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Hand-held non-electric power tools — Noise measurement code — Engineering method (grade 2)

*Machines à moteur portatives non électriques — Code pour le mesurage
du bruit — Méthode d'expertise (classe de précision 2)*



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

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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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15744 was prepared by Technical Committee ISO/TC 118, *Compressors, pneumatic tools and pneumatic machines*, Subcommittee SC 3, *Pneumatic tools and machines*.

Annexes A, B and C of this International Standard are for information only.

Introduction

The noise test code presented by this International Standard gives methods for determining and declaring the noise emission values of hand-held non-electric power tools: i.e. the total noise level from the power tool expressed as sound power level and as the emission sound pressure level at the work station. These methods have been designed to give results that make it possible to compare the acoustic performance of various power tools.

The power tools are either run at no load, when this gives a representative value, or in an on-load condition but with the process noise muffled so that it is well below the noise level of the power tool. The methods were chosen to give a satisfactory reproducibility of results and are based on present practice in industry.

For many power tools in a real work situation the noise from the process dominates the total noise emission in actual use. The process noise varies within very wide limits and cannot be predicted. Users are cautioned that the emission sound pressure level as determined by this code may not be representative of actual operator exposure levels, which are unique characteristics of individual applications and environmental factors beyond the control of the manufacturers of the equipment covered by this International Standard, and are under the exclusive control (and therefore the responsibility) of the users of the equipment.

This International Standard was prepared with the assistance of both PNEUROP, the European body representing manufacturers of compressors, vacuum pumps, pneumatic tools, pneumatic machines and allied equipment, and CAGI, the compressed air and gas institute, in the United States.

Hand-held non-electric power tools — Noise measurement code — Engineering method (grade 2)

1 Scope

This International Standard specifies methods for the measurement, determination and declaration of the noise emission from hand-held non-electric power tools. It prescribes the loading and working conditions under which can be determined

- a) the noise emission, under specified load conditions, expressed as the sound power level, and
- b) the emission sound pressure level at the work station under specified load conditions.

This International Standard is applicable to typical hand-held non-electric power tools including rotary tools, orbital and random orbital sanders, rotary and non-rotary reciprocating and percussive tools and a variety of assembly tools. It is not applicable to cartridge-operated tools, fastener driving tools (e.g. nailers, staplers) or any tool powered by an internal combustion engine, nor is it applicable to breakers or other power tools which, when placed on the market, are required to meet the provisions of legislation specifying test methods and imposing limits on noise emission from, for example, equipment used outdoors.

NOTE This noise measurement code could also be applied to other equipment such as winches, pneumatic motors, auto-feed drills and tappers, pumps, hydraulic motors and screw feed systems, provided their principles of operation were in accordance with those of pneumatic and hydraulic equipment.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 2787:1984, *Rotary and percussive pneumatic tools — Performance tests*

ISO 3744:1994, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering method in an essentially free field over a reflecting plane*

ISO 4871:1996, *Acoustics — Declaration and verification of noise emission values of machinery and equipment*

ISO 5391, *Pneumatic tools and machines — Vocabulary*

ISO 8662-2, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 2: Chipping hammers and riveting hammers*

ISO 8662-3, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 3: Rock drills and rotary hammers*

ISO 8662-7, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 7: Wrenches, screwdrivers and nut runners with impact, impulse or ratchet action*

ISO 8662-8, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 8: Polishers and rotary, orbital and random orbital sanders*

ISO 8662-14, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 14: Stone-working tools and needle scalers*

ISO 11203:1995, *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*

IEC 60651, *Sound level meters*

IEC 60804, *Integrating-averaging sound level meters*

EN 292-2:1991, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles and specifications*

3 Terms, definitions and symbols

For the purposes of this International Standard, the terms and definitions given in ISO 5391 and the following apply. For the symbols, see Table 1.

3.1

declared dual-number noise emission value

L, K

measured noise emission value, L , and its associated uncertainty K , both rounded to the nearest decibel

[ISO 4871:1996]

3.2

emission

airborne sound radiated by a well-defined noise source (e.g. the machine under test)

[ISO 11203:1995]

NOTE Emission values may be incorporated in a product label or published in a product specification, or both these. The basic noise emission descriptors are the sound power level of the product itself and the emission sound pressure levels at the work station and at other specified positions (if any) in the vicinity of the product.

3.3

emission sound pressure

p

sound pressure, at a specified position near a noise source, when the source is in operation under specified operating and mounting conditions on a reflecting plane surface, excluding the effects of background noise as well as the effects of reflections other than those from the plane or planes permitted for the purpose of the test; expressed in pascals

[ISO 11203:1995]

3.4

emission sound pressure level

L_p

ten times the logarithm to the base 10 of the ratio of the square of the emission sound pressure, $p^2(t)$, to the square of the reference sound pressure, p_0^2 , measured with a particular time weighting and a particular frequency weighting selected from those defined in IEC 60651; expressed in decibels

NOTE 1 The reference sound pressure is 20 μ Pa.

NOTE 2 Adapted from ISO 11203:1995.

3.5**hand-held power tool**

power tool driven by a rotary or linear motor powered by compressed air, hydraulic fluid, gaseous or liquid fuel, electricity or stored energy (e.g. by a spring) to do mechanical work and so designed that the motor and the mechanism form an assembly that can easily be brought to its place of operation

NOTE The power tool can be operated using one or two hands.

3.6**inserted tool**

tool inserted in the hand-held power tool to perform the intended work

3.7**loading device**

device providing a simulated work piece for a hand-held power tool under test conditions

3.8**noise emission declaration**

information on the noise emitted by the machine, given by the manufacturer or supplier in technical documents or other literature concerning noise emission values

NOTE 1 The noise emission declaration may take the form of either the declared single-number noise emission value or the declared dual-number value.

NOTE 2 Adapted from ISO 4871:1996.

