INTERNATIONAL STANDARD

ISO 28927-8

First edition
2009-12-15

Hand-held portable power tools — Test methods for evaluation of vibration emission —

Part 8: Saws, polishing and filing machines with reciprocating action and small saws with oscillating or rotating action

Machines à moteur portatives — Méthodes d'essai pour l'évaluation de l'émission de vibrations —

Partie 8: Scies, polisseuses et limes alternatives, et petites scies oscillantes ou circulaires

Reference number
ISO 28927-8:2009(E)

Contents

Page

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 28927-8 was prepared by Technical Committee ISO/TC 118, *Compressors and pneumatic tools, machines and equipment*, Subcommittee SC 3, *Pneumatic tools and machines*.

This first edition of ISO 28927-8 cancels and replaces ISO 8662-12:1997, of which it constitutes a technical revision. The most important changes are

— vibration measurement in three axes and at both hand positions,

— new transducer positions, and

— improved definition of transducer positions and orientation.

ISO 28927 consists of the following parts, under the general title *Hand-held portable power tools — Test methods for evaluation of vibration emission*:

— *Part 1: Angle and vertical grinders*[1)]

— *Part 2: Wrenches, nutrunners and screwdrivers*[2)]

— *Part 3: Polishers and rotary, orbital and random orbital sanders*[3)]

— *Part 4: Straight grinders*[4)]

---

1) Together with Part 4, replaces ISO 8662-4, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 4: Grinders*.

2) Replaces ISO 8662-7, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 7: Wrenches, screwdrivers nut runners with impact, impulse and ratcheting action*. All screwdrivers and nutrunners except for one-shot tools now covered.

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

4) Together with Part 1, replaces ISO 8662-4, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 4: Grinders*.

— *Part 5: Drills and impact drills*[5)]

— *Part 6: Rammers*[6)]

— *Part 7: Nibblers and shears*[7)]

— *Part 8: Saws, polishing and filing machines with reciprocating action and small saws with oscillating or rotating action*

— *Part 9: Scaling hammers and needle scalers*[8)]

— *Part 10: Percussive drills, hammers and breakers*[9)]

— *Part 11: Stone hammers*[10)]

---

5) Replaces ISO 8662-6, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 6: Impact drills.* Non-impacting drills now covered.

6) Replaces ISO 8662-9, *Hand-held portable power tools — Measurement of vibrations at the handle —Part 9: Rammers*.

7) Replaces ISO 8662-10, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 10: Nibblers and shears*.

8) Together with Part 11, replaces ISO 8662-14, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 14: Stone-working tools and needle scalers*.

9) Replaces 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*, and ISO 8662-5, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 5: Pavement breakers and hammers for construction work.* Chipping and riveting hammers, rock drills and rotary hammers all covered.

10) Together with Part 9, replaces ISO 8662-14, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 14: Stone-working tools and needle scalers*.

Introduction

This document is a type-C standard as stated in ISO 12100.

When requirements of this type-C standard are different from those which are stated in type-A or -B standards, the requirements of this type-C standard take precedence over the requirements of the other standards for machines that have been designed and built according to the requirements of this type-C standard.

The vibration test codes for portable hand-held machines given in ISO 28927 are based on ISO 20643, which gives general specifications for the measurement of the vibration emission of hand-held and hand-guided machinery. ISO 28927 specifies the operation of the machines under type-test conditions and other requirements for the performance of type tests. The structure/numbering of its clauses follows that of ISO 20643.

The basic principle for transducer positioning first introduced in the EN 60745 series of European standards is followed, representing a deviation from ISO 20643 for reasons of consistency. The transducers are primarily positioned next to the hand in the area between the thumb and the index finger, where they give the least disturbance to the operator gripping the machine.

It has been found that vibrations generated by files and saws vary considerably in typical use. For reciprocating saws and files, the motion of reciprocation is the prime source of vibration. The variation is largely due to variations in the handling of the machine and the characteristics of the material worked on, while differences in the support of the material and counterbalancing of the machine also cause differences in vibration.

This part of ISO 28927 uses a working process where the machine is used to cut sheet metal or wood. In order to achieve good reproducibility, it is important that the material have good support and that the files or saw blades used be in good condition. The procedures of ISO 5349 are required whenever exposure at the workplace is to be assessed.

The values obtained are type-test values intended to be representative of the average of the upper quartile of typical vibration magnitudes in real-world use of the machines. However, the actual magnitudes will vary considerably from time to time and depend on many factors, including the operator, the task and the inserted tool or consumable. The state of maintenance of the machine itself might also be of importance. Under real working conditions the influences of the operator and process can be particularly important at low magnitudes. It is therefore not recommended that emission values below 2,5 m/s^2 be used for estimating the vibration magnitude under real working conditions. In such cases, 2,5 m/s^2 is the recommended vibration magnitude for estimating the machine vibration.

If accurate values for a specific work place are required, then measurements (according to ISO 5349) in that work situation could be necessary. Vibration values measured in real working conditions can be either higher or lower than the values obtained using this part of ISO 28927.

Higher vibration magnitudes can easily occur in real working situations, depending on the characteristics of the material being worked on, the condition of the inserted tool and the handling of the machine.

The vibration test codes given in ISO 28927 supersede those given in ISO 8662, whose parts have been replaced by the corresponding parts of ISO 28927 (see Foreword).

NOTE ISO 8662-11, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 11: Fastener driving tools*, and ISO 8662-13, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 13: Die grinders*, could be replaced by future parts of ISO 28927.

Hand-held portable power tools — Test methods for evaluation of vibration emission —

Part 8:
Saws, polishing and filing machines with reciprocating action and small saws with oscillating or rotating action

1 Scope

This part of ISO 28927 specifies a laboratory method for measuring hand-transmitted vibration emission at the handles of hand-held, power-driven saws, polishing and filing machines with reciprocating action and small saws with oscillating or rotating action. It is a type-test procedure for establishing the magnitude of vibration in the gripping areas of a machine run under specified test conditions. It is intended that the results be used to compare different models of the same type of machine.

This part of ISO 28927 is applicable to reciprocating files intended for surface finishing equipped with a file or polishing tool, saws intended for parting sheets, plaster for medical use or wood, or equipped with a saw blade for use on all kinds of materials, and small circular saws primarily intended for cutting metal or composite materials (see Clause 5), whether driven pneumatically or by other means. It is not applicable to files that are normally used with one hand on the file blade, nor to large circular saws intended for cutting wood.

