

BS EN 60745-1:2009 + A11:2010



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Hand-held motor-operated electric tools — Safety

Part 1: General requirements

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National foreword

This British Standard is the UK implementation of EN 60745-1:2009+A11:2010, incorporating corrigendum December 2009. It was derived from IEC 60745-1:2006. It supersedes BS EN 60745-1:2009, which will be withdrawn on 1 October 2013.

The CENELEC common modifications have been implemented at the appropriate places in the text and are indicated by tags (e.g. **Ⓒ** **Ⓒ**).

The UK participation in its preparation was entrusted to Technical Committee CPL/116, Portable motor-operated tools.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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Amendments/corrigenda issued since publication

Date	Text affected
28 February 2011	Implementation of CENELEC amendment A11:2010 – addition of text to 19.1

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 2009-03-01. 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, Bulgaria, 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

Central Secretariat: Avenue Marnix 17, B - 1000 Brussels

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.

Two draft amendments (prAB and prAC), prepared by the Technical Committee CENELEC TC 61F (transformed into CENELEC TC 116, Safety of hand-held motor-operated electric tools), were submitted to the Unique Acceptance Procedure.

The text of EN 60745-1:2006 together with that of the draft amendments prAB and prAC were approved by CENELEC as a new edition of EN 60745-1 on 2009-03-01.

This European Standard supersedes EN 60745-1:2006.

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) 2009-12-29
- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) -

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 supports the essential health and safety requirements of the Machinery Directive 2006/42/EC.

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.

Compliance with the relevant clauses of Part 1 together with a relevant Part 2 of this standard provides one means of conforming with 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 Annex ZA, 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.

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

NOTE 1 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.

NOTE 2 In Annexes B, K, L and M, subclauses which are additional to those in the main body of the text are numbered starting from 201.

The contents of the corrigendum of December 2009 have been included in this copy.

Foreword to amendment A11

This amendment was prepared by the Technical Committee CENELEC TC 116, Safety of motor-operated electric tools.

The text of the draft was submitted to the Unique Acceptance Procedure and was approved by CENELEC as amendment A11 to EN 60745-1:2009 on 2010-10-01.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

- | | | |
|---|-------|------------|
| – latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2011-10-01 |
| – latest date by which the national standards conflicting with the amendment have to be withdrawn | (dow) | 2013-10-01 |

Endorsement notice

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

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INTRODUCTION

Individual countries may wish to consider the application of this Part 1 of IEC 60745, so far as is reasonable, to tools not mentioned in an individual part 2 and to tools designed on new principles.

If the functions of a tool are covered by the different parts 2 of IEC 60745, the relevant part 2 is applied to each function separately, so far as is reasonable. If applicable, the influence of one function on the other is taken into account.

A product employing materials or having forms of construction differing from those detailed in the requirements of this standard may be examined and tested according to the intention of the requirements and, if found to be substantially equivalent, may be judged to comply with the standard.

Standards dealing with non-safety aspects of hand-held tools are:

- IEC standards published by TC 59 on methods of measuring performance;
- CISPR 11 and 14 on radio interference suppression;
- IEC 61000-3-2 and IEC 61000-3-3 on electromagnetic compatibility.

HAND-HELD MOTOR-OPERATED ELECTRIC TOOLS – SAFETY –

Part 1: General requirements

1 Scope

This part of IEC 60745 deals with the safety of hand-held motor-operated or magnetically driven electric tools, the rated voltage of the tools being not more than 250 V for single-phase a.c. or d.c. tools, and 440 V for three-phase a.c. tools.

So far as is practicable, this standard deals with the common hazards presented by hand-held tools which are encountered by all persons in the normal use and reasonably foreseeable misuse of the tools.

Tools with an electric heating element are within the scope of this standard. They should also comply with relevant parts of IEC 60335.

Requirements for motors not isolated from the supply, and having basic insulation not designed for the rated voltage of the tools, are given in Annex B. Requirements for rechargeable battery-powered motor-operated or magnetically driven tools and the battery packs for such tools are given in Annex K. Those for such tools that are also operated and/or charged directly from the mains or a non-isolated source are given in Annex L.

Hand-held electric tools, hereinafter referred to as tools, which can be mounted on a support or working stand for use as fixed tools without any alteration of the tool itself, are within the scope of this standard. Requirements for such supports or working stands are given in Annex M.

This standard does not apply to:

- hand-held tools intended to be used in the presence of explosive atmosphere (dust, vapour or gas);
- hand-held tools used for preparing and processing food;
- hand-held tools for medical purposes (IEC 60601);
- heating tools which are covered by IEC 60335-2-45;
- ☐ – tools intended to be used with cosmetics or pharmaceutical products. ☐

For hand-held tools intended to be used in vehicles or on board ships or aircraft, additional requirements may be necessary.

For hand-held tools intended to be used in tropical countries, special requirements may be necessary.

NOTE Attention is drawn to the fact that in many countries, additional requirements are specified by the national health authorities, the national authorities responsible for the protection of labour, the national water supply authorities, etc.

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.

IEC 60061-DB¹⁾:2005, *Lamp caps and holders together with gauges for the control of interchangeability and safety*

IEC 60065:2001, *Audio, video and similar electronic apparatus – Safety requirements*

IEC 60068-2-75:1997, *Environmental testing – Part 2: Tests – Test Eh: Hammer tests*

IEC 60085, *Electrical insulation – Thermal classification*

IEC 60112:2003, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60127-3, *Miniature fuses – Part 3: Sub-miniature fuse-links*

IEC 60227 (all parts), *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V*

IEC 60245 (all parts), *Rubber insulated cables – Rated voltages up to and including 450/750 V*

IEC 60309 (all parts), *Plugs, socket-outlets and couplers for industrial purposes*

IEC 60320 (all parts), *Appliance couplers for household and similar general purposes*

IEC 60335-1:2001, *Safety of household and similar electrical appliances – Part 1: General requirements*
Amendment 1 (2004)²

IEC 60384-14, *Fixed capacitors for use in electronic equipment – Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains*

IEC 60417-DB³⁾:2002, *Graphical symbols for use on equipment*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*
Amendment 1 (1999)⁴

1) 'DB' refers to the on-line IEC database.

2) A consolidated edition (4.1) exists including IEC 60335-1:2001 and its Amendment 1 (2001).

3) 'DB' refers to the on-line IEC database.

4) A consolidated edition (2.1) exists including IEC 60529:1989 and its Amendment 1 (1999).

IEC 60695-2-11, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products*

IEC 60695-11-5:2004, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*

IEC 60695-11-10, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

IEC 60730-1:1999, *Automatic electrical controls for household and similar use – Part 1: General requirements*
Amendment 1 (2003)⁵

IEC 60760, *Flat, quick connect terminations*

IEC 60825-1, *Safety of Laser Products – Part 1: Equipment classification, requirements and user's guide*

IEC 60884 (all parts), *Plugs and socket-outlets for household and similar purposes*

IEC 60998-2-1, *Connecting devices for low-voltage circuits for household and similar purposes – Part 2-1: Particular requirements for connecting devices as separate entities with screw-type clamping units*

IEC 60998-2-2, *Connecting devices for low-voltage circuits for household and similar purposes – Part 2-2: Particular requirements for connecting devices as separate entities with screwless-type clamping units*

IEC 60999-1:1999, *Connecting devices – Electrical copper conductors – Safety requirements for screw-type and screwless-type clamping units – Part 1: General requirements and particular requirements for clamping units for conductors from 0,2 mm² up to 35 mm² (included)*

IEC 61058-1:2000, *Switches for appliances – Part 1: General requirements*
Amendment 1 (2001)⁶

IEC 61540:1997, *Electrical accessories – Portable residual current devices without integral overcurrent protection for household and similar use (PRCDs)*
Amendment 1 (1998)⁷

IEC 61558-1, *Safety of power transformers, power supplies, reactors and similar products – Part 1: General requirements and tests*

ISO 1463, *Metallic and oxide coatings – Measurement of coating thickness – Microscopical method*

ISO 2178, *Non-magnetic coatings on magnetic substrates – Measurement of coating thickness – Magnetic method*

⁵) A consolidated edition (3.1) exists including IEC 60730-1:1999 and its Amendment 1 (2003).

