

AS/NZS 60745.1:2009
(Incorporating Amendment No. 1)



Australian/New Zealand Standard™

Hand-held motor-operated electric Tools — Safety

Part 1: General requirements (IEC 60745-1 Ed 4, MOD)



AS/NZS 60745.1:2009

This Joint Australian/New Zealand Standard™ was prepared by Joint Technical Committee EL-002, Safety of Household and Similar Electrical Appliances and Small Power Transformers and Power Supplies. It was approved on behalf of the Council of Standards Australia on 17 March 2009 and by the Council of Standards New Zealand on 13 March 2009.

This Standard was published on 29 May 2009.

The following are represented on Committee EL-002:

- Association of Accredited Certification Bodies
- Australian Industry Group
- Business New Zealand
- Consumer Electronic Suppliers Association, Australia
- Consumers' Federation of Australia
- Electrical Regulatory Authorities, Australia
- Electrical consultants
- Engineers Australia
- JAS-ANZ
- National Retailers Association (Australia)
- New Zealand Electric Fence Energizer Manufacturers' Standards Group
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This Standard was issued in draft form for comment as DR 08948.

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ISBN 0 7337 9101 8

Australian/New Zealand Standard™

Hand-held motor-operated electric Tools — Safety

Part 1: General requirements (IEC 60745-1 Ed 4, MOD)

Originated in Australia as AS C160—1959.

Previous edition AS/NZS 3160:1996.

Jointly revised and redesignated, in part, as AS/NZS 7450.1:1999.

Jointly revised and redesignated as AS/NZS 60745.1:2003.

Jointly revised and redesignated as AS/NZS 60745.1:2009.

Reissued incorporating Amendment No 1 (June 2021).



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AUSTRALIA/NEW ZEALAND STANDARD

HAND-HELD MOTOR-OPERATED ELECTRIC TOOLS – SAFETY –

Part 1: General requirements

FOREWORD

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-002 - Safety of Household and Similar Electrical Appliances and Small Power Transformers. It will supersede AS/NZS 60745.1:2003 and its amendments after all of the Parts 2 of that standard have been superseded by the relevant Parts 2 of this standard.

Main changes in this edition include the introduction of requirements for tools with a liquid system, particularly in Clauses 8, 14 and 21; clarification in Clause 8 on the application of safety warnings; adaptation of Annex I to the latest version of IEC 61058-1; addition of requirements for electronic circuits in 18.10; introduction of requirements for supports or working stands in Annex M; and information about routine tests in Annex N.

The objective of this Standard is to provide manufacturers, designers, regulatory authorities, testing laboratories and similar organizations with safety requirements designed to give the user protection against hazards that might occur during normal operation and abnormal operation of the appliance and which may be used as the basis for approval for sale or for connection to the electricity supply mains in Australia and New Zealand

This Standard is an adoption with national modifications and contains the full text of the fourth edition of IEC 60745-1, Hand-held motor-operated electric tools – Safety – Part 1: General requirements, and has been varied as indicated to take account of Australian and New Zealand conditions.

This part is to be used in conjunction with the appropriate Part 2 of AS/NZS 60745. The Parts 2 contain clauses to supplement or modify the corresponding clauses in this part to provide the relevant requirements for each type of product.

NOTE 1 The following print types are used:

- requirements: in roman type;
- *test specifications: in italic type;*
- notes: in small roman type.

Annexes A, B, F, G, I, K and L form an integral part of this standard.

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

The numbering of clauses, subclauses, notes, tables, figures and annexes follows that of IEC 60745-1 Ed 4.0. To allow for the introduction of additional material by the IEC, the numbers 101 to 300 have been reserved. To allow for additional material to be introduced by Australia and New Zealand, the numbers 301 to 400 are used to number further clauses, subclauses, notes, tables and figures in part 1. Additional annexes are lettered ZA, ZB and so on.

This scheme has been introduced to reduce the likelihood of the IEC and Australia and New Zealand using the same identifier for different purposes.

The use of the word VOID indicates that the IEC text is not used in Australia or New Zealand. The use of this word also avoids the need to renumber, clauses, notes, tables and figure if an earlier clause, note, table or figure is not used.

Clause 2 has been reformatted to indicate the Australia/New Zealand standard that is equivalent to the IEC standard or ISO standard to which normative reference is made.