NOTE To avoid confusion with the terms "power tool" and "inserted tool", *machine* is used for the former throughout this document.

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

ISO 5349:2001 (all parts), *Mechanical vibration — Measurement and evaluation of human exposure to hand-transmitted vibration*

ISO 5391:2003, *Pneumatic tools and machines — Vocabulary*

ISO 17066:2007, *Hydraulic tools — Vocabulary*

ISO 20643:2005, *Mechanical vibration — Hand-held and hand-guided machinery — Principles for evaluation of vibration emission*

EN 12096:1997, *Mechanical vibration — Declaration and verification of vibration emission values*

ISO 16893-1:2008, *Wood-based panels — Particleboard — Part 1: Classifications*

3 Terms, definitions and symbols

For the purposes of this document, the terms and definitions given in ISO 5391, ISO 17066 and ISO 20643, and the following terms, definitions and symbols, apply.

3.1 Terms and definitions

3.1.1
circular saw
machine equipped with a rotary saw blade

NOTE Adapted from ISO 5391:2003, definition 2.1.8.1.

3.1.2
oscillation saw
machine equipped with a saw blade that moves with an angular reciprocating movement

3.1.3
reciprocating saw
sabre saw
hack saw
machine with a rotary or reciprocating motor, adapted to drive a saw blade in a reciprocating motion

[ISO 5391:2003, definition 2.1.8.3]

3.1.4
jig saw
saw with a reciprocating and pendulum motion

[ISO 5391:2003, definition 2.1.8.5]

3.1.5
reciprocating filing and polishing machine
machine with a rotary and reciprocation motor that drives a file or polishing inserted tool in an angular or straight reciprocating motion

3.2 Symbols

Symbol	Description	Unit
a_{hw}	root-mean-square (r.m.s.) single-axis acceleration value of the frequency-weighted hand-transmitted vibration	m/s^2
a_{hv}	vibration total value of frequency-weighted r.m.s. acceleration; root sum of squares of a_{hw} values for the three measured axes of vibration	m/s^2
$\overline{a_{\text{hv}}}$	arithmetic mean value of a_{hv} values of runs for single operator using one hand position	m/s^2
a_{h}	arithmetic mean value of $\overline{a_{\text{hv}}}$ values for all operators for one hand position	m/s^2
$\overline{a_{\text{h}}}$	arithmetic mean value of a_{h} values for one hand position on several machines	m/s^2
a_{hd}	declared vibration emission value	m/s^2
$s_{\text{n}-1}$	standard deviation for a test series (for a sample, s)	m/s^2
σ_{R}	standard deviation of reproducibility (for a population, σ)	m/s^2
C_{v}	coefficient of variation for a test series	
K	uncertainty	m/s^2

4 Basic standards and vibration test codes

This part of ISO 28297 is based on the requirements of ISO 20643 and corresponds to its structure in respect of clause subjects and numbering except for the annexes.

Annex A presents a model test report and Annex B the means for determining the uncertainty, K.

5 Description of the family of machines

This part of ISO 29827 applies to hand-held machines intended for surface finishing, equipped with a file or polishing tool, and to hand-held machines intended for parting sheets, plaster for medical use or wood, or for use on all kinds of materials, and for cutting metal or composite materials.

Figures 1 to 9 show examples of typical saws and files covered by this part of ISO 29827.

