

Australian Standard™

**Safety requirements for electrical
equipment for measurement, control
and laboratory use—**

**Part 1: General requirements
(IEC 61010-1:2001 MOD)**



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Australian Chamber of Commerce and Industry
Bureau of Steel Manufacturers of Australia
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Electrical Compliance Testing Association
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This Standard was issued in draft form for comment as DR 03308.

STANDARDS AUSTRALIA

RECONFIRMATION

OF

AS 61010.1—2003

**Safety requirements for electrical equipment for measurement, control and
laboratory use —**

Part 1: General requirements (IEC 61010-1:2001 MOD)

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Technical Committee EL-049 has reviewed the content of this publication and in accordance with Standards Australia procedures for reconfirmation, it has been determined that the publication is still valid and does not require change.

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Approved for reconfirmation in accordance with Standards Australia procedures for reconfirmation on 03 September 2015.

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Electrical Compliance Testing Association

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First published as AS 61010.1—2003.

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Published by Standards Australia International Ltd
GPO Box 5420, Sydney, NSW 2001, Australia
ISBN 0 7337 5432 5

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PREFACE

This Standard was prepared by the Standards Australia Committee EL-049, Safety of Electrical Equipment for Measurement and Laboratory Use.

The objective of this Standard is to specify the general safety requirements that are generally applicable for electrical measurement, control and laboratory equipment intended for professional, industrial process and educational purposes. The essential safety requirements specified in AS/NZS 3820 that apply to electrical equipment for measurement, control and laboratory use are covered in this Standard.

This Standard is an adoption with national modifications and has been reproduced from IEC 61010-1:2001, *Safety requirements for electrical equipment for measurement, control, and laboratory use—Part 1: General requirements*, and has been varied as indicated to take account of Australian conditions. This Standard includes IEC Corrigendum 1:2001 and Corrigendum 2:2003.

Variations to IEC 61010-1:2001 are indicated at the appropriate places throughout this standard. Strikethrough (~~example~~) identifies IEC text, tables and figures which, for the purposes of this Australian Standard, are deleted. Where text, tables or figures 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. The variations are also included in a new Annex ZZ for easy reference.

Annex ZA lists alternate requirements for Australian conditions on resistance to fire.

Additional safety requirements for other allied equipment are to be covered in the relevant Part 2 series of Standards. These are intended to be published in the near future.

The Committee is also considering the publication of a handbook for guidance on the safe use of electrical test measurement equipment, some time in the future.

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 only on the cover and title page.
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- (c) A full point should be substituted for a comma when referring to a decimal marker.
- (d) Any French text on figures should be ignored.

The terms ‘normative’ and ‘informative’ are used to define the application of the annex to which they apply. A normative annex is an integral part of a standard, whereas an informative annex is only for information and guidance.

CONTENTS

	<i>Page</i>
Introduction.....	ix
1 Scope and object.....	1
1.1 Scope.....	1
1.1.1 Equipment included in scope.....	1
1.1.2 Equipment excluded from scope.....	1
1.1.3 Computing equipment.....	2
1.2 Object.....	2
1.2.1 Aspects included in scope.....	2
1.2.2 Aspects excluded from scope.....	2
1.3 Verification.....	2
1.4 Environmental conditions.....	3
1.4.1 Normal environmental conditions.....	3
1.4.2 Extended environmental conditions.....	3
2 Normative references.....	3
3 Terms and definitions.....	5
3.1 Equipment and states of equipment.....	5
3.2 Parts and accessories.....	6
3.3 Electrical quantities.....	6
3.4 Tests.....	7
3.5 Safety terms.....	7
3.6 Insulation.....	8
4 Tests.....	9
4.1 General.....	9
4.2 Sequence of tests.....	10
4.3 Reference test conditions.....	10
4.3.1 Environmental conditions.....	10
4.3.2 State of equipment.....	10
4.4 Testing in SINGLE FAULT CONDITION.....	12
4.4.1 General.....	12
4.4.2 Application of fault conditions.....	12
4.4.3 Duration of tests.....	14
4.4.4 Conformity after application of fault conditions.....	15
5 Marking and documentation.....	15
5.1 Marking.....	15
5.1.1 General.....	15
5.1.2 Identification.....	16
5.1.3 MAINS supply.....	16
5.1.4 Fuses.....	17
5.1.5 TERMINALS, connections and operating devices.....	18
5.1.6 Switches and circuit-breakers.....	19
5.1.7 Equipment protected by DOUBLE INSULATION or REINFORCED INSULATION.....	19
5.1.8 Field-wiring TERMINAL boxes.....	19

	<i>Page</i>
5.2 Warning markings	19
5.3 Durability of markings	20
5.4 Documentation	20
5.4.1 General	20
5.4.2 Equipment RATINGS	21
5.4.3 Equipment installation	21
5.4.4 Equipment operation	21
5.4.5 Equipment maintenance	22
6 Protection against electric shock	22
6.1 General	22
6.1.1 Requirements	22
6.1.2 Exceptions	22
6.2 Determination of ACCESSIBLE parts	23
6.2.1 Examination	23
6.2.2 Openings above parts that are HAZARDOUS LIVE	23
6.2.3 Openings for pre-set controls	23
6.3 Permissible limits for ACCESSIBLE parts	23
6.3.1 Values in NORMAL CONDITION	24
6.3.2 Values in SINGLE FAULT CONDITION	24
6.4 Protection in NORMAL CONDITION	27
6.5 Protection in SINGLE FAULT CONDITION	27
6.5.1 PROTECTIVE BONDING	27
6.5.2 DOUBLE INSULATION and REINFORCED INSULATION	30
6.5.3 PROTECTIVE IMPEDANCE	30
6.5.4 Automatic disconnection of the supply	31
6.6 Connections to external circuits	31
6.6.1 General	31
6.6.2 TERMINALS for external circuits	32
6.6.3 Circuits with TERMINALS which are HAZARDOUS LIVE	32
6.6.4 ACCESSIBLE TERMINALS for stranded conductors	32
6.7 CLEARANCES and CREEPAGE DISTANCES	32
6.7.1 General requirements	33
6.7.2 MAINS CIRCUITS	34
6.7.3 Circuits other than MAINS CIRCUITS	34
6.7.4 Measuring circuits	39
6.8 Procedure for dielectric strength tests	40
6.8.1 Reference test earth	40
6.8.2 Humidity preconditioning	40
6.8.3 Conduct of tests	40
6.8.4 Voltage tests	41
6.9 Constructional requirements for protection against electric shock	43
6.9.1 General	43
6.9.2 ENCLOSURES of equipment with DOUBLE INSULATION or REINFORCED INSULATION	43
6.9.3 Over-range indication	44
6.10 Connection to MAINS supply source and connections between parts of equipment	44
6.10.1 MAINS supply cords	44
6.10.2 Fitting of non-detachable MAINS supply cords	44

6.10.3	Plugs and connectors	46
6.11	Disconnection from supply source	46
6.11.1	General	46
6.11.2	Requirements according to type of equipment	47
6.11.3	Disconnecting devices	48
7	Protection against mechanical HAZARDS	48
7.1	General	48
7.2	Moving parts	48
7.3	Stability	49
7.4	Provisions for lifting and carrying	49
7.5	Wall mounting	50
7.6	Expelled parts	50
8	Mechanical resistance to shock and impact	50
8.1	ENCLOSURE rigidity test	51
8.1.1	Static test	51
8.1.2	Dynamic test	51
8.2	Drop test	52
8.2.1	Equipment other than HAND-HELD EQUIPMENT and direct plug-in equipment	52
8.2.2	HAND-HELD EQUIPMENT and direct plug-in equipment	53
9	Protection against the spread of fire	53
9.1	Eliminating or reducing the sources of ignition within the equipment	54
9.2	Containment of fire within the equipment, should it occur	55
9.2.1	Constructional requirements	55
9.3	Limited-energy circuit	57
9.4	Requirements for equipment containing or using flammable liquids	58
9.5	Overcurrent protection	59
9.5.1	PERMANENTLY CONNECTED EQUIPMENT	59
9.5.2	Other equipment	59
10	Equipment temperature limits and resistance to heat	59
10.1	Surface temperature limits for protection against burns	59
10.2	Temperatures of windings	60
10.3	Other temperature measurements	60
10.4	Conduct of temperature tests	61
10.4.1	Temperature measurement of heating equipment	61
10.4.2	Equipment intended for installation in a cabinet or a wall	61
10.5	Resistance to heat	61
10.5.1	Integrity of CLEARANCES and CREEPAGE DISTANCES	61
10.5.2	Non-metallic ENCLOSURES	62
10.5.3	Insulating material	62
11	Protection against HAZARDS from fluids	63
11.1	General	63
11.2	Cleaning	63
11.3	Spillage	63
11.4	Overflow	64
11.5	Battery electrolyte	64
11.6	Specially protected equipment	64

