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Hand-held motor-operated electric tools - Safety - Part 1: General requirements (IEC 60745-1:2006, modified)

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English version

Hand-held motor-operated electric tools - Safety Part 1: General requirements

(IEC 60745-1:2006, modified)

Outils électroportatifs à moteur - Sécurité
Partie 1: Règles générales
(CEI 60745-1:2006, modifiée)

Handgeführte motorbetriebene Elektrowerkzeuge - Sicherheit
Teil 1: Allgemeine Anforderungen
(IEC 60745-1:2006, modifiziert)

This European Standard was approved by CENELEC on 2006-06-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 61F/632/FDIS, future edition 4 of IEC 60745-1, prepared by SC 61F, Safety of hand-held motor-operated electric tools, of IEC TC 61, Safety of household and similar electrical appliances, was submitted to the IEC-CENELEC parallel vote.

A draft amendment, prepared by the Technical Committee CENELEC TC 61F, Safety of hand-held and transportable motor-operated electric tools, was submitted to the formal vote.

The combined texts were approved by CENELEC as EN 60745-1 on 2006-06-01.

This European Standard supersedes EN 60745-1:2003 + A1:2003.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2007-06-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2009-06-01

This European Standard has been prepared under a mandate given to CEN and CENELEC by the European Commission and the European Free Trade Association and covers essential health and safety requirements of the Machinery Directive.

Compliance with the clauses of Part 1 together with a Part 2 provides one means of conforming to the essential health and safety requirements of the Directive concerned.

A relevant Part 2 is one in which the type of the tool or an accessory which is to be used with the tool is within the scope of that Part 2.

When a relevant Part 2 does not exist, Part 1 can help to establish the requirements for the tool, but will not by itself provide a means of conforming to the relevant essential health and safety requirements of the Machinery Directive.

Other standards referred to in this European Standard are also listed in Clause 2, which gives the valid edition of those documents at the time of issue of this EN.

CEN Technical Committees have produced a range of standards dealing with a similar range of non-electrically powered tools. Where necessary normative references are made to these standards in the relevant Part 2.

This European Standard follows the overall requirements of EN ISO 12100-1 and EN ISO 12100-2.

This European Standard is divided into two parts:

Part 1: General requirements which are common to most hand-held electric motor operated tools (for the purpose of this standard referred to simply as tools) which could come within the scope of this standard;

Part 2: Requirements for particular types of tools which either supplement or modify the requirements given in Part 1 to account for the particular hazards and characteristics of these specific tools.

Subclauses, tables and figures which are additional to those in IEC 60745-1 are prefixed “Z”.

NOTE In this standard the following print types are used:
- requirements proper; in roman type
- *test specifications: in italic type;*
- explanatory matter: in smaller roman type.

Endorsement notice

The text of the International Standard IEC 60745-1:2006 was approved by CENELEC as a European Standard with agreed common modifications as given below.

COMMON MODIFICATIONS

2 Normative references

Add *the following normative references:*

CR 1030-1:1995, *Hand-arm vibration – Guidelines for vibration hazards reduction – Part 1: Engineering methods by design of machinery*

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

EN 27574-4:1988, *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* (ISO 7574-4:1985)

EN ISO 8041:2005, *Human response to vibration - Measuring instrumentation* (ISO 8041:2005)

EN ISO 3744:1995, *Acoustics - Determination of sound power levels of noise sources using sound pressure - Engineering method in an essentially free field over a reflecting plane* (ISO 3744:1994)

EN ISO 4871:1996, *Acoustics - Declaration and verification of noise emission values of machinery and equipment* (ISO 4871:1996)

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

EN 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* (ISO 11203:1995)

EN ISO 11688-1:1998, *Acoustics - Recommended practice for the design of low noise machinery and equipment - Part 1: Planning* (ISO/IR 11688-1:1995)

EN ISO 11690-3:1998, *Acoustics - Recommended practice for the design of low-noise workplaces containing machinery - Part 3: Sound propagation and noise prediction in workrooms* (ISO/TR 11690-3:1997)