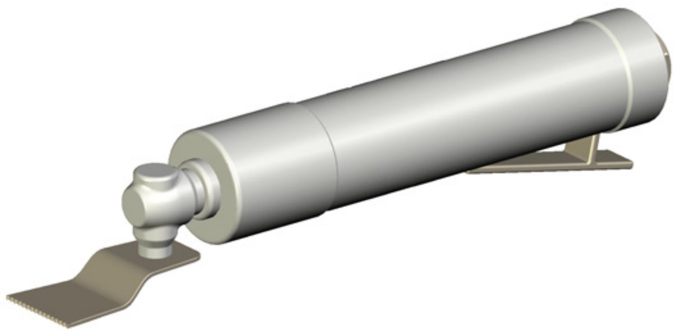


Figure 1 — Straight oscillating saw

Figure 2 — Small circular saw

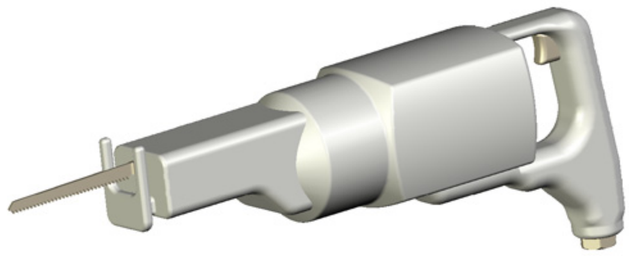


Figure 3 — Reciprocating saw with bow handle

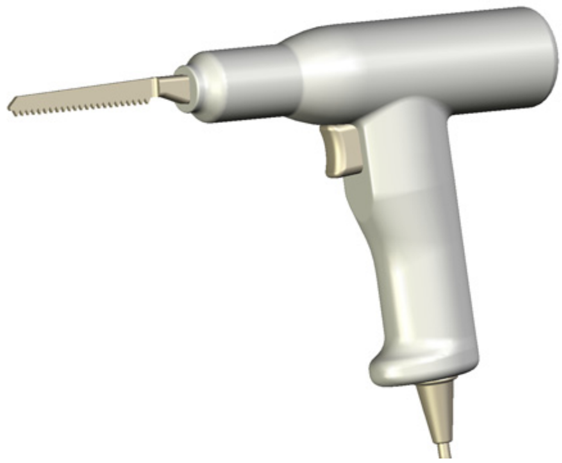


Figure 4 — Reciprocating saw with pistol grip

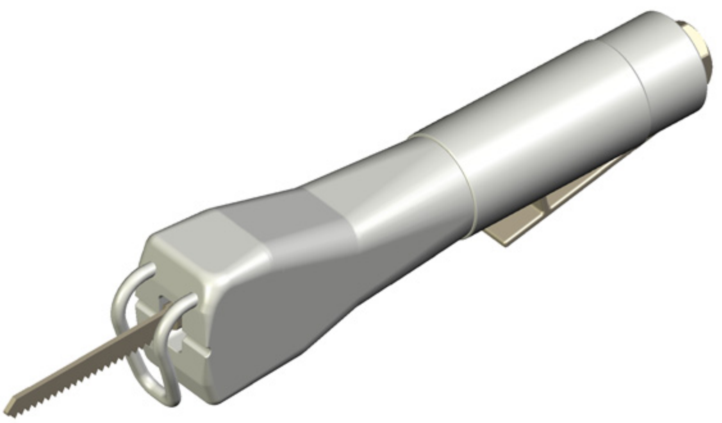


Figure 5 — Straight reciprocating saw

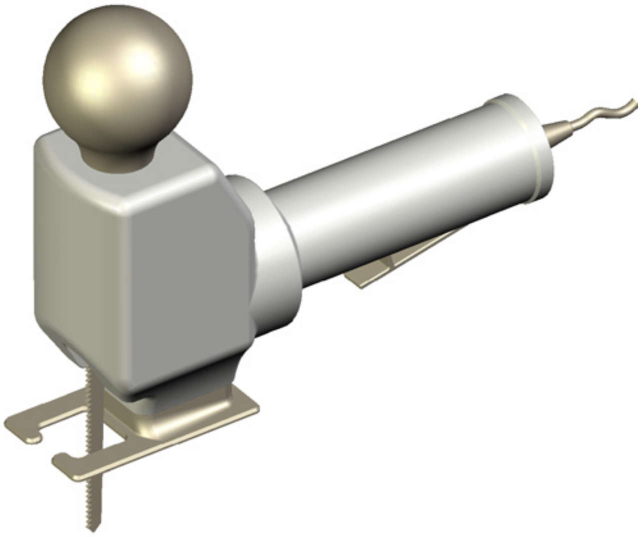


Figure 6 — Jig saw

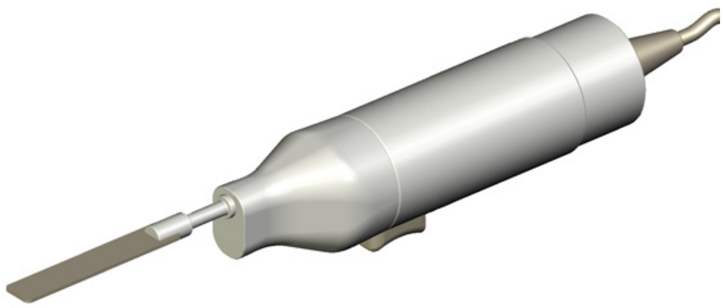


Figure 7 — Straight reciprocating file

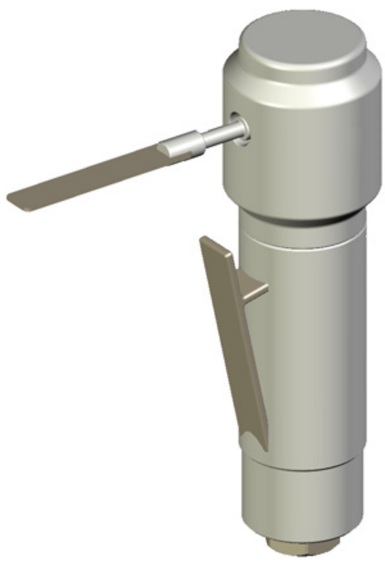


Figure 8 — Angle reciprocating file

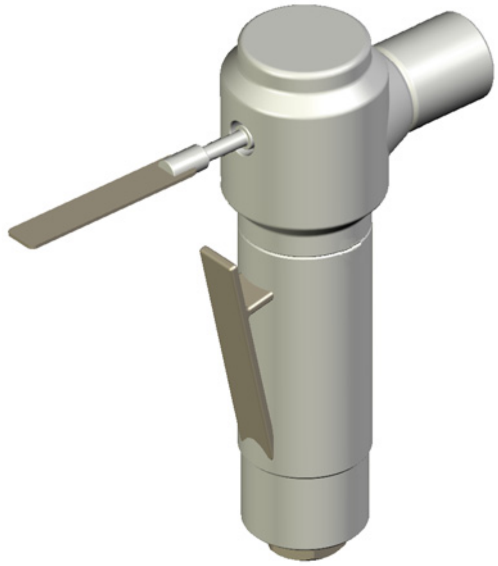


Figure 9 — Angle reciprocating file — Alternative design

6 Characterization of vibration

6.1 Direction of measurement

The vibration transmitted to the hand shall be measured and reported for three directions of an orthogonal coordinate system. At each hand position, the vibration shall be measured simultaneously in the three directions shown in Figures 10 to 18.

6.2 Location of measurements

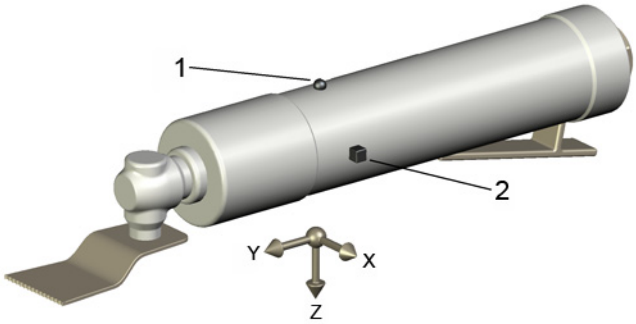
Measurements shall be made at the gripping zones, where the operator normally holds the machine and applies the feed force. For machines intended for one-handed operation, it is only necessary to measure at a single point.

The prescribed transducer location shall be as close as possible to the hand between the thumb and index finger. This shall apply to both hand positions, with the machine held as in normal operation. Whenever possible, measurements shall be made at the prescribed locations.

A secondary location is defined as being on the side of, and as close as possible to, the inner end of the handle where the prescribed location is found. If the prescribed location of the transducer cannot be used, this secondary location shall be used instead.

The prescribed or secondary location shall also be used on anti-vibration handles.

Figures 10 to 18 show the prescribed and secondary locations and measurement directions for the hand positions normally used for the different types of machines in this family.