3.9**no-load speed**

free speed

idling speed

rotational speed of the output spindle, with no inserted tool mounted, subject to no external load, and operated at maximum energy supply as specified by the manufacturer; expressed in revolutions per minute

3.10**normal sound intensity level**

$$\overline{L}_{In}$$

ten times the logarithm to the base 10 of the ratio of the component of the sound intensity, in the direction normal (perpendicular) to the measurement surface, to the reference sound intensity; expressed in decibels

NOTE The reference sound intensity is 10^{-12} W/m².

3.11**work station**

operator's position

position in the vicinity of the machine under test which is intended for the operator

[ISO 11203:1995]

3.12**sound intensity**

time-averaged value of the rate of flow of sound energy per unit of surface area in the direction of the local instantaneous acoustic particle velocity

3.13**sound power**

$$W$$

rate per unit time at which airborne sound energy is radiated by a source, expressed in watts

[ISO 3744:1994]

3.14
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, expressed in decibels

NOTE 1 The frequency weighting or the width of the frequency band used is indicated, for example: A-weighted sound power level, L_{WA} .

NOTE 2 The reference sound power is 1 pW (10^{-12} W).

NOTE 3 Adapted from ISO 3744:1994.

3.15
standard deviation of reproducibility

σ_R

standard deviation of noise emission values obtained under reproducibility conditions: i.e. the repeated application of the same noise emission measurement method on the same noise source at different times and under different conditions (different laboratory, different operator, different apparatus), and therefore including the standard deviation of repeatability

NOTE Adapted from ISO 4871:1996.

3.16
surface sound pressure level

$\overline{L_{pf}}$

energy-average of the time-averaged sound pressure levels at all microphone positions on the measurement surface, expressed in decibels, with background noise correction K_1 and environmental correction K_2 applied

[ISO 3744:1994]

NOTE 1 See Table 1 for equivalent A-weighted symbol.

NOTE 2 The background noise correction K_1 and the environmental correction K_2 are defined in ISO 3744:1994.

3.17
time-averaged emission sound pressure level

L_{peqT}

emission sound pressure level of a continuous steady sound that, within a measurement time interval, T , has the same mean square sound pressure as a sound under consideration which varies with time; expressed in decibels

[ISO 11203:1995]

NOTE See Table 1 for equivalent A-weighted symbol.

3.18
uncertainty

K

value of the measurement uncertainty associated with a measured noise emission value, expressed in decibels

[ISO 4871:1996]

Table 1 — Symbols

Symbol	Description
D	Diameter of energy absorber
F_A	Feed force
K_1, K_{1A}	Background noise correction, A-weighted background noise correction
K_2, K_{2A}	Environmental correction, A-weighted environmental correction
$K_{WA}, K_{pA}, K_{pC,peak}$	Measurement uncertainties
L	Noise emission value
\bar{L}	Arithmetical mean of noise emission values
\overline{L}_{In}	Normal sound intensity level
L_p	Emission sound pressure level
L_{peqT}	Time-averaged emission sound pressure level
L_{pAeqT}	A-weighted time-averaged emission sound pressure level (usually abbreviated to L_{pA}) ^a
$L_{pC,peak}$	C-weighted peak emission sound pressure level
$\overline{L}_{pf}, \overline{L}_{pfA}$	Surface sound pressure level, A-weighted surface sound pressure level
L'_{pAi}	A-weighted sound pressure level measured at the i -th microphone position
L_W, L_{WA}	Sound power level, A-weighted sound power level
Q	Numerical difference between L_{WA} and L_{pA}
R	Measurement surface hemisphere radius and cylinder radius
S	Measurement surface area
h	Free length of inserted tool
σ_R	Standard deviation of reproducibility
^a	It shall be measured with an instrument which complies with the requirements of IEC 60804.

4 Machinery families

4.1 Applicability of this International Standard

The hand-held non-electric power tools to which this International Standard is applicable comprise a range of types and models, based on similar mechanical parts, technology and design, and giving similar acoustic properties.

They can be grouped into the following families:

- a) **rotary tools**, including drills, tappers, grinders, belt sanders, polishers, rotary files, rotary sanders, die grinders and circular saws;
- b) **orbital and random orbital sanders**;
- c) **rotary reciprocating tools**, including jig saws, nibblers, oscillating saws, reciprocating saws, reciprocating files and shears, having a rotary drive;

- d) **non-rotary reciprocating tools**, including reciprocating saws, files and knives and oscillating saws and knives, having a non-rotary drive;
- e) **percussive non-rotary tools**
 - where the piston and working tools are in two parts (not integrated), such as chipping hammers and riveting hammers,
 - where the piston itself is the working tool, such as rammers, tampers and scaling hammers, and
 - needle scalers;
- f) **percussive rotary tools**, including drifters, plug-hole drills, rotary hammers, rock drills and stopers;
- g) **non-impact assembly tools**, such as non-ratchet screwdrivers and nut-runners;
- h) **ratcheting assembly tools**, including screwdrivers and wrenches with ratchet clutches (also known as slip clutches), and pawl-type ratchet wrenches;
- i) **impact assembly tools**, such as impact wrenches and screwdrivers, and air-hydraulic impulse wrenches and screwdrivers.

See also Table 2.

4.2 Other equipment

The use of this International Standard may be extended to other equipment that does not have a dedicated noise test code, provided the principles of operation of that equipment accord with the general principles for the operation of pneumatic and hydraulic equipment.

EXAMPLES Winches, pneumatic motors, auto-feed drills and tappers, pumps, hydraulic motors, screw feed systems.

5 Sound power level determination

5.1 General

The acoustic environment, instrumentation, quantities to be measured and determined, and measurement procedure shall be as specified in ISO 3744:1994.

The sound power level shall be given as an A-weighted sound power level in decibels, with a reference of 1 pW. The A-weighted sound pressure levels, from which the sound power is to be determined, should be measured directly, and not calculated from frequency band data.

