

Safety of transportable motor-operated tools

Part 1. General requirements

The European Standard EN 61029-1 : 1995 has the status of a
British Standard

ICS 25.140.20

Committees responsible for this British Standard

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Association of Control Manufacturers (TACMA (BEAMA Ltd.))
Association of Manufacturers Allied to the Electrical and Electronic Industry (BEAMA Ltd.)
Consumer Policy Committee of BSI
Consumers' Association
Department of Trade and Industry (Consumer Safety Unit, CA Division)
Electricity Association
Health and Safety Executive
Hire Association Europe
Institution of Incorporated Executive Engineers
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Coopted members

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National foreword

This British Standard has been prepared by Subcommittee CPL/61/6 and is the English language version of EN 61029-1 : 1995 *Safety of transportable motor-operated tools Part 1: General requirements*, published by the European Committee for Electrotechnical Standardization (CENELEC). It was derived by CENELEC from IEC 1029-1 : 1990 published by the International Electrotechnical Commission (IEC) which has the same title. The CENELEC common modifications have been implemented at appropriate places in the text and are indicated by a side line in the margin. Parts of the original IEC text that have been modified by CENELEC have been quoted in national annex NA.

This standard should be read in conjunction with the relevant Part 2.¹⁾

The relevant essential safety requirements of the following European directives are covered by this standard:

73/23/EEC	Low Voltage Directive,
89/392/EEC	Machinery Directive.

For tools intended to be used in locations where special conditions prevail, as in ships and vehicles, and in hazardous locations, for example, where explosions are liable to occur, requirements additional to those specified in this standard may be necessary.

This standard calls for test procedures that may be injurious to safety or health if adequate precautions are not taken when conducting tests.

Cross-references

Publication referred to Corresponding British Standard

EN 50144-1 : 1995	BS EN 50144 <i>Safety of hand-held motor operated electric tools Part 1 General requirements</i>
EN 60065 : 1993	BS EN 60065 : 1994 <i>Safety requirements for mains operated electronic and related apparatus for household and similar general use</i>
EN 60127-3 : 1991 (IEC 127-3 : 1988)	BS EN 60127 <i>Miniature fuses Part 3 : 1991 Specification for sub-miniature fuse-links</i>
EN 60204-1 : 1992	BS EN 60204 <i>Safety of machinery. Electrical equipment of machines Part 1 : 1993 Specification for general requirements</i>
EN 60309-1 : 1992	BS EN 60309 <i>Plugs, socket-outlets and couplers for industrial purposes Part 1 : 1992 General requirements</i>
EN 60309-2 : 1992	BS EN 60309 <i>Plugs, socket-outlets and couplers for industrial purposes Part 2 : 1992 Dimensional interchangeability requirements for pin and contact-tube accessories of harmonized configurations</i>
EN 60320-1 : 1987 (IEC 320 : 1981)	BS 4491 <i>Appliance couplers for household and similar general purposes Part 1 : 1989 Specification for general requirements</i>
EN 60335-1 : 1994	BS EN 60335 <i>Specification for safety of household and similar electrical appliances Part 1 : 1995 General requirements</i>
EN 60529 : 1991 (IEC 529 : 1989)	BS EN 60529 : 1992 <i>Specification for degrees of protection provided by enclosures (IP code)</i>
EN 61058-1 : 1992 (IEC 1058-1 : 1990)	BS EN 61058 <i>Switches for appliances Part 1 : 1992 General requirements</i>
HD 21 } HD 22 }	BS 6500 : 1994 <i>Specification for insulated flexible cords and cables</i>

¹⁾ In preparation by CENELEC.

HD 495 S1
(IEC 817 : 1984)
IEC 384-14 : 1993

BS 7003 : 1988 *Specification for spring-operated impact-test apparatus and its calibration*
BS 6201 *Fixed capacitors for use in electronic equipment*
Part 3 : 1982 *Specification for fixed capacitors for radio interference suppression. Selection of test methods and general requirements*

Product certification. Users of this British Standard are advised to consider the desirability of third party certification of product conformity with this British Standard based on testing and continuing surveillance, which may be coupled with assessment of a supplier's quality systems against the appropriate Part of BS EN ISO 9000.

Enquiries as to the availability of third party certification schemes will be forwarded by BSI to the Association of British Certification Bodies. If a third party certification scheme does not already exist, users should consider approaching an appropriate body from the list of association members.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

ICS 25.140.20

Descriptors: Transportable motor-operated electric tools, safety requirements, protection against electric shock, fire protection, protection against mechanical hazards

English version

Safety of transportable motor-operated electric tools Part 1: General requirements

(IEC 1029-1 : 1990, modified)

Sécurité des machines-outils électriques
semi-fixes
Partie 1: Règles générales
(CEI 1029-1 : 1990, modifiée)

Sicherheit transportabler motorbetriebener
Elektrowerkzeuge
Teil 1: Allgemeine Anforderungen
(IEC 1029-1 : 1990, modifiziert)

This European Standard was approved by CENELEC on 1994-07-05. 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.

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CENELEC

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

Central Secretariat: rue de Stassart 35, B-1050 Brussels

Foreword

This European Standard has been prepared by Technical Committee CENELEC TC 61F, Hand-held and transportable electric motor operated tools.

The draft, consisting of the text of the International Standard IEC 1029-1 : 1990 with common modifications, was submitted to the Unique Acceptance Procedure (UAP) in March 1993 and was approved by CENELEC as EN 61029-1 on 1994-07-05.

NOTE. Finland and Sweden have no obligation to implement this European Standard.