⁶) A consolidated edition (3.1) exists including IEC 61058-1:2000 and its Amendment 1 (2001).

⁷) A consolidated edition (1.1) exists including IEC 61540:1997 and its Amendment 1 (1998).

ISO 3864-2, *Graphical symbols – Safety colours and safety signs – Part 2: Design principles for product safety labels*

ISO 7010, *Graphical symbols – Safety colours and safety signs – Safety signs used in workplaces and public areas*

ISO 9772, *Cellular plastics – Determination of horizontal burning characteristics of small specimens subjected to a small flame*

☐ 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/TR 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)

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* ☐

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

Where the terms voltage and current are used, they imply the r.m.s. values, unless otherwise specified.

Where in this standard the expressions “with the aid of a tool”, “without the aid of a tool”, and “requires the use of a tool”, are used, the word “tool” means a hand tool, for example a screwdriver, which may be used to operate a screw or other fixing means.

3.1

accessible part

part which can be touched by means of the standard test finger in Figure 1, including, for accessible metal parts, any metal part connected to it

3.2

accessory

device that is attached only to the output mechanism of the tool

3.3

all-pole disconnection

disconnection of all supply conductors except the protective earthing (grounding) conductor by a single initiating action

3.4

attachment

device attached to the housing or other component of the tool and which may or may not be attached to the output mechanism and does not modify the normal use of the tool within the scope of this standard

3.5

basic insulation

insulation, not necessarily including insulation used for functional purposes, applied to live parts to provide basic protection against electric shock

3.6

class I tool

tool in which protection against electric shock does not rely on basic, double or reinforced insulation only, but which includes an additional safety precaution in that conductive accessible parts are connected to the protective earthing conductor in the fixed wiring of the installation in such a way that conductive accessible parts cannot become live in the event of a failure of the basic insulation. Also considered as class I tools are tools with double insulation and/or reinforced insulation throughout having an earthing terminal or earthing contact

3.7

class II tool

tool in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions, such as double insulation or reinforced insulation, are provided, there being no provision for protective earthing or reliance upon installation conditions

3.8

class III tool

tool in which protection against electric shock relies on supply at safety extra-low voltage, and in which voltages higher than those of safety extra-low voltages are not generated

3.9

class II construction

part of a tool for which protection against electric shock relies upon double insulation or reinforced insulation

3.10

class III construction

part of a tool for which protection against electric shock relies upon safety extra-low voltage, and in which voltages higher than those of safety extra-low voltages are not generated

3.11

clearance

shortest distance between two conductive parts, or between a conductive part and the outer surface of the enclosure, considered as though metal foil were pressed into contact with accessible surfaces of insulating material, measured through air

NOTE Examples of clearance distances are given in Annex A.

3.12

creepage distance

shortest path between two conductive parts, or between a conductive part and the outer surface of the enclosure, considered as though metal foil were pressed into contact with accessible surfaces of insulating material, measured along the surface of the insulating material

NOTE Examples of creepage distances are given in Annex A.

3.13

detachable cord

flexible cord, for supply, intended to be connected to the tool by means of a suitable appliance coupler

3.14

detachable part

part which can be removed or opened without the aid of a tool, or a part which is removed in accordance with the instruction for use, except user maintenance items, even if removal requires the use of a tool

3.15

double insulation

insulation system comprising both basic insulation and supplementary insulation

3.16

electronic circuit

circuit incorporating at least one electronic component

3.17

electronic component

part in which conduction is achieved principally by electrons moving through a vacuum, gas or semiconductor, with the exclusion of neon indicators

3.18

exchange type tool

tool which is intended not to be repaired at all, or to be repaired by the manufacturer's service organization only

3.19

extra-low voltage

voltage supplied from a source within the tool and, which, when the tool is supplied at rated voltage, does not exceed 50 V between conductors and between conductors and earth

3.20

extra-severe duty conditions of insulating material

where there is heavy deposition of conductive material and a long period of electrical stress; or an extra heavy deposition of conductive material and a short period of electrical stress

3.21

hand-held tool (in this standard abbreviated to "tool")

electric motor-operated or magnetically-driven machine intended to do mechanical work, with or without provisions for mounting on a support, and so designed that the motor and the machine form an assembly which can easily be brought to the place of operation, and which is either held or supported by hand or suspended during operation

NOTE Hand-held tools may be provided with a flexible shaft, the motor being either fixed or portable.

3.22

intermittent operation

operation in a series of specified identical cycles, each cycle being composed of a period of operation under normal load followed by a rest period with the tool running idle or switched off

3.23

liquid system

system that employs water or a water-based liquid from an external or integral supply that is necessary to complete the intended function of the tool

3.24

live part

any conductor or conductive part intended to be energized in normal use, including a neutral conductor but, by convention, not a PEN conductor.

3.25

no-load input / current

highest input or current obtained when a tool is operated at rated voltage and frequency with no external load (work) applied to the accessories packaged with the tool by the manufacturer and adjusted according to manufacturer's instructions, ready for use

3.26

non-detachable part

part which can only be removed or opened with the aid of a tool, or a part which fulfils the test of 21.22

3.27

non-self-resetting thermal cut-out

thermal cut-out which requires a manual operation for resetting, or replacement of a part, in order to restore the current

3.28

normal duty conditions of insulating material

where there is virtually no deposition of conductive material and a long period of electrical stress; or a light deposition of conductive material and a short period of electrical stress

3.29

normal load

load to be applied to a tool at rated voltage or at the upper limit of the rated voltage range, to obtain rated input or rated current, any marking of short-time or intermittent operation being observed and, unless otherwise specified, heating elements, if any, being operated as in normal use

3.30

normal use

use of a tool for which it is designed, taking into account the manufacturer's instructions

3.31

protective device

device the operation of which prevents a hazardous situation under abnormal operation conditions

3.32

protective impedance

impedance connected between live parts and accessible conductive parts, and of value so that the current is limited to a safe value

3.33

rated current

current assigned to the tool by the manufacturer. If no current rating is assigned to the tool, the rated current for the purpose of this standard is the current measured when the tool is operated under normal load

3.34

rated frequency

frequency assigned to the tool by the manufacturer

3.35

rated frequency range

frequency range assigned to the tool by the manufacturer, expressed by its lower and upper limits

3.36

rated input

input in watts assigned to the tool by the manufacturer. If no input is assigned to the tool, the rated input for the purpose of this standard is the input measured when the tool is operated under normal load

3.37

rated input range

input range in watts assigned to the tool by the manufacturer, expressed by its lower and upper limits

3.38

rated no-load speed

no-load speed at rated voltage or at the upper limit of the rated voltage range assigned to the tool by the manufacturer

3.39

rated operating time

operating time assigned to the tool by the manufacturer

3.40

rated voltage

voltage assigned to the tool by the manufacturer. For three-phase supply, it is the voltage between phases

3.41

rated voltage range

voltage range assigned to the tools by the manufacturer, expressed by its lower and upper limits

3.42

reinforced insulation

insulation of hazardous live parts which provides a degree of protection against electric shock equivalent to double insulation

NOTE Examples of reinforced insulation are a single layer or several layers which cannot be tested singly as basic insulation or supplementary insulation.