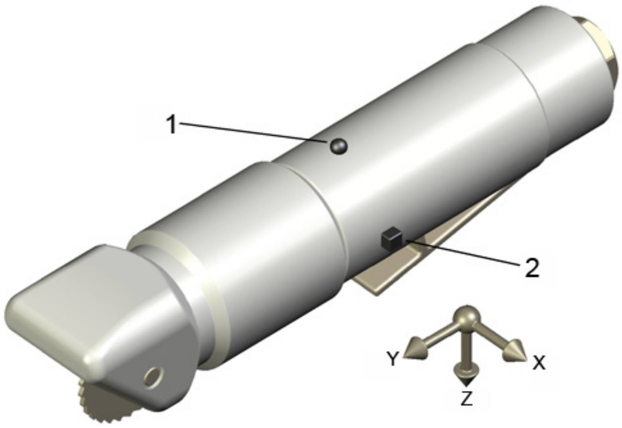


Key

1 prescribed location

2 secondary location

Figure 10 — Measurement locations — Straight oscillating saw

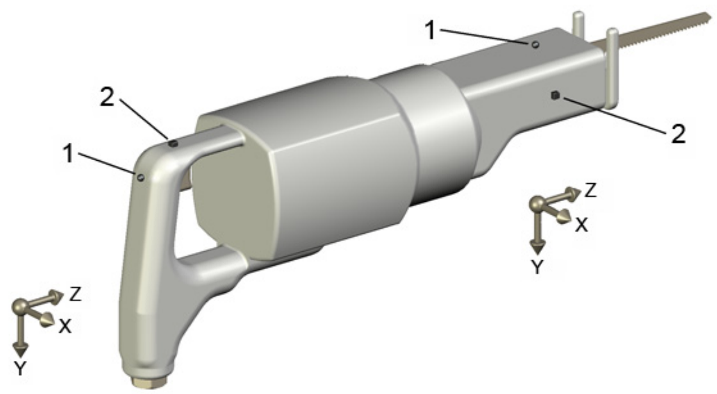


Key

1 prescribed location

2 secondary location

Figure 11 — Measurement locations — Small circular saw

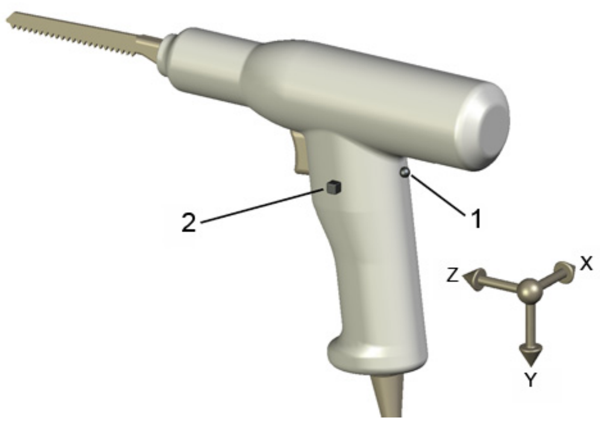


Key

1 prescribed location

2 secondary location

Figure 12 — Measurement locations — Reciprocating saw with bow handle

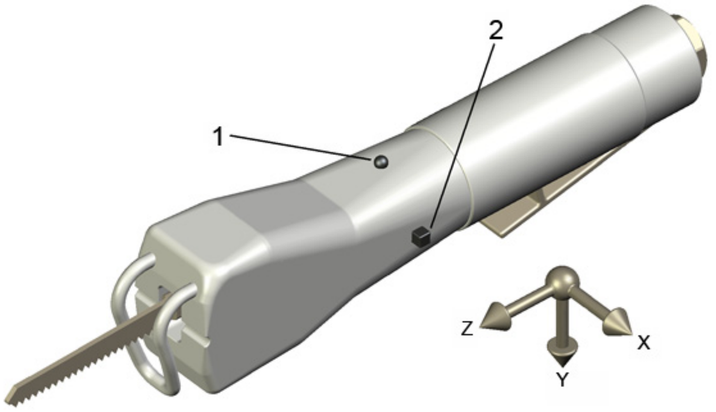


Key

1 prescribed location

2 secondary location

Figure 13 — Measurement locations — Reciprocating saw with pistol grip

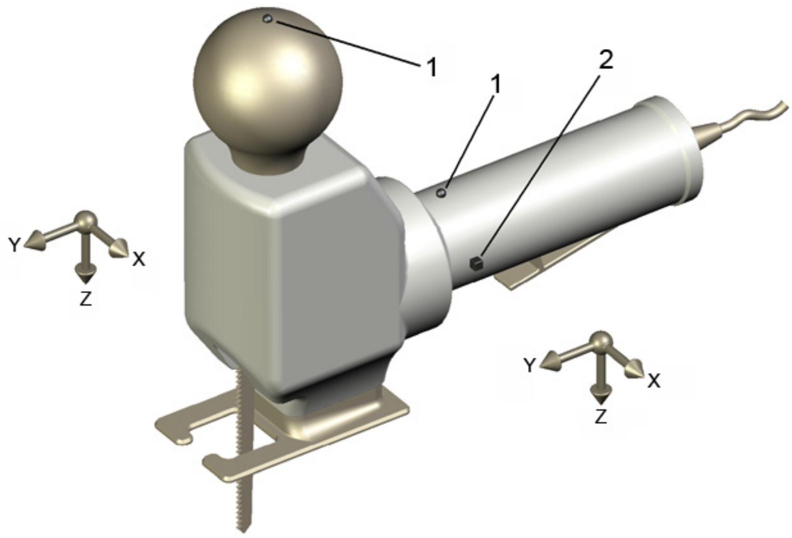


Key

1 prescribed location

2 secondary location

Figure 14 — Measurement locations — Straight reciprocating saw

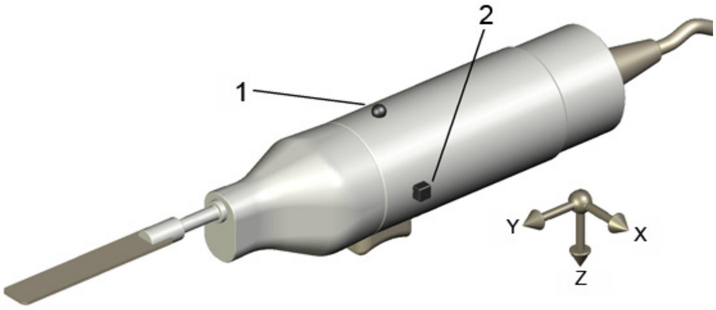


Key

1 prescribed location

2 secondary location

Figure 15 — Measurement locations — Jig saw

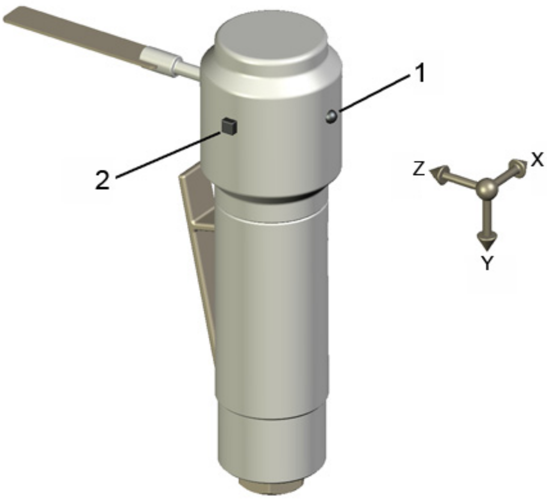


Key

1 prescribed location

2 secondary location

Figure 16 — Measurement locations — Straight reciprocating file

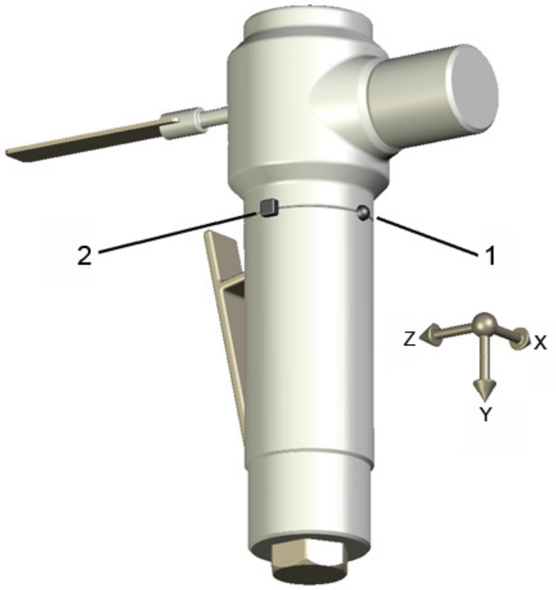


Key

1 prescribed location

2 secondary location

Figure 17 — Measurement locations — Angle reciprocating file



Key

1 prescribed location

2 secondary location

Figure 18 — Measurement locations — Angle reciprocating file — Alternative design

6.3 Magnitude of vibration

The definitions for the magnitude of vibration given in ISO 20643:2005, 6.3, apply.

6.4 Combination of vibration directions

The vibration total value defined in ISO 20643:2005, 6.4, shall be reported for both hand positions when applicable. It is acceptable to report on and carry out tests on the hand position having the highest reading. The vibration total value at that hand position shall be at least 30 % higher than the other. This result may be obtained during a preliminary test carried out by a single operator during five test runs.

To obtain the vibration total value, a_{hv}, for each test run, the results in each direction shall be combined using Equation (1):

$$a_{\text{hv}} = \sqrt{{a_{\text{hwx}}}^2 + {a_{\text{hwy}}}^2 + {a_{\text{hwz}}}^2} \qquad (1)$$

7 Instrumentation requirements

7.1 General

The instrumentation shall be in accordance with ISO 20643:2005, 7.1.

7.2 Mounting of transducers

7.2.1 Specification of transducer

The specification of the transducer given in ISO 20643:2005, 7.2.1, applies.

The total mass of the transducers and mounting device shall be small enough, compared with that of the machine, handle, etc., so as not to influence the measurement result.

This is particularly important for low-mass plastic handles (see ISO 5349-2).

7.2.2 Fastening of transducers

The transducer or mounting block used shall be rigidly attached to the surface of the handle.

If three single-axis transducers are used, these shall be attached to three sides of a suitable mounting block.

For the two axes aligned parallel to the vibrating surface, the measurement axes of the two transducers — or the two transducer elements in a triaxial transducer — shall be at a maximum of 10 mm from the surface.