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

ISO 5347 (all parts), *Methods for the calibration of vibration and shock pick-ups*

ISO 16063-1:1998, *Methods for the calibration of vibration and shock transducers - Part 1: Basic concepts*

***Replace** the existing Clause 6 - Void by the following:*

6 Environmental requirements

6.1 Noise

6.1.1 Noise reduction

Noise reduction at tools is an integral part of the design process and shall be achieved by particularly applying measures at source to control noise, see for example EN ISO 11688-1. The success of the applied noise reduction measures is assessed on the basis of the actual noise emission values in relation to other machines of the same type with comparable non acoustical technical data.

The major sound sources of tools are: motor, fan, gear.

6.1.2 Noise test code (grade 2)

6.1.2.1 General

Noise emission values like the emission sound pressure level L_{pA} and the sound power level L_{WA} to be quoted in the user instructions as required by 8.12.2 Za)1) shall be measured according to the test procedure described in 6.1.2.1 to 6.1.2.6.

The overall noise can be divided into the pure machine noise and the noise of processing the workpiece. Both are influenced by the method of operation, however for percussive tools the noise emission of the workpiece can be dominant. The load conditions for particular tools are therefore specified in the relevant Part 2.

Noise emission values obtained under these measurement conditions will not necessarily correspond to the noise levels produced under the operational conditions of practical use.

NOTE It is not possible to simulate all conditions of practical use. A statement of process noise could therefore
- be misleading and cause faulty assessment of the risk in individual cases,
- discourage the development of more silent machines,
- lead to low repeatability of measurements and thus cause problems when verifying declared noise values,
- make the comparison of the noise emission from different tools difficult.

6.1.2.2 Sound power level determination

The sound power level shall be measured according to EN ISO 3744, where the acoustic environment, instrumentation, quantities to be measured, quantities to be determined, and the measurement procedure are specified.

The sound power level shall be given as A-weighted sound power level in dB reference 1 pW. The A-weighted sound pressure levels, from which the sound power is to be determined, shall be measured directly, and not calculated from frequency band data. Measurements shall be made in an essentially free field over a reflecting plane.

For all hand-held electric power tools, the sound power level shall be determined by using a hemispherical / cylindrical measurement surface according to Figure Z2.

The hemispherical / cylindrical measurement surface is described by a hemisphere standing on a cylindrical pedestal (see Figure Z2). 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 geometric centre of the power tool.

The A-weighted sound power level, L_{WA}, shall be calculated, in accordance with Subclause 8.6 of EN ISO 3744 as follows :

$$L_{WA} = \overline{L_{pfA}} + 10\lg(\frac{S}{S_0}), \text{ in dB} \quad (Z1)$$

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

$$\overline{L_{pfA}} = 10\lg\left[\frac{1}{5}\sum_{i=1}^{5} 10^{0,1L'_{pA,i}}\right] - K_{1A} - K_{2A}$$

where

$\overline{L_{pfA}}$ is the A-weighted surface sound pressure level according to EN ISO 3744

$L'_{pA,i}$ A-weighted sound pressure level measured at the i[th] microphone position, in dB

K_{1A} Background noise correction, A-weighted

K_{2A} Environmental correction, A-weighted

S Area of the measurement surface, in m^2

S_0 = 1 m^2

For the hemispherical / cylindrical measurement surface shown in Figure Z2, the area S of the measurement surface is calculated as follows:

$$S = 2\pi(R^2 + Rd), \text{ in } m^2. \quad (Z2)$$

where

d = 1 m is the height of the distance of the geometrical centre of the power tool above the reflecting plane

and

R = 1 m is the radius of the hemisphere and of the cylinder which comprise the measurement surface.