3.43

residual current device

RCD

device intended to detect a diversion of current from a circuit in a way that may expose the user to an electric shock; in such conditions the device opens the circuit

NOTE Such a device is also known as portable residual current device (PRCD), ground fault circuit interrupter (GFCI) or earth leakage circuit breaker (ELCB).

3.44

routine servicing

periodic servicing which requires tool disassembly as instructed by the instruction manual and performed by authorized service centre

3.45

safety extra-low voltage

rated voltage not exceeding 42 V between conductors and between conductors and earth, the no-load voltage not exceeding 50 V. When safety extra-low voltage is obtained from the supply mains, it is to be through a safety isolating transformer or a convertor with separate windings, the insulation of which complies with double or reinforced insulation requirements

3.46

safety isolating transformer

transformer, the input winding of which is electrically separated from the output winding by an insulation at least equivalent to double insulation or reinforced insulation, and which is intended to supply a distribution circuit, a tool or other equipment at safety extra-low voltage

3.47

self-resetting thermal cut-out

thermal cut-out which automatically restores the current after the relevant part of the tool has cooled down to a given value

3.48

severe duty conditions of insulating material

where there is a light deposition of conductive material and a long period of electrical stress; or a heavy deposition of conductive material and a short period of electrical stress

3.49

short-time operation

operation under normal load for a specified period, starting from cold, the intervals between each period of operation being sufficient to allow the tool to cool down approximately to ambient temperature

3.50

supplementary insulation

independent insulation applied in addition to the basic insulation, in order to provide protection against electric shock in the event of a failure of the basic insulation

3.51

supply cord

flexible cord, for supply purposes, which is fixed to the tool

3.52

temperature limiter

temperature-sensing device, the operating temperature of which may be either fixed or adjustable, and which, during normal operation, operates by opening or closing a circuit when the temperature of the controlled part reaches a predetermined value. It does not make the reverse operation during the normal duty cycle of the tool

3.53

thermal cut-out

device which, during abnormal operation, limits the temperature of the controlled part by automatically opening the circuit, or by reducing the current, and which is so constructed that its setting cannot be altered by the user

3.54

thermal link

thermal cut-out which operates only once, and then requires partial or complete replacement

3.55

thermostat

temperature-sensing device, the operating temperature of which may be either fixed or adjustable; and which, during normal operation, keeps the temperature of the controlled part between certain limits by automatically opening and closing a circuit

3.56

type X attachment

method of attachment of the supply cord so that it can easily be replaced

3.57

type Y attachment

method of attachment of the supply cord such that any replacement is intended to be made by the manufacturer, its service agent or similar qualified person

3.58

type Z attachment

method of attachment of the supply cord so that it cannot be replaced without breaking or destroying the tool

3.59

user maintenance

any maintenance operation stated in the instructions for use or marked on the tool which the manufacturer of the tool intends the user to perform

3.60

working voltage

maximum voltage, without the effect of transient voltages, to which the part under consideration is subjected when the tool is supplied at its rated voltage and operating under normal load

4 General requirements

Tools shall be so constructed that in normal use they function safely so as to cause no danger to persons or surroundings, even in the event of reasonably foreseeable misuse.

In general, this principle is achieved by fulfilling the relevant requirements specified in this standard, and compliance is checked by carrying out all the relevant tests.

NOTE Annex N shows an example of routine tests.

5 General conditions for the tests

5.1 Tests according to this standard are type tests.

5.2 Unless otherwise specified, the tests are made on a single tool, which shall withstand all the relevant tests. However, any test that requires tool modifications or disassembly after the test may be performed on a separate sample.

Additional samples may be required, for example, if the tool is designed for different supply voltages. The testing of components may necessitate the submission of additional samples of these components.

The cumulative stress resulting from successive tests on electronic circuits is to be avoided. It may be necessary to replace components or to use additional samples. The number of additional samples should be kept to a minimum by an evaluation of the relevant electronic circuits.

5.3 Unless otherwise specified, the tests are carried out in the order of the clauses. If it is evident from the construction of the tool that a particular test is not applicable, the test is not made.

5.4 The tests are carried out with the tool, or any movable part of it, placed in the most unfavourable position that may occur in normal use.

5.5 Tools provided with controls or switching devices are tested with these controls or devices adjusted to their most unfavourable settings, if the setting can be altered by the user. Electronic speed control devices are set for the highest speed.

If the adjusting means of the control is accessible without the aid of a tool, this subclause applies whether the setting can be altered by hand or with the aid of a tool. If the adjusting means is not accessible without the aid of a tool, and if the setting is not intended to be altered by the user, this subclause does not apply.

Adequate sealing is regarded as preventing alteration of the setting by the user.

5.6 *The tests are made in a draught-free location and, in general, at an ambient temperature of (20 ± 5) °C.*

If the temperature attained by any part is limited by a temperature sensitive device, or is influenced by the temperature, the room temperature is, in case of doubt, maintained at (23 ± 2) °C.

5.7.1 *Tools for a.c. only are tested with a.c. at rated frequency, if marked, and those for a.c./d.c. are tested at the more unfavourable supply.*

Tools for a.c. which are not marked with rated frequency, or marked with a frequency range of 50 Hz to 60 Hz, are tested with either 50 Hz or 60 Hz, whichever is the more unfavourable.

5.7.2 *Tools having more than one rated voltage are tested on the basis of the most unfavourable voltage.*

When it is specified for tools marked with a rated voltage range that the supply voltage is equal to the rated voltage multiplied by a factor, the supply voltage is equal to:

- *the upper limit of the rated voltage range multiplied by this factor, if greater than 1;*
- *the lower limit of the rated voltage range multiplied by this factor, if smaller than 1.*

When a factor is not specified, the supply voltage is the most unfavourable within the rated voltage range.

For tools having more than one rated voltage or rated voltage range, it may be necessary to make some of the tests at the minimum, the mean, and the maximum values of the rated voltage, or the rated voltage range, in order to establish the most unfavourable voltage.

5.7.3 *For tools marked with a rated voltage range and rated input corresponding to the mean of the rated voltage range, when it is specified that the power input is equal to rated input multiplied by a factor, the input is equal to:*

- *the calculated input corresponding to the upper limit of the rated voltage range multiplied by this factor, if greater than 1:*
- *the calculated input corresponding to the lower limit of the rated voltage range multiplied by this factor, if smaller than 1.*

When a factor is not specified, the input corresponds to the input at the most unfavourable rated voltage within the range.

5.8 *When alternative attachments are made available for the tool by its manufacturer, the tool is tested with those attachments which give the most unfavourable results.*

5.9 *Unless otherwise specified, tools are tested with the appropriate flexible cord connected to the tool.*

5.10 *If class I tools have accessible metal parts which are not connected to an earthing terminal or earthing contact, and are not separated from live parts by an intermediate metal part which is connected to an earthing terminal or earthing contact, such parts are checked for compliance with the appropriate requirements specified for class II construction.*

If class I tools have accessible non-metallic parts, such parts are checked for compliance with the appropriate requirements specified for class II construction, unless these parts are separated from live parts by an intermediate metal part connected to an earthing terminal or earthing contact.

5.11 *If class I or class II tools have parts operating at safety extra-low voltage, such parts are checked for compliance with the appropriate requirements specified for class III tools.*

5.12 *When testing electronic circuits, the supply is to be free from those perturbations from external sources that can influence the results of the tests.*

5.13 *If, in normal use, the heating element cannot be operated unless the motor is running, the element is tested with the motor running. If the heating element can be operated without the motor running, the element is tested with or without the motor running, whichever is the more unfavourable. Heating elements incorporated in the tool are connected to a separate supply unless otherwise specified.*

5.14 *For attachments performing a function which is within the scope of one of the relevant parts 2, the tests are made in accordance with that part 2.*

For other attachments, the tests are made in accordance with manufacturer's instructions; in the absence of such instructions, the tool is operated continuously at a load at which rated input or rated current is attained.