	<i>Page</i>
11.7 Fluid pressure and leakage	64
11.7.1 Maximum pressure	64
11.7.2 Leakage and rupture at high pressure	65
11.7.3 Leakage from low-pressure parts	65
11.7.4 Overpressure safety device	66
12 Protection against radiation, including laser sources, and against sonic and ultrasonic pressure	66
12.1 General	66
12.2 Equipment producing ionizing radiation	67
12.2.1 Ionizing radiation	67
12.2.2 Accelerated electrons	67
12.3 Ultraviolet (UV) radiation	67
12.4 Microwave radiation	67
12.5 Sonic and ultrasonic pressure	67
12.5.1 Sound level	67
12.5.2 Ultrasonic pressure	68
12.6 Laser sources	68
13 Protection against liberated gases, explosion and implosion	68
13.1 Poisonous and injurious gases	68
13.2 Explosion and implosion	69
13.2.1 Components	69
13.2.2 Batteries and battery charging	69
13.2.3 Implosion of cathode ray tubes	69
13.2.4 Equipment RATED for high pressures	70
14 Components	70
14.1 General	70
14.2 Motors	71
14.2.1 Motor temperatures	71
14.2.2 Series excitation motors	72
14.3 Over-temperature protection devices	72
14.4 Fuse holders	72
14.5 MAINS voltage selecting devices	72
14.6 HIGH INTEGRITY components	73
14.7 MAINS transformers tested outside equipment	73
14.8 Printed circuit boards	73
14.9 Circuits or components used as transient overvoltage limiting devices	73
15 Protection by interlocks	74
15.1 General	74
15.2 Prevention of reactivating	74
15.3 Reliability	74
16 Test and measurement equipment	75
16.1 Current measuring circuits	75
16.2 Multifunction meters and similar equipment	75
Annex A (normative) Measuring circuits for ACCESSIBLE current (see 6.3)	76
Annex B (normative) Standard test finger (see 6.2)	79
Annex C (normative) Measurement of CLEARANCES and CREEPAGE DISTANCES	81

	<i>Page</i>
Annex D (normative) Parts between which insulation requirements are specified (see 6.4 and 6.5.2)	86
Annex E (normative) Reduction of POLLUTION degrees	89
Annex F (normative) ROUTINE TESTS	90
Annex G (informative) Leakage and rupture from fluids under pressure	91
Annex H (informative) Index of defined terms	96
Annex ZA (normative) Resistance to fire	99
Annex ZZ (normative) Variations to IEC 61010-1:2001 for application in Australia and New Zealand	102
Figure 1 – Maximum duration of short-term temporary ACCESSIBLE voltages in SINGLE FAULT CONDITION	25
Figure 2 – Charged capacitance level in NORMAL CONDITION and SINGLE FAULT CONDITION	26
Figure 3 – Detachable MAINS supply cords and connections	45
Figure 4 – Impact test using sphere	52
Figure 5 – Flow chart to explain the requirements for protection against the spread of fire	54
Figure 6 – Baffle	56
Figure 7 – Area of the bottom of an ENCLOSURE to be constructed as specified in 9.2.1 b)1)	57
Figure 8 – Ball-pressure test apparatus	63
Figure 9 – Ratio between hydraulic test pressure and RATED maximum working pressure	66
Figure 10 – Flow chart for conformity options 14.1 a), b), c) and d)	71
Figure A.1 – Measuring circuit for a.c. with frequencies up to 1 MHz and for d.c.	76
Figure A.2 – Measuring circuits for a.c. with sinusoidal frequencies up to 100 Hz and for d.c.	77
Figure A.3 – Current measuring circuit for electrical burns	78
Figure A.4 – Current measuring circuit for wet contact	78
Figure B.1 – Rigid test finger (test probe 11 of IEC 61032)	79
Figure B.2 – Jointed test finger (test probe B of IEC 61032)	80
Figure C.1 – Examples of methods of measuring CLEARANCE and CREEPAGE DISTANCES	85
Figures D.1 a) to D.1 d) – Protection between HAZARDOUS LIVE circuits and circuits not exceeding the values of 6.3.2 in NORMAL CONDITION and having external TERMINALS of ACCESSIBLE parts	86
Figures D.1 e) to D.1 h) – Protection between HAZARDOUS LIVE circuits and other circuits which do not exceed the values of 6.3.2 in NORMAL CONDITION and which have external TERMINALS	87
Figure D.2 a) and D.2 b) – Protection from a HAZARDOUS LIVE internal circuit for an ACCESSIBLE part which is not bonded to other ACCESSIBLE parts	87
Figure D.2 c) and D.2 d) – Protection from a HAZARDOUS LIVE primary circuit for ACCESSIBLE TERMINALS of a secondary circuit which does not exceed the values of 6.3.2 in NORMAL CONDITION	88
Figure D.3 – Protection of external ACCESSIBLE TERMINALS of two HAZARDOUS LIVE circuits	88
Figure G.1 – Conformity verification process	92

	<i>Page</i>
Table 1 – Symbols	17
Table 2 – Tightening torque for screw assemblies.....	29
Table 3 – Multiplication factors for CLEARANCE for altitudes up to 5 000 m.....	33
Table 4 – CLEARANCES and CREEPAGE DISTANCES for MAINS CIRCUITS.....	34
Table 5 – CLEARANCES for circuits derived from MAINS CIRCUITS.....	36
Table 6 – CLEARANCE values for the calculation of 6.7.3.2.....	37
Table 7 – CREEPAGE DISTANCES	38
Table 8 – CLEARANCES for measurement categories II, III and IV.....	39
Table 9 – Test voltages for BASIC INSULATION.....	42
Table 10 – Correction factors for test voltage according to test site altitude	43
Table 11 – Physical tests on power supply cords	46
Table 12 – Acceptable perforation of the bottom of an ENCLOSURE	56
Table 13 – Limits of maximum available current.....	58
Table 14 – Overcurrent protective device.....	58
Table 15 – Surface temperature limits in NORMAL CONDITION.....	60
Table 16 – Insulation material of windings	60
Table 17 – Impulse withstand voltages.....	74
Table 18 – Output impedance for impulse generators	74
Table E.1 – Reduction of the POLLUTION degree of internal environment through the use of additional protection	89
Table G.1 – Test pressures for equipment with pressures above 14 MPa.....	94

INTRODUCTION

This part 1 specifies the safety requirements that are generally applicable to all equipment within its scope. For certain types of equipment, these requirements will be supplemented or modified by the special requirements of one, or more than one, particular part 2 of the standard which must be read in conjunction with the part 1 requirements.

X

NOTES

STANDARDS AUSTRALIA

Australian Standard

**Safety requirements for electrical equipment for measurement,
control and laboratory use—
Part 1: General requirements (IEC 61010-1:2001 MOD)**

Any table, figure or text of the international standard that is struck through is not part of this standard. Any Australian/New Zealand table, figure or text that is added is part of this standard and is identified by shading.

1 Scope and object

1.1 Scope

1.1.1 Equipment included in scope

This part of IEC 61010 specifies general safety requirements for electrical equipment intended for professional, industrial processes, and educational use, any of which may incorporate computing devices, as defined in a) to d) below, when used under the environmental conditions of 1.4.

a) Electrical test and measurement equipment

This is equipment which by electrical means tests, measures, indicates or records one or more electrical or non-electrical quantities, also non-measuring equipment such as signal generators, measurement standards, power supplies, transducers, transmitters, etc.

NOTE All indicating and recording electrical measuring instruments (except those excluded in 1.1.2) fall within the scope of IEC 61010 unless they are panel meters designed only for building-in to other equipment. Built-in panel meters are considered to be components and only need to meet the relevant requirements of IEC 61010, or other standards, as part of the equipment into which they are built.

b) Electrical control equipment

This is equipment which controls one or more output quantities to specific values, with each value determined by manual setting, by local or remote programming, or by one or more input variables.

c) Electrical laboratory equipment

This is equipment which measures, indicates, monitors or analyses substances, or is used to prepare materials, and includes in vitro diagnostic (IVD) equipment

This equipment may also be used in areas other than laboratories, for example self-test IVD equipment may be used in the home.

d) Accessories intended for use with the above (for example, sample handling equipment).