Therefore,

$$S = 4\pi\ m^2,$$

so, from equation (Z1)

$$L_{WA} = \overline{L_{pfA}} + 11, \text{ in dB.} \quad (Z3)$$

6.1.2.3 Emission sound pressure level determination

The A-weighted emission sound pressure level at the work station, L_{pA}, shall be determined in accordance with EN ISO 11203 as follows:

$$L_{pA} = L_{WA} - Q, \text{ in dB} \quad (Z4)$$

where

Q = 11, in 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 do not, in general, have uniquely defined work stations. Under free field conditions, where it may be required to estimate the emission sound pressure level, L_{pA1}, at a distance r_1 in m from the geometric centre of the power tool, this may be done by applying the formula :

$$L_{pA1} = L_{pA} + 20 \lg(\frac{1}{r_1}), \text{ in dB}$$

NOTE 2 At any given position in relation to a particular machine, and for given mounting and operating conditions, the emission sound pressure levels determined by the method of this European Standard will in general be lower than the directly measured sound pressure levels for the same machine in the typical workroom where it is used. This is due to the influence of sound reflecting surfaces in the workroom compared to the free field conditions of the test specified here. A method of calculating the sound pressure levels in the vicinity of a machine operating alone in a workroom is given in EN ISO 11690-3. Commonly observed differences are 1 dB to 5 dB, but in extreme cases the difference may be even greater.

If required, the C-weighted peak emission sound pressure level L_{pCpeak} shall be measured at each of the five measurement positions specified in 6.1.2.2. The C-weighted peak emission sound pressure level at the work station is the highest C-weighted peak sound pressure level measured at any of the five microphone positions; no corrections are permitted.

6.1.2.4 Installation and mounting conditions of the power tools during noise tests

The installation and mounting conditions shall be the same 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 which affect the 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 tool is held by the operator or suspended in such a way as to correspond to normal use, as specified in the relevant Part 2.

If the power tool is used horizontally, it shall be positioned so that its axis is at 45° between the microphone positions 1 - 4 and 2 - 3; its geometrical centre shall be 1 m above the ground (reflecting plane). If these requirements are impracticable or the tool is not used horizontally, the adopted positions shall be recorded and described in the test report.

The operator shall not be positioned directly between any microphone position and the power tool.

6.1.2.5 Operating conditions

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

Measurements shall be carried out on a new tool.

Tools are tested under the two operating conditions "no load" or "load" as appropriate for the type of tool and specified in the relevant Part 2. Before starting the test, the tool shall be operated under these conditions for a period of at least 1 min.

A measurement under "load" is to be carried out during processing of a workpiece or under external mechanical load equivalent to normal operation.

Where tests are required to be carried out on a bench it shall be in accordance with the test bench shown in Figure Z1.

Care shall be taken that the location of the work piece on its support does not adversely affect the result of the test. If necessary, or when specified in the Part 2, the work piece shall be supported on a resilient material 20 mm thick compressed to 10 mm under the weight of the work piece.

Three consecutive tests for no-load or five for load shall be carried out and the result of the test L_{WA} shall be the arithmetic mean, rounded to the nearest decibel, of the three or five tests.

During measurements, the power tool shall operate under stable conditions. Once the noise emission is steady, the measurement time interval shall be at least 15 s, unless the operating conditions specified in the relevant Part 2 do not require another time interval. 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 the frequency bands centred on or above 200 Hz.

6.1.2.6 Measurement uncertainties

A standard deviation of reproducibility of less than 1,5 dB is expected for the A-weighted sound power level determined according to EN ISO 3744 and the A-weighted emission sound pressure level determined according to EN ISO 11203.

6.1.2.7 Information to be recorded

The information to be recorded covers all of the technical requirements of this noise test code. Any deviations from this noise test code or from the basic standards upon which it is based are to be recorded together with the technical justification for such deviations.

6.1.2.8 Information to be reported

The information to be included in the test report is at least that which is required to prepare a noise declaration or to verify the declared values. Thus as a minimum the following information shall be included:

- reference to this noise test code and to the basic standards used;
- description of the power tool;
- description of the mounting and operating conditions;
- the noise emission values obtained.

It shall be confirmed that all requirements of the noise test code have been fulfilled, or, if this 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.

