet changing operation should be carried out. The time of measurement should correspond with the period of the workpiece/pallet changing operation.

The time-averaged sound pressure level and the time-averaged sound power level resulting from the measurement period and the peak sound pressure level at the operator's position shall be recorded. In addition, the maximum measured values and the time period of the workpiece/pallet changing operation shall be recorded.

If possible, the sound pressure level at the operator's position during the workpiece/pallet changing operation should be measured and presented as a graph against time, in addition to the report.

B.3.3 Test cycles

B.3.3.1 Standard work cycle

The work cycle of the machine undergoing the test is specified below in precise and quantitative terms. Each operational period which is part of this test cycle has been identified. The duration of each period is specified by the machine features, such as the travels defined in B.2.1, the maximum spindle speed of the machine, the rapid feed rates and the maximum working feed rates of the linear axes. Noise-emission values shall be determined for a complete test cycle at each measuring point.

Starting from the conditions specified in B.3.1, the following test cycle shall be carried out:

a) load the nearest tool into the spindle (see B.3.1.2);

b) move back the three main axes to the centre of the machining volume (see B.2.1);

c) rotate the spindle at its maximum speed;

d) first move all three axes simultaneously to their maximum positions (X_{max}, Y_{max} and $Z_{max)}$, and then to their minimum positions (X_{min}, Y_{min}, and Z_{min}), and then back to the centre (X_{mean}, Y_{mean} and Z_{mean}) at the maximum programmable feed rate;

e) stop the spindle rotation;

f) change the tool with the nearest one (see B.3.1.2);

g) change the pallet with the nearest one (see B.3.1.3);

h) move back the three main axes to the centre of the machining volume (see B.2.1);

i) rotate the spindle at its maximum speed;

j) first move all three axes simultaneously to their maximum positions (X_{max}, Y_{max}, and Z_{max}), then to their minimum positions (X_{min}, Y_{min}, and Z_{min}), and then back to the centre (X_{mean}, Y_{mean}, and Z_{mean}) at the maximum programmable feed rate;

k) stop the spindle rotation;

l) change the tool with the nearest one (see B.3.1.2);

m) change the pallet with the nearest one (see B.3.1.3);

n) move back the three main axes to the centre of the machining volume (see B.2.1);

o) first move all three axes simultaneously to their maximum positions (X_{max}, Y_{max}, and Z_{max}), then to their minimum positions (X_{min}, Y_{min}, and Z_{min}), and then back to the centre (X_{mean}, Y_{mean}, and Z_{mean}) at the maximum programmable feed rate;

p) stop the spindle rotation;

q) unload the tool from the spindle;

r) move back the three main axes to the centre of the machining volume (see B.2.1).

B.3.3.2 Special work cycle

A special work cycle defined and agreed between user and supplier may be used as an alternative to the standard cycle described above. This may also include cutting operations as required.

Annex C
(informative)

Data sheets for noise-emission measurement of turning machines

The data sheets given in this annex are examples and the suitable tables need to be selected. For the data which are not required, the corresponding data fields may be kept void.

Table C.1

Machine data
Name of manufacturer: .....
Year of manufacture: ..... Type/Serial No.: .....
Overall dimensions of machine:
length: ..... mm width: ..... mm height ..... mm
Maximum centre height:..... mm Maximum turning length:..... mm
Main spindle:
Nominal power at 100 % operating factor:.....
Maximum torque of the spindle:..... Speed range of the spindle: .....
Nominal spindle speed:..... Size of the tool: .....
Rapid federate of axes: X..... Y ..... Z .....
Maximum programmable feed of axes: X..... Y ..... Z .....

Table C.2

Machine installation	
Machine installed according to manufacturer's instructions Yes ☐ No ☐	Remarks/description: ....
Dimensions of the room:	
length: ..... m width: ..... m height: ..... m	
Volume of test room:.....m^3	Environmental correction, K_2:.....
Guards fitted and in use.....Yes ☐ No ☐	

Table C.3

General results of measurement	Grade of accuracy for L_{pA} according ISO 11200: for L_{WA} according ISO 3740:		A weighted environmental correction K_{2A}
	Sound power level L_{WA}	K_{3A}	Emission sound pressure level at operator's position L_{pA}
Idle running of spindle (n_{max}:..... min^{-1})			
Machine ready for service, all ancillary devices in operation			
Test cycle according ISO 8525:2008, A.3.4			