1.1.2 Equipment excluded from scope

This standard does not apply to equipment within the scope of

- a) IEC 60065 (Safety requirements for audio, video and similar electronic apparatus);
- b) IEC 60204 (Controls for electrical machines);
- c) AS/NZS 60335 (Safety of household and similar electrical appliances);
- d) IEC 60364 (Electrical installations of buildings);
- e) IEC 60439-1 (Low-voltage switchgear and controlgear assemblies);
- f) IEC 60521 (Class 0,5; 1 and 2 alternating current watt-hour meters);

- g) IEC 60601 (Medical electrical equipment);
- h) IEC 60950 (Safety of information technology equipment including electrical business equipment, except as specified in 1.1.3);
- i) IEC 61558 (Power transformers, power supply units and similar).

1.1.3 Computing equipment

This standard applies only to computers, processors, etc. which form part of equipment within the scope of this standard or are designed for use exclusively with the equipment.

NOTE Computing devices and similar equipment within the scope of IEC 60950 and conforming to its requirements are considered to be suitable for use with equipment within the scope of this standard. However, some of the requirements of IEC 60950 for resistance to moisture and liquids are less stringent than those in this standard. If HAZARDS from moisture or liquids could affect equipment that conforms to IEC 60950 and is used with equipment which conforms to this standard, the instructions for use should specify any additional precautions required.

1.2 Object

1.2.1 Aspects included in scope

The purpose of the requirements of this part 1 is to ensure that the design and methods of construction used provide adequate protection for the OPERATOR and the surrounding area against

- a) electric shock or burn (see clause 6);
- b) mechanical HAZARDS (see clauses 7 and 8);
- c) excessive temperature (see clauses 9 and 10);
- d) spread of fire from the equipment (see clause 9);
- e) effects of fluids and fluid pressure (see clause 11);
- f) effects of radiation, including lasers sources, and sonic and ultrasonic pressure (see clause 12);
- g) liberated gases, explosion and implosion (see clause 13).

NOTE Attention is drawn to the existence of additional requirements which may be specified by national authorities responsible for the health and safety of labour forces.

1.2.2 Aspects excluded from scope

This standard does not cover

- a) reliable function, performance or other properties of the equipment not related to safety;
- b) effectiveness of transport packaging;
- c) EMC requirements, which are covered by IEC 61326;
- d) protective measures for explosive atmospheres (see IEC 60079);
- e) servicing (repair);
- f) protection of servicing (repair) personnel.

NOTE Servicing personnel are expected to be reasonably careful in dealing with obvious HAZARDS, but the design should protect against mishap by the use of warning labels, shields for hazardous voltage TERMINALS, segregation of low-voltage circuits from hazardous voltages, etc. More important, servicing personnel should be trained to recognize unexpected HAZARDS and to react accordingly.

1.3 Verification

This standard also specifies methods of verifying, through inspection and type testing, that the equipment meets the requirements of this standard.

NOTE Requirements for ROUTINE TESTS are given in annex F.

1.4 Environmental conditions

1.4.1 Normal environmental conditions

This standard applies to equipment designed to be safe at least under the following conditions:

- a) indoor use;
- b) altitude up to 2 000 m;
- c) temperature 5 °C to 40 °C;
- d) maximum relative humidity 80 % for temperatures up to 31 °C decreasing linearly to 50 % relative humidity at 40 °C;
- e) MAINS supply voltage fluctuations up to ± 10 % of the nominal voltage;

NOTE – Mains supply voltage in Australia is 230 V/400 V

+10%
– 6%

- f) transient overvoltages typically present on the MAINS supply.

NOTE - The normal level of transient overvoltages is impulse withstand (overvoltage) category II of IEC 60364-4-443.

- g) applicable RATED POLLUTION degree.

1.4.2 Extended environmental conditions

This standard applies to equipment designed to be safe not only in the environmental conditions specified in 1.4.1, but also in any of the following conditions for which the equipment is RATED by the manufacturer:

- a) outdoor use;
- b) altitude above 2 000 m;
- c) ambient temperatures below 5 °C or above 40 °C;
- d) relative humidity above the levels specified in 1.4.1;
- e) MAINS supply voltage fluctuations exceeding ± 10 % of the nominal voltage.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 61010. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 61010 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

References to international standards that are struck through in this clause are replaced by references to Australian or Australian/New Zealand Standards that are listed immediately thereafter and identified by shading. Any Australian or Australian/New Zealand Standard that is identical to the International Standard it replaces is identified as such.

AS/NZS 3109.1, *Approval and test specification—Appliance couplers for household and similar general purposes—General requirements*

AS/NZS 4695.2.2, *Fire hazard testing of electrotechnical products - Part 2.2: Test methods—Needle-flame test*

AS/NZS 4695.2.11, *Fire hazard testing of electrotechnical products - Part 2.11: Test methods—Glow-wire end-product test and guidance*

AS/NZS 4695.707, *Fire hazard testing of electrotechnical products, Part 707: Methods of test for the determination of the flammability of solid electrical insulating materials when exposed to an igniting source*

IEC 60695-11-10, *Fire hazard testing – Part 11-4: Test flames—50 W horizontal and vertical flame test methods*

IEC 60027, *Letter symbols to be used in electrical technology*

IEC 60060, *High-voltage test techniques*

~~IEC 60065, Audio, video and similar electronic apparatus—Safety requirements~~

AS/NZS 60065:2000, *Audio, video and similar electronic apparatus—Safety requirements*

IEC 60085, *Thermal evaluation and classification of electrical insulation*

~~IEC 60227, Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V~~

AS/NZS 3191, *Approval and test specification—Electrical flexible cords*

~~IEC 60245, Rubber insulated cables—Rated voltages up to and including 450/750 V~~

AS/NZS 3191, *Approval and test specification—Electrical flexible cords*

~~IEC 60309, Plugs, socket outlets and couplers for industrial purposes~~

AS/NZS 3112, *Approval and test specification—Plugs and socket outlets*

AS/NZS 3123, *Approval and test specification—Plugs, socket-outlets and couplers for general industrial application*

~~IEC 60335, Safety of household and similar electrical appliances~~

AS/NZS 60335, *Household and similar electrical appliances—Safety*

~~IEC 60529, Degrees of protection provided by enclosures (IP Code)~~

AS 1939, *Degrees of protection provided by enclosures (IP Code) (identical to IEC 60529)*

~~IEC 60651, Sound level meters~~

AS 1259.1, *Acoustics—Sound level meters—Part 1: Non-integrating*

IEC 60664-3, *Insulation coordination for equipment within low-voltage systems – Part 3: Use of coatings to achieve insulation coordination of printed board assemblies*

IEC 60707, *Flammability of solid non-metallic materials when exposed to flame sources – List of test methods*

IEC 60799, *Electrical accessories – Cord sets and interconnection cord sets*

~~IEC 60804, Integrating averaging sound level meters~~

AS 1259.2, *Acoustics—Sound level meters—Part 2: Integrating-Averaging* (Identical to IEC 60804)

~~IEC 60825-1, *Safety of laser products — Part 1: Equipment classification, requirements and user's guide*~~

AS/NZS 2211.1, *Laser safety—Equipment classification, requirements and user's guide*

~~IEC 60947-1, *Low-voltage switchgear and controlgear — Part 1: General rules*~~

AS/NZS 3947.1:2001, *Low-voltage switchgear and controlgear, Part 1: General rules* (identical to IEC 60947-1:1999)

~~IEC 60947-3, *Low-voltage switchgear and controlgear — Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*~~

AS/NZS 3947.3, *Low-voltage switchgear and controlgear, Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units* (identical to IEC 60947-3:1999)

~~ISO 306:1994, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST)*~~

AS 1368, *Plastics – Thermoplastic materials – Determination of Vicat softening temperature (VST)* (identical to ISO 306:1994)

ISO 3746, *Acoustics – Determination of sound power levels of noise sources using sound pressure – Survey method using an enveloping measurement surface over a reflecting plane*

ISO 4126-1, *Safety valves – Part 1: General requirements*

ISO 9614-1, *Acoustics – Determination of sound power levels of noise sources using sound intensity – Part 1: Measurement at discrete points*

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

3 Terms and definitions

For the purpose of this part of IEC 61010 the following definitions apply.