NOTE It is normally not necessary that mechanical filters be used for the measurements.

7.3 Frequency weighting filter

Frequency-weighting filters shall be in accordance with ISO 5349-1.

7.4 Integration time

The integration time shall be in accordance with ISO 20643:2005, 7.4. The integration time for each test run shall preferably not be less than 8 s, but the actual integration time is determined by the duration of machine operation defined in 8.4.

7.5 Auxiliary equipment

For pneumatic machines, the air pressure shall be measured using a pressure gauge with an accuracy equal to or better than 0,1 bar[11)].

For hydraulic machines, the flow shall be measured using a flow meter with an accuracy equal to or better than 0,25 l/min.

For electrical machines, the voltage shall be measured using a volt meter with accuracy equal to or better than 3 % of the actual value.

The feed force shall be measured with an accuracy better than 1 N — for example, with the operator standing on a scale.

7.6 Calibration

The specifications for calibration given in ISO 20643:2005, 7.6, apply.

11) 1 bar = 0,1 MPa = 0,1 N/mm^2 = 10^5 N/m^2.

8 Testing and operating conditions of the machinery

8.1 General

Measurements shall be carried out on new, and properly serviced and lubricated machines. If, for some types of machines, a warming-up period is specified by the manufacturer, this shall be undertaken prior to the start of the test.

Machines intended for one-handed operation shall be held with only one hand during testing. Measurements shall be made in one location only and for the hand position used. During measurement, a support handle shall not be mounted.

Saws and files are tested by cutting or filing a metal sheet or wood rigidly fixed to a support. During testing, a feed force shall be applied to ensure stable and smooth operation (see 8.4), and the energy supply to the machine shall be at rated conditions, as specified by the manufacturer.

8.2 Operating conditions

8.2.1 Pneumatic machines

During testing, the machine shall be operated at the rated air pressure, in accordance with the manufacturer's specifications. The operation shall be stable and smooth. The air pressure shall be measured and reported.

Air shall be supplied to the machine by means of a hose of the diameter recommended by the machine manufacturer. The test hose shall be attached to the machine via a threaded hose connector, preferably the one supplied with the machine. The length of the test hose shall be 3 m. The test hose shall be secured with a hose clip. Quick-couplings shall not be used, since their mass will influence the vibration magnitude.

The air pressure of pneumatically powered machines shall be measured in accordance with ISO 2787 and maintained as specified by the manufacturer. During testing, the air pressure measured immediately before the test hose shall not drop more than 0,2 bar below the pressure recommended by the manufacturer.