6.1.2.9 Declaration and verification of noise emission values

The declaration of the noise emission values shall be a dual number according to EN ISO 4871. It shall declare the noise emission value L (L_{pA}, L_{pCpeak} and L_{WA}) and separately the respective uncertainty K (K_{pA}, K_{pCpeak} and K_{WA}).

For a standard deviation of reproducibility of 1,5 dB and for a typical standard deviation of production, the values for the uncertainty, K_{pA}, K_{pCpeak} and K_{WA} respectively, are expected to be 3 dB.

The noise declaration shall state that the noise emission values have been obtained according to this noise test code. If this statement is not true, the noise declaration shall indicate clearly what the deviations from this standard, and from the basic standards, are.

NOTE If the measured value is the average based on a sample of three power tools that has been properly sampled, then K normally is 3 dB. Further guidance on sampling and uncertainty terms is given in EN 27574-4 and EN ISO 4871.

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 Subclause 6.3 of EN ISO 4871. The verification shall be conducted by using the same mounting, installation and operating conditions as those used for the initial determination of noise emission values.

6.2 Vibration

6.2.1 Vibration reduction

The vibration at the handles shall be kept as low as possible without unduly affecting the performance and the ergonomics (weight, handling, etc.) of the tool.

In particular vibration shall be reduced by the application of engineering measures as given in CR 1030-1. The success of the applied vibration measures is assessed by comparing the vibration levels for the tool with those for other tools of the same type and with a comparable specification and performance.

6.2.2 Vibration measurement - General

Details for particular types of tools are given in the relevant Part 2. The test code gives all the information necessary to carry out efficiently the determination, declaration and verification of the vibration emission characteristics. It shall allow comparison of test results for different tools.

EN 12096 gives guidance on how to declare the vibration emission values of machinery, and specifies requirements for verification of declared values.

The vibration levels for hand-arm vibration a_h to be quoted in the user instructions, as required by 8.12.2 Za)3) shall be measured in accordance with the following test procedure.

The uncertainty K is provided as an indication of the measured deviation from the mean during the test.

The measurement and assessment of human exposure to hand-transmitted vibration in the workplace is given in EN ISO 5349-1 and EN ISO 5349-2.

NOTE Annex ZB provides information on possible sources of errors of measurement.

6.2.3 Symbols

In this subclause, the following symbols are used.

$a_{hw}(t)$	instantaneous single-axis acceleration value of the frequency-weighted hand-transmitted vibration at time t, in m/s²
a_{hw}	root-mean-square (r.m.s.) single-axis acceleration value of the frequency-weighted hand-transmitted vibration, in m/s²
a_{hwx}, a_{hwy}, a_{hwz}	values of a_{hw} in m/s², for the axes denoted X, Y and Z respectively
a_{hv}	vibration total value of frequency-weighted r.m.s. acceleration, in m/s²; it is the root-sum-of-squares of the a_{hw} values for the three measured axes of vibration
a_h	arithmetic mean total vibration value of the measurement results of all runs and operators in m/s², this is the result of the test
σ_R	standard deviation of reproducibility
K	uncertainty of a_h in m/s^2

C_V coefficient of variation of a test series, defined as the ratio of the standard deviation of a series of measurement values and the mean value of the series:

$$C_V = \frac{s_{N-1}}{\bar{a}_{hv}}$$

where

$$s_{N-1} = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(a_{hvi} - \bar{a}_{hv})^2}$$ is the standard deviation

$\bar{a}_{hv}$ is the mean vibration total value of the series of 5 measurements in m/s²

a_{hvi} is the i-th vibration total value of one series of measurements in m/s²

N is the number of measured values within one series of measurements (here N = 5)

6.2.4 Characterisation of vibration

6.2.4.1 Direction of measurement

Vibration transmitted to the hand is related to the three orthogonal directions X, Y and Z as shown in Figure Z3. For particular types of tools, these directions may be defined in the relevant Part 2.