5.15 *If a torque is to be applied, the method of loading is chosen so as to avoid additional stresses, such as those caused by side thrust. Additional loads necessary for the correct operation of the tool are, however, taken into consideration.*

If a brake is used for applying a load, it must be applied gradually to assure that the starting current does not affect the test. Modification of output means for purpose of loading is permitted for the connection to a brake.

5.16 *Tools intended to be operated at safety extra-low voltage are tested together with their supply transformer, if this is normally sold with the tool.*

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 noise emission may be determined by using the measurements from a machine which has design and technical specifications replicating the machine concerned.

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:

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

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

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

where

$\overline{L_{pfA}}$	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	$= 1 \text{ m}^2$

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

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

where

$d = 1 \text{ m}$ is the height of the distance of the geometrical centre of the power tool above the reflecting plane

and

$R = 1 \text{ m}$ is the radius of the hemisphere and of the cylinder which comprise the measurement surface.

Therefore,

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

so, from equation (Z1)

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

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

$$Q = 11, \text{ in dB}$$

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:

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

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 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 as specified in 8.12.2 Za) 1) 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 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.

The vibration total value may be determined by using the measurements from a machine which has design and technical specifications replicating the machine concerned.

EN 12096 gives guidance on how to declare the vibration total 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/s^2
a_{hw}	root-mean-square (r.m.s.) single-axis acceleration value of the frequency-weighted hand-transmitted vibration, in m/s^2
$a_{hwx}, a_{hwy}, a_{hwz}$	values of a_{hw} in m/s^2 , for the axes denoted X, Y and Z respectively
a_{hv}	vibration total value of frequency-weighted r.m.s. acceleration, in m/s^2 ; 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/s^2 , 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

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

$\bar{a}_{hv}$ is the mean vibration total value of the series of 5 measurements in m/s^2

a_{hvi} is the i -th vibration total value of one series of measurements in m/s^2

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. 

- Ⓒ For vibration isolated stick type side handles, the transducer may alternatively be placed half way along the length of the handle. In this case, in order not to disturb the operator's normal grip, the transducer shall be placed inside the handle.

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.

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/s^2 .

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 $a_{hw}(t)$:

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

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

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

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 8041, 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 tool

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 tool 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 total 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.

To determine the uncertainty K of the declared value according to EN 12096, the following formula shall be used that takes the standard deviation into account:

$K = 1,65 s_R$ or $K = 1,5 \text{ m/s}^2$, whatever is higher

$$s_R = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (a_{hvi} - a_h)^2}$$

with

s_R = standard deviation (considered equal to σ_R)

n = 3 (number of operators)

a_{hvi} = average vibration total value of each operator (= result for each operator)

a_h = average vibration total value of all measurements (= test result)

The vibration value(s) a_h shall be declared as follows:

Vibration total values (triaxial vector sum) determined according to EN 60745:	
Work mode description 1 (if required by the relevant Part 2)	Vibration emission value $a_h = \dots \text{ m/s}^2$
	Uncertainty $K = \dots \text{ m/s}^2$
Work mode description 2 (if required by the relevant Part 2)	Vibration emission value $a_h = \dots \text{ m/s}^2$
	Uncertainty $K = \dots \text{ m/s}^2$

6.2.8 Measurement report

The report shall, as a minimum, include the following information:

- reference to this standard including any relevant Part 2;
- specification of the machine tested (i.e. manufacturer, type and serial number of the machine, etc.);
- attachment or accessories;
- operating and testing conditions (voltage, feed force, speed setting, duration and number of test runs, etc.);
- measuring institution (e.g. laboratory, manufacturer); ☐

- Ⓒ f) date of measurement and name of the person responsible for the test;
- g) instrumentation (transducer mass, filters, integrators, recording system, etc.);
- h) position and fastening of transducers, measuring directions and individual vibration values when relevant (e.g. recorded by photos);
- i) the arithmetic mean total vibration a_h , for each operator the total vibration value a_{hv} and the three single axis weighted acceleration values a_{hw} . It is good practice to report all the measured values (i.e. for all axes of vibration, tests and operators);
- j) the uncertainty K of the vibration total value a_h .

Any deviations from the vibration test code in this standard shall be reported together with the technical justification for such deviations. Ⓒ

7 Classification

7.1 Tools shall be of one of the following classes with respect to protection against electric shock:

class I, class II, class III.

Compliance is checked by inspection and by the relevant tests.

7.2 Tools shall have the appropriate degree of protection against harmful ingress of water according to IEC 60529. If a degree other than IPX0 is required this shall be specified in the relevant part 2.

Compliance is checked by inspection and by the relevant tests.

8 Marking and instructions

8.1 Tools shall be marked with:

- rated voltage(s) or rated voltage range(s), in volts. Tools for star-delta connection shall be clearly marked with the two rated voltages (for example 230 Δ / 400 V);
- symbol for nature of supply, unless the rated frequency is marked. The symbol for nature of supply shall be placed next to the marking for rated voltage;
- rated input, in watts or rated current, in amperes. The rated input or current to be marked on the tool is the total maximum input or current that can be on circuit at the same time. If a tool has alternative components which can be selected by a control device, the rated input or rated current is that corresponding to the highest loading possible;
- Ⓒ – the business name and address of the manufacturer and, where applicable, his authorised representative. Any address shall be sufficient to ensure contact;
- designation of the tool;
designation of the tool may be achieved by a combination of letters and/or numbers;
- designation of series or type;
allowing the technical identification of the product. This may be achieved by a combination of letters and/or numbers and may be combined with the designation of the tool; Ⓒ
- IP number according to degree of protection against ingress of water other than IPX0. If the first numeral for the IP numbering is omitted, the omitted numeral shall be replaced by the letter X, for example IPX5;
- Ⓒ – the year of manufacture; Ⓒ

- “WARNING – To reduce the risk of injury, user must read instruction manual” or the sign M002 of ISO 7010⁸⁾.

If used, the word “WARNING” shall be in capital letters not less than 2,4 mm high and shall not be separated from the cautionary statement.

If used, the statement shall be verbatim except the term “operator’s manual” or “user guide” may be used for the term “instruction manual”.

Additional markings are allowed, provided they do not give rise to misunderstanding.

Compliance is checked by inspection.

8.2 Tools for short-time operation or intermittent operation shall be marked with rated operating time, or rated operating time and rated resting time respectively, unless the operating time is limited by the construction of the tool.

The marking of short-time operation or intermittent operation shall correspond to normal use.

The marking of intermittent operation shall be such that the rated operating time precedes the rated resting time, both markings being separated by an oblique stroke.

Compliance is checked by inspection.

8.3 The marking of tools intended to be operated without adjustment in a rated range of values (voltage, frequency, etc.) shall be differentiated from those intended to be operated with or without adjustment under different values of the same criteria (voltage, frequency, etc.).

The lower and upper limits of the rated range of values shall be separated by a hyphen (-).

The different rated values shall be separated by an oblique stroke (/).

Examples:

115-230 V: The tool is suitable for any value within the marked range.

115/230 V: The tool is only suitable for the marked values.

Compliance is checked by inspection.

8.4 If the tool can be adjusted to suit different rated voltages, the voltage to which the tool is adjusted shall be clearly discernible.

This requirement does not apply to tools for star-delta connection.

For tools where frequent changes in voltage setting are not required, this requirement is considered to be met if the rated voltage to which the tool is adjusted can be determined from a wiring diagram fixed to the tool. The wiring diagram may be on the inside of a cover which has to be removed to connect the supply conductors. It is not to be on a label loosely attached to the tool.