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) 1996-05-15
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1996-12-01

As far as certification is concerned, CENELEC Memorandum 6 applies.

Part 1 of this standard together with related Parts 2 give directly or by reference the complete requirements for a specific type of transportable tool considered in the scope. CEN have proposed standards for a wide range of industrial machines which may extend to transportable machines. Although CEN and CENELEC have where appropriate used common solutions to provide uniform levels of production, persons using this standard should check the scope of both this and the corresponding CEN standard to ensure that the correct standard is used.

The relevant essential safety requirements of the following European directives are covered by this standard:

- 73/23/EEC — Low Voltage Directive;
- 89/392/EEC — Machinery Directive.

Annexes designated 'normative' are part of the body of the standard. Annexes designated 'informative' are given only for information. In this standard, annexes A, B, C and D are normative and annexes IA and ZA are informative.

The reference of subclauses, notes and annexes which are in addition to those in IEC 1029-1 is prefixed with the letter Z.

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SAFETY OF TRANSPORTABLE MOTOR-OPERATED ELECTRIC TOOLS

Part 1: General requirements

INTRODUCTION

| This European Standard is divided into two parts:

Part 1: General requirements, comprising clauses of a general character.

Part 2: Particular requirements, dealing with particular types of tools.

The clauses of these particular requirements supplement or modify the corresponding clauses in part 1.

Where the text of part 2 indicates an "addition" to or a "replacement" of the relevant requirement, test specification or explanation of part 1, these changes are made to the relevant text of part 1, which then becomes part of the standard. Where no change is necessary, the words "This clause of part 1 is applicable" are used in part 2.

This standard only applies when a part 2 for a particular type of tool exists. Part 1 alone does not apply.

1 Scope

1.1 This standard applies to electric motor-operated or magnetically-driven tools, intended for indoor and for outdoor use, which have all the following characteristics:

- a) easily moved by one person, simple devices to facilitate transportation may be incorporated, e.g. handles, wheels and the like;
- b) used in a safe stationary position with or without fixing, e.g. fast clamping devices, bolting and the like;
- c) used under the control of an operator;
- d) not intended for continuous production or production line use;
- e) intended to be connected to electric supply by a flexible cord and a plug;
- f) maximum rated voltage not exceeding 250 V single-phase, a.c. or d.c., or 440 V three-phase, a.c.;
- g) maximum rated input not exceeding 2 500 W, for single-phase a.c. or d.c., and 4 000 W for three-phase a.c.

NOTES

1 These tools are commonly known as "transportable motor-operated electric tools", hereinafter referred to, in the text, as tools. Examples of these tools are given in the footnote.*

2 Additional special driving mechanisms for cooling pumps and dust-exhaust devices are allowed.

3 When tools are used in locations where special conditions prevail, for example explosive atmospheres or areas where hazards arising from dust and fire are likely to occur, special precautionary measures or special types of construction are necessary.

4 Multifunction tools that have clearly separate modes of operation are required to comply separately with the requirements applicable to each specific mode of operation.

5 This standard does not apply to

- electric motor-operated household and similar electrical appliances according to EN 60335-1;
- hand-held electric motor-operated tools according to EN 50144-1;
- electrical equipment for industrial machine-tools according to EN 60204-1;
- small low voltage transformer operated bench tools intended for model making, e.g. radio controlled model aircraft or cars, etc.;
- food preparation machines.

2 Definitions

For the purpose of this International Standard, the following definitions apply.

NOTE - Where the terms "voltage" and "current" are used, they imply the r.m.s. value unless otherwise specified.

* Circular saws, band saws, planers, thicknessers, radial arm saws, spindle moulders, fret saws, jig saws, mitre/chop saws, wood lathes, belt sanders, disc sanders, thicknessers-planers, chain mortisers, multipurpose machines, combing machines, metal lathes, bench grinders, bench drilling machines, pipe threaders, pipe benders, pipe saws, key cutting machines, sharpening machines, sheet metal shears, concrete drills, concrete saws, wood shredders, pipe cleaners.

2.1 rated voltage: Voltage (for three-phase supply, the voltage between phases) assigned to the tool by the manufacturer.

2.2 rated voltage range: Voltage range assigned to the tool by the manufacturer, expressed by its lower and upper limits.

2.3 working voltage: Maximum voltage to which the part under consideration can be subjected when the tool is operating at its rated voltage and under normal conditions of use.

NOTES

1 Normal conditions of use include changes of voltage within the tool imposed by likely occurrences such as the operation of a circuit breaker or the failure of a lamp.

2 When determining the working voltage, the effect of possible transient voltages on the supply mains is ignored.

2.4 rated input: Input at rated voltage or the mean of the rated voltage range assigned to the tool by the manufacturer.

2.5 rated current: Current at rated voltage or at the mean of the rated voltage range assigned to the tool by the manufacturer.

NOTE - If no current is assigned to the tool, the rated current for the purpose of this standard is determined by calculation from the rated input and the rated voltage and/or by measuring the current when the tool is operating at rated voltage under normal load and at normal operating temperature.

2.6 rated frequency: Frequency assigned to the tool by the manufacturer.

2.7 rated frequency range: Frequency range assigned to the tool by the manufacturer, expressed by its lower and upper limits.

2.8 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.

2.9 detachable flexible cord: Flexible cord, for supply or other purposes, intended to be connected to the tool by means of a suitable appliance coupler.

NOTE - Cord sets are covered by EN 60799. Appliance couplers for household and similar general purposes by EN 60320-1.