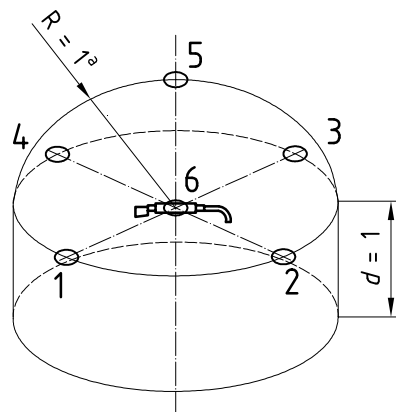
5.2 Measurement surface

For all hand-held non-electric power tools, the sound power level shall be determined using a hemispherical/cylindrical measurement surface, consisting of a hemisphere standing on a cylindrical pedestal (see Figure 1). The technical justification for the selection of this surface is given in Annex C.

Measurements shall be made in a free field over a reflecting plane.

Five microphone positions shall be located 1 m from the geometric centre of the power tool. Four positions shall be spaced at regular intervals on a plane defined as passing through the geometric centre of the power tool and parallel to the reflecting plane; the fifth position shall be located at a distance of 1 m above the geometric centre of the power tool, as shown in Figure 1.

Dimensions in metres

**Key**

- 1 to 5 Microphone positions
 6 Geometric centre of power tool
 a Radius of hemisphere and cylinder.

Figure 1 — Power tool and microphone positions on hemispherical/cylindrical measurement surface

5.3 Calculation**5.3.1 General**

The A-weighted sound power level, L_{WA} , shall be calculated as follows (see ISO 3744:1994, 8.6), in decibels:

$$L_{WA} = \overline{L_{pfA}} + 10 \lg \frac{S}{S_0} \quad (1)$$

with $\overline{L_{pfA}}$ determined from

$$\overline{L_{pfA}} = 10 \lg \left(\frac{1}{5} \sum_{i=1}^5 10^{0,1 L'_{pAi}} \right) - K_{1A} - K_{2A} \quad (2)$$

in decibels,

where

$\overline{L_{pfA}}$ is the surface sound pressure level (according to ISO 3744:1994, 8.5), A-weighted;

L'_{pAi} is the A-weighted sound pressure level measured at the i -th microphone position, in decibels;

K_{1A} is the A-weighted background noise correction;

K_{2A} is the A-weighted environmental correction;

S is the area of the measurement surface, in square metres;

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

5.3.2 Hemispherical/cylindrical measurement surface

The area, S , of the measurement hemispherical/cylindrical surface is calculated as follows, in square metres:

$$S = 2\pi (R^2 + Rd) \quad (3)$$

where

d = 1 m, the distance of the geometrical centre of the power tool above the reflecting plane;

R = 1 m, the radius of the hemisphere and of the cylinder comprising the measurement surface.

Therefore

$$S = 4\pi \text{ m}^2$$

So, from equation (1):

$$L_{WA} = \overline{L_{pA}} + 11 \text{ dB} \quad (4)$$

in decibels.

6 Emission sound pressure level determination

6.1 A-weighted emission sound pressure level at the work station

The A-weighted emission sound pressure level at the work station, L_{pA} , shall be calculated as follows (see ISO 11203:1995, 6.2), in decibels:

$$L_{pA} = L_{WA} - Q \quad (5)$$

where

$$Q = 11 \text{ dB.}$$

NOTE 1 This value of Q has been determined, during experimental investigations, to be applicable to hand-held power tools. The resulting A-weighted emission sound pressure level at the workstation is equivalent to the value of the surface sound pressure level at a distance of 1 m from the power tool. This distance has been chosen to give satisfactory reproducibility of results and to permit comparison of the acoustic performance of different hand-held power tools, which generally do not have uniquely defined work stations. Under free field conditions, where an estimation of the emission sound pressure level, L_{pA1} , may be required at a particular distance from the geometric centre of the power tool, this may be done by applying the formula:

$$L_{pA1} = L_{pA} + 20 \lg \frac{1}{r_1}$$

in decibels,

where

r_1 is the distance from the geometric centre of the power tool, in metres.

NOTE 2 For a particular machine and for given mounting and operating conditions, the emission sound pressure level determined by the method specified in this International Standard will in general be lower than any directly measured sound pressure level at a 1 m distance for the same machine in the typical workroom where it is used. This is due to the influence of sound reflecting surfaces and also to contributions from other machines in the actual situation. A method of calculating sound pressure levels in a workroom, due to the noise emission of a machine, is given in ISO/TR 11690-3 [1]. Commonly observed differences are 1 dB to 5 dB, but in extreme cases the difference may be even greater.

6.2 C-weighted peak emission sound pressure level at the work station

If the C-weighted peak emission sound pressure level is required, it shall be measured at each of the five measurement positions specified in 5.2. The C-weighted peak emission sound pressure level at the work station used for the noise emission declaration according to clause 12 is the highest C-weighted peak sound pressure level measured at any of the five microphone positions; no corrections are permitted.

7 Power tool installation and mounting during noise tests

7.1 General

The installation and mounting conditions shall be identical for the determination of both sound power level and emission sound pressure level at the work station.

The power tool under test shall be new and equipped with accessories affecting its acoustic properties, as recommended by the manufacturer. Prior to commencing testing, the power tool (including any required ancillary equipment) shall be set up in a stable condition in accordance with the manufacturer's instructions for safe use.

The power tool shall be hand-held in a manner typical of normal use, unless otherwise specified. If a power tool is normally used both vertically and horizontally, preference shall be given to the position that results in the simplest loading device and acoustic environment.

If the power tool is normally used horizontally, it shall be positioned so that its axis is at 45° between the microphone positions 1 and 4 and 2 and 3; its geometrical centre shall be 1 m above the ground (reflecting plane). However, if these requirements are impracticable, the adopted positions shall be recorded and described in the test report (see clause 11).

The direct discharge of exhaust air from a pneumatic power tool or cooling air from the loading device directly towards a microphone position shall be avoided.