Compliance is checked by inspection.

⁸⁾ The future safety sign M002 is currently in DIS stage as ISO 7010:2003/DAMd4.

8.5 For tools marked with more than one rated voltage or with more than one rated voltage range, the rated power input for each of these voltages or ranges shall be marked.

The upper and lower limits of the rated power input shall be marked on the tool so that the relation between input and voltage appears distinctly, unless the difference between the limits of a rated voltage range does not exceed 10 % of the mean value of the range, in which case the marking for rated power input may be related to the mean value of the range.

Compliance is checked by inspection.

8.6 If units or technical data are expressed by symbols, the following symbols shall be used:

V	volts
A	amperes
Hz	hertz
W	watts
kW	kilowatts
F	farads
μF	microfarads
l	litres
g	grams
kg.....	kilograms
bar	bars
Pa	pascals
h	hours
min.....	minutes
s.....	seconds
n ₀	no-load speed
.../min or ...min ⁻¹	Revolutions or reciprocations per minute
— — — or d.c.	Direct current
~ or a.c.	Alternating current
2 ~	Two-phase alternating current
2N ~	Two-phase alternating current with neutral
3 ~	Three-phase alternating current
3N ~	Three-phase alternating current with neutral
—  — A	Rated current of the appropriate fuse-link in amperes
—  —	Time-lag miniature fuse-link where X is the symbol for the time/current characteristic, as given in IEC 60127-3
	Protective earth
	Class II tool
IPXX	IP symbol

The dimensions for the symbol for class II tools shall be such that the length of the sides of the outer square is about twice the length of the sides of the inner square. The length of the sides of the outer square shall not be less than 5 mm, unless the largest dimension of the tool does not exceed 15 cm, in which case the dimensions of the symbol may be reduced, but the length of the sides of the outer square shall not be less than 3 mm.

The symbol for class II tools shall be so placed that it will be obvious that it is a part of the technical information, and is unlikely to be confused with any other marking.

When other units are used, the units and their symbols shall be those of the international standardized system.

Additional symbols other than international symbols are allowed, provided they do not give rise to misunderstanding.

Compliance is checked by inspection and measurement.

8.7 Tools to be connected to more than two supply conductors shall be provided with a connection diagram, fixed to the tool, unless the correct mode of connection is obvious.

The correct mode of connection is deemed to be obvious if the terminals for the supply conductors are indicated by arrows pointing towards the terminals. The earthing conductor is not a supply conductor. For tools for star-delta connection, the wiring diagram should show how the windings are to be connected.

Compliance is checked by inspection.

8.8 Except for type Z attachments, terminals shall be indicated as follows:

- Terminals intended exclusively for the neutral conductor shall be indicated by the letter N.
- Earthing terminals shall be indicated by the symbol 

These indications shall not be placed on screws, removable washers or other parts which might be removed when conductors are being connected.

Compliance is checked by inspection.

8.9 Unless it is obviously unnecessary, switches which may give rise to a hazard when operated shall be marked, or so placed as to indicate clearly which part of the tool they control.

Indications used for this purpose shall, wherever practicable, be comprehensible without a knowledge of languages, national standards, etc.

Compliance is checked by inspection.

8.10 For tools which might cause danger when started unexpectedly, the “off” position of the mains switch shall be indicated, unless this position is obvious; the indication, if required, shall be the figure O, as given by symbol IEC 60417-5008 (DB:2002-10).

The figure O shall not be used for any other indication.

The position of the moving contacts of the mains switch shall correspond to the indications for the different positions of its operating means.

NOTE The figure O may, for example, also be used on a digital programming keyboard.

Compliance is checked by inspection.

8.11 Regulating devices and the like, intended to be adjusted during operation, shall be provided with an indication for the direction of adjustment to increase or to decrease the value of the characteristic being adjusted. An indication of + and – is considered to be sufficient.

The requirement does not apply to regulating devices provided with an adjusting means, if its fully “on” position is opposite to its “off” position.

If figures are used for indicating the different positions, the “off” position shall be indicated by the figure O and the other positions shall be indicated by figures reflecting the greater output, input, speed, etc.

The indication for the different positions of the operating means of a control device need not to be placed on the device itself.

Compliance is checked by inspection.

8.12 An instruction manual and safety instructions shall be provided with the tool and packaged in such a way that is noticed by the user when the tool is removed from the packaging. The safety instructions may be separate from the instruction manual. An explanation of the symbols required by this standard shall be provided in either the instruction manual or the safety instructions.

They shall be written in the official language(s) of the country in which the tool is sold.  The words "Original instructions" shall appear on the language version(s) verified by the manufacturer or his authorised representative. Where no "Original instructions" exist in the official language(s) of the country where the tool is to be used, a translation into that/those language(s) shall be provided by the manufacturer or his authorised representative or by the person bringing the tool into the language area in question. The translations shall bear the words "Translation of the original instructions", and they shall be accompanied by a copy of the "Original instructions". 

They shall be legible and contrast with the background.

 They shall include the business name and address of the manufacturer and, where applicable, his authorised representative. Any address shall be sufficient to ensure contact.

They shall include the designation of the tool and series or type as required by 8.1, including description of machine such as "drill", "planer" etc. 

8.12.1 The subjects of safety instructions are the General Power Tool Safety Warnings of Part 1 as given in 8.12.1.1, the specific tool Safety Warnings of the relevant part 2 and any additional safety warning statements deemed necessary by the manufacturer. The General Power Tool Safety Warnings and the specific tool Safety Warnings, if in English, shall be verbatim and in any other official language to be equivalent.

Format of all Safety Warnings must differentiate, by font highlighting or similar means, the context of clauses as illustrated below.

All notes in the safety instructions are not to be printed, they are information for the designer of the manual.

8.12.1.1 General Power Tool Safety Warnings

 **WARNING** Read all safety warnings and all instructions. Failure to follow the warnings and instructions may result in electric shock, fire and/or serious injury.

Save all warnings and instructions for future reference.

The term "power tool" in the warnings refers to your mains-operated (corded) power tool or battery-operated (cordless) power tool.

1) Work area safety

- a) **Keep work area clean and well lit.** Cluttered or dark areas invite accidents.
- b) **Do not operate power tools in explosive atmospheres, such as in the presence of flammable liquids, gases or dust.** Power tools create sparks which may ignite the dust or fumes.
- c) **Keep children and bystanders away while operating a power tool.** Distractions can cause you to lose control.

2) Electrical safety

- a) **Power tool plugs must match the outlet. Never modify the plug in any way. Do not use any adapter plugs with earthed (grounded) power tools.** Unmodified plugs and matching outlets will reduce risk of electric shock.
- b) **Avoid body contact with earthed or grounded surfaces, such as pipes, radiators, ranges and refrigerators.** There is an increased risk of electric shock if your body is earthed or grounded.
- c) **Do not expose power tools to rain or wet conditions.** Water entering a power tool will increase the risk of electric shock.
- d) **Do not abuse the cord. Never use the cord for carrying, pulling or unplugging the power tool. Keep cord away from heat, oil, sharp edges or moving parts.** Damaged or entangled cords increase the risk of electric shock.
- e) **When operating a power tool outdoors, use an extension cord suitable for outdoor use.** Use of a cord suitable for outdoor use reduces the risk of electric shock.
- f) **If operating a power tool in a damp location is unavoidable, use a residual current device (RCD) protected supply.** Use of an RCD reduces the risk of electric shock.

NOTE The term "residual current device (RCD)" may be replaced by the term "ground fault circuit interrupter (GFCI)" or "earth leakage circuit breaker (ELCB)".