2.10 power supply cord: Flexible cord, for supply purposes, fixed to, or assembled with, the tool according to one of the following methods:

- **type X attachment:** Method of attachment such that the flexible cord can easily be replaced, without the aid of special purpose tools, by a flexible cord not requiring any special preparation;
- **type M attachment:** Method of attachment such that the flexible cable or cord can easily be replaced, without the aid of special purpose tools, by a special cord with, for example, a moulded-on cord or crimped terminations.

2.11 basic insulation: Insulation applied to live parts to provide basic protection against electric shock.

NOTE - Basic insulation does not necessarily include insulation used exclusively for functional purposes.

2.12 supplementary insulation: Independent insulation applied in addition to the basic insulation, in order to ensure protection against electric shock in the event of a failure of the basic insulation.

2.13 double insulation: Insulation comprising both basic insulation and supplementary insulation.

2.14 reinforced insulation: Single insulation system applied to live parts, which provides a degree of protection against electric shock equivalent to double insulation under the conditions specified in this standard.

NOTE - The term "single insulation system" does not imply that the insulation must be one homogeneous piece. It may comprise several layers which cannot be tested singly as supplementary or basic insulation.

2.15 class I tool: Tool in which protection against electric shock does not rely on basic insulation only, but which includes an additional safety precaution in such a way that means are provided for the connection of accessible conductive parts to the protective (earthing) conductor in the fixed wiring of the installation in such a way that accessible conductive parts cannot become live in the event of a failure of the basic insulation.

NOTES

1 For tools intended for use with a flexible cord, the provision includes a protective conductor as part of the flexible cord.

2 Class I tools may have parts with double insulation or reinforced insulation or parts operating at safety extra-low voltage.

2.16 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.

Such a tool may be of one of the following types:

a) a tool having a durable and substantially continuous enclosure of insulating material which envelopes all metal parts, with the exception of small parts, such as nameplates, screws and rivets, which are isolated from live parts by insulation at least equivalent to reinforced insulation; such a tool is called an insulation-encased class II tool;

b) a tool having a substantially continuous metal enclosure, in which double insulation is used throughout, except for those parts where reinforced insulation is used, because the application of double insulation is manifestly impracticable; such a tool is called a metal-encased class II tool;

c) a tool which is a combination of types a) and b).

2.17 class III tool: Tool in which protection against electric shock relies on supply at safety extra-low voltage (SELV) and in which voltages higher than those of SELV are not generated.

NOTE - Tools intended to be operated at safety extra-low voltage and having internal circuits which operate at a voltage other than safety extra-low voltage (SELV), are not included in the classification and are subject to additional requirements; these requirements are under consideration.

2.18 extra-low voltage: Voltage supplied from a source within the tool and, when the tool is operated at its rated voltage, not exceeding 42 V between conductors and between conductors and earth or, for three-phase supply, not exceeding 24 V between conductors and neutral, the extra-low voltage circuit being separated from other circuits by basic insulation only.

2.19 safety extra-low voltage (SELV): Nominal voltage not exceeding 42 V between conductors and between conductors and earth or, for three-phase supply, not exceeding 24 V between conductors and neutral, the no-load voltage not exceeding 50 V and 29 V respectively.

NOTES

1 When SELV is obtained from the supply mains, it must be through a safety isolating transformer or a convertor with separate windings.

2 The voltage limits specified are based on the assumption that the safety isolating transformer is operated at its rated supply voltage.

3 The d.c. value is under consideration.

4 Limitations to voltages lower than 50 V a.c. should be specified in the particular standards, especially when direct contact with live parts is involved.

5 Separation from the mains by protective impedance is excluded.

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

2.21 normal load: Load to be applied to a tool so that the stress imposed corresponds to that occurring under normal conditions of use, any marking of short-time or intermittent operation being observed and, unless otherwise specified, heating elements, if any, being operated as in normal use.

NOTE - The normal load is based on the rated voltage or on the upper limit of the rated voltage range.

2.22 rated operating time: Operating time assigned to the tool by the manufacturer.

2.23 continuous operation: Operation under normal load for an unlimited period.

2.24 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 room temperature.

2.25 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.

2.26 non-detachable part: Part which can only be removed with the aid of a tool.

NOTE - 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" occur, the word "tool" means a screwdriver, a coin or any other object which may be used to operate a screw or similar fixing means.

2.27 detachable part: Part which can be removed without the aid of a tool.

2.28 thermal cut-out: Device which, during abnormal operation, limits the temperature of a tool, or of parts of it, by automatically opening the circuit or by reducing the current, and which is so constructed that its setting cannot be altered by the user.

2.29 non-self-resetting thermal cut-out: Thermal cut-out which requires resetting by hand, or replacement of a part, in order to restore the current.

2.30 creepage distance: Shortest path between two conductive parts, or between a conductive part and the bounding surface of the tool, measured along the surface of the insulating material.

2.31 clearance: Shortest distance between two conductive parts, or between a conductive part and the bounding surface of the tool, measured through air.

NOTE - The bounding surface of the tool is the outer surface of the enclosure, considered as though metal foil were pressed into contact with accessible surfaces of insulating material.

2.32 all-pole disconnection: For single-phase a.c. tools and for d.c. tools, disconnection of both supply conductors by a single switching action or, for tools to be connected to more than two supply conductors, disconnection of all supply conductors, except the earthed (grounded) conductor, by a single switching action.

NOTE - The protective earthing conductor is not a supply conductor.

2.33 accessible part or accessible surface: Part or surface which can be touched by means of the standard test finger shown in figure 1.

NOTES

1 For accessible metal parts, it includes any other metal part which is in electrical contact with such parts.

2 The term body includes all accessible metal parts, shafts of handles, knobs, grips and the like and metal foil in contact with all surfaces of insulating material; it does not include inaccessible metal parts.