6.2.4.2 Location of measurement

Measurements shall be made in three directions at each hand position. All measurements shall be conducted simultaneously.

Measurements shall be carried out as close as possible to the hand between the thumb and the index finger, where an operator normally holds the machine.

If gripping areas are covered by soft surface material, precaution shall be taken to avoid resonance effects of the transducer mounting. If soft surface material is provided in the gripping area it shall be removed or strongly compressed by a transducer mounting clamp or suitable adaptor.

In the case of vibration isolated handles the location of measurement can influence the vibration significantly. If the transducer cannot be placed half way along the length of the handle, the points of measurement shall be left and right to the hand to determine the relevant vibration over the gripping area (see Figure Z3a). In this case, the test result for this handle is the average of the results of these two measurement positions.

NOTE 1 E.g. at vibration-isolated handles of grinding machines, the vibration changes significantly over the length of the gripping zone.

NOTE 2 The above paragraph is under review.

The measurement positions for particular types of tools are specified in the relevant Part 2.

When machines are operated with more than one grip or grasping surface, the vibration at the hand positions where an operator normally holds the tool during normal operation shall be measured and recorded. If it can be shown that the vibration magnitude at one grip is always dominant, the vibration test code may specify that measurements are made only at that gripping zone.

6.2.4.3 Magnitude of vibration

The quantity used to describe the magnitude of vibration shall be the frequency-weighted acceleration a_{hw} in m/s².

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

The r.m.s. value a_{hw} in accordance with this European Standard is defined as the r.m.s. value of the frequency-weighted acceleration signal $a_{hw}(t)$:

$$a_{hw} = \left[\frac{1}{T} \int_0^T a_{hw}^2(t)\, dt \right]^{1/2} \quad \text{(Z5)}$$

An integrating device equipped with linear integration facilities shall be used in order to obtain r.m.s. values of signals substantially varying with time.

The measurement time shall be as long as reasonably possible and normally not less than 8 s for hand-transmitted vibration measurements.

If the measurement time of 8 s for individual machines is not possible, e.g. because of short duration of operation (defined in 6.2.6.3), this shall be specified in the relevant Part 2 of this standard.

6.2.4.4 Combination of vibration directions

The vibration total value a_{hv} is determined from

$$a_{hv} = \left[a_{hwx}^2 + a_{hwy}^2 + a_{hwz}^2 \right]^{1/2} \quad \text{(Z6)}$$

where

a_{hwx}, a_{hwy}, a_{hwz} are the r.m.s. values of the frequency-weighted acceleration in the directions X, Y and Z, respectively.

6.2.5 Instrumentation requirements

6.2.5.1 General

The vibration measurement equipment shall be in accordance with EN ISO 8041.

Instrumentation for measuring other parameters (e.g. for controlling the working conditions), whose characteristics are not covered by EN ISO 8401, shall be specified in the relevant Part 2.

6.2.5.2 Transducers

6.2.5.2.1 Specification of transducers

The vibration values as specified in 6.2.4.3 shall be measured using transducers and other appropriate measurement equipment conforming to EN ISO 8041.

The total mass of the vibration transducer and its mounting shall not be sufficient to influence the measurement result and shall not be more than 5 g for each direction of measurement.

NOTE Lightweight plastic handles are an example, where heavy transducers may not be suitable. See EN ISO 5349-2 for further information.

Factors such as the transverse sensitivity (less than 10 %), the ambient temperature range, the typical temperature transient sensitivity and the maximum shock acceleration shall be considered in the selection of transducers.

6.2.5.2.2 Fastening of transducers

Guidance on mounting of transducers is given in EN ISO 5349-2. The transducer and the mechanical filter, if used, shall be mounted rigidly and on the vibrating surface.

Mechanical filters or other appropriate means may be needed to minimize measurement errors likely to occur when measuring vibration containing impulsive elements, such as occur in percussive tools. For more details, see EN ISO 5349-2.

NOTE High acceleration in the high-frequency components of the vibration can cause the transducer to generate false signals (e.g. dc shift) in the frequency range of interest because of excitation of the resonance of the transducer itself.