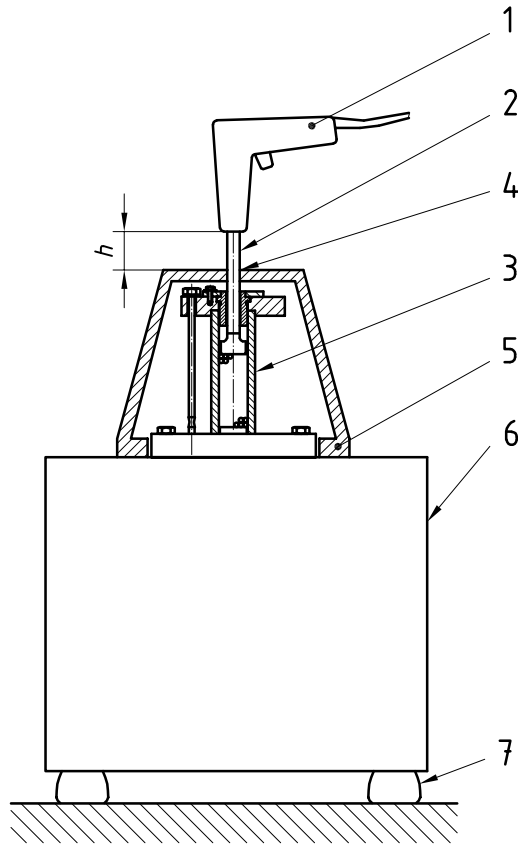
The operator shall not be positioned directly between any microphone position and the power tool, except as is strictly necessary for the operation of the power tool during the test procedure.

7.2 Loading devices

Loading devices, where required, shall be according to clause 8.

The noise from any loading device shall be at least 10 dB lower than the noise from the power tool under test, in each octave band influencing the A-weighted values. To achieve this, it may be necessary to enclose the loading device in an acoustic insulation box as shown in Figure 2.

NOTE Guidance on the design of noise control enclosures is given in ISO 15667 [2]. The efficacy of the loading device noise reduction measures can be verified by measuring the noise under normal test conditions, but with the power tool enclosed in an acoustic insulation box and its air exhaust (if any) piped away from the measurement area. For further guidance, see ISO 11546-2 [3].



Key

- 1 Power tool
- 2 Inserted tool
- 3 Steel ball energy absorber
- 4 Foam
- 5 Acoustic insulation box
- 6 Concrete block
- 7 Rubber feet

Figure 2 — Example of loading device with noise reduction — Acoustic insulation box

8 Loading and operating conditions

8.1 General

The loading and operating conditions shall be identical for the determination of both sound power level and emission sound pressure level at the work station.

The power tool operator shall be competent, and adequately trained, instructed and supervised, and shall be provided with a safe procedure for testing (which may necessitate the monitoring or control of noise exposure, provision of personal protective equipment etc.), as required under relevant workplace health and safety regulations.

During measurements, the power tool shall operate under stable conditions and at the rated energy supply, in accordance with the manufacturer's instructions. The air pressure of a pneumatic power tool shall be measured in accordance with ISO 2787. For hydraulic tools, a warming up time of at least 5 min shall be allowed before measurements are taken. The hydraulic fluid rate shall be measured using an electric flowmeter (accuracy class ± 2,5 % of flow reading).

Once the noise emission is steady, under the specified operating conditions for the power tool, the measurement time interval shall be at least 15 s. If measurements are to be made in octave or one-third octave frequency bands, the minimum period of observation shall be 30 s for the frequency bands centred on or below 160 Hz and 15 s for those centred on or above 200 Hz.

NOTE It is not possible to simulate all conditions of practical use. Owing to this, a statement of process noise could be misleading and could cause faulty assessment of the risk in individual cases, discourage the development of more silent power tools, or else lead to a low repeatability of measurements, thus causing problems when verifying declared noise levels, or make comparison of the noise emission from different tools difficult.

Table 2 — Hand-held power tool families and their operating conditions

Power tool family	Speed	Loading device	Feed force F_A N
Rotary tools (e.g. drills and tappers, grinders, rotary sanders, belt sanders, polishers, die grinders, circular saws)	No-load	None	None
Orbital and random orbital sanders		See 8.2	30 ± 5
Rotary reciprocating tools (e.g. oscillating saws, reciprocating saws, shears, nibblers)	No-load	None	None
Non-rotary reciprocating tools (e.g. reciprocating saws, files and knives, oscillating saws and knives)	No-load	None	None
Non-rotary percussive tools — where piston and working tool are not integrated (e.g. chipping hammers, riveting hammers)		See 8.3	80 to 200
Non-rotary percussive tools — where piston itself is the working tool (e.g. single and multi-head scalers, rammers, tampers)	No-load	None	None
Needle scalers		See 8.4	20 × mass (in kg) of power tool
Rotary percussive tools (e.g. rotary hammers, rock drills, stopers, drifters)		See 8.5	80 to 200
Assembly tools for threaded fasteners — non-impact (e.g. non-ratcheting screwdrivers, nutrunners)	No-load	None	None
Assembly tools for threaded fasteners — ratcheting			
Ratcheting screwdrivers	a) No-load and b) < 50 r/min	a) None b) see 8.6	a) None b) see 8.6
Pawl-type ratchet wrenches	No-load	None	None
Assembly tools for threaded fasteners — impact			
Impact screwdrivers and wrenches	a) No-load and b) < 50 r/min	a) None b) see 8.6	a) None b) see 8.6
Impulse screwdrivers and wrenches	a) No-load and b) < 50 r/min	a) None b) see 8.6	a) None b) see 8.6