Table C.4

Movements of slide rest						
	Speed	Distance	Sound power level L_{WA}	K_{3A}	Emission sound pressure level at operator's position L_{pA}	Peak emission sound pressure level $L_{pC,\ peak}$
Moving x-axes positive						
Moving x-axes negative						
Moving z-axes positive						
Moving z-axes negative						
Movements of slide rest (time averaged value)						
Movements of slide rest (peak sound pressure level)						

Table C.5

Acceleration of the spindle	Time of acceleration: ..... Time of braking:	
Measurement at operator's position	Increase of the sound pressure level	Diagram - Sound pressure level versus time (optional)
Acceleration		
Braking		

Table C.6

Workpiece changing	Time period of the workpiece changing operation:		
Time averaged emission sound pressure level at the operator's position $L_{p\mathrm{Aeq}T}$		$K_{3A:}$	Diagram — Sound pressure level versus time (optional)
Peak emission sound pressure level at the operator's position $L_{p\mathrm{C,peak}}$			
Sound power level $L_{W\mathrm{A}}$			

Table C.7

Tool changing	Time period of the tool changing operation:		
Time averaged emission sound pressure level at the operator's position $L_{p\mathrm{Aeq}T}$		$K_{3A:}$	Diagram — Sound pressure level versus time (optional)
Peak emission sound pressure level at the operator's position $L_{p\mathrm{C,peak}}$			
Sound power level $L_{W\mathrm{A}}$			

Table C.8

Dimensions of the machine tool and microphone positions/
Location of the machine:

Height of the microphones	
Micro measurement path	Height

Distance of the microphones:		

Plan of the test room:

Dimensions of the test room	
Width:	
Length:	
Height:	
Volume:	

Short description of the test room:

Table C.9

Sound pressure level at the different microphone positions

Measurement under no load at n_{max}

Measuring point i	Measured sound pressure level L_{pA}'	Background noise $L_{p}A''$	Difference $\Delta L = L_{pA}' - L_{pA}''$	Background noise correction[a] K_{1A}	Sound pressure level $L_{pA\,i} = L_{pA}' - K_{1A}$
1					
2					
...					
n					
Operator's position					

Sound pressure level averaged over the measurement surface, $\overline{L_{pA}}$:

$$\overline{L_{pA}} = 10\lg\left[\frac{1}{n}\cdot\sum_{i=1}^{n}10^{0,1L_{pAi}}\right]\mathrm{dB(A)}$$

Surface sound pressure level [b], $\overline{L_{pfA}}$:

$$\overline{L_{pfA}} = \overline{L_{pA}} - K_{2A}$$

K_{2A} = environmental correction (see ISO 230-5)

Sound power level, L_{WA}:

$$L_{WA} = \overline{L_{pfA}} + L_S$$

with:

$$L_S = 10\lg\left[\frac{S}{S_0}\right]\mathrm{dB}$$

Emission sound pressure level at the operator's position, L_{pA}:

$$L_{pA} = L'_{pA} - K_{3A} \qquad \mathrm{dB(A)}$$

L_{pA} = background noise corrected sound pressure level at the operator's position

K_{3A} = local environmental correction (see ISO 230-5)

Testing laboratory

Firm/institution:

Address:

Telephone:

Date:..... Signature: .....

Test carried out:

Place: ..... Date: .....

[a] See ISO 3744 or ISO 3746.

[b] Alternatively, Equation (9) from ISO 230-5, page 18, may be used.

Annex D
(informative)

Data sheets for noise-emission measurement of milling machines

The data sheets given in this annex are examples and the suitable tables need to be selected. For the data which are not required, the corresponding data fields may be kept void.

Table D.1

Machine data
Name of manufacturer: .....
Year of manufacture:..... Serial No.:.....
Overall dimensions of machine:
length:..... mm width: ..... mm height..... mm
Working area:
length:..... mm width: ..... mm height..... mm
Main spindle:
Nominal power at 100 % operating factor:.....
Maximum torque of the spindle:..... Speed range of the spindle: .....
Nominal spindle speed:..... Size of the tool:.....
Rapid federate of axes: X ..... Y ..... Z.....
Maximum programmable feed of axes: X ..... Y ..... Z.....