Unless otherwise specified, values of "voltage" and "current" are the r.m.s. values of an alternating, direct or composite voltage or current.

NOTE An index of defined terms is given in annex H.

3.1 Equipment and states of equipment

3.1.1

fixed equipment

equipment fastened to a support, or otherwise secured in a specific location [IEV 826-07-07]

3.1.2

PERMANENTLY CONNECTED EQUIPMENT

equipment that is electrically connected to a supply by means of a permanent connection which can be detached only by the use of a TOOL

3.1.3**PORTABLE EQUIPMENT**

equipment intended to be carried by hand

3.1.4**HAND-HELD EQUIPMENT**

PORTABLE EQUIPMENT intended to be supported by one hand during NORMAL USE

3.1.5**TOOL**

external device, including keys and coins, used to aid a person to perform a mechanical function

3.2 Parts and accessories**3.2.1****TERMINAL**

a component provided for the connection of a device (equipment) to external conductors [IEV 151-01-03, modified]

NOTE TERMINALS can contain one or several contacts and the term therefore includes sockets, connectors, etc.

3.2.2**FUNCTIONAL EARTH TERMINAL**

TERMINAL by which electrical connection is made direct to a point of a measuring or control circuit or to a screening part and which is intended to be earthed for any functional purpose other than safety

NOTE For measuring equipment, this TERMINAL is often termed measuring earth TERMINAL.

3.2.3**PROTECTIVE CONDUCTOR TERMINAL**

TERMINAL which is bonded to conductive parts of an equipment for safety purposes and is intended to be connected to an external protective earthing system

3.2.4**ENCLOSURE**

part providing protection of equipment against certain external influences and, in any direction, protection against direct contact

3.2.5**BARRIER**

part providing protection against direct contact from any usual direction of access

NOTE ENCLOSURES and BARRIERS may provide protection against the spread of fire (see 9.2.1 b)).

3.3 Electrical quantities**3.3.1****RATED (value)**

quantity value assigned, generally by a manufacturer, to a specified operating condition of a component, device or equipment [IEV 151-04-03]

3.3.2**RATING**

set of RATED values and operating conditions [IEV 151-04-04]

3.3.3**WORKING VOLTAGE**

highest r.m.s. value of the a.c. or d.c. voltage across any particular insulation which can occur when the equipment is supplied at RATED voltage

NOTE 1 Transients are disregarded.

NOTE 2 Both open-circuit conditions and normal operating conditions are taken into account.

3.4 Tests**3.4.1****TYPE TEST**

test of one or more samples of equipment (or parts of equipment) made to a particular design, to show that the design and construction meet one or more requirements of this standard [IEV 151-04-15, modified]

NOTE This is an amplification of the IEV 151-04-15 definition to cover both design and construction requirements.

3.4.2**ROUTINE TEST**

test to which each individual device (equipment) is subjected during or after manufacture to ascertain whether it conforms to certain criteria [IEV 151-04-16, modified] (See annex F)

3.5 Safety terms**3.5.1****ACCESSIBLE (of a part)**

able to be touched with a standard test finger or test pin, when used as specified in 6.2

3.5.2**HAZARD**

potential source of harm

3.5.3**HAZARDOUS LIVE**

capable of rendering an electric shock or electric burn in NORMAL CONDITION or SINGLE FAULT CONDITION

NOTE See 6.3.1 for values applicable to NORMAL CONDITION and 6.3.2 for the higher values deemed to be appropriate in SINGLE FAULT CONDITION.

3.5.4**HIGH INTEGRITY**

not liable to become defective in such a manner as to cause a risk of HAZARD; a HIGH INTEGRITY part is considered as not subject to failure when tests under fault conditions are made

3.5.5**MAINS**

low-voltage electricity supply system (above the values of 6.3.2 a)) to which the equipment concerned is designed to be connected for the purpose of powering the equipment

NOTE Some measuring circuits may also be connected to the MAINS for measuring purposes.

3.5.6**MAINS CIRCUIT**

circuit which is intended to be conductively connected to the MAINS for the purpose of powering the equipment

NOTE Measuring circuits and circuits that are inductively derived from MAINS CIRCUITS are not MAINS CIRCUITS.

3.5.7**POTENTIAL IGNITION SOURCE**

possible fault such as a faulty contact or interruption in an electrical connection, including a conductive pattern on printed boards, which can start a fire if, under normal operating conditions, the open circuit voltage exceeds 50 V (peak) a.c. or d.c. and the product of this open circuit voltage and the measured current through this possible fault exceeds 15 VA.

3.5.8**PROTECTIVE IMPEDANCE**

component, assembly of components or the combination of BASIC INSULATION and a current or voltage-limiting device, whose impedance, construction and reliability are such that, when connected between ACCESSIBLE conductive parts and parts which are HAZARDOUS LIVE, it provides protection to the extent required by this standard in NORMAL CONDITION and SINGLE FAULT CONDITION

3.5.9**PROTECTIVE BONDING**

electrical connection of ACCESSIBLE conductive parts or protective screening to provide electrical continuity to the means for connection of an external protective conductor

3.5.10**NORMAL USE**

operation, including stand-by, according to the instructions for use or for the obvious intended purpose

NOTE In most cases, NORMAL USE also implies NORMAL CONDITION, because the instructions for use will warn against using the equipment when it is not in NORMAL CONDITION.

3.5.11**NORMAL CONDITION**

condition in which all means for protection against HAZARDS are intact

3.5.12**SINGLE FAULT CONDITION**

condition in which one means for protection against HAZARD is defective or one fault is present which could cause a HAZARD

NOTE If a SINGLE FAULT CONDITION results unavoidably in another SINGLE FAULT CONDITION, the two failures are considered as one SINGLE FAULT CONDITION

3.5.13**OPERATOR**

person operating equipment for its intended purpose

NOTE The OPERATOR should have received training appropriate for this purpose.

3.5.14**RESPONSIBLE BODY**

individual or group responsible for the use and maintenance of equipment and for ensuring that OPERATORS are adequately trained

3.5.15**WET LOCATION**

location where water or another conductive liquid may be present and is likely to cause reduced human body impedance due to wetting of the contact between the human body and the equipment, or wetting of the contact between the human body and the environment

3.6 Insulation**3.6.1****BASIC INSULATION**

insulation, the failure of which could cause a risk of electric shock

NOTE BASIC INSULATION may serve also for functional purposes.

3.6.2**SUPPLEMENTARY INSULATION**

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

3.6.3**DOUBLE INSULATION**

insulation comprising both BASIC INSULATION and SUPPLEMENTARY INSULATION

3.6.4**REINFORCED INSULATION**

insulation which provides protection against electric shock not less than that provided by DOUBLE INSULATION. It may comprise several layers which cannot be tested singly as SUPPLEMENTARY INSULATION or BASIC INSULATION

3.6.5**POLLUTION**

addition of foreign matter, solid, liquid or gaseous (ionized gases), that may produce a reduction of dielectric strength or surface resistivity

3.6.6**POLLUTION degree**

for the purpose of evaluating spacings, the following degrees of POLLUTION in the micro-environment are defined

3.6.6.1**POLLUTION DEGREE 1**

no POLLUTION or only dry, non-conductive POLLUTION occurs. The POLLUTION has no influence

3.6.6.2**POLLUTION DEGREE 2**

normally only non-conductive POLLUTION occurs. Occasionally, however, a temporary conductivity caused by condensation must be expected

3.6.6.3**POLLUTION DEGREE 3**

conductive POLLUTION occurs, or dry, non-conductive POLLUTION occurs which becomes conductive due to condensation which is expected

NOTE In such conditions, equipment is normally protected against exposure to direct sunlight, precipitation, and full wind pressure, but neither temperature nor humidity is controlled.

3.6.7**CLEARANCE**

shortest distance in air between two conductive parts

3.6.8**CREEPAGE DISTANCE**

shortest distance along the surface of the insulating material between two conductive parts [IEV 151-03-37]

4 Tests**4.1 General**

Tests in this standard are TYPE TESTS to be carried out on samples of equipment or parts. Their only purpose is to check that the design and construction ensure conformity with this standard. In addition, manufacturers shall perform the ROUTINE TESTS of annex F on 100 % of equipment produced which has both HAZARDOUS LIVE parts and ACCESSIBLE conductive parts.

Tests on subassemblies of the equipment meeting the requirements of the relevant standards specified in this standard and used in accordance with them, need not be repeated during TYPE TESTS of the whole equipment.