8.2 Orbital and random orbital sanders

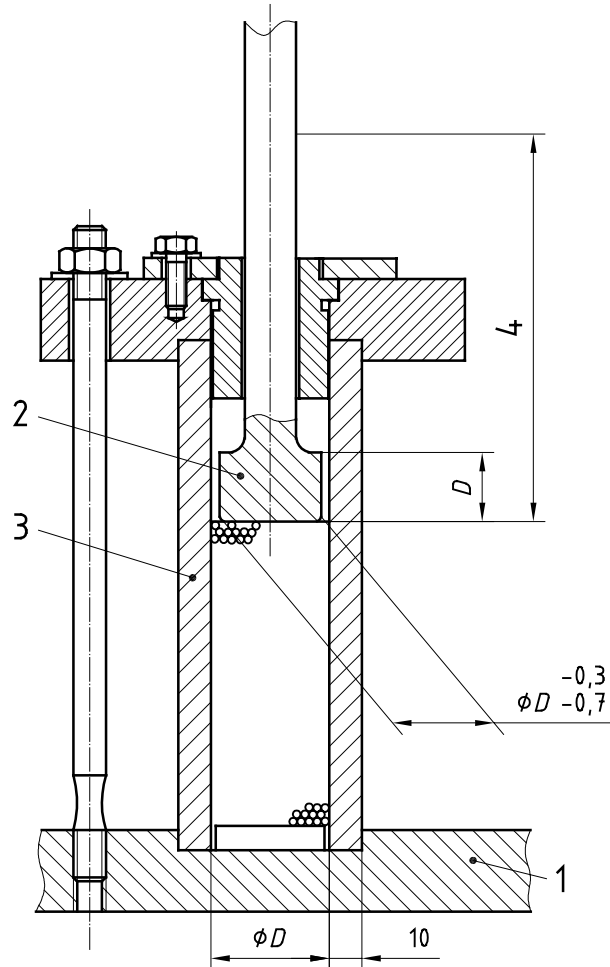
The noise test shall be carried out during sanding and shall be performed by a trained operator. The sander shall be equipped with a sanding paper of grade 180 grit and operated on a horizontal rigid plain steel plate. The feed force shall be 30 N ± 5 N, applied vertically downwards. During the test, the power tool shall be moved over the surface of the steel plate in a figure-of-eight pattern, according to ISO 8662-8. Each figure-of-eight pattern shall take approximately 4 s to be completed.

8.3 Non-rotary percussive tools

Non-rotary percussive power tools, where the piston and working tools are in two parts (not integrated), shall be operated on a loading device in accordance with Figure 3. The inserted tool and the piston of the energy absorber shall be made in one part. For the full specification of the loading device, see ISO 8662-2.

The energy absorber shall be arranged so that the operator can have an upright posture when operating the power tool for the test. The free length of the inserted tool, depending upon the diameter of the energy absorber and the type of power tool under test, shall be in accordance with Table 3.

Dimensions in millimetres



Key

- 1 Steel block
- 2 Hardened steel of 55 HRC \pm 2 HCR
- 3 Hardened steel of 62 HRC \pm 2 HCR
- 4 Length of inserted tool

The steel block shall be fixed to a concrete block with a minimum mass of 300 kg.

Figure 3 — Steel ball energy absorber — Percussive power tools

Table 3 — Diameter of energy absorber and free length of inserted tool — Percussive power tools

Dimensions in millimetres

Type	Diameter of energy absorber D	Free length of inserted tool h^a
Riveting hammer	20	10 ± 4
	40	10 ± 4
Other percussive tools	20	40 ± 15
	40	60 ± 20
	60	80 ± 20
^a See Figure 2.		

The feed force to be applied in addition to the weight of the power tool shall ensure that it operates at its normal level of performance. This means a stable operation and no contact established with the collar of the inserted tool. This is generally achieved when F_A (in newtons) is in the order of n times the mass (in kilograms) of the power tool, where n is chosen according to Table 4. Maximum and minimum values of F_A are also given in Table 4; the values in this table are, however, given only as guidance.

NOTE F_A can be controlled during the test by having the operator stand on a scale. The feed force is then the operator's own weight minus the reading on the scale.

Table 4 — Guide for choosing feed force values — Percussive power tools

Type	Value of n	Feed force F_A N	
		max.	min.
Rock drill	15	200	80
Chipping and riveting hammers	40	200	80

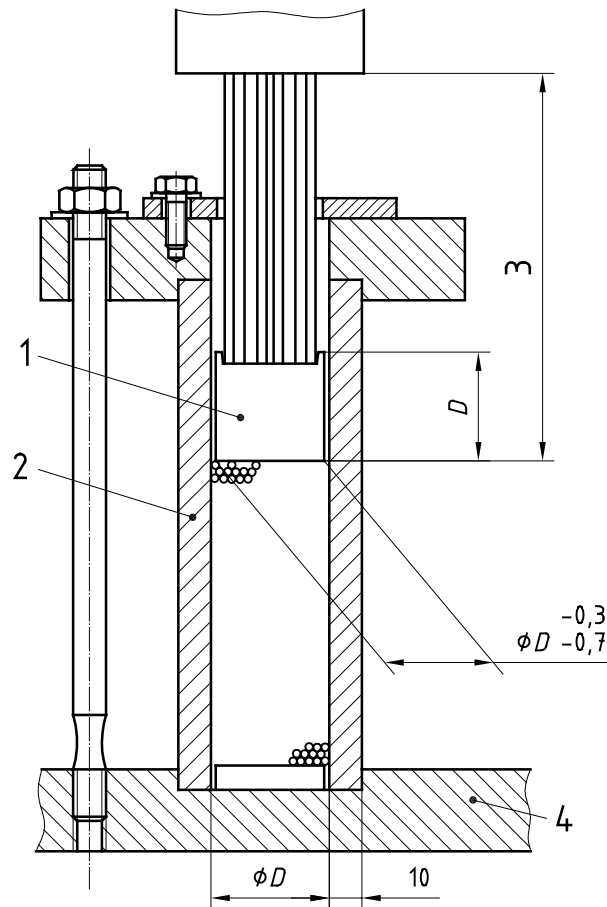
8.4 Needle scalars

Needle scalars shall be operated on a loading device in accordance with Figure 4. For the full specification of the loading device, see ISO 8662-14.

The energy absorber shall be arranged so that the operator can have an upright posture when operating the power tool for the test.

The feed force to be applied in addition to the weight of the power tool shall ensure that it operates at its normal level of performance. This means a stable operation where the piston does not hit the front end of the needle scalar. This is generally achieved when F_A (in newtons) is in the order of 20 times the mass (in kilograms) of the power tool.

NOTE F_A can be controlled during the test by having the operator stand on a scale. The feed force is then the operator's own weight minus the reading on the scale.