8.2.2 Hydraulic machines

During testing, the machine shall be operated at the rated power supply, i.e. the rated flow, and shall be used in accordance with the manufacturer's specifications. The operation shall be stable and smooth. A warming up period of about 10 min should be allowed before starting the measurements. The flow shall be measured and reported.

8.2.3 Electrical machines

During testing, the machine shall be operated at the rated voltage, and shall be used in accordance with the manufacturer's specifications. The operation shall be stable and smooth. The voltage shall be measured and reported.

8.3 Other quantities to be specified

The feed force shall be measured and reported.

8.4 Attached equipment, work piece and task

8.4.1 General

During testing, the machine shall be equipped and held in a manner typical to that when sawing or filing. The operation shall be stable and smooth. The working process shall be such that the operator can have an upright or almost upright posture. The operator shall be able to hold the machine comfortably during the test (see Figures 19 and 20 for examples). The forces and torques applied to the handles influence the vibration. It is therefore important that that the force and torque distribution between the handles equal that under real working conditions.

Tests are defined for the most common machine types in 8.4.2 below. For machines not covered in 8.4.2, the following applies.

Measurements shall be made when filing on or cutting the maximum thickness of such materials as specified by the manufacturer.

New file or sawing blades as specified for the material shall be used for each test.

The machine shall be tested using a feed force giving maximum loading as specified by the manufacturer, at rated power, and loaded accordingly. The loading of the tool shall ensure that operation of the machine is stable. The cut shall be as near the work-piece support as the machine being tested allows.

The test rig shall be rigid enough not to influence the test result. Figure 21 show an example of a test rig for saws.

Care shall be taken to avoid vibrations in the work piece. In no case shall the mounted work piece have any resonances within the frequency range for hand–arm vibration that could influence the test result.

8.4.2 Test set-up, conditions and procedures

8.4.2.1 Jig saws and reciprocating saws cutting board

The test set-ups and test procedures for jig saws and reciprocating saws used for cutting board are as follows.

a) **Jig saws**

Cut a horizontal piece of chipboard of quality PF REG, as specified in ISO 16893-1, or of similar composition, 38 mm thick and having a minimum length of 500 mm and width of 600 mm. The board shall be supported on resilient material and fixed by screws or clamps to a test rig.

The horizontal feed force (force in direction of the cut) applied to the tool shall be (35 ± 5) N. Excessive gripping force shall be avoided. Methods that can be used to determine the feed force include using a scale or applying a mass on a string parallel to the workpiece surface via a pulley.

The guide plate shall be in contact with the work piece during the cut, with a force being applied that is just great enough to ensure this. Usually, the downward force, in addition to the mass of the machine, needed to keep the guide plate of a jig saw in contact with the workpiece is between 50 N and 100 N.

b) **Reciprocating saws**

Cut a vertical piece of chipboard of quality PF REG, as specified in ISO 16893-1, 38 mm thick and having a minimum length of 500 mm and width of 600 mm. The board shall be supported on resilient material and fixed vertically by screws or clamps to a test rig.

The vertical feed force (force in direction of the cut) applied to the tool in addition to its mass shall be (40 ± 5) N. The feed force shall be determined — for example, by means of a scale — and shall be recorded. Excessive gripping force shall be avoided.

The guide plate shall be in contact with the work piece during the cut, with a force being applied that is just great enough to ensure this. Usually, the horizontal force needed to keep the guide plate of a sabre saw in contact with the workpiece is between 50 N and 100 N.

For both jig saws and reciprocating saws used for cutting board:

— a new saw blade, as specified for sawing chipboard, shall be used;

— pendulum systems, if any, shall be set at maximum and, for reciprocating saws, the guide plate shall be fitted;

— the board excess end shall be 250 mm from the clamp and shall be readjusted at the beginning of each series of tests;

— each test series shall consist of five test cycles, each comprising the cutting of a 30 mm wide strip across the 600 mm width of chipboard;

— the duration of measurement shall not be less than 8 s, starting when the saw blade enters the wood and stopping before it leaves the wood.

In general, stable operation is achieved by a feed force of not more than 100 N.

8.4.2.2 Jig saws cutting sheet metal

Cut a horizontal piece of sheet mild steel having a minimum length of 300 mm, width of 100 mm and thickness of 3 mm. The work piece shall be supported on resilient material and fixed by screws or clamps to a test rig.

The metal sheet excess shall be 80 mm from the clamped area and shall be readjusted at the beginning of a series of tests, consisting of five test cycles, each comprising of the cutting of an approximately 8 mm wide strip across the 100 mm width of metal sheet.

The horizontal feed force (force in direction of the cut) applied to the tool shall be (35 ± 5) N. Excessive gripping force shall be avoided. Methods that can be used to determine the feed force include using a scale or applying a mass on a string parallel to the workpiece surface via a pulley.

The guide plate shall be in contact with the work piece during the cut, with a force being applied that is just great enough to ensure this. Usually, the downward force, in addition to the mass of the machine, needed to keep the guide plate in contact with the workpiece is between 50 N and 100 N.

A new saw blade as specified for sawing mild steel shall be used.

The pendulum system, if any, shall be set in the “OFF” position.

The duration of measurement shall not be less than 8 s, starting when the saw blade enters the metal sheet and stopping before it leaves the metal sheet.

In general, stable operation is achieved by a feed force of not more than 100 N.

8.4.2.3 Reciprocating saws cutting wooden beams

Cut a horizontal beam of construction wood, such as fir, having a cross-section of 100 mm $\times$ 100 mm and a minimum length of 500 mm.

The beam shall be supported on resilient material and fixed by screws or clamps to a test rig.

The beam excess end shall be 250 mm from the clamp and shall be readjusted at the beginning of each series of tests, consisting of five test cycles, each comprising the cutting of a 30 mm thick slice.

A new saw blade as specified for sawing large wooden beams shall be used.

The pendulum system, if any, shall be set at maximum.

The vertical feed force (force in direction of the cut) applied to the tool in addition to its weight shall be (40 ± 5) N. The feed force shall be determined — for example, by means of a scale — and recorded. Excessive gripping force shall be avoided.

The guide plate shall be in contact with the work piece during the cut applying a force just great enough to ensure this. Usually, the total horizontal force to keep the guide plate of a sabre saw in contact with the workpiece is between 50 N and 100 N.