6.2.5.3 Calibration of the measurement chain

The whole measurement system shall be checked both before and after a sequence of measurements using a calibrator which produces a known acceleration at a known frequency.

The transducers shall be calibrated in accordance with ISO 5347 and ISO 16063-1. The whole measurement system shall be checked according to the requirements in EN ISO 8041.

6.2.6 Testing and operating conditions of the machinery

6.2.6.1 General

Measurements shall be carried out on a new tool that is only used for the noise and vibration tests required by this standard.

When the test procedure is not provided in a relevant Part 2 or there is no relevant Part 2, the operating conditions and working procedure shall be specified in sufficient detail as to achieve appropriate reproducibility. Test procedures based on a typical real working situation are preferred. The vibration test may simulate a single phase of a task or a working cycle, consisting of a set of operations where the operator is being exposed to vibration.

If for reasons of better reproducibility a simulated work condition is defined, the vibration source shall produce approximately the same magnitude of vibration as that in a typical working situation. If necessary to provide realistic emission levels, tests shall be carried out under more than one operating condition or set of operating conditions as defined in the relevant Part 2.

If the machinery is equipped with means or devices to reduce the vibration emission in comparable operating conditions, these shall be used, in accordance with the user instructions, during vibration testing. If this requires a deviation from the type test method, this shall be reported and explained in the test report.

During the measurements the hands of the operator shall guide the machine as is necessary by the design of the tool and as specified in the instructions supplied with the machine.

6.2.6.2 Attachment, workpiece and task

The attachment or accessories to be used with the machine shall be as recommended in the user instruction.

If these attachments are of a vibration reduction type, it shall be reported together with the declared vibration value.

Care shall be taken that the location of the work piece on its support does not affect the results of the test. Details for task and work piece are given in the relevant Part 2.

NOTE It should be noted that even small differences in size, shape, material, wear, unbalance, etc. of the accessory can alter the vibration magnitude considerably.

6.2.6.3 Operating conditions

Tools are tested under load only, unless the operating condition no-load is considered as important in practical use (no-load accounts for more than 20 % of the time when tool is switched on). In this case the tool shall be tested under both load and no-load condition, or at a typical work cycle containing load and no-load. The relevant Part 2 describes the modes of operation and the calculation of the declared emission value.

The machine shall be operated at normal working conditions and working modes according to the user instructions, which shall be maintained for the duration of the test. Those operating conditions shall be used that are representative of the highest vibration values likely to occur at typical and normal use of the machine under test. The measurement may be carried out by processing a work piece or under external mechanical load equivalent to normal operation.

Before starting the test, the tool shall be operated under these conditions of at least 1 min to warm it up.

6.2.6.4 Operator

The vibration of the machine is influenced by the operator. The operator shall therefore be skilled and able to operate the machine properly, i.e. he shall be experienced in the use of the tool.

The gripping force shall be as under long term working conditions and not be excessive.

6.2.7 Measurement procedure and validity

6.2.7.1 Reported vibration value

Three series of five consecutive tests shall be carried out using a different operator for each series. If it can be shown that the vibration is not affected by operator characteristics, it is acceptable to perform all 15 measurements with one operator only. Details are specified in the relevant Part 2.

The measurements are made in three axes and the results of each direction shall be combined using equation (Z6) to obtain the vibration total value a_{hv}.

If the coefficient of variation C_V of the five vibration total values a_{hv}, recorded for each series, is less than 0,15 or the standard deviation s_{N-1} is less than 0,3 m/s², the results are accepted (Annex ZB provides information on possible sources of errors of measurement).

The measurement result a_h shall be determined as the arithmetic mean of vibration total values over the tests and operators.

6.2.7.2 Declaration of the vibration emission value

The result a_h is the basis for the declared value. If values have been obtained for different hand positions, the greatest value shall be the basis for the declaration.

If required by the relevant Part 2, the work mode description corresponding to the vibration emission shall be stated next to each declared value.