Conformity with the requirements of this standard is checked by carrying out all applicable tests, except that a test may be omitted if examination of the equipment demonstrates conclusively that the equipment would pass the test. Tests are carried out under

- a) *reference test conditions (see 4.3);*
- b) *fault conditions (see 4.4).*

NOTE *If when carrying out a conformity test, there is any uncertainty about the exact value of an applied or measured quantity (for example, voltage) due to the tolerance:*

- *the manufacturer should ensure that at least the specified test value is applied;*
- *the test house should ensure that no more than the specified test value is applied.*

4.2 Sequence of tests

The sequence of tests is optional unless otherwise specified in this standard. The equipment under test shall be carefully inspected after each test. If the result of a test causes doubt whether any earlier tests would have been passed if the sequence had been reversed, these earlier tests shall be repeated. If tests under fault conditions may be destructive, these tests may follow those under reference test conditions.

4.3 Reference test conditions

4.3.1 Environmental conditions

Unless otherwise specified in this standard, the following environmental conditions shall exist in the test location:

- a) a temperature of 15 °C to 35 °C;
- b) a relative humidity of not more than 75 %, but not exceeding the limits of 1.4.1 d);
- c) an air pressure of 75 kPa to 106 kPa;
- d) no hoar-frost, dew, percolating water, rain, solar radiation, etc.

4.3.2 State of equipment

Unless otherwise specified, each test shall be carried out on the equipment assembled for NORMAL USE and under the least favourable combination of the conditions given in 4.3.2.1 to 4.3.2.13.

If dimensions or mass make it unsuitable to carry out particular tests on a complete equipment, tests on sub-assemblies are allowed, provided it is verified that the assembled equipment will meet the requirements of this standard.

Equipment intended to be built into a wall, recess, cabinet, etc., shall be installed as specified in the manufacturer's instructions.

4.3.2.1 Position of equipment

The equipment shall be in any position of NORMAL USE and with any ventilation unimpeded.

4.3.2.2 Accessories

Accessories and OPERATOR interchangeable parts available from, or recommended by, the manufacturer for use with the equipment under test shall be either connected or not connected.

4.3.2.3 Covers and removable parts

Covers or parts which can be removed without using a TOOL shall be removed or not removed.

4.3.2.4 MAINS supply

The following requirements apply.

- a) The supply voltage shall be between 90 % and 110 % of any RATED supply voltage for which the equipment can be set or, if the equipment is RATED for a greater fluctuation, at any supply voltage within the fluctuation range.
- b) The frequency shall be any RATED frequency.
- c) Equipment for both a.c. and d.c. shall be connected to an a.c. or d.c. supply.
- d) Equipment for d.c. or single-phase supply shall be connected both with normal and reverse polarity.
- e) Unless the equipment is specified for use only on a non-earthed MAINS supply, one pole of the reference test supply shall be at or near earth potential.
- f) If the means of connection permits reversal, battery-operated equipment shall be connected with both reverse and normal polarity.

4.3.2.5 Input and output voltages

Input and output voltages, including floating voltages but excluding the MAINS supply voltage, shall be set to any voltage within the RATED voltage range.

4.3.2.6 Earth TERMINALS

PROTECTIVE CONDUCTOR TERMINALS, if any, shall be connected to earth. FUNCTIONAL EARTH TERMINALS shall be connected or not connected to earth.

4.3.2.7 Controls

Controls which the OPERATOR can adjust by hand shall be set to any position except that

- a) MAINS selection devices shall be set to the correct value;
- b) combinations of settings shall not be made if they are prohibited by the manufacturer's marking on the equipment.

4.3.2.8 Connections

The equipment shall be connected for its intended purpose, or not connected.

4.3.2.9 Load on motors

Load conditions of motor-driven parts of equipment shall be in accordance with the intended purpose.

4.3.2.10 Output

For equipment giving an electrical output:

- a) the equipment shall be operated in such a way as to provide the RATED output power to the RATED load;
- b) the RATED load impedance of any output shall be connected or not connected.

4.3.2.11 Duty cycle

Equipment for short-term or intermittent operation shall be operated for the longest period and shall have the shortest recovery period consistent with the manufacturer's instructions.

4.3.2.12 Loading and filling

Equipment intended to be loaded with a specific material in NORMAL USE shall be loaded with the least favourable quantity of the materials specified in the instructions for use, including not loaded (empty) if the instructions for use permit this in NORMAL USE.

NOTE 1 In case of doubt, tests should be performed in more than one loading condition.

NOTE 2 If the specified material could cause a HAZARD during test, another material may be used provided that it can be shown that the result of the test is not affected.

4.3.2.13 Heating equipment

When measuring temperatures to evaluate the spread of fire, heating equipment shall be tested in a test corner as required by 10.4.1.

4.4 Testing in SINGLE FAULT CONDITION

4.4.1 General

The following requirements apply.

- a) Examination of the equipment and its circuit diagram will generally show the fault conditions which are liable to result in HAZARDS and which, therefore, shall be applied.
- b) Fault tests shall be made unless it can be demonstrated that no HAZARD could arise from a particular fault condition, or specified alternative methods of checking conformity are chosen in place of fault testing (see clause 9 b) and c)).
- c) The equipment shall be operated under the least favourable combination of reference test conditions (see 4.3). These combinations may be different for different faults and they shall be recorded for each test.

4.4.2 Application of fault conditions

Fault conditions shall include those specified in 4.4.2.1 to 4.4.2.12. They shall be applied only one at a time and shall be applied in turn in any convenient order. Multiple simultaneous faults shall not be applied unless they are a consequence of an applied fault.

After each application of a fault condition, the equipment or part shall pass the applicable tests of 4.4.4.

4.4.2.1 PROTECTIVE IMPEDANCE

- a) If a PROTECTIVE IMPEDANCE is formed by a combination of components, each component shall be short-circuited or disconnected, whichever is less favourable.
- b) If a PROTECTIVE IMPEDANCE is formed by the combination of BASIC INSULATION and a current- or voltage-limiting device, both the BASIC INSULATION and the current- or voltage-limiting device shall be subjected to single faults, applied one at a time. BASIC INSULATION shall be bridged and the current- or voltage-limiting device shall be short-circuited or disconnected, whichever is less favourable.

Parts of PROTECTIVE IMPEDANCE which are HIGH-INTEGRITY components need not be short-circuited or disconnected (see 6.5.3 and 14.6).

4.4.2.2 Protective conductor

The protective conductor shall be interrupted, except for PERMANENTLY CONNECTED EQUIPMENT or equipment utilizing a connector in accordance with IEC 60309-AS/NZS 3123.

4.4.2.3 Equipment or parts for short-term or intermittent operation

These shall be operated continuously if continuous operation could occur in a SINGLE FAULT CONDITION. Individual parts may include motors, relays, other electromagnetic devices and heaters.

4.4.2.4 Motors

Motors shall be stopped while fully energized or prevented from starting, whichever is less favourable.

4.4.2.5 Capacitors

Capacitors (except for self-healing capacitors) in the auxiliary winding circuits of motors shall be short-circuited.

4.4.2.6 MAINS transformers

The secondary windings of MAINS transformers shall be short-circuited as specified in 4.4.2.6.1, and overloaded as specified in 4.4.2.6.2.

A transformer damaged during one test may be repaired or replaced before the next test.

Tests for MAINS transformers tested as separate components are specified in 14.7.

4.4.2.6.1 Short circuit

Each untapped output winding, and each section of a tapped output winding, which is loaded in NORMAL USE, shall be tested in turn, one at a time, to simulate short circuits in the load. Overcurrent protection devices remain fitted during the test. All other windings are loaded or not loaded, whichever load condition of NORMAL USE is less favourable.

4.4.2.6.2 Overload

Each untapped output winding, and each section of tapped output winding, is overloaded in turn one at a time. The other windings are loaded or not loaded, whichever load condition of NORMAL USE is less favourable. If any overloads arise from testing in the fault conditions of 4.4, secondary windings shall be subjected to those overloads.

Overloading is carried out by connecting a variable resistor across the winding. The resistor is adjusted as quickly as possible and readjusted, if necessary, after 1 min to maintain the applicable overload. No further readjustments are then permitted.

If overcurrent protection is provided by a current-breaking device, the overload test current is the maximum current which the overcurrent protection device is just capable of passing for 1 h. Before the test, the device is replaced by a link with negligible impedance. If this value cannot be derived from the specification, it is to be established by test.