2.34 power circuit: Circuit which contains electrical equipment intended for generation, transformation, distribution or consumption of electric energy.

2.35 control circuit: Auxiliary circuit which is used to control electrical equipment.

2.36 control device: Device, for example push-buttons, selector switches, which is used to control, by hand, the function of the tool.

3 General requirement

3.1 Tools shall be so designed and constructed that in normal use they function safely so as to cause no danger to persons or to the surroundings, even in the event of such careless use which is likely to occur in normal service.

In general, compliance is checked by carrying out all the relevant tests.

NOTES

Z1 The material used for the construction of the tool should not introduce additional hazards during use or disposal of the tool.

Z2 The risks due to noise and vibration should be reduced to the lowest level practicable, taking into account the appropriate European standards.

Z3 If laser equipment is supplied as part of the tool there should be no risk to health due to its use, taking into account the appropriate European standards.

4 General notes on tests

4.1 *Tests according to this standard are type tests.*

4.2 *Unless otherwise specified, tests are carried out on a single test sample as delivered, the said sample withstanding all the relevant tests.*

NOTES

1 Where the tool is designed for varying supply voltages, for both a.c. and d.c. and for different speeds, etc., then more than one sample may be required.

2 When testing a tool in accordance with EN 60529 a further test sample is required when the type of protection concerned involves a higher degree of severity than IP20.

3 Testing of components may necessitate the submission of additional samples of the said components. When the submission of such samples is necessary, they should be submitted together with the tool.

4.3 *Unless otherwise specified, tests are carried out in the order of the clauses in which they are given in this standard.*

Prior to testing, the tool shall be operated at rated voltage or at the lower limit of its rated voltage range in order to verify that it is in working order.

4.4 *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.*

4.5 If the test results are influenced by the temperature of the ambient air, the room temperature is, in general, maintained at $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$. If, however, the temperature attained by any part is limited by a temperature sensitive device, or is influenced by the temperature at which a change of state occurs, for example the temperature of boiling water, the room temperature is, in case of doubt, maintained at $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$.

4.6 Tools for a.c. only are tested with a.c., at rated frequency, if marked; those for d.c. only are tested with d.c. 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 are marked with a frequency range of 50 Hz to 60 Hz are tested with either 50 Hz or 60 Hz, whichever is the national frequency.

Tools marked with a rated frequency range other than 50 Hz to 60 Hz are tested at the most unfavourable frequency within the range.

Tools designed for more than one rated voltage are tested at the most unfavourable voltage.

Unless otherwise specified, tools designed for one or more rated voltage ranges are tested at the most unfavourable voltage within the relevant range.

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.*

NOTE 1 - Where reference is made to the maximum or minimum rated input, the rated input related to the upper limit or lower limit respectively of the rated voltage range is meant.

When testing tools for d.c. only, the possible influence of polarity on the operation of the tools is taken into consideration.

NOTE 2 - If the tool is designed for 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.

4.7 Tools for which alternative heating elements or accessories are available are tested in accordance with the relevant part 2, with those elements or accessories which give the most unfavourable results, provided that the elements or accessories used are within the tool manufacturer's specification.

4.8 *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, and tested according to EN 60335-1.*

4.9 *Unless otherwise specified, tools provided with a regulating device or similar control are tested with these controls adjusted to their most unfavourable setting, if the setting can be altered by the user.*

NOTES

1 If the adjusting means of the control is accessible without the aid of a tool, this sub-clause 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, this sub-clause applies only if the setting can be altered by hand.

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

4.10 *When the conditions of normal load are specified in part 2, the tool is loaded according to these conditions, irrespective of any marking of short-time or intermittent operation, unless it is evident from the design of the tool that these conditions will not occur in normal use.*

When the conditions of normal load are not specified in part 2, the tool is loaded according to the manufacturer's instructions; in the absence of such instructions, the tool is operated continuously at a load such that rated input is attained.

For accessories performing a function which is within the scope of one part 2, the tests are made in accordance with that part 2.

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

Electronic speed control devices are set for the highest speed.

NOTE - The introduction of tests to be made at other settings is under consideration.

4.11 When the normal load or the loading conditions are not specified in a part 2, only the test at rated input applies.

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

4.13 *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.*

4.14 *For the purpose of clauses 8, 15, 23 and 25, parts separated from live parts by double insulation or reinforced insulation are not regarded as likely to become live in the event of an insulation fault; connection of accessible metal parts to an earthing terminal or earthing contact does not remove the necessity for carrying out these tests.*

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

4.16 *Unless otherwise specified, 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.*

4.17 *For tools incorporating electronic circuits, see annex C.*

5 Rating

5.1 The maximum rated voltage is

- 250 V for single-phase a.c. or d.c. tools;
- 440 V for three-phase tools.

Compliance is checked by inspection of the marking.

For class III tools the preferred values of the rated voltage are 24 V and 42 V.

6 Classification

Tools are classified

6.1 According to protection against electric shock:

- class I tools;
- class II tools;
- class III tools.

6.2 According to degree of protection against ingress of foreign bodies and moisture in accordance with EN 60529.

7 Marking

7.1 Tools shall be marked with

- rated voltage(s) or rated voltage range(s) in volts;

- symbol for nature of supply, if applicable;
- rated frequency or rated frequency range, in hertz, unless the tool is designed for d.c. only or for a.c. of both 50 Hz and 60 Hz;
- rated input in W or kW, or rated current in amperes;
- rated current in A, if greater than 10 A;
- manufacturer's or responsible vendor's name, trade mark or identification mark;
- manufacturer's address or country of origin;
- manufacturer's or responsible vendor's model or type reference and serial number, if any;
- rated operating time, or rated operating time and rated resting time, in h, min or s, if applicable;
- symbol for class II construction, for class II tools only;
- symbol for degree of protection against foreign bodies and moisture if greater than IP20.
- any mandatory mark showing compliance with legislation by reference to this standard.