The duration of measurement shall not be less than 8 s, starting when the saw blade enters the wood and stopping before it leaves the wood.

8.4.2.4 Reciprocating filing and polishing machines

File the horizontal surface of a work piece of mild steel at least 10mm thick and having a minimum length of 100 mm and width of 100 mm.

The stroke shall be set to 2 mm and the speed to 6 000 rev/min.

The feed force used shall be (10 ± 2) N.

A new file blade as specified for filing mild steel and of mass 25 g shall be used.

The duration of measurement time shall be at least 8 s.

Figure 19 — Operator working position — Circular saw — Example

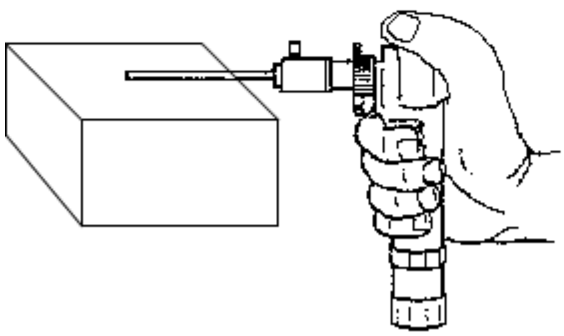


Figure 20 — Operator working position — Reciprocating file — Example

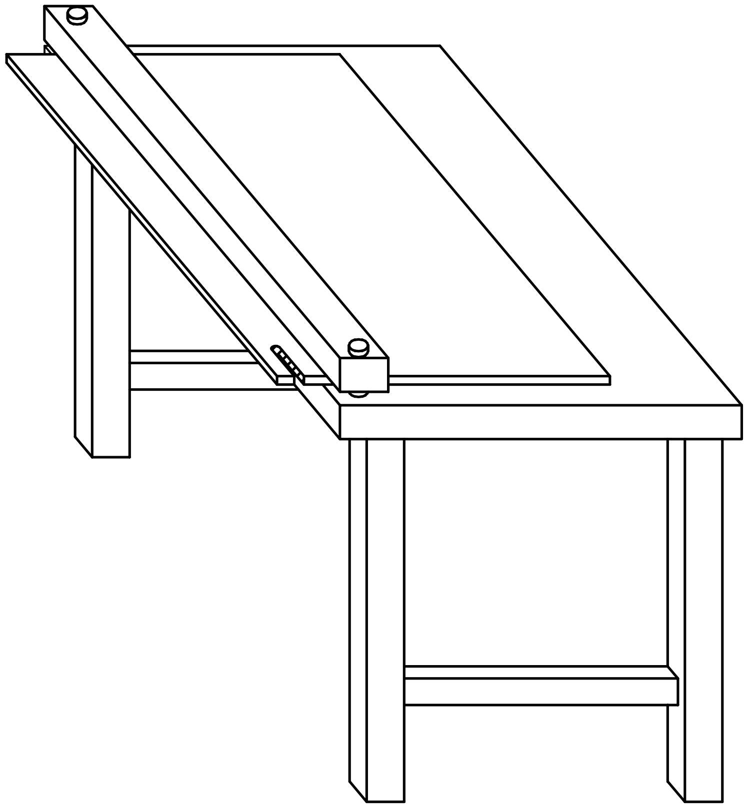


Figure 21 — Test rig — Saws

8.5 Operators

Three different operators shall operate the machine during testing. The vibration of the machine is influenced by the operators. They shall therefore be skilled enough to be able to hold and operate the machine correctly.

9 Measurement procedure and validity

9.1 Reported vibration values

Three series of five consecutive tests shall be carried out on each machine tested, using a different operator for each series.

The values (see also 6.4) should be reported as in Annex A.

The coefficient of variation, C_v, and the standard deviation, $s_{\mathrm{n}-1}$, shall be calculated for each hand position for each of the three operators. The C_v of a test series is defined as the ratio of $s_{\mathrm{n}-1}$ to the mean value of the series:

$$C_\mathrm{v} = \frac{s_{\mathrm{n}-1}}{\overline{\overline{a_\mathrm{hv}}}} \quad (2)$$

with s_{n-1} identical to s_{rec} (see Annex B) and where the standard deviation of the i^{th} value, a_{hvi}, is:

$$s_{n-1} = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(a_{hvi} - \overline{a_{hv}}\right)^2} \tag{3}$$

where

$\overline{a_{hv}}$ is the mean value of the series in m/s^2;

n is equal to 5, the number of measured values.

If C_V, is greater than 0,15 or s_{n-1} is greater than 0,3 m/s^2, then the measurements shall be checked for error before data are accepted.

9.2 Declaration and verification of the vibration emission value

The $\overline{a_{hv}}$ value for each operator shall be calculated as the arithmetic mean of a_{hv} values for the five test runs.

For each hand position, the result from the three operators should be combined into one value, a_h, using the arithmetic mean of the three $\overline{a_{hv}}$ values.

For tests using only one machine, the declared value, a_{hd}, is the highest of the a_h values reported for the two hand positions.

For tests using three or more machines, $\overline{a_h}$ values for each hand position shall be calculated as the arithmetic mean of the a_h values for the different machines on that hand position. The declared value, a_{hd}, is the highest of the a_h values reported for the two hand positions.

Both a_{hd} and the uncertainty, K, shall be presented with a precision determined in accordance with EN 12096. The value of a_{hd} is to be given in m/s^2 and presented by using two and a half significant digits for numbers starting with 1 (e.g. 1,20 m/s^2, 14,5 m/s^2); otherwise, two significant digits are sufficient (e.g. 0,93 m/s^2, 8,9 m/s^2). The value of K shall be presented with the same number of decimals as a_{hd}.

K shall be determined in accordance with EN 12096, based on the standard deviation of reproducibility, σ_R. The value of K shall be calculated in accordance with Annex B.

10 Measurement report

The following information shall be given in the test report:

a) reference to this part of ISO 28927 (i.e. ISO 28927-8);

b) name of the measuring laboratory;

c) date of measurement and name of the person responsible for the test;

d) specification of the hand-held machine (manufacturer, type, serial number. etc.);

e) declared emission value a_{hd} and uncertainty K;

f) attached or inserted tools;

g) energy supply (air pressure/input voltage, etc., as applicable);

h) instrumentation (accelerometer, recording system, hardware, software, etc.);

i) position and fastening of transducers, measuring directions and individual vibration values;

j) operating conditions, and other quantities to be specified according to 8.2 and 8.3;

k) detailed results of the test (see Annex A).