Key

- 1 Anvil surface to fit the needles
- 2 Steel tube
- 3 Length of inserted tool
- 4 Base plate

Figure 4 — Steel ball energy absorber — Needle scalars

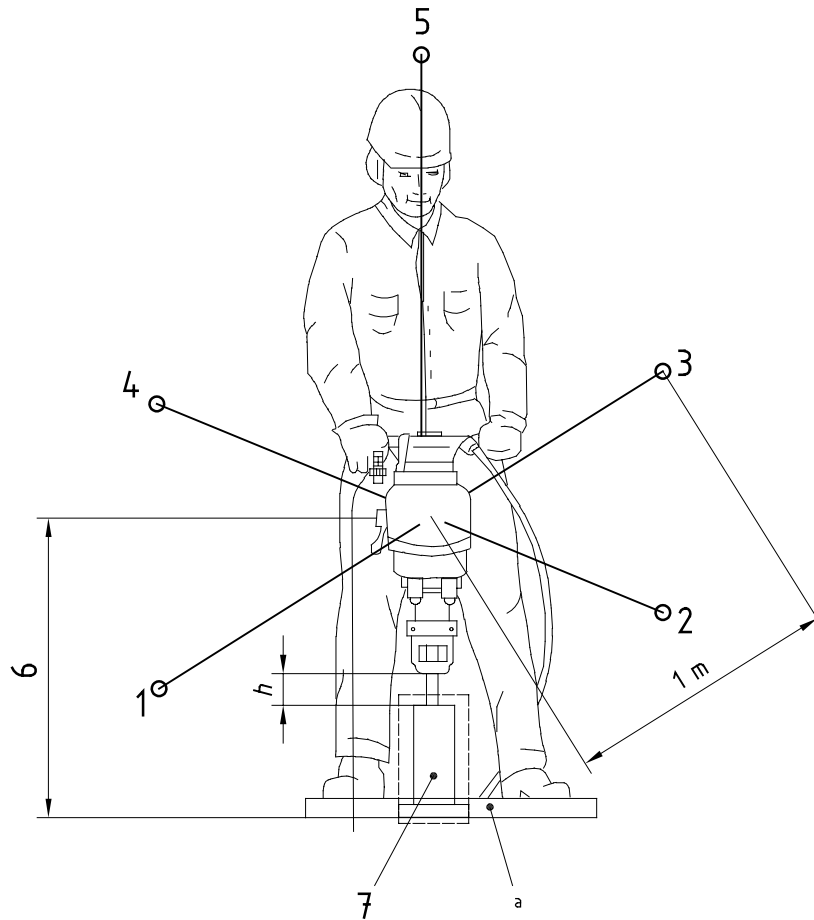
8.5 Rotary percussive tools

Rotary percussive power tools shall be operated on a loading device in accordance with Figure 3. The inserted tool and the piston of the energy absorber shall be made in one part. For the full specification for the loading device, see ISO 8662-3.

The energy absorber shall be arranged so that the operator can have an upright posture when operating the power tool for the test (see Figure 5). The free length of the inserted tool, depending upon the diameter of the energy absorber and the type of power tool under test, shall be in accordance with Table 3.

The feed force to be applied in addition to the weight of the power tool shall ensure that it operates at its normal level of performance. This means a stable operation and no contact established with the collar of the inserted tool. This is generally achieved when F_A (in newtons) is in the order of n times the mass (in kilograms) of the power tool, where n is chosen according to Table 4. Maximum and minimum values of F_A are also given in Table 4; the values in this table are, however, given only as guidance.

NOTE F_A can be controlled during the test by having the operator stand on a scale. The feed force is then the operator's own weight minus the reading on the scale.



Key

- 1 to 5 Microphone positions
- 6 Geometric centre of power tool (1 m above reflecting plane)
- 7 Steel ball energy absorber

a The operator is shown standing on a scale (see note to 8.3, 8.4 and 8.5).

Figure 5 — Working position of operator and microphone positions — Rock drills

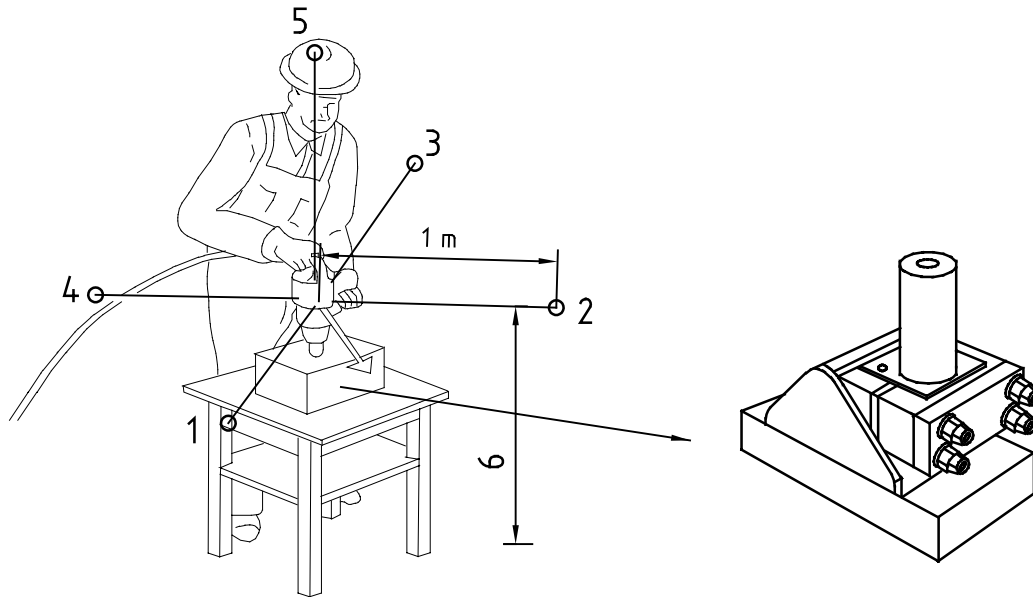
8.6 Ratcheting screwdrivers, impact wrenches and impulse wrenches

Perform two tests [a) and b)] on ratcheting screwdrivers and nutrunners (except pawl-type), and on impact and impulse wrenches. The results from the test, a) or b), which yields the higher emission sound pressure level at the work station shall be used as the basis for the declaration of the noise emission values.