NOTES

1 Tools for star-delta connection should be clearly marked with the two voltages (e.g. 230 Δ /400 Y).

2 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.

3 If a tool has alternative components which can be selected by a control device, the rated input is that corresponding to the highest loading possible.

4 Additional markings are allowed, provided that they do not give rise to misunderstanding. If the motor of a tool is marked separately, the marking of the tool and that of the motor should be such that there can be no doubt with regard to the rating and manufacturer of the tool itself.

7.2 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 or by the description of normal load given in part 2.

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.

7.3 For tools with heating elements incorporated, the complete marking for heating elements required in EN 60335-1 shall, in addition, be given on the marking plate of the tool.

7.4 If the tool can be adjusted to suit different rated voltages or different rated inputs, the voltage or input to which the tool is adjusted shall be easily and clearly discernible.

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

NOTE - For tools where frequent changes in voltage setting are not required, this requirement is deemed to be met if the rated voltage or the rated input 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. This diagram may be on a card which is riveted to the cover or on a paper or similar label secured to the cover by an adhesive but it shall not be on a label loosely attached to the tool.

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

The upper and lower limits of the rated 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 input may be related to the mean value of this range.

7.6 When symbols are used, they shall be as follows:

V	.....	volts
A	.....	amperes
Hz	.....	hertz
W	.....	watts
kW	.....	kilowatts
μF	.....	microfarads
l	.....	litres
kg	.....	kilograms
N/cm ²	.....	newtons per square centimetre
Pa	.....	pascals
h	.....	hours
min	.....	minutes
s	.....	seconds
	.....	alternating current
3	.....	three-phase alternating current
3N	.....	three-phase alternating current with neutral
==	.....	direct current
n ₀	.....	no-load speed
	.....	class II tools
IPXX	.....	degree of protection
min ⁻¹ or .../min	.....	revolutions or reciprocations per minute

The symbol for nature of supply shall be placed next to the marking for rated voltage.

The dimensions of the symbol of class II 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.

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.

7.7 Terminals intended exclusively for the neutral conductor shall be marked with the letter N.

Earthing terminals shall be marked with the symbol .

This marking shall not be positioned on screws, removable washers or other parts which might be removed and forgotten when conductors are connected.

7.8 The different positions of regulating devices and different positions of switches on tools shall be indicated by numerals, letters or other visual means.

If figures are used for indicating the different positions, the "OFF" position shall be indicated by the symbol "0" and the position for a greater output, input, speed, etc. shall be indicated by a higher numeral or appropriate symbol.

Where push-buttons are used the "OFF" position shall be marked with the figure "0" and the actuator shall, in addition, be red.

The "ON" position shall be marked with the figure "1" and the actuator may be any colours except red.

Switches without locking means need not be marked, if their intended operation is obvious.

Manual reset buttons of thermal cut-outs incorporated in motors are exempt from the requirements of this sub-clause provided these cannot be mistaken for main controls.

7.9 Marking shall be easily legible and durable.

Marking specified in 7.1 to 7.12 shall be on a main part of the tool in such a way that it is clearly discernible when the tool is ready for use.

NOTE 1 - Self-adhesive labels glued in recesses in the body of the tool or on a surface where they cannot be damaged during normal use are allowed for tools with degree of protection IPX0.

Marking on, and indications for, switches, thermostats, thermal cut-outs and other control devices shall be placed in the vicinity of these components; they shall not be placed on removable parts if these parts can be replaced in such a way that the marking is misleading.

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

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

The petroleum spirit to be used for the test is aliphatic solvent hexane having a maximum aromatics content of 0,1% by volume, a kauri-butanol value of 29, an initial boiling point of approximately 65 °C, a dry point of approximately 69 °C and a specific mass of approximately 0,66 kg/l.

7.10 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.

NOTES

- 1 An indication of + and - is considered to be sufficient.
- 2 The requirement does not apply to a regulating device provided with an adjusting means if its "fully-on" position is opposite to its "OFF" position.
- 3 The indication for the different positions of the operating means of a control device need not be placed on the device itself.

7.11 Unless it is obviously unnecessary, switches shall be marked or placed so 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.

7.12 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.

NOTES

- 1 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.
- 2 For tools for star-delta connection, the wiring diagram should show how the windings are to be connected.
- 3 The connection diagram may be that referred to in 7.4

7.13

A handbook or information sheet to cover the subjects listed below, as applicable, shall be provided with the tool by the manufacturer or supplier. It shall be written in the official language(s) of the country in which the tool is sold.

The subjects are:

a) Installation instructions

- 1 – Unpacking and assembly.
- 2 – Setting-up or fixing the tool in a stable position as appropriate.
- 3 – Connection to the 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 work piece.
- 5 – General instructions for use.

c) Safety precautions

- 1 – Precautions and use protective clothing (where necessary).
- 2 – Special safety precautions.
- 3 – Dust extraction.
- 4 – Guards: security and adjustment.
- 5 – General safety instructions.

These shall consist of the following text:

'WARNING ! When using electric tools basic safety precautions should always be followed to reduce the risk of fire, electric shock and personal injury, including the following.