If transducer positions or measurements other than those specified in this part of ISO 29827 are used, they shall be clearly defined and an *explanation of the reason* for the change in the position of the transducer shall be inserted in the test report.

Annex A
(informative)

Model test report for vibration emission of saws and files

See Tables A.1 and A.2.

Table A.1 — General information and reported results

The test has been carried out in accordance with ISO 28927-8, *Hand-held portable power tools — Test method for evaluation of vibration emission — Part 8: Saws, polishing and filing machines with reciprocating action and small saws with oscillating or rotating action*.	
Tester:	
Measured by (company/laboratory):	Tested by: Reported by: Date:
Test object and declared value:	
Machine tested (power supply and machine type, type of material used, manufacturer, machine model and name):	Declared vibration emission value a_{hd} and uncertainty K:
Measuring equipment:	
Transducers (manufacturer, type, positioning, fastening method, photos, mechanical filters if used):	
Vibration instrumentation:	Auxiliary equipment:
Operating and test conditions and results:	
Test conditions (test method used, material used for test, type of inserted tool used, operator posture, hand position, photos, and force feed when applicable):	
Power supply (air pressure, hydraulic flow, voltage):	Measured feed force:
Any other quantities to report:	

Table A.2 — Measurement results for one machine

Date:			Machine type:							Serial number:						
			Main handle (hand position 1)							Support handle (hand position 2)						
Test	Operator	Test run	a_{hwx}	a_{hwy}	a_{hwz}	a_{hv}	Statistics for operator $\overline{a_{hv}}$	s_{n-1}	C_v	a_{hwx}	a_{hwy}	a_{hwz}	a_{hv}	Statistics for operator $\overline{a_{hv}}$	s_{n-1}	C_v
1	1	1														
2	1	2														
3	1	3														
4	1	4														
5	1	5														
6	2	1														
7	2	2														
8	2	3														
9	2	4														
10	2	5														
11	3	1														
12	3	2														
13	3	3														
14	3	4														
15	3	5														
			a_h for hand position 1:							a_h for hand position 2:						
			s_R for hand position 1:							s_R for hand position 2:						

NOTE The a_{hv} and $\overline{a_{hv}}$ values are calculated according to 6.4 and 9.2, s_{n-1} and C_v are calculated according to 9.1, and s_R is calculated according to Annex B.

Annex B
(normative)

Determination of uncertainty

B.1 General

The uncertainty value, K, represents the uncertainty of the declared vibration emission value, a_{hd}, and, in the case of batches, production variations of machinery. It is expressed in m/s^2.

The sum of a_{hd} and K indicates the limit below which the vibration emission value of a single machine, and/or a specified large proportion of the vibration emission values of a batch of machines, are stated to lie when the machines are new.

B.2 Tests on single machines

For tests made on only a single machine, K shall be given as

$$K = 1{,}65\sigma_{\text{R}}$$

where σ_{R} is the standard deviation of reproducibility, estimated by the value s_{R}, given by

a) $s_{\text{R}} = \sqrt{\overline{s_{\text{rec}}^{\,2}} + s_{\text{op}}^{\,2}}$

or

b) $s_{\text{R}} = 0{,}06 a_{\text{hd}} + 0{,}3$,

whichever is the greater.

NOTE 1 Formula b) is empirical, based on experience giving a lower limit for s_{R} .

The calculations are performed on the hand position giving the highest value of a_{h} where

$\overline{s_{\text{rec}}^{\,2}}$ is the arithmetic mean value of the standard deviation from the results of five tests, $s_{\text{rec}j}$, for operator j, identical to $s_{\text{n}-1}$ according to 9.2, and with the $s_{\text{rec}j}^{\,2}$ value for each operator calculated using

$$s_{\text{rec}j}^{\,2} = \frac{1}{n-1}\sum_{i=1}^{n}\left(a_{\text{hv}ji} - \overline{a_{\text{hv}j}}\right)^2$$

where

n is 5, the number of measured values;

$a_{\text{hv}ij}$ is the vibration total value for the i^{th} test with the j^{th} operator;

$\overline{a_{\text{hv}j}}$ is the average vibration total value of measurements on the j^{th} operator;

s_{op} is the standard deviation of the results from the three operators, i.e.

$$s_{op}{}^2 = \frac{1}{m-1}\sum_{j=1}^{m}(\overline{a_{hvj}} - a_h)^2$$

where

m is three (i.e. the number of operators);

$\overline{a_{hvj}}$ is the average vibration value from the j th operator (average of five tests);

a_h is the average vibration value from all three operators;

a_{hd} is the highest of the a_h values reported for the two hand positions.

NOTE 2 The value of s_R is an estimate of the standard deviation of reproducibility of testing performed at different test centres. Since there is currently no information on reproducibility for the tests defined in this part of ISO 29827, the value for s_R is based on the repeatability of the test for individual test subjects and across the different test subjects, according to EN 12096.

B.3 Tests on batches of machines

For tests on three or more machines, the K value shall be given as

$$K = 1{,}5\sigma_t$$

where σ_t is estimated by the value s_t, given by

a) $s_t = \sqrt{\overline{s_R{}^2} + s_b{}^2}$

or

b) $s_t = 0{,}06 a_{hd} + 0{,}3$,

whichever is the greater.

The calculations are performed on the hand position giving the highest value of $\overline{a_h}$ and where:

$\overline{s_R{}^2}$ is the mean value of $s_R{}^2$ for the different machines in the batch, where the s_R value for each machine is calculated using B.2 a), above;

s_b is the standard deviation of the test results for individual machines, i.e.

$$s_b{}^2 = \frac{1}{p-1}\sum_{l=1}^{p}(a_{hl} - \overline{a_h})^2$$

where

a_{hl} is the single-machine emission for one hand position on the l th machine;

$\overline{a_h}$ is the mean value of the single-machine emissions for one hand position;

a_{hd} is the highest of the $\overline{a_h}$ values reported for the two hand positions;

p is the number of machines tested ($\geqslant$ 3).

Bibliography

[1] ISO 12100, *Safety of machinery — General principles for design, risk assessment and risk reduction*

[2] IEC 60745 (all parts), *Hand-held motor-operated electric tools — Safety*

ICS 13.160; 25.140.10

Price based on 24 pages