For equipment in which the output voltage is designed to collapse when a specified overload current is reached, the overload is slowly increased to a point just before the point which causes the output voltage to collapse.

In all other cases, the loading is the maximum power output obtainable from the transformer.

Transformers with over-temperature protection which meets the requirements of 14.3 during the short-circuit test of 4.4.2.6.1 need not be subjected to overload tests.

4.4.2.7 Outputs

Outputs shall be short-circuited one at a time.

4.4.2.8 Equipment for more than one supply

Equipment which is designed to be operated from more than one type of supply shall be simultaneously connected to these supplies, unless this is prevented by the construction.

4.4.2.9 Cooling

Equipment cooling shall be restricted as follows, one fault at a time:

- a) air-holes with filters shall be closed;
- b) forced cooling by motor-driven fans shall be stopped;
- c) cooling by circulation of water or other coolant shall be stopped.

4.4.2.10 Heating devices

In equipment incorporating heating devices, the following faults shall be applied one at a time:

- a) timers which limit the heating period shall be overridden to energize the heating circuit continuously;
- b) temperature controllers, except for over-temperature protection devices meeting the requirements of 14.3, shall be overridden to energize the heating circuit continuously;
- c) loss of cooling liquid shall be simulated.

4.4.2.11 Insulation between circuits and parts

Insulation between circuits and parts which is below the level specified for BASIC INSULATION shall be bridged to check against the spread of fire.

NOTE See clause 9 a) and b) for alternative methods of checking protection against spread of fire.

4.4.2.12 Interlocks

Each part of an interlock system for the protection of OPERATORS shall be short-circuited or open-circuited in turn if the system prevents access to HAZARDS when a cover, etc. is removed without the use of a TOOL.

HIGH INTEGRITY components of interlock systems (see 14.6 and 15.3) need not be short-circuited or open-circuited.

4.4.3 Duration of tests

4.4.3.1 The equipment shall be operated until further change as a result of the applied fault is unlikely. Each test is normally limited to 1 h since a secondary fault arising from a SINGLE FAULT CONDITION will usually manifest itself within that time. If there is an indication that a risk of electric shock, spread of fire or injury to persons may eventually occur, the test shall be continued until one of these HAZARDS does occur or for a maximum period of 4 h, unless a HAZARD occurs before then.

4.4.3.2 Where a device which interrupts or limits the current during operation is included to limit the temperature of parts which can easily be touched, the maximum temperature attained by the equipment shall be measured, whether the device operates or not.

4.4.3.3 If a fault is terminated by the opening of a fuse and if the fuse does not operate within approximately 1 s, the current through the fuse under the relevant fault condition shall be measured. Evaluation with the pre-arcing time/current characteristics shall be made to find out whether the minimum operating current of the fuse is reached or exceeded and what is the maximum time before the fuse operates. The current through the fuse may vary as a function of time.

If the minimum operating current of the fuse is not reached in the test, the equipment shall be operated for a period corresponding to the maximum fusing time or continuously for the duration specified in 4.4.3.1.

4.4.4 Conformity after application of fault conditions

4.4.4.1 *Conformity with requirements for protection against electric shock is checked after the application of single faults as follows:*

- a) *by making the measurements of 6.3.2 to check that no ACCESSIBLE conductive parts have become HAZARDOUS LIVE;*
- b) *by performing a voltage test on DOUBLE INSULATION or REINFORCED INSULATION to check that there is still one level of protection by insulation. The voltage test is made as specified in 6.8 (without conformity preconditioning) with the test voltage for BASIC INSULATION.*
- c) *by measuring the temperature of transformer windings if the protection against electrical HAZARDS is achieved by DOUBLE INSULATION or REINFORCED INSULATION within the transformer. The temperatures of table 16 shall not be exceeded.*

4.4.4.2 *Conformity with requirements for temperature protection is checked by determining the temperature of the outer surface of the ENCLOSURE and of parts which can easily be touched.*

Except for heated surfaces of heating equipment, the temperature of these parts shall not exceed 105 °C at an ambient temperature of 40 °C or the maximum RATED ambient temperature if higher.

This temperature is determined by measuring the temperature rise of the surface or part and adding it to 40 °C or the maximum RATED ambient temperature if higher.

4.4.4.3 *Conformity with requirements for protection against the spread of fire is checked by placing the equipment on white tissue-paper covering a softwood surface and covering the equipment with cheesecloth. No molten metal, burning insulation, flaming particles, etc. shall fall on the surface on which the equipment stands and there shall be no charring, glowing, or flaming of the tissue paper or cheesecloth. Melting of insulation material shall be ignored if no HAZARD could arise.*

4.4.4.4 *Conformity with requirements for protection against other HAZARDS is checked as specified in clauses 7 and 8, and 11 to 16.*

5 Marking and documentation

5.1 Marking

5.1.1 General

Equipment shall be marked in English language.

Equipment shall bear markings as specified in 5.1.2 to 5.2. Except for marking of internal parts, these markings shall be visible from the exterior, or be visible after removing a cover or opening a door without the aid of a TOOL, if the cover or door is intended to be removed or opened by an OPERATOR. Markings applying to the equipment as a whole shall not be put on parts which can be removed by an OPERATOR without the use of a TOOL.

For rack- or panel-mounted equipment, markings are permitted to be on a surface that becomes visible after removal of the equipment from the rack or panel.

Letter symbols for quantities and units shall be in accordance with IEC 60027. Graphic symbols shall be in accordance with table 1 if applicable. There are no colour requirements for symbols. Graphic symbols shall be explained in the documentation.

NOTE 1 IEC or ISO symbols should be used if available.

NOTE 2 Markings should not be on the bottom of the equipment, except on HAND-HELD EQUIPMENT or where space is limited.

Conformity is checked by inspection.

5.1.2 Identification

The equipment shall, as a minimum, be marked with

- a) the name or trade mark of the manufacturer or supplier;
- b) a model number, name or other means to identify the equipment. If equipment bearing the same distinctive designation (model number) is manufactured at more than one location, equipment from each manufacturing location shall be marked so that the location can be identified.

NOTE The marking of factory location may be in code and need not be on the equipment exterior.

Conformity is checked by inspection.

5.1.3 MAINS supply

The equipment shall be marked with the following information:

- a) nature of supply:
 - 1) a.c.: RATED MAINS frequency or range of frequencies;
 - 2) d.c.: symbol 1 of table 1;

NOTE 1 For information purposes it may be useful to mark

 - equipment intended for a.c. with symbol 2 of table 1;
 - equipment suitable for both a.c. and d.c. with symbol 3 of table 1;
 - equipment for three-phase supply with symbol 4 of table 1.
- b) the RATED value(s) of the supply voltage(s) or the RATED range of the supply voltages;

NOTE 2 RATED voltage fluctuations may also be marked.
- c) the maximum RATED power in watts (active power) or volt-amperes (apparent power), or the maximum RATED input current, with all accessories or plug-in modules connected. If the equipment can be used on more than one voltage range, separate values shall be marked for each voltage range unless the maximum and minimum values do not differ by more than 20 % of the mean value;
- d) equipment which the OPERATOR can set for different RATED supply voltages shall be provided with means for the indication of the voltage for which the equipment is set. For PORTABLE EQUIPMENT the indication shall be visible from the exterior. If the equipment is so constructed that the supply voltage setting can be altered without the use of a TOOL, the action of changing the setting shall also change the indication;
- e) accessory MAINS socket-outlets accepting standard MAINS plugs shall be marked with the voltage if it is different from the MAINS supply voltage. If the outlet is for use only with specific equipment, it shall be marked to identify the equipment for which it is intended. If not, the maximum RATED current or power shall be marked, or symbol 14 of table 1 placed beside the outlet with the full details included in the documentation.

Conformity is checked by inspection and by measurement of power or input current to check the marking of 5.1.3 c). The measurement is made after the current has reached a stationary stage (usually after 1 min) so as to exclude any initial inrush current. The equipment shall be in the condition of maximum power consumption. Transients are ignored. The measured value shall not exceed the marked value by more than 10 %.