Table D.2

Machine installation	
Machine installed according to manufacturer's instructions Yes ☐ No ☐	Remarks/description: ....
Dimensions of the room:	
length:..... m width:..... m	height: ..... m
Volume of test room:.....m^3	Environmental correction, K_2:.....
Guards fitted and in use.....Yes ☐	No ☐

Table D.3

General results of measurement	Grade of accuracy for L_{pA} according ISO 11200: for L_{WA} according ISO 3740:		A weighted environmental correction K_{2A}
	Sound power level L_{WA}	K_{3A}	Emission sound pressure level at operator's position L_{pA}
Idle running of spindle (n_{max}: ..... min^{-1})			
Rapid traverse movement (time averaged values)			
Rapid traverse movement (peak sound pressure level)			
Tool changing (time averaged values)			
Tool changing (peak sound pressure level)			
Workpiece/pallet changing (time averaged values)			
Workpiece/pallet changing (peak sound pressure level)			
Machine ready for service, all ancillary devices in operation			
Test cycle according ISO 8525:2008, B.3.3			

Table D.4

Movements of movable elements (e.g. table)						
	Speed	Distance	Sound power level L_{WA}	K_{3A}	Emission sound pressure level at operator's position L_{pA}	Peak emission sound pressure level $L_{pC,\ peak}$
Moving x-axes positive						
Moving x-axes negative						
Moving y-axes positive						
Moving y-axes negative						
Moving z-axes positive						
Moving z-axes negative						

Table D.5

Acceleration of the spindle	Time of acceleration: ..... Time of braking:	
Measurement at operator's position	Increase of the sound pressure level	Diagram — Sound pressure level versus time (optional)
Acceleration		
Braking		

Table D.6

Tool changing	Time period of the tool changing operation:		
Time averaged emission sound pressure level at the operator's position $L_{p\mathrm{AeqT}}$		$K_{3A:}$	Diagram — Sound pressure level versus time (optional)
Peak emission sound pressure level at the operator's position $L_{p\mathrm{C,peak}}$			
Sound power level $L_{W\mathrm{A}}$			

Table D.7

Workpiece changing	Time period of the workpiece changing operation:.....		
Time averaged emission sound pressure level at the operator's position $L_{p\mathrm{AeqT}}$		$K_{3A:}$	Diagram — Sound pressure level versus time (optional)
Peak emission sound pressure level at the operator's position $L_{p\mathrm{C,peak}}$			
Sound power level $L_{W\mathrm{A}}$			

Table D.8

<table>
<tr><td colspan="3">Dimensions of the machine tool and microphone positions/ Location of the machine:</td></tr>
<tr><td colspan="2" rowspan="5"></td><td>Height of the microphones</td></tr>
<tr><td>Micro measurement path</td><td>Height</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Distance of the microphones:</td><td></td><td></td></tr>
<tr><td colspan="3">Plan of the test room:</td></tr>
<tr><td colspan="2" rowspan="5"></td><td>Dimensions of the test room</td></tr>
<tr><td>Width:</td><td></td></tr>
<tr><td>Length:</td><td></td></tr>
<tr><td>Height:</td><td></td></tr>
<tr><td>Volume:</td><td></td></tr>
<tr><td colspan="3">Short description of the test room:</td></tr>
</table>

Table D.9

Sound pressure level at the different microphone positions

Measurement under no load at n_{max}

Measuring point i	Measured sound pressure level L_{pA}'	Background noise $L_{p}A''$	Difference $\Delta L = L_{pA}' - L_{pA}''$	Background noise correction [a] K_{1A}	Sound pressure level $L_{pA\,i} = L_{pA}' - K_{1A}$
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Operator's position					

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L_{pA} = background noise corrected sound pressure level at the operator's position

K_{3A} = local environmental correction (see ISO 230-5)

Testing laboratory

Firm/institution:

Address:

Telephone:

Date:..... Signature:.....

Test carried out:

Place: ..... Date:.....

[a] See ISO 3744 or ISO 3746.

[b] Alternatively, Equation (9) from ISO 230-5, page 18, may be used.

Bibliography

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

[2] ISO 3746[5)], *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*

[3] 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*

5) To be published. (Revision of ISO 3746:1995)

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