The bibliography has been reformatted to indicate the Australia/New Zealand standard that is equivalent to the IEC standard or ISO standard to which an informative reference is made.

As this Standard is reproduced from an International Standard, the following applies:

- (a) Its number does not appear on each page of text and its identity is shown on the cover and title page only.
- (b) In the source text "this International Standard" should read "this Australian/New Zealand Standard".
- (c) A full point substitutes for a comma when referring to a decimal marker.

Variations to IEC 60745-1 Ed 4.0 are indicated at the appropriate places throughout this standard. Strikethrough (~~example~~) identifies IEC tables, figures and passages of text which, for the purposes of this Australian/New Zealand standard are deleted. Where Australian/New Zealand tables, figures or passages of text are added, each is set in its proper place and identified by shading (**example**). Added figures are not themselves shaded, but are identified by a shaded border.

Variations made to IEC 60745-1 Ed 4.0 form the New Zealand variations for the purposes of the IECEE scheme for recognition of testing to standards for safety of electrical equipment (the CB scheme). These variations have been incorporated in the body of the standard. They are listed in Annex ZZ for easy reference.

INTRODUCTION

It has been assumed in the drafting of this Standard that the execution of its provisions is entrusted to appropriately qualified and experienced people.

The requirements in this Standard maybe applied, so far as is reasonable, to tools not mentioned in part 2, and to tools designed on new principles.

If the functions of a tool are covered by the different parts 2 of AS/NZS 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 motor-operated electric tools are

- IEC standards published by TC 59 concerning methods of measuring performance;
- CISPR 14-1, IEC 61000-3-2 and IEC 61000-3-3 concerning electromagnetic emissions;
- CISPR 14-2 concerning electromagnetic immunity.

The essential safety requirements in AS/NZS 3820 that could be applicable to hand-held motor operated electric tools are covered by this standard

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.

~~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.

<u>International standard</u>	<u>Year</u>	<u>Title</u>	<u>AU/NZ standard</u>	<u>Year</u>
IEC 60061-DB ¹⁾	2005	<i>Lamp caps and holders together with gauges for the control of interchangeability and safety</i>		
IEC 60065	2001	<i>Audio, video and similar electronic apparatus – Safety requirements</i>	AS/NZS 60065	2003
IEC 60068-2-75	1997	<i>Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests</i>		
IEC 60085		<i>Thermal evaluation and classification of electrical insulation</i>		
IEC 60112	2003	<i>Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions</i>	AS/NZS 60112	2003
IEC 60127-3		<i>Miniature fuses – Part 3: Sub-miniature fuse-links</i>		

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

IEC 60227 (all parts),		<i>Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V</i>	AS/NZS 60227	
IEC 60245 (all parts)		<i>Rubber insulated cables – Rated voltages up to and including 450/750</i>	AS/NZS 60245	
IEC 60309 (all parts)		<i>Plugs, socket-outlets and couplers for industrial purposes</i>	AS/NZS 3123	
IEC 60320 (all parts)		<i>Appliance couplers for household and similar general purposes</i>	AS/NZS 60320	
IEC 60335-1 Amendment 1	2001 (2004) ²	<i>Safety of household and similar electrical appliances – Part 1: General requirements</i>	AS/NZS 60335.1	2002
IEC 60384-14		<i>Fixed capacitors for use in electronic equipment – Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains</i>		
IEC 60417-DB ³ :	2002	<i>Graphical symbols for use on equipment</i>		

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.

IEC 60529 Amendment 1	1989 (1999) ⁴	<i>Degrees of protection provided by enclosures (IP Code)</i>		
IEC 60695-2-11		<i>Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products</i>	AS/NZS 60695.2.11	
IEC 60695-11-5	2004	<i>Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance</i>	AS/NZS 60695.11.5	2005
IEC 60695-11-10		<i>, Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods</i>	AS/NZS 60695.11.10	
IEC 60730-1	1999	<i>Automatic electrical controls for household and similar use – Part 1: General requirements</i>		
IEC 60760		<i>Flat, quick connect terminations</i>		
IEC 60825-1		<i>Safety of Laser Products – Part 1: Equipment classification, requirements and user's guide</i>		