Table 1 – Symbols

Number	Symbol	Reference	Description
1		IEC 60417 – 5031	Direct current
2		IEC 60417 – 5032	Alternating current
3		IEC 60417 – 5033	Both direct and alternating current
4			Three-phase alternating current
5		IEC 60417 – 5017	Earth (ground) TERMINAL
6		IEC 60417 – 5019	PROTECTIVE CONDUCTOR TERMINAL
7		IEC 60417 – 5020	Frame or chassis TERMINAL
8		IEC 60417 – 5021	Equipotentiality
9		IEC 60417 – 5007	On (Supply)
10		IEC 60417 – 5008	Off (Supply)
11		IEC 60417 – 5172	Equipment protected throughout by DOUBLE INSULATION or REINFORCED INSULATION
12			Caution, risk of electric shock
13		IEC 60417 – 5041	Caution, hot surface
14		ISO 7000 – 0434	Caution, risk of danger (See note.)
15		IEC 60417 – 5268	In position of a bi-stable push control
16		IEC 60417 – 5269	Out position of a bi-stable push control
NOTE See 5.4.1 which requires manufacturers to state that documentation must be consulted in all cases where this symbol is marked.			

5.1.4 Fuses

For any fuse which may be replaced by an OPERATOR, there shall be a marking beside the fuseholder, which will enable the OPERATOR to identify the correct replacement fuse (see 5.4.5).

Conformity is checked by inspection.

5.1.5 TERMINALS, connections and operating devices

If necessary for safety, an indication shall be given of the purpose of TERMINALS, connectors, controls, and indicators, including any connections for fluids such as gas, water and drainage. Where there is insufficient space, symbol 14 of table 1 may be used.

NOTE 1 For additional information, see IEC 60445 and IEC 60447.

NOTE 2 Individual pins of multi-pin connectors need not be marked.

5.1.5.1 TERMINALS

TERMINALS for connection to the MAINS supply shall be identifiable.

The following TERMINALS shall be marked as follows:

- a) FUNCTIONAL EARTH TERMINALS with symbol 5 of table 1;
- b) PROTECTIVE CONDUCTOR TERMINALS with symbol 6 of table 1, except when the PROTECTIVE CONDUCTOR TERMINAL is part of an approved MAINS appliance inlet. The symbol shall be placed close to, or on, the TERMINAL;
- c) TERMINALS of measuring and control circuits which are permitted by 6.6.3 to be connected to ACCESSIBLE conductive parts with symbol 7 of table 1 if this connection is not self-evident;

NOTE This symbol may also be considered as a warning symbol in that it indicates that a HAZARDOUS LIVE voltage must not be connected to the TERMINAL. The symbol should also be used if it is likely that the OPERATOR could make such a connection inadvertently.

- d) TERMINALS supplied from the interior of the equipment and which are HAZARDOUS LIVE, with the voltage, current, charge or energy value or range, or with symbol 14 of table 1. This requirement does not apply to MAINS supply outlets where a standard MAINS socket outlet is used;
- e) ACCESSIBLE FUNCTIONAL EARTH TERMINALS connected to ACCESSIBLE conductive parts, with an indication that this is the case, unless it is self-evident. Symbol 8 of table 1 is acceptable for this marking.

Conformity is checked by inspection.

5.1.5.2 Measuring circuit TERMINALS

Unless a clear indication (see note below) is provided on a measuring instrument that voltage and current measuring circuit TERMINALS are not intended to be connected to voltages to earth above 50 V a.c. or 120 V d.c., the TERMINALS shall be marked as follows.

- a) Measuring circuit TERMINALS for measurements within measurement category I (see 6.7.4) shall be marked with the RATED voltage or current as applicable and with symbol 14 of table 1 (see also 5.4.1 f) and g)).
- b) Measuring circuit TERMINALS for measurements within measurement categories II, III and IV (see 6.7.4) shall be marked with the RATED voltage or current as applicable and the relevant measurement category. The measurement category markings shall be "CAT II", "CAT III" or "CAT IV" as applicable.

NOTE Examples of acceptable indications that the inputs in all cases are intended to be less than 50 V a.c. or 120 V d.c. to earth include

- a) the full-scale deflection marking of a single-range indicating voltmeter or maximum marking of a multi-range voltmeter;
- b) the maximum range marking of a voltage selector switch;
- c) the marked intended function of the instrument (for example, millivoltmeter).

Voltage and current measuring circuit TERMINALS that are permanently connected and not ACCESSIBLE need not be marked (see 5.4.3 i)). The measurement category and the RATED maximum WORKING VOLTAGE or RATED maximum current for such TERMINALS shall be stated in the equipment installation instructions (see 5.4.3).

An exception is also permitted for circuit TERMINALS (connectors) which are dedicated only for connection to specific TERMINALS of other equipment, provided that there is a means for identifying these TERMINALS.

Markings shall be placed adjacent to the TERMINALS. However, if there is insufficient space (as in multi-input equipment), it is permissible for the marking to be on the RATING plate or scale plate, or for the TERMINAL to be marked with symbol 14 of table 1.

Conformity is checked by inspection.

5.1.6 Switches and circuit-breakers

If the power supply switch or circuit-breaker is used as the disconnecting device, the on-position or the off-position shall be clearly marked. Symbols 9 and 10 of table 1 can, in some cases, also be suitable as the device identification (see 6.11.2.5). A lamp alone is not considered to be a satisfactory marking. Symbols 9 and 10 shall not be used for switches other than the power supply switch.

If a push-button switch is used as the power supply switch, symbols 9 and 15 of table 1 may be used to indicate the on-position, or symbols 10 and 16 to indicate the off-position, with the pair of symbols (9 and 15, or 10 and 16) close together.

Conformity is checked by inspection.

5.1.7 Equipment protected by DOUBLE INSULATION or REINFORCED INSULATION

Equipment protected throughout by DOUBLE INSULATION or REINFORCED INSULATION shall be marked with symbol 11 of table 1 unless it is provided with a PROTECTIVE CONDUCTOR TERMINAL.

Equipment which is only partially protected by DOUBLE INSULATION or REINFORCED INSULATION shall not bear symbol 11 of table 1.

Conformity is checked by inspection.

5.1.8 Field-wiring TERMINAL boxes

If the temperature of the TERMINALS or the ENCLOSURE of a field-wiring TERMINAL box or compartment exceeds 60 °C in NORMAL CONDITION at an ambient temperature of 40 °C, or the maximum RATED ambient temperature if higher, there shall be a marking of the minimum temperature RATING of the cable to be connected to the TERMINALS. The marking shall be visible before and during connection, or be beside the TERMINALS.

Conformity, in case of doubt, is checked by measurement as specified in 10.3 a) and, if applicable, by inspection of markings.

5.2 Warning markings

Warning markings shall be visible when the equipment is ready for NORMAL USE. If a warning applies to a particular part of the equipment, the marking shall be placed on, or near to, this part.

The size of warning markings shall be as follows.

- a) Symbols shall be at least 2,75 mm high. Text shall be at least 1,5 mm high and contrast in colour with the background.
- b) Symbols or text moulded, stamped or engraved in a material shall be at least 2,0 mm high. If not contrasting in colour, they shall have a depth or raised height of at least 0,5 mm.

If it is necessary for the RESPONSIBLE BODY or OPERATOR to refer to the instruction manual to preserve the protection afforded by the equipment, the equipment shall be marked with symbol 14 of table 1. Symbol 14 is not required to be used with symbols which are explained in the manual.

If the instructions for use state that an OPERATOR is permitted to gain access, using a TOOL, to a part which in NORMAL USE may be HAZARDOUS LIVE, there shall be a warning marking which states that the equipment must be isolated or disconnected from the HAZARDOUS LIVE voltage before access.

Warning markings are specified in 5.1.5.1 c), 6.1.2 b), 6.5.1.2 g), 6.6.2, 7.2 c), 7.3, 10.1, 13.2.2.

Conformity is checked by inspection.

5.3 Durability of markings

Markings in accordance with 5.1.2 to 5.2 shall remain clear and legible under conditions of NORMAL USE and resist the effects of cleaning agents specified by the manufacturer.

Conformity is checked by inspection and by performing the following test for durability of markings on the outside of the equipment. The markings are rubbed by hand, without undue pressure, for 30 s with a cloth soaked with the specified cleaning agent (or, if not specified, with isopropyl alcohol).

The markings shall be clearly legible after the above treatment, and adhesive labels shall not have worked loose or become curled at the edges

5.4 Documentation

5.4.1 General

Equipment shall be accompanied by documentation for safety purposes as follows:

- a) intended use of the equipment;
- b) technical specification;
- c) instructions for use;
- d) name and address of manufacturer or supplier from whom technical assistance may be obtained;
- e) the information specified in 5.4.2 to 5.4.5;
- f) definition of the relevant measurement category if marking of TERMINALS is required on the equipment (see 5.1.5.2);
- g) for equipment marked with measurement category I, a warning shall be given not to use the equipment for measurements within measurement categories II, III and IV, and a detailed RATING including the RATED transient overvoltages is given in the documentation.