3) Personal safety

- a) **Stay alert, watch what you are doing and use common sense when operating a power tool. Do not use a power tool while you are tired or under the influence of drugs, alcohol or medication.** A moment of inattention while operating power tools may result in serious personal injury.
- b) **Use personal protective equipment. Always wear eye protection.** Protective equipment such as dust mask, non-skid safety shoes, hard hat, or hearing protection used for appropriate conditions will reduce personal injuries.
- c) **Prevent unintentional starting. Ensure the switch is in the off-position before connecting to power source and/or battery pack, picking up or carrying the tool.** Carrying power tools with your finger on the switch or energising power tools that have the switch on invites accidents.
- d) **Remove any adjusting key or wrench before turning the power tool on.** A wrench or a key left attached to a rotating part of the power tool may result in personal injury.

- e) **Do not overreach. Keep proper footing and balance at all times.** *This enables better control of the power tool in unexpected situations.*
- f) **Dress properly. Do not wear loose clothing or jewellery. Keep your hair, clothing and gloves away from moving parts.** *Loose clothes, jewellery or long hair can be caught in moving parts.*
- g) **If devices are provided for the connection of dust extraction and collection facilities, ensure these are connected and properly used.** *Use of dust collection can reduce dust-related hazards.*

4) Power tool use and care

- a) **Do not force the power tool. Use the correct power tool for your application.** *The correct power tool will do the job better and safer at the rate for which it was designed.*
- b) **Do not use the power tool if the switch does not turn it on and off.** *Any power tool that cannot be controlled with the switch is dangerous and must be repaired.*
- c) **Disconnect the plug from the power source and/or the battery pack from the power tool before making any adjustments, changing accessories, or storing power tools.** *Such preventive safety measures reduce the risk of starting the power tool accidentally.*
- d) **Store idle power tools out of the reach of children and do not allow persons unfamiliar with the power tool or these instructions to operate the power tool.** *Power tools are dangerous in the hands of untrained users.*
- e) **Maintain power tools. Check for misalignment or binding of moving parts, breakage of parts and any other condition that may affect the power tool's operation. If damaged, have the power tool repaired before use.** *Many accidents are caused by poorly maintained power tools.*
- f) **Keep cutting tools sharp and clean.** *Properly maintained cutting tools with sharp cutting edges are less likely to bind and are easier to control.*
- g) **Use the power tool, accessories and tool bits etc. in accordance with these instructions, taking into account the working conditions and the work to be performed.** *Use of the power tool for operations different from those intended could result in a hazardous situation.*

5) Service

- a) **Have your power tool serviced by a qualified repair person using only identical replacement parts.** *This will ensure that the safety of the power tool is maintained.*

8.12.1.2 The order of the Safety Instructions shall be either in accordance with either item A) or B) and in accordance with item C):

- A) The Part 1 warnings are followed by the relevant part 2 warnings. The order of the warnings within the Part 1 and the part 2 warnings shall remain as given above and in the relevant part 2.
- B) The Part 1 and the part 2 warnings may be divided into the sections defined by the numbered subtitles and the associated warnings below the numbered subtitle. The order of warnings within each section shall remain as given above and in the relevant part 2.

When warnings are presented in this manner, the title of the Part 1 “General Power Tool Safety Warnings” shall be omitted and the 1st sentence of the warnings in 8.12.1.1 and 8.12.2, if applicable, shall be modified as follows:

 **WARNING** Read all safety warnings designated by the  symbol and all instructions.

The sections of the safety warnings shall be presented in the related topic of the Instruction Manual.

The Instruction Manual section titles for Part 1 warnings shall have a format:

 **General Power Tool Safety Warnings – [Section subtitle]**

Example:

 **General Power Tool Safety Warnings – Personal Safety**

The Instruction Manual section titles for part 2 warnings shall have a format:

 **[Tool category name] Safety Warnings – [Section subtitle]**

Example:

 **Circular Saw Safety Warnings – Cutting Procedures**

If particular part 2 warnings do not have a numbered subtitle, then all warnings required by the particular part 2 shall be presented in the given order and the formatting rule above shall be followed without the **[Section subtitle]**.

- C) Any additional warnings deemed necessary by the manufacturer, shall not be inserted within any of the Part 1 or part 2 warnings. They may be either appended to the section(s) of the Part 1 or part 2 in accordance with the topic of the safety warnings or located in any other part of the instruction manual.

8.12.2 If the Safety Instructions are separate from the Instruction Manual, then the following warnings shall be included in the Instruction Manual. These warnings, if in English, shall be verbatim and in any other official language to be equivalent.

 **WARNING** Read all safety warnings and all instructions. *Failure to follow the warnings and instructions may result in electric shock, fire and/or serious injury.*

Save all warnings and instructions for future reference.

The Instruction Manual shall be provided with the following information, if appropriate.

- a) Instructions for putting into use
 - 1) Setting-up or fixing power tool in a stable position as appropriate for power tools which can be mounted on a support
 - 2) Assembly
 - 3) Connection to power supply, cabling, fusing, socket type and earthing requirements
 - 4) Illustrated description of functions
 - 5) Limitations on ambient conditions
 - 6) List of contents
- b) Operating instructions
 - 1) Setting and testing
 - 2) Tool changing
 - 3) Clamping of work
 - 4) Limits on size of workpiece  and type of material 
 - 5) General instructions for use
- c) Maintenance and servicing
 - 1) Regular cleaning, maintenance, method for keeping tools sharp, and lubrication
 - 2) Servicing by manufacturer or agent; list of addresses
 - 3) List of user-replaceable parts , if any 
 - 4) Special tools which may be required
 - 5) For power tools with type X attachment, where a specially prepared cord is needed to replace the cord: if the supply cord of this power tool is damaged, it must be replaced by a specially prepared cord available through the service organization.
 - 6) For power tools with type Y attachment: if the replacement of the supply cord is necessary, this has to be done by the manufacturer or his agent in order to avoid a safety hazard.
 - 7) For power tools with type Z attachment: the supply cord of this power tool cannot be replaced, and the power tool shall be scrapped.
- d) For tools with a liquid system, the substance of the following, as appropriate:
 - 1) Instructions for
 - the connection to the liquid supply;
 - the use of the liquid and the use of attachments to comply with 14.4 in order to avoid affection of the tool by liquid;
 - the inspection of hoses and other critical parts which could deteriorate;
 - the maximum permitted pressure of the liquid supply
 - 2) For tools provided with an RCD
 - warning and instruction never to use the tool without the RCD provided with the tool;
 - warning and instruction always to test the correct operation of the RCD before starting work, unless the RCD is of a self-checking type
 - 3) For tools for use in combination with an isolating transformer: warning and instruction never to use the tool without the transformer delivered with the tool or of the type as specified in these instructions

- 4) Warning and instruction that replacement of the plug or the supply cord shall always be carried out by the manufacturer of the tool or his service organization
- 5) Warning and instruction to keep liquid clear off the parts of the tool and away from persons in the working area

Ⓒ) Za) Emissions

- 1) The noise emission, measured in accordance with 6.1.2, as follows:
 - A-weighted sound pressure level L_{pA} and its uncertainty K_{pA} , where L_{pA} exceeds 70 dB(A).
Where L_{pA} does not exceed 70 dB(A), this fact shall be indicated;
 - A-weighted sound power level L_{WA} and its uncertainty K_{WA} , where the A-weighted sound pressure level L_{pA} exceeds 80 dB(A);
 - peak C-weighted instantaneous sound pressure value L_{pCpeak} and its uncertainty K_{pCpeak} , where this exceeds 63 Pa (130 dB in relation to 20 µPa).
- 2) Recommendation for the operator to wear hearing protection.
- 3) The vibration total value and its uncertainty measured in accordance with 6.2.
When the vibration total value does not exceed 2,5 m/s², this shall be stated.
When the vibration total value exceeds 2,5 m/s², its value shall be given in the instructions.
- 4) The following information:
 - that the declared vibration total value has been measured in accordance with a standard test method and may be used for comparing one tool with another;
 - that the declared vibration total value may also be used in a preliminary assessment of exposure.
- 5) A warning:
 - that the vibration emission during actual use of the power tool can differ from the declared total value depending on the ways in which the tool is used; and
 - of the need to identify safety measures to protect the operator that are based on an estimation of exposure in the actual conditions of use (taking account of all parts of the operating cycle such as the times when the tool is switched off and when it is running idle in addition to the trigger time). Ⓒ

8.13 Markings required by the standard shall be easily legible and durable. Signs shall be in contrast such as colour, texture, or relief, to their background such that the information or instructions provided by the signs are clearly legible when viewed by the naked eye from a distance of not less than 500 mm. Signs need not be in accordance with the blue colour requirements of ISO 3864-2.