Read all these instructions before attempting to operate this product and save these instructions'.

d) Maintenance and servicing

- 1 Regular cleaning, maintenance and lubrication.
(Which shall include the warning 'Remove the plug before carrying out any adjustment, servicing or maintenance').
- 2 – Servicing by manufacturer or agent; list of addresses.
- 3 – List of user replaceable parts.
- 4 – Special tools which may be required.

e) Safe operation

- 1 – Keep work area clear
 - Cluttered areas and benches invite injuries.
- 2 – Consider work area environment
 - Do not expose tools to rain.
 - Do not use tools in damp or wet locations.
 - Keep work area well lit.
 - Do not use tools in the presence of flammable liquids or gases.
- 3 – Guard against electric shock
 - Avoid body contact with earthed or grounded surfaces.
- 4 – Keep other persons away
 - Do not let persons, especially children, not involved in the work touch the tool or the extension cord and keep them away from the work area.
- 5 – Store idle tools
 - When not in use, tools should be stored in a dry locked-up place, out of reach of children.
- 6 – Do not force the tool
 - It will do the job better and safer at the rate for which it was intended.
- 7 – Use the right tool
 - Do not force small tools to do the job of a heavy duty tool.
 - Do not use tools for purposes not intended; for example do not use circular saws to cut tree limbs or logs.
- 8 – Dress properly
 - Do not wear loose clothing or jewellery, they can be caught in moving parts.
 - Non-skid footwear is recommended when working outdoors.
 - Wear protective hair covering to contain long hair.
- 9 – Use protective equipment
 - Use safety glasses.
 - Use face or dust mask if cutting operations create dust.
- 10– Connect dust extraction equipment
 - If device are provided for the connection of dust extraction and collecting equipment, ensure these are connected and properly used.
- 11– Do not abuse the cord
 - Never yank the cord to disconnect it from the socket. Keep the cord away from heat, oil and sharp edges.

- 12– Secure work
 - Where possible use clamps or a vice to hold the work. It is safer than using your hand.
- 13– Do not overreach
 - Keep proper footing and balance at all times.
- 14– Maintain tools with care
 - Keep cutting tools sharp and clean for better and safer performance.
 - Follow instructions for lubricating and changing accessories.
 - Inspect tool cords periodically and if damaged have them repaired by an authorized service facility.
 - Inspect extension cords periodically and replace if damaged.
 - Keep handles dry, clean and free from oil and grease.
- 15– Disconnect tools
 - When not in use, before servicing and when changing accessories such as blades, bits and cutters, disconnect tools from the power supply.
- 16– Remove adjusting keys and wrenches
 - Form the habit of checking to see that keys and adjusting wrenches are removed from the tool before turning it on.
- 17– Avoid unintentional starting
 - Ensure switch is in “off” position when plugging in
- 18– Use outdoor extension leads
 - When the tool is used outdoors, use only extension cords intended for outdoor use and so marked.
- 19– Stay alert
 - Watch what you are doing, use common sense and do not operate the tool when you are tired.
- 20– Check damaged parts
 - Before further use of tool, it should be carefully checked to determine that it will operate properly and perform its intended function.
 - Check for alignment of moving parts, binding of moving parts, breakage of parts, mounting and any other conditions that may affect its operation.
 - A guard or other part that is damaged should be properly repaired or replaced by an authorized service centre unless otherwise indicated in this instruction manual.
 - Have defective switches replaced by an authorized service centre.
 - Do not use the tool if the switch does not turn it on and off.
- 21– Warning
 - The use of any accessory or attachment other than one recommended in this instruction manual may present a risk of personal injury.
- 22– Have your tool repaired by a qualified person
 - This electric tool complies with the relevant safety rules. Repairs should only be carried out by qualified persons using original spare parts, otherwise this may result in considerable danger to the user.

The following information shall also be given:

- The name and address of the manufacturer;
- The manufacturer's model or type reference;
- A repeat of the safety markings (e.g. maximum speed, capacity, etc.) that are to be marked on the tool;

- The noise emission (measured in accordance with 13.2) as follows:
 - a) the continuous A-weighted equivalent sound pressure level at the operator's ear if over 70 dB(A), or a statement to the effect if it does not exceed 70 dB (A);
 - b) the peak C-weighted instantaneous sound pressure level if over 63 Pa (130 dB in relation to 20 μ Pa).
 - c) the sound power level emitted by the tool where the equivalent continuous sound pressure level exceeds 85 dB (A).
- An explanation of any symbols or pictograms marked on the tool;
- The mass of the tool including detachable parts;
- The vibration level to which the arms are subjected, if applicable, (measured in accordance with 13.3) as follows:
 - a) the weighted root mean square acceleration value if it exceeds 2,5 m/s²;
 - b) a statement to the effect if it does not exceed 2,5 m/s².

8 Protection against electric shock

8.1 Tools shall be so constructed and enclosed that there is adequate protection against accidental contact with the live parts and, for class II tools, with metal parts separated from live parts by basic insulation only, even after removal of detachable parts. There shall be, in addition, adequate protection against the risk of contact with basic insulation.

This requirement applies to all positions of the tool, when it is connected and operated as in normal use, even after opening of lids and doors, which can be opened without the aid of a tool and removal of detachable parts.

If a manufacturer instructs the user to remove a part during normal operation or user maintenance, that part is regarded as a detachable part even if a tool has to be used for its removal.

The insulating properties of lacquer, enamel, paper, cotton, oxide film on metal parts, beads, sealing compound and similar coverings shall not be relied upon to give the required degree of protection against accidental contact with live parts.

Enclosures shall have no openings giving access to live parts other than openings necessary for the use and working of the tool, and, for class II tools, to parts separated from live parts by basic insulation only.