If applicable, warning statements and a clear explanation of warning symbols marked on the equipment shall be provided in the documentation or shall be durably and legibly marked on the equipment. In particular, there shall be a statement that documentation needs to be consulted in all cases where symbol 14 of table 1 is used, in order to find out the nature of the potential HAZARD and any actions which have to be taken.

NOTE If NORMAL USE involves the handling of hazardous substances, instruction should be given on correct use and safety provisions. If any hazardous substance is specified or supplied by the equipment manufacturer, the necessary information on its constituents and the correct disposal procedure should also be given.

Conformity is checked by inspection.

5.4.2 Equipment RATINGS

Documentation shall include the following:

- a) the supply voltage or voltage range, frequency or frequency range, and power or current RATING;
- b) a description of all input and output connections;
- c) the RATING of the insulation of external circuits, appropriate for SINGLE FAULT CONDITIONS, if such circuits are nowhere ACCESSIBLE (see 6.6.2);
- d) a statement of the range of environmental conditions for which the equipment is designed (see 1.4);
- e) a statement of the degree of protection, if the equipment is RATED according to IEC 60529.

Conformity is checked by inspection.

5.4.3 Equipment installation

The documentation shall include installation and specific commissioning instructions (examples are listed below) and, if necessary for safety, warnings against HAZARDS which could arise during installation or commissioning of the equipment:

- a) assembly, location and mounting requirements;
- b) instructions for protective earthing;
- c) connections to the supply;
- d) for PERMANENTLY CONNECTED EQUIPMENT:
 - 1) supply wiring requirements;
 - 2) requirements for any external switch or circuit-breaker (see 6.11.2.1) and external overcurrent protection devices (see 9.5.1) and a recommendation that the switch or circuit-breaker be near the equipment;
- e) ventilation requirements;
- f) requirements for special services, for example, air, cooling liquid;
- g) the maximum sound power level produced by equipment which emits sound, if measurement is required by 12.5.1;
- h) instructions relating to sound pressure level (see 12.5.1);
- i) for voltage- and current-measuring circuit TERMINALS that are permanently connected and not ACCESSIBLE, information regarding the measurement category, RATED maximum WORKING VOLTAGE or RATED maximum current (see 5.1.5.2).

Conformity is checked by inspection.

5.4.4 Equipment operation

Instructions for use shall include, if applicable:

- a) identification of operating controls and their use in all operating modes;
- b) an instruction not to position the equipment so that it is difficult to operate the disconnecting device;
- c) instructions for interconnection to accessories and other equipment, including indication of suitable accessories, detachable parts and any special materials;
- d) specification of limits for intermittent operation;
- e) an explanation of symbols related to safety which are used on the equipment;
- f) instructions for replacement of consumable materials;
- g) instructions for cleaning and decontamination;

- h) a statement listing any potentially poisonous or injurious gases that can be liberated from the equipment, and possible quantities;
- i) detailed instructions about risk-reduction procedures relating to flammable liquids (see 9.4 c)).

There shall be a statement in the instructions that, if the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Conformity is checked by inspection.

5.4.5 Equipment maintenance

Instructions for the RESPONSIBLE BODY concerning preventive maintenance and inspection necessary for safety shall be given in sufficient detail. These shall include the inspection and replacement, if necessary, of any hoses or other parts containing liquids, if their failure could cause a HAZARD (see 11.7).

NOTE Instructions should advise the RESPONSIBLE BODY of any tests necessary to check that equipment is still in a safe condition. They should also warn against the repetition of any tests of this standard which could damage the equipment and reduce protection against HAZARDS.

For equipment using replaceable batteries, the specific battery type shall be stated.

The manufacturer shall specify any parts which are required to be examined or supplied only by the manufacturer or his agent.

The RATING and characteristics of replaceable fuses shall be stated.

Conformity is checked by inspection.

6 Protection against electric shock

6.1 General

6.1.1 Requirements

Protection against electric shock shall be maintained in NORMAL CONDITION (see 6.4) and SINGLE FAULT CONDITION (see 6.5). ACCESSIBLE parts of equipment shall not be HAZARDOUS LIVE (see 6.3).

Conformity is checked by the determination of ACCESSIBLE parts as specified in 6.2 and the measurements of the levels of 6.3, followed by the tests of 6.4 to 6.11.

6.1.2 Exceptions

If it is not feasible for operating reasons to prevent the following parts being both ACCESSIBLE and HAZARDOUS LIVE, they are permitted to be ACCESSIBLE to the OPERATOR during NORMAL USE while they are HAZARDOUS LIVE:

- a) parts of lamps and lamp sockets after lamp removal;
- b) parts intended to be replaced by the OPERATOR (for example, batteries) and which may be HAZARDOUS LIVE during the replacement or other OPERATOR action, but only if they are ACCESSIBLE only by means of a TOOL and have a warning marking (see 5.2);
- c) locking and screw-held type measuring TERMINALS, including TERMINALS which do not require the use of a TOOL.

If any of the parts in a) and b) receive a charge from an internal capacitor, they shall not be HAZARDOUS LIVE 10 s after interruption of the supply.

If a charge is received from an internal capacitor, conformity is checked by the measurements of 6.3 to establish that the levels of 6.3.1 c) are not exceeded.

6.2 Determination of ACCESSIBLE parts

Unless obvious, determination of whether a part is ACCESSIBLE shall be made as specified in 6.2.1 to 6.2.3. Test fingers (see annex B) and pins shall be applied without force unless a force is specified. Parts are considered to be ACCESSIBLE if they can be touched with a test finger or pin, or if they could be touched in the absence of a covering which is not considered to provide suitable insulation (see 6.9.1). For HAZARDOUS LIVE parts at a voltage to earth exceeding 1 kV r.m.s. or 1,5 kV d.c., a part is considered to be ACCESSIBLE if the test finger or pin reaches a point nearer to the HAZARDOUS LIVE part than the applicable CLEARANCE for BASIC INSULATION for the WORKING VOLTAGE.

If the OPERATOR is intended to perform any actions in NORMAL USE (with or without a TOOL) which will increase the accessibility of parts, such actions shall be taken before performing the examinations of 6.2.1 to 6.2.3. Examples include:

- a) removing covers;
- b) opening doors;
- c) adjusting controls;
- d) replacing consumable material;
- e) removing parts.

For rack- or panel-mounted equipment, the equipment is installed as specified in the manufacturer's instructions before making the examinations of 6.2.1 to 6.2.3. For such equipment, the OPERATOR is assumed to be in front of the panel.

6.2.1 Examination

The jointed test finger (see figure B.2) is applied in every possible position. If a part could become ACCESSIBLE by applying a force, the rigid test finger (see figure B.1) is applied with a force of 10 N. The force is exerted by the tip of the test finger so as to avoid wedge and lever action. The test is applied to all outer surfaces, including the bottom. However, on equipment accepting plug-in modules the tip of the jointed test finger is inserted only to a depth of 180 mm from the opening in the equipment.

6.2.2 Openings above parts that are HAZARDOUS LIVE

A metal test pin 100 mm long and 4 mm in diameter is inserted in any openings above parts which are HAZARDOUS LIVE. The test pin is suspended freely and allowed to penetrate up to 100 mm. The additional safety measures of 6.5 for protection in SINGLE FAULT CONDITION are not required solely because a part is ACCESSIBLE by this test only.

This test is not applied to TERMINALS.

6.2.3 Openings for pre-set controls

A metal test pin 3 mm in diameter is inserted through holes intended to give access to pre-set controls which require the use of a screwdriver or other TOOL. The test pin is applied in every possible direction through the hole. Penetration shall not exceed three times the distance from the ENCLOSURE surface to the control shaft or 100 mm, whichever is smaller.

6.3 Permissible limits for ACCESSIBLE parts

The voltage, current, charge or energy between an ACCESSIBLE part and reference test earth, or between any two ACCESSIBLE parts on the same piece of equipment within a distance of 1,8 m (over a surface or through air), shall not exceed the values of 6.3.1 in NORMAL CONDITION nor of 6.3.2 in SINGLE FAULT CONDITION.