Compliance is checked by inspection and by rubbing the marking by hand for 15 s with a piece of cloth soaked with water and again for 15 s with a piece of cloth soaked with petroleum spirit.

After all the tests of this standard, the marking shall be easily legible, it shall not be easily possible to remove marking plates, and they shall show no curling.

In considering the durability of the marking, the effect of normal use is taken into account. Thus, for example, marking by means of paint or enamel other than vitreous enamel on containers that are likely to be cleaned frequently is not considered to be durable.

The petroleum spirit to be used for the test is aliphatic solvent hexane having a maximum aromatics content of 0,1 % by volume, a kauributanol value of 29, an initial boiling point of approximately 65 °C, a dry point of approximately 69 °C and a specific mass of approximately 0,689 kg/l.

8.14 Markings specified in 8.1 to 8.5 shall be on a main part of the tool. Markings specified in 8.1, 8.2, 8.3 and 8.5 shall be placed together.

Markings on the tool shall be clearly discernible from the outside of the tool, but after removal of a cover, if necessary. It shall be possible to remove or open this cover without the aid of a tool.

Indications for switches and controls shall be placed on or in the vicinity of these components; they shall not be placed on parts which can be repositioned, or positioned in such a way that the marking is misleading.

Compliance is checked by inspection.

8.15 If compliance with this standard depends upon the operation of a replaceable thermal link or fuse-link, the reference number or other means for identifying the link shall be marked on the link, or in a place that it is clearly visible after the link has failed, when the tool has been dismantled to the extent necessary for replacing the link.

This requirement does not apply to links which can only be replaced together with a part of the tool.

Compliance is checked by inspection.

9 Protection against access to live parts

Tools shall be so constructed and enclosed that there is adequate protection against accidental contact with live parts.

Compliance is checked by inspection, and by the tests of 9.2 to 9.4, as applicable.

9.1 An accessible part is not considered to be live if:

- the part is supplied with safety extra-low voltage, provided that
 - for a.c., the peak value of the voltage does not exceed 42 V;
 - for d.c., the voltage does not exceed 42 V;
- or
- the part is separated from live parts by protective impedance.

In the case of protective impedance, the current between the part and the supply source shall not exceed 2 mA for d.c., and its peak value shall not exceed 0,7 mA for a.c., and moreover:

- for voltages having a peak value over 42 V up to and including 450 V, the capacitance shall not exceed 0,1 µF;

- for voltages having a peak value over 450 V up to and including 15 kV, the discharge shall not exceed 45 μC .

Compliance is checked by operating the tool at rated voltage. Voltages and currents are measured between the relevant parts and either pole of the supply source. Discharges are measured immediately after the interruption of the supply.

9.2 *The requirement of 9.1 applies for all positions of the tool when it is operated as in normal use, even after removal of detachable parts.*

Lamps located behind a detachable cover are not removed, provided the tool can be isolated from the supply by means of a plug or an all-pole switch. However, during insertion or removal of lamps which are located behind a detachable cover, protection against contact with live parts of the lamp cap shall be ensured.

This excludes the use of screw type fuses and screw-type miniature circuit breakers which are accessible without the aid of a tool.

The test finger of Figure 1 is applied without appreciable force, the tool being in every possible position.

Through openings, the test finger is applied to any depth that the finger will permit, and it is rotated or angled before, during, and after insertion to any position.

If the opening does not allow the entry of the finger, the force on the finger in the straight position is increased to 20 N and the test with the finger bent repeated.

It shall not be possible to touch with the test finger live parts or live parts protected only by lacquer, enamel, ordinary paper, cotton, oxide film, beads or sealing compound.

Lacquer, enamel, ordinary paper, cotton, oxide film on metal parts, beads and sealing compound, except self-hardening resins, are not considered to give the required protection against contact with live parts.

9.3 *For openings in class II tools or class II constructions, except for those giving access to lamp caps or live parts in socket-outlets of class I tools, the test pin of Figure 2 is applied without appreciable force. It shall not be possible to touch live parts with the test pin.*

9.4 *In addition, class II tools and class II constructions shall be so constructed and enclosed that there is adequate protection against accidental contact with basic insulation, and metal parts separated from live parts by basic insulation only.*

Parts which are not separated from live parts by double insulation or reinforced insulation shall not be accessible.

Compliance is checked by inspection and by applying the test finger of Figure 1.

This requirement applies for all positions of the tool when it is operated as in normal use, even after removal of detachable parts.

10 Starting

10.1 Motors shall start under all normal voltage conditions which may occur in use.

Compliance is checked by operating the tool with no-load 10 times at a voltage equal to 0,85 times rated voltage, regulating devices, if any, being set as in normal use.

In all cases, the tool shall function safely and correctly.

10.2 Centrifugal and other automatic starting switches shall operate reliably, and without contact chattering.

Tools provided with a centrifugal or other automatic starting switch are, in addition, operated 10 times at a voltage equal to 1,1 times rated voltage. The interval between consecutive starts is made sufficiently long to prevent undue heating.

In all cases, the tool shall function safely and correctly.

10.3 Overload protection devices shall not operate under normal starting conditions.

The tests of 10.1 and 10.2 check compliance with this requirement.

11 Input and current

The rated power input or rated current shall be at least 110 % of the measured no-load input or current.

For tools marked with one or more rated voltage ranges, the test is made at both the upper and lower limits of the ranges, unless the marking or the rated power input is related to the mean value of the relevant voltage range, in which case the test is made at a voltage equal to the mean value of that range.

Compliance is checked by measuring the power input or current of the tool when stabilized while all circuits which can operate simultaneously are in operation.

12 Heating

12.1 Tools shall not attain excessive temperatures under normal load.

Compliance is checked by determining the temperature rise of the various parts under the conditions specified in 12.2 to 12.5 immediately followed by the test of Clause 13 with the tool in the "on" position and under the following conditions.

For single-phase tools and for three-phase tools suitable for single-phase supply: S1 of Figure 3 in the "on" position, for three-phase tools with the three sections connected in parallel.

For three-phase tools not suitable for single-phase supply:

a, b and c in Figure 4 in the "on" position, repeated with each of the switches a, b, c open in turn, the other two switches being closed.

For heating elements, the measurements are repeated with each of the switches a, b and c open in turn, the other two switches being closed.

12.2 *The tool is operated in still air under normal load. While the torque is maintained, the voltage is then adjusted to 0,94 times the rated voltage or 1,06 times the rated voltage, or the mean of the rated voltage range, whichever is the most unfavourable.*

Heating elements, if any, are operated under the conditions specified in Clause 11 of IEC 60335-1, when the tool is operated at a voltage equal to 1,06 times rated voltage.