NOTE 1 - Unless otherwise specified, parts operating at safety extra-low voltage not exceeding 24 V are not considered to be live parts.

Compliance is checked by inspection and, if necessary, by a test with the test finger shown in figure 1.

In addition, apertures in class II and class I tools, other than those in metal parts connected to an earthing terminal or earthing contact, shall be tested with the test pin shown in figure 2.

After removal of detachable parts, the test finger and the test pin are applied in every possible position, the test finger being applied without appreciable force and the test pin with a force of 10 N.

Apertures preventing the entry of the test finger are further tested by means of a straight unjointed test finger of the same dimensions, which is applied with a force of 50 N; if this finger enters, the test with the test finger shown in figure 1 is repeated, except that the force necessary to push the finger through the aperture is exerted. An electrical contact indicator is used to show contact with live parts.

It shall not be possible to touch bare live parts or live parts protected by lacquer, enamel, paper, cotton, oxide film, sealing compound or similar covering only, with the test finger, nor for class II tools, with the test pin.

For class II tools it shall not be possible to touch metal parts separated from live parts by basic insulation only, with the test finger.

It shall not be possible to touch basic insulation with the test finger.

NOTE 2 - It is recommended that a lamp be used for contact indication and that the voltage used be not less than 40 V.

During introduction or removing of bulbs, direct contact with live parts of the holder shall be prevented.

8.2 Parts providing protection against electric shock shall have adequate mechanical strength and shall not work loose in normal use.

It shall not be possible to remove the said parts without the aid of a tool.

Compliance is checked by inspection, by manual test and by the tests given in clauses 16 and 19.

8.3 Shafts of operating knobs, handles, levers and the like shall not be live.

Compliance is checked by inspection.

8.4 For tools, other than those of class III, handles or knobs of switch-operating means, if of metal, shall either be adequately covered by insulating material or their accessible parts shall be separated from their shafts of fixing by supplementary insulation.

Compliance is checked by inspection.

8.5 For class II tools, capacitors shall not be connected to accessible metal parts.

Metal casings of capacitors shall be separated from the accessible metal parts by supplementary insulation.

Compliance is checked by inspection and by the tests specified for supplementary insulation.

8.6 Tools shall be so designed that, in normal use, there is no risk of electric shock from charged capacitors.

Compliance is checked by the following test which shall be carried out ten times:

The tool is operated at rated voltage or at the upper limit of the rated voltage range. The tool switch, if any, is then moved to the "OFF" position and the tool is disconnected from the supply by withdrawing the plug.

One second after disconnection, the voltage between the pins of the plug shall not exceed 34 V.

NOTES

1 Care should be taken that the voltage is measured with an instrument which does not appreciably affect the value to be measured.

2 Capacitors with a rated capacitance not exceeding 0,1 μF are not considered likely to entail a risk of electric shock. In this case the above-mentioned test may be dispensed with.

9 Starting

9.1 Tools shall start under all normal voltage conditions which may occur in use.

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

Compliance is checked by starting the tool at no load, three times in succession at a voltage equal to 0,85 times rated voltage or the lower limit of the voltage range, regulating devices, if any, being set as in normal use.

Tools provided with a centrifugal or other automatic starting switch shall be, in addition, started three times in succession at a voltage equal to 1,06 times rated voltage or the upper limit of the voltage range. In all cases the tool shall function correctly.

In accordance with 4.5 the test shall be made at $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$.

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

Compliance is checked by the test of 9.1.

10 Input and current

10.1 The input of the tool at rated voltage and under normal load shall not deviate from the rated input by more than the values given in table 1.

Table 1 - Input deviation

Rated input W	Deviation
Up to and including 33,3	+10 W
Over 33,3 up to and including 150	+30%
Over 150 up to and including 300	+45 W
Over 300	+15%

Compliance is checked by measuring the input of the tool operated under normal load at rated voltage or at the mean value of the rated voltage range if the voltage range does not exceed 10% of its mean value.

NOTE - For tools marked with a rated voltage range having limits differing by more than 10% of the mean value of the range, the permissible deviations apply for both limits of the range.

10.2 If the tool is marked with rated current, the current taken by the tool under normal load shall not exceed the rated current by more than 15%.

Compliance is checked by measuring the current taken by the tool operating under normal load conditions, at rated voltage or at the mean value of the rated voltage range, if the voltage range does not exceed 10% of its mean value at rated frequency.

NOTE - For tools marked with a rated voltage range having limits differing by more than 10% of the mean value of the range, the permissible deviations apply for both limits of the range.

11 Heating

11.1 Tools shall not attain excessive temperatures in normal use.

Compliance is checked by determining the temperature rise of the various parts under the following conditions:

11.2 The tool is operated in still air under normal load or under the torque load necessary to attain rated input or under the loading conditions as specified in part 2, whichever causes the higher temperature rise, and at a supply voltage equal to 0,94 times, 1,00 times or 1,06 times rated voltage, whichever is the most unfavourable.

The torque is kept constant at the value recorded when operating at rated voltage, or at the mean of the rated voltage range, under the most unfavourable of the three loading conditions quoted above while the voltage is adjusted to 0,94 or 1,06 times the rated voltage or mean of the rated voltage range.

When applying the torque load necessary to attain rated input, the operating time to be chosen is that specified for normal load.

11.3 Temperature rises of windings are determined by the resistance method unless the windings are non-uniform or it involves severe complications to make the necessary connections for the resistance measurement. In this 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.

The temperature rise of electrical insulation, other than that of windings, is determined on the surface of the 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 27.1.