- a) Run the power tool at no-load.
- b) Load the power tool on a brake system, so that the socket driving the brake rotates at a test speed which is less than 50 r/min and so that the ratchet, impact or impulse mechanism is caused to operate continuously. A suitable brake is shown in Figure 6 (see also ISO 8662-7 for a suitable description). It may be necessary to use an extended socket when enclosing the brake in an acoustic insulation box. During the test, the operator shall apply an F_A equal to the weight of the power tool ($\pm 50\%$). For push-start type power tools, the feed force shall be sufficient to cause the power tool to operate according to the manufacturer's instructions.

Impact and impulse tools with automatic shut-off that cannot be run in the test rig in a clockwise direction shall be run in anti-clockwise rotation.

Pawl-type ratchet wrenches are unable to be operated on the brake in a stable manner, and shall therefore be tested only at no-load.



Key

- 1 to 5 Microphone positions
- 6 Geometric centre of power tool (1 m above reflecting plane)

Figure 6 — Working position of operator and microphone positions — Impact and impulse wrenches

9 Measurement uncertainty

Perform the measurements three times and retain the average value as the measured value. Measurements made in accordance with this noise test code will result in standard deviations of reproducibility, σ_R , for the A-weighted sound power level and A-weighted emission sound pressure level at the work station of $\leq 1,5$ dB.

10 Information to be recorded

The information to be recorded covers all technical requirements of this noise test code, including

- reference to this International Standard and the other standards used, and
- a statement to the effect that the test has been made, to accuracy grade 2, in full conformity with this International Standard and with ISO 3744:1994 and ISO 11203:1995.

If appropriate, the manufacturer's additional instructions shall be recorded.

Any deviations from this International Standard or from the basic standards upon which it is based shall be recorded, together with the technical justification for such deviations.

Record, too, the following information.

- a) Power tool:
 - manufacturer;
 - type, model, machinery family;

- serial number;
 - year of manufacture;
 - capacity;
 - blow frequency (if relevant);
 - inserted tool;
 - accessories fitted.
- b) Loading and operating conditions:
- description of loading and operating conditions of the power tool, including any not specified in this noise test code;
 - working pressure (if relevant);
 - flow rate (if relevant);
 - feed force (if relevant);
 - test speed (if relevant).
- c) Acoustic environment:
- description of test environment;
 - ambient temperature, atmospheric pressure, relative humidity and wind speed.
- d) Instrumentation:
- specification of equipment used including name, type, serial number and manufacturer;
 - methods used for calibration of microphones and other system components;
 - date and place of calibration and result of calibration;
 - characteristics of wind screen, if used.
- e) Test arrangements:
- sketch showing test layout and microphone positions, with direction and distance to large objects within the test area indicated where applicable;
 - number of microphones;
 - height above reflecting plane;
 - operator's posture in sketch;
 - orientation of power tool;
 - direction of exhaust (for pneumatic power tools).

f) Acoustical data:

- all measured sound pressure level data;
- A-weighted emission sound pressure level at the work station;
- C-weighted peak emission sound pressure level at the work station (if required);
- A-weighted sound power level;
- other acoustical data required by ISO 3744:1994, 9.4;
- place where and date when measurements were performed, and person responsible for test.

11 Test report

The information to be included in the test report shall be at least that required to prepare a noise declaration or to verify the declared values, and as a minimum shall include

- a description of the power tool,
- reference to this noise test code and to the basic noise emission standards used,
- the mounting and operating conditions, and
- the emission sound pressure level and sound power level obtained.

It shall be confirmed that all requirements of this noise test code have been fulfilled. If that is not the case, any unfulfilled requirements shall be identified. Deviations from the requirements shall be stated and technical justification for the deviations shall be given.

An example of the format of the test report is given in Annex A.

12 Declaration and verification of noise emission values

The declaration of the noise emission values shall be made as a dual number noise emission declaration in accordance with ISO 4871:1996. It shall declare the noise emission value L (L_{pA} , $L_{pC,peak}$ and L_{WA}) and the respective uncertainty K (K_{pA} , $K_{pC,peak}$ and K_{WA}) according to EN 292-2:1991, A.1.7.4 and this International Standard.

The likely values for the uncertainty, K_{pA} , $K_{pC,peak}$ and K_{WA} , respectively, are indicated in Table 5, according to the basic standards given.

Table 5 — Uncertainty values

Basic standard ^a	Uncertainty	Value dB
ISO 11203	K_{pA}	3
	$K_{pC,peak}$	
ISO 3744	K_{WA}	
^a Grade 2 ($K_{2A} \leq 2$ dB).		

The noise declaration shall state that the noise emission values have been obtained according to the noise code of this International Standard and according to ISO 3744:1994 and ISO 11203:1995. If this is not the case, the noise declaration shall clearly indicate the deviations from these International Standards.

NOTE 1 If the measured value is the average based on a sample of three power tools, properly sampled, then K is normally 3 dB. Further guidance on sampling and uncertainty terms is given in ISO 4871 and ISO 7574-4 [4].

NOTE 2 Additional noise emission quantities may also be given in the declaration.

If undertaken, the verification shall be performed for a batch of power tools, in accordance with ISO 4871:1996, 6.3. The verification shall be conducted using the same mounting, installation and operating conditions as those used for the initial determination of noise emission values.

An example of a noise declaration form is given in Annex B.