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

IEC 60884 (all parts)		<i>Plugs and socket-outlets for household and similar purposes</i>	
IEC 60998-2-1		<i>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</i>	AS/NZS 60998.2.1
IEC 60998-2-2		<i>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</i>	AS/NZS 60998.2.2
IEC 60999-1	1999	<i>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)</i>	

IEC 61008-1		<i>Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs) - Part 1: General rules</i>	AS/NZS 61008.1	
IEC 61009-1		<i>Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs) - Part 1: General rules</i>	AS/NZS 61009.1	
IEC 61058-1 Amendment 1	2000 (2001) ⁵	<i>Switches for appliances – Part 1: General requirements and tests</i>	AS/NZS 61058.1	2002
IEC 61540 Amendment 1	1997 (1998) ⁶	<i>Electrical accessories – Portable residual current devices without integral overcurrent protection for household and similar use (PRCDs)</i>		
IEC 61558-1		<i>Safety of power transformers, power supply units and similar – Part 1: General requirements and tests</i>	AS/NZS 61558.1	
ISO 1463		<i>Metallic and oxide coatings – Measurement of coating thickness – Micro-scopical method</i>		

⁵) A consolidated edition (3.1) exists including IEC 61058-1:2000 and its Amendment 1 (2001).

⁶) A consolidated edition (1.1) exists including IEC 61540:1997 and its Amendment 1 (1998).

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

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*

*Approval and test
specification –
Plugs and
socket-outlets*

AS/NZS 3112

*Approval and test
specification –
Residual current
devices (current-
operated earth-
leakage devices*

AS/NZS 3190

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 $(20 \pm 5) ^\circ\text{C}$.*

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 $(23 \pm 2) ^\circ\text{C}$.

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.~~

Tools for a.c. only are tested with a.c. at 50 Hz, and those for a.c./d.c. are tested at a.c. 50 Hz or d.c., whichever is the more unfavourable supply.

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.*

5.301 For Australia the following applies:

For tools that are intended for connection to the supply mains and that are not marked with

– a rated voltage of at least 240 V for single-phase tools and at least 415 V for three-phase tools, or

– a rated voltage range that includes 240 V for single-phase tools and 415 V for three-phase tools,

the rated voltage is equal to 240 V for single-phase tools and 415 V for three-phase tools, and the upper limit of the rated voltage range is equal to 240 V for single-phase tools and 415 V for three-phase tools.

For tools that are intended to be supplied from a transformer, this general condition of test applies to the input side of the transformer.

For Clause 17, the rated voltage is the marked rated voltage.

NOTE This general test condition does not apply in New Zealand.

6 Void

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 Y);
- 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;
- name or trade mark or identification mark and address of the manufacturer or any other agent responsible for placing the tool on the market;
- model or type reference;
- symbol for class II construction, for class II tools only;
- 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;
- “WARNING – To reduce the risk of injury, user must read instruction manual” or the sign M002 of ISO 7010⁷⁾.

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”.

Tools intended for connection to the supply mains other than class III tools and tools that are required by the standard to be supplied from a transformer, shall be marked with

– a rated voltage of at least:

- 230 V for single phase tools;
- 400 V for polyphase tools.

or

– a rated voltage range that includes:

- 230 V for single phase tools;
- 400 V for polyphase tools.

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.

⁷⁾ The future safety sign M002 is currently in DIS stage as ISO 7010:2003/DAmD4.

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.

8.5 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.

They shall be written in English.

They shall be legible and contrast with the background.

They shall include the name and address of the manufacturer or supplier or any other agent responsible for placing the tool on the market.

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.~~ The General Power Tool Safety Warnings and the specific tool Safety Warnings, shall be verbatim.

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
 - 5) General instructions for use
- 301) Recommendation that the tool always be supplied via a residual current device with a rated residual current of 30 mA or less
- 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
 - 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
- 301) For tools with a water supply intended to be supplied by an isolating transformer, the method of supply shall be specified, including details of the isolating transformer to be used.

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
<p>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.</p> <p>b) T signifies the maximum operating temperature.</p> <p>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.</p> <p>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.</p> <p>c) This limit applies to cables, cords and wires complying with the relevant IEC standards; for others, it may be different.</p> <p>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.</p> <p>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.</p> <p>f) The limit specified concerns the deterioration of wood, and it does not take into account deterioration of surface finishes.</p> <p>g) There is no limit for the temperature rise of capacitors which are short-circuited in 18.10.</p> <p>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.</p>	

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.