11.4 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.*

11.5 During the test, thermal cut-outs shall not operate. The temperature rises shall not exceed the values shown in table 2 except as allowed by 11.6.

Sealing compound, if any, shall not flow out.

Table 2 - Temperature rises

Parts	Temperature rise K
Windings¹⁾, and core laminations in contact therewith, if the winding insulation is: - of class A material²⁾ 75 (65) - of class E material²⁾ 90 (80) - of class B material²⁾ 98 (85) - of class F material²⁾ 115 - of class H material²⁾ 140 Ambient of switches and thermostats marked with individual ratings³⁾: - without T-marking 30 - with T-marking T-25 Pins of appliance inlets: - for very hot conditions 130 - for hot conditions 95 - for cold conditions 40 Rubber or polyvinyl chloride insulation of internal and external wiring including power supply cords: - without T-marking 50⁴⁾ - with T-marking T-25⁵⁾ Cord sheaths used as supplementary insulation 35 Rubber 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 Material used as insulation other than for wires and windings⁶⁾: - impregnated or varnished textile, paper or press board 70 - laminates bonded with: • melamine-formaldehyde, phenol-formaldehyde or phenol-furfural resins 85 (175) • urea-formaldehyde resins 65 (150) - mouldings of: • phenol-formaldehyde with cellulose fillers 85 (175) • phenol-formaldehyde with mineral fillers 100 (200) • melamine-formaldehyde 75 (150) • urea-formaldehyde 65 (150)	

Table 2 (continued)

Parts	Temperature rise K
- polyester with glass-fibre reinforcement	110
- silicone rubber	145
- polytetrafluorethylene	265
- pure mica and tightly sintered ceramic material, when such products are used as supplementary or reinforced insulation ⁷⁾	400
- thermoplastic material	-
Wood, in general ⁸⁾	65
Outer surfaces of capacitors:	
- 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
• other capacitors	20
External enclosure, 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. of 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	$t-50$
1) To allow for the fact that the temperature of windings of universal motors, relays, solenoids, etc. measured at points accessible to thermocouples is generally below the average, 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.	

Table 2 (concluded)

In case of doubt, the results obtained by means of the resistance method are decisive.

2) *The classification is in accordance with HD 566 S1.*

Examples of class A material are:

- *impregnated cotton, silk, artificial silk and paper;*
- *enamels based on oleo- or polyamide resins.*

Examples of class B material are:

- *asbestos, glass fibre, melamine-formaldehyde and phenol-formaldehyde resins.*

Examples of class E material are:

- *mouldings with cellulose fillers, cotton fabric laminates and paper laminates, bonded with melamine-formaldehyde, phenol-formaldehyde or phenol-furfural resins;*
- *cross-linked polyester resins, cellulose triacetate films, polyethylene terephthalate films;*
- *varnished polyethylene terephthalate textile bonded with oil-modified alkyd resin varnish;*
- *enamels based on polyvinylformal, polyurethane or epoxy resins.*

There is no limit specified for windings insulated with materials other than those of class A, class E, class B or class F, but they shall withstand the test of 11.6.

These tests are always made when the temperature rise of windings or core laminations exceeds 75 K and where there are doubts with regard to the classification of winding insulation.

For totally enclosed motors the temperature rise limits for class A, class E, and class B may be increased by 5 K.

A totally enclosed motor is a motor so constructed 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.

3) *T signifies the maximum operating temperature.*

For the purpose of this test, switches and thermal cut-outs marked with individual ratings may be considered as having no marking in this respect, if requested by the tool manufacturer.

4) *This limit applies to cables, cords and wires complying with the relevant CENELEC standards; for others it may be different.*

5) *This limit will become applicable as soon as there are CENELEC standards for high temperature cables, cords and wires.*

6) *The values in parentheses apply, if the material is used for handles, knobs, grips and the like and is in contact with hot metal.*

7) *There is no specific limit for thermoplastic material which shall withstand the tests of 28.1 or 28.2, for which purpose the temperature rise must be determined.*

8) *The limit is concerned with the deterioration of wood and it does not take into account deterioration of surface finishes.*

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.

NOTE - The values in the table are based on an ambient temperature not normally exceeding 25 °C but occasionally reaching 35 °C.

However, the temperature rise values are based on an ambient temperature of 25 °C.

In determining the temperature rise of the ambient of a switch or thermostat, the temperature rise resulting from the current through the switch or thermostat is not taken into account, provided it does not influence its ambient temperature.

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

$$\Delta t = \frac{R_2 - R_1}{R_1} (234,5 + t_1) - (t_2 - t_1) \text{ (for copper)}$$

$$\Delta t = \frac{R_2 - R_1}{R_1} (225,0 + t_1) - (t_2 - t_1) \text{ (for electrical conductor grade aluminium)}$$

where:

Δt is the temperature rise in K

R_1 is the resistance at the beginning of the test

R_2 is the resistance at the end of the test

t_1 is the room temperature at the beginning of the test in °C

t_2 is the room temperature at the end of the test in °C

At the beginning of the test, the windings are to be at room 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.

11.6 *If the temperature rise of a winding exceeds the value specified in 11.5, three additional samples are subjected to the following tests:*

1) The temperature rise of the windings is determined by the test of 11.2.

2) The samples are then dismantled as far as is possible without damaging any part. Windings and core laminations are kept for 10 days (240 h) in a heating cabinet, the temperature of which is 80 K ± 1 K in excess of the temperature rise determined according to item 1).

3) 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.

4) Immediately afterwards, the samples shall withstand the tests of clause 15.

5) The samples are then subjected to a humidity treatment as specified in 14.2.