Annex A (informative)

Model test report

This test has been carried out according to ISO 15744, ISO 11203 and ISO 3744.	
General	
Tested by: Date:	Reported by: Date:
Power tool tested	
Manufacturer: Model No. Type: Serial No. Year of manufacture:	Inserted tool: No-load speed, r/min: Capacity: Blow frequency, Hz:
Operating conditions	
Working pressure, bar: Test speed, r/min:	Feed force (F_A): Flow rate, l/s:
Test arrangement	
Test site, including direction and distance to large objects near the power tool on test and direction of exhaust:	
Sketch showing positions and number of microphones (e.g. Figure 1):	
Height above reflecting plane:	
Acoustical data	
A-weighted sound pressure level at each microphone position:	dB (reference 20 μ Pa)
A-weighted background sound pressure level at each microphone position:	dB (reference 20 μ Pa)
Background noise correction, K_{1A} :	dB
A-weighted emission sound pressure level at the work station:	dB (reference 20 μ Pa)
A-weighted sound power level:	dB (reference 1 pW)
If applicable, C-weighted peak emission sound pressure level:	dB (reference 20 μ Pa)

Annex B (informative)

Model form for declared noise emission values

Declared dual number noise emission values in accordance with ISO 4871	
Power tool tested Manufacturer: Model No. Type: Serial No. Year of manufacture:	Inserted tool: No-load speed, r/min: Capacity: Blow frequency: Hz
Operating conditions, reference ISO 15744:	No load/On load (delete as required)
A-weighted sound power level, L_{WA} :	dB (reference 1 pW)
Uncertainty, K_{WA} :	dB
A-weighted emission sound pressure level at the work station, L_{pA} :	dB (reference 20 μ Pa)
Uncertainty, K_{pA} :	dB
C-weighted peak emission sound pressure level, $L_{pC,peak}$:	dB (reference 20 μ Pa)
Uncertainty, $K_{pC,peak}$:	dB
NOTE 1 Values determined according to noise test code ISO 15744, using, as basic standards, ISO 3744 and ISO 11203. NOTE 2 The sum of a measured noise emission value and its associated uncertainty represents an upper boundary of the range of values which is likely to occur in measurements.	

Annex C (informative)

Technical justification for selection of measurement surface and method of sound power calculation

In a free field, or a free field over a reflecting plane, and with a suitable choice of measurement surface, the sound power level may be calculated from:

$$L_W = \overline{L_{pf}} + 10 \lg \frac{S}{S_0} \text{ dB}$$

where

L_W is the sound power level, in decibels, reference 1 pW;

$\overline{L_{pf}}$ is the surface-average sound pressure level, in decibels, reference 20 µPa;

S is the area of the measurement surface, in square metres;

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

This relationship is based upon an assumption of proportionality between mean-square sound pressure and the sound intensity. The specific requirement is that $\overline{L_{pf}}$ be equal to $\overline{L_{in}}$, the level, in dB reference 1 pW/m², of the component of the sound intensity vector normal (perpendicular) to the measurement surface, averaged over the measurement surface.

Sound pressure levels measured at the five locations used in this International Standard are useful to manufacturers and users of air tools, and it is desirable to retain these locations for the determination of sound power. As shown in the following table, however, the area of the measurement surface for the purpose of sound power determination depends upon which surface the five locations are assumed to represent.

Table C.1 — Measurement surfaces

Measurement surface	S m ²	$10 \lg \frac{S}{S_0}$ dB
Cube of 2 m edge, with measurement locations centred on five faces	20	13,0
Octahedron of equilateral triangles of $\sqrt{2}$ m leg, with measurement locations at five vertices	$4\sqrt{3} \approx 6,9$	8,4
Cylinder of 1 m radius, 2 m high	$5\pi \approx 15,7$	12,0
Sphere of 1 m radius	$4\pi \approx 12,6$	11,0
Hemisphere of 1 m radius on 1 m cylinder pedestal	$4\pi \approx 12,6$	11,0

While the locations define a multiplicity of surfaces, the sound power level is accurate only if the measured $\overline{L_{pf}}$ is equal to the actual $\overline{L_{in}}$ for the surface.

Under free field conditions, $\overline{L_{pf}}$ is equal to the level of the average intensity vector at the five points of this International Standard. Whether this average level is equal to $\overline{L_{ln}}$ depends upon the geometric relationship between the intensity vector and the measurement surface, the average intensity level and $\overline{L_{pf}}$ being closest to $\overline{L_{ln}}$ when the average distance between source and surface is the same as for the five points of this International Standard, and the local intensity vector is everywhere normal to the measurement surface.

The cube surface appears to be the preferred measurement surface of ISO 3744. However, measurement in conformance with ISO 3744 requires sound pressure measurements at nine points to define the cube, i.e. the five points of this International Standard plus four corner positions. Due to the geometry involved, it is evident that the $\overline{L_{pf}}$ from measurements at the five points of this International Standard will substantially overestimate the nine-point average and the actual $\overline{L_{ln}}$. In essence, the surface area of the cube is too large.

By the same geometrical argument, it is evident that the surface area of the cylinder is too large, while that for the equilateral octahedron is too small.

If the source were in a free field, and if the five-point average adequately sampled source directivity, then the spherical surface would be theoretically ideal. With the source at the origin of the sphere, all points on the surface are equidistant from the source, and all intensity vectors are aligned with radii and hence normal to the surface of the sphere. With the introduction of the reflecting plane, the analogous ideal surface would be a hemisphere, centred on the projection of the source on the plane and with the radius large compared with the source elevation above the plane. However, such a hemisphere does not pass through the five measurement locations of this standard.

With a hemisphere not possible, and with measurement points at the same distance from the source as the source distance from the reflecting plane, the hemisphere/cylinder surface appears to be ideal. Interestingly, the area of the hemisphere/cylinder is the same as that of the related sphere.

Bibliography

- [1] ISO/TR 11690-3, *Acoustics — Recommended practice for the design of low-noise workplaces containing machinery — Part 3: Sound propagation and noise prediction in workrooms*
- [2] ISO 15667, *Acoustics — Guidelines for noise control by enclosures and cabins*
- [3] ISO 11546-2, *Acoustics — Determination of sound insulation performances of enclosures — Part 2: Measurements in situ (for acceptance and verification purposes)*
- [4] ISO 7574-4, *Acoustics — Statistical methods for determining and verifying stated noise emission values of machinery and equipment — Part 4: Methods for stated values for batches of machines*

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