13.2 *The leakage current is measured by means of the circuit of Figure 10 between any pole of the supply and accessible metal parts and metal foil with an area not exceeding 20 cm × 10 cm in contact with accessible surfaces of insulating material, connected together.*

The metal foil has the largest area possible on the surface under test, without exceeding the dimensions specified. If its area is smaller than the surface under test, it is moved so as to test all parts of the surface. The heat dissipation of the tool shall, however, not be affected by the metal foil.

Three-phase tools, which are suitable for single-phase supply, are tested as single-phase tools with the three sections connected in parallel. For single-phase tools and three-phase tools to be tested as single-phase tools, the leakage current is measured with the selector switch shown in Figure 3, in each of the positions 1 and 2, and the switch S1 in “on” position.

For three-phase tools not suitable for single-phase supply, the leakage current is measured according to Figure 4, with the switches a, b and c in the “on” position. For tools intended to be connected in star connection only, the neutral is not connected.

The leakage current is measured within 5 s after the application of the test voltage and shall not exceed the following values:

- *to accessible metal parts and metal foil:*
 - *for class I tools* 0,75 mA;
 - *for class II tools* 0,25 mA;
 - *for class III tools* 0,5 mA.

If the tool incorporates one or more capacitors, and is provided with a single-pole switch, the measurements are repeated with the switch in the “off” position.

14 Moisture resistance

14.1 *The enclosure of the tool shall provide the degree of protection against moisture in accordance with the classification of the tool.*

Compliance is checked by the appropriate treatment specified in 14.1.2, with the tool conditions as in 14.1.1.

14.1.1 *The tool is not connected to the supply.*

Tools are turned continuously through the most unfavourable positions during the test.

Tools with type X attachment are fitted with the lightest permissible type of flexible cord of the smallest cross-sectional area specified in 25.2; other tools are tested as delivered.

Electrical components, covers and other parts which can be removed without the aid of a tool are removed and subjected, if necessary, to the relevant treatment with the main part.

14.1.2 *Tools other than IPX0 are subjected to tests of IEC 60529 as follows:*

- *IPX1 tools are subjected to the test described in 14.2.1;*
- *IPX2 tools are subjected to the test described in 14.2.2;*
- *IPX3 tools are subjected to the test described in 14.2.3;*
- *IPX4 tools are subjected to the test described in 14.2.4;*
- *IPX5 tools are subjected to the test described in 14.2.5;*
- *IPX6 tools are subjected to the test described in 14.2.6;*
- *IPX7 tools are subjected to the test described in 14.2.7.*

For this last test, the tool is immersed in water containing approximately 1,0 % NaCl.

Immediately after the appropriate treatment, the tool shall withstand the electric strength test of Clause 15, and inspection shall show that there is no trace of water on insulation which could result in a reduction of creepage distances and clearances below the values specified in 28.1.

Tools which are not subject to spillage of liquid in normal use are allowed to stand in normal test-room atmosphere for 24 h before being subjected to the test of 14.3.

14.2 *Tools subject to spillage of liquid in normal use shall be so constructed that such spillage does not affect their electrical insulation.*

Compliance is checked by the following test:

Tools incorporating an appliance inlet are fitted with an appropriate connector and flexible cord; tools with type X attachment are fitted with the lightest permissible type of flexible cord of the smallest cross-sectional area specified in 25.2; other tools are tested as delivered.

Electrical components, covers and other parts which can be removed without the aid of a tool are removed, except those fulfilling the test of 21.22.

The liquid container of the tool is completely filled with water containing approximately 1,0 % NaCl, and a further quantity, equal to 15 % of the capacity of the container, or 0,25 l, whichever is the greater, is poured in steadily over a period of 1 min.

Immediately after this treatment, the tool shall withstand an electric strength test as specified in Clause 15, and inspection shall show that there is no trace of water on insulation which could result in a reduction of creepage distances and clearances below the values specified in 28.1.

The tool is allowed to stand in normal test-room atmosphere for 24 h before being subjected to the test of 14.3.

14.3 *Tools shall be proof against humid conditions which may occur in normal use.*

Compliance is checked by the following humidity test.

Cable entries, if any, are left open; if knock-outs are provided, one of them is opened.