12.3 *Temperature rises, other than those of windings, are determined by means of fine-wire thermocouples so chosen and positioned that they have the minimum effect on the temperature of the part under test.*

The temperature rise of electrical insulation, other than that of windings, is determined on the surface of insulation, at places where failure could cause a short circuit, contact between live parts and accessible metal parts, bridging of insulation, or reduction of creepage distances or clearances below the values specified in 28.1.

Temperature rises of windings are determined by the resistance method, unless the windings are non-uniform, or the method involves severe complications to make the necessary connections for the resistance measurement. In that case, the measurement is made by thermocouples.

Such temperature rises are determined by means of fine-wire thermocouples so chosen and positioned that they have the minimum effect on the temperature of the part under test.

In determining the temperature rises of handles, knobs, grips and the like, consideration is given to all parts which are gripped in normal use, and, if of insulating material, to those parts in contact with hot metal.

NOTE 1 If it is necessary to dismantle the tool to position thermocouples, the power input is measured again to check that the tool has been correctly reassembled.

NOTE 2 The point of separation of the cores of a multicore cord is an example of a place where thermocouples are positioned.

12.4 *The tool is operated:*

- *for the rated operating time for tools for short time operation;*
- *on consecutive cycles of operation, until steady conditions are established, for tools for intermittent operation, the "on" and "off" periods being the rated "on" and "off" periods;*
- *until steady conditions are established for tools for continuous operation.*

12.5 *During the test, protective devices shall not operate. The temperature rises shall not exceed the values shown in Table 1, except as allowed by 12.6.*

Sealing compound, if any, shall not flow out.

Table 1 – Maximum normal temperature rises

Parts	Temperature rise K
Windings ^{a)} , if the winding insulation according to IEC 60085 is:	
– class 105	75 (65)
– class 120	90 (80)
– class 130	95 (85)
– class 155	115
– class 180	140
– class 200	160
– class 220	180
– class 250	210
Pins of appliance inlets:	
– for hot conditions	95
– for cold conditions	40
Ambient of switches, temperature limiters ^{b)} :	
– without T-marking	30
– with T-marking	T-25
Rubber or polyvinyl chloride insulation of internal and external wiring, including supply cords:	
– without temperature rating ^{c)}	50
– with temperature rating (T)	T-25
Cord sheath used as supplementary insulation	35
Rubber, other than synthetic, used for gaskets or other parts, the deterioration of which could affect safety:	
– when used as supplementary insulation or as reinforced insulation	40
– in other cases	50
Lampholders E14 and B15:	
– metal or ceramic type	130
– insulated type, other than ceramic	90
– with T-marking	T-25
Material used as insulation other than that specified for wires and windings ^{d)}	
– impregnated or varnished textile, paper or press board	70
– laminates bonded with:	
• melamine-formaldehyde; phenol-formaldehyde or phenol-furfural resins	85 (175)
• urea-formaldehyde resin	65 (150)
– printed circuit boards bonded with epoxy resin	120
– moulding of:	
• phenol-formaldehyde with cellulose fillers	85 (175)
• phenol-formaldehyde with mineral fillers	100 (200)
• melamine-formaldehyde	75 (175)
• urea-formaldehyde	65 (150)
– polyester with glass-fibre reinforcement	110
– silicone rubber	145
– polytetrafluoroethylene	265
– pure mica and tightly sintered ceramic material when such materials are used as supplementary insulation or reinforced insulation	400
– thermoplastic material ^{e)}	–

Table 1 (continued)

Wood, in general ^{f)}	65
Outer surface of capacitors ^{g)} :	
– with marking of maximum operating temperature (T)	T-25
– without marking of maximum operating temperature:	
• small ceramic capacitors for radio and television interference suppression	50
• capacitors complying with IEC 60384-14 or 14.2 of IEC 60065	50
• other capacitors ^{g)}	20
External enclosure of tools without heating elements except handles held in normal use	60
Handles, knobs, grips and the like which, in normal use, are continuously held:	
– of metal	30
– of porcelain or vitreous material	40
– of moulded material, rubber or wood	50
Handles, knobs, grips and the like which, in normal use, are held for short periods only (e.g. switches):	
– of metal	35
– of porcelain or vitreous material	45
– of moulded material, rubber or wood	60
Parts in contact with oil having a flash-point of t °C	t-50
^{a)} To allow for the fact that the average temperature of windings of universal motors, relays, solenoids, etc., is usually above the temperature at the points on the windings where thermocouples are placed, the figures without parentheses apply when the resistance method is used, and those within parentheses apply when thermocouples are used. For windings of vibrator coils and a.c. motors, the figures without parentheses apply in both cases. For motors constructed so that the circulation of the air between the inside and the outside of the case is prevented, but not necessarily sufficiently enclosed to be called airtight, the temperature rise limits may be increased by 5 K. ^{b)} T signifies the maximum operating temperature. The ambient temperature of switches, thermostats and temperature limiters is the temperature of the air at the hottest point at a distance of 5 mm from the surface of the switch and component concerned. For the purpose of this test, switches and thermostats marked with individual ratings may be considered as having no marking for the maximum operating temperature, if requested by the tool manufacturer. ^{c)} This limit applies to cables, cords and wires complying with the relevant IEC standards; for others, it may be different. ^{d)} The values in parentheses apply, if the material is used for handles, knobs, grips and the like, and is in contact with hot metal. ^{e)} There is no specific limit for thermoplastic material, which has to withstand the tests of 29.1, for which purpose the temperature rise must be determined. ^{f)} The limit specified concerns the deterioration of wood, and it does not take into account deterioration of surface finishes. ^{g)} There is no limit for the temperature rise of capacitors which are short-circuited in 18.10. If these or other materials are used, they shall not be subjected to temperatures in excess of the thermal capabilities as determined by ageing tests made on the materials themselves.	

Table 1 (continued)

The value of the temperature rise of a winding is calculated from the formula:

$$\Delta t = \frac{R_2 - R_1}{R_1} (k + t_1) - (t_2 - t_1)$$

where

Δt is the temperature rise;

R_1 is the resistance at the beginning of the test;

R_2 is the resistance at the end of the test;

k is equal to 234,5 for copper windings, and 225 for aluminium windings;

t_1 is the ambient temperature at the beginning of the test;

t_2 is the ambient temperature at the end of the test.

At the beginning of the test, the windings are to be at ambient temperature. It is recommended that the resistance of windings at the end of the test be determined by taking resistance measurements as soon as possible after switching off, and then at short intervals so that a curve of resistance against time can be plotted for ascertaining the resistance at the instant of switching off.

12.6 If the windings are classified according to IEC 60085 and the temperature rise does not exceed the value in Table 1, the following test is not necessary.

Three additional samples are subjected to the following tests.

- a) *The samples are dismantled as far as is possible without damaging any part. Windings are kept for 10 days (240 h) in a heating cabinet, the temperature of which is $(80 \pm 1)^\circ\text{C}$ in excess of the temperature rise of the windings determined according to 12.3.*
- b) *After this treatment, the samples are reassembled and no interturn short circuit shall occur. Interturn short circuits may be detected by means of a winding tester.*
- c) *The samples are then subjected to a humidity treatment as specified in 14.3.*
- d) *After this treatment, they shall withstand the tests of Clauses 13 and 15.*

Faults which may occur in insulation, which did not show an excessive temperature rise during the test of 12.3, are ignored and are repaired, if necessary, in order to complete the tests of this subclause.

13 Leakage current

13.1 The leakage current shall not be excessive.

Compliance is checked by the following test at a supply voltage equal to 1,06 times rated voltage.

The leakage current test is made with a.c. unless the tool is for d.c. only, in which case the test is not made.

Protective impedance is disconnected from live parts before carrying out the tests.

It is recommended that the tool be supplied through an isolating transformer; otherwise, it must be insulated from earth.