Electrical components, covers, and other parts which can be removed without the aid of a tool are removed and subjected, if necessary, to the humidity test with the main part.

The humidity treatment is carried out in a humidity cabinet containing air with a relative humidity of $(93 \pm 2) \%$, obtained e.g. by placing in the humidity cabinet a saturated solution of Na_2SO_4 or KNO_3 in water, having a sufficiently large contact surface with the air. The temperature of the air, at all places where samples can be located, is maintained within 1 K of any convenient value t between 20 °C and 30 °C. In order to achieve the specified conditions within the cabinet, it is necessary to ensure constant circulation of the air within and, in general, to use a cabinet which is thermally insulated.

Before being placed in the humidity cabinet, the sample is brought to a temperature between t and $(t + 4) \text{ °C}$. The tool is considered to be brought to the specified temperature by keeping it at this temperature for at least 4 h before the humidity treatment.

The tool is kept in the cabinet for 48 h.

Immediately after this test, the tool shall withstand the tests of Clause 13 at rated voltage or the mean of the rated voltage range with the tool switch in the “on” position and under the following conditions.

For single-phase tools and for three-phase tools to be tested as single-phase tools: S1 of Figure 3 in the “off” position.

For three-phase tools not suitable for single-phase supply: a in Figure 4 in the “on” position, b and c in “off” position.

Then the tool shall withstand the test of Clause 15 in the humidity cabinet, or in the room in which the tool was brought to the prescribed temperature after reassembly of those parts which may have been removed.

14.4 Liquid systems shall not subject the user to an increased risk of electrical shock during foreseeable misuse.

Compliance is checked by the following test:

The residual current device, if any, shall be disabled during the test.

The tool is operated at rated voltage with approximately 1,0 % NaCl solution in the following modes if applicable:

- after overfilling of the fluid reservoir by 15 % of the capacity of the container, or by 0,25 l, whichever is the greater;
- omission of a washer or other user removable part;
- misassembly of liquid system connections routinely made by the user.

In each mode, the tool is operated for 1 min in all positions consistent with the relevant part 2 and the manufacturer's instructions while monitoring the leakage current as in Clause 13. During the test the leakage current shall not exceed:

- 2 mA for a class II tool;
- 5 mA for a class I tool.

Following this test, the tool shall meet the test of 13.1 after being allowed to dry for 24 h at ambient temperature.

14.5 Liquid systems shall be constructed of components capable of withstanding the pressure in normal use without leaking.

Compliance is checked by the following test:

The liquid system is closed and an approximately 1,0 % NaCl solution at a hydrostatic pressure equal to twice the pressure stated in 8.12.2 d) 1) is applied for 1 h. The leakage current of accessible parts is measured as described in Clause 13. During the test the leakage current shall not exceed:

- 2 mA for a class II tool;
- 5 mA for a class I tool.

Following this test, the tool shall meet the test of 13.1 after being allowed to dry for 24 h at ambient temperature.

The residual current device, if any, shall be disabled during the test.

14.6 Residual current devices used to provide protection from shock in the case of failure of the liquid system shall comply with IEC 61540 and shall meet the following requirements a) to c):

- a) The RCD shall disconnect both mains conductors, but not the earth conductor if provided, when the leakage exceeds 10 mA and with a maximum response of 300 ms.

Compliance is checked by inspection and the test of 9.9.2 of IEC 61540. In addition, during the test, the earthing conductor shall not become disconnected.

- b) The RCD shall be reliable for its intended use.

Compliance is checked at rated voltage by operating the residual current device under conditions of simulated leakage as in (a) above during conditions of locked rotor of the tool for 50 cycles. The residual current device shall operate correctly for all cycles.

- c) The RCD shall be installed such that it is unlikely to be removed during use or routine normal maintenance.

This requirement is considered fulfilled if the residual current device is fixed to the tool or the power supply cord connected to the tool.

~~Where fitted in the supply cord, the residual current device shall be provided with Type Y attachment or Type Z attachment for connection with the supply cord and interconnecting cord.~~

Where fitted in the supply cord, the residual current device shall be within a distance of 0,5 m from the supply or it shall be fitted in the supply plug

Compliance is checked by inspection.

15 Electric strength

15.1 The electric strength shall be adequate.

Compliance is checked by the tests of 15.2.

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

The tests are made on the tools at room temperature and not connected to the supply.