UL 61010B-1

ISBN 0–7629–0839–4

Electrical Measuring and Test Equipment; Part 1: General Requirements

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Underwriters Laboratories Inc. (UL)
333 Pfingsten Road
Northbrook, IL 60062-2096

UL Standard for Safety for Electrical Measuring and Test Equipment Part 1: General Requirements, UL 61010B-1

First Edition, Dated January 24, 2003

Summary of Topics

These revisions adopt the following changes in requirements:

> ***1. Change in Number and Format of UL 3111–1 (number changed to UL 61010B-1). In addition to changing the standard number, UL has editorially reformatted the standard. The reformatting includes, but is not limited to, referring to "deviations" as "national differences" and incorporating them into the body of the standard.***
>
> ***2. Having the first edition of UL 61010B-1 correlate with the requirements in Amendment No. 2 to IEC Publication 61010–1.***

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Text that has been changed in any manner is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The new and/or revised requirements are substantially in accordance with UL's Bulletin on this subject dated July 5, 2002. The bulletin is now obsolete and may be discarded.

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New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

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This Standard consists of pages dated as shown in the following checklist:

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B1-B2	January 24, 2003
C1-C2	January 24, 2003
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Electrical Measuring and Test Equipment Part 1: General Requirements

Prior to this first edition numbered UL 61010B-1, the requirements for products covered by this standard were included in the first edition of UL 3111–1. This standard replaces UL 3111–1.

First Edition

January 24, 2003

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Revisions of this standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

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Preface (UL)

This UL Standard is based on IEC Publication 1010-1 (1990): First edition – Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements, as revised by Amendment 1 and Amendment 2. IEC publication 1010-1 is copyrighted by the IEC.

This is the UL Standard for Safety for Electrical Measuring and Test Equipment; Part 1: General Requirements. This UL part 1 is to be used in conjunction with the appropriate UL part 2, which contains clauses to supplement or modify the corresponding clauses in part 1, to provide relevant requirements for each type of product.

The text, figures and tables of IEC Publication Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements, IEC 1010-1 copyright 1990 as amended in 1992 and in 1995 are used in this Standard with the consent of the IEC and the American National Standards Institute (ANSI). The IEC copyrighted material has been reproduced with permission from ANSI. ANSI should be contacted regarding the reproduction of any portion of the IEC material. The IEC Foreword and Introduction are not a part of the requirements of this Standard but are included for information purposes only. Copies of IEC Publication 1010-1 may be purchased from ANSI, 11 West 42nd Street, New York, New York, 10036, (212) 642-4900.

Also, note that IEC 1010–1 has now been renumbered as IEC 61010–1 in accordance with a renumbering scheme that IEC has enacted for all of its standards.

Note – Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.

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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

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NATIONAL DIFFERENCES

GENERAL

National Differences from the text of International Electrotechnical Commission (IEC) Publication 61010-1, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements copyright 1990 as amended in 1992 and in 1995 are indicated by notations (differences) and are presented in bold text.

There are five types of National Differences as noted below. The difference type is noted on the first line of the National Difference in the standard. The standard may not include all types of these National Differences.

DR – These are National Differences based on the **National Electrical Code (NEC)** and **other U.S. Regulatory Requirements**.

D1 – These are National Differences which are based on **basic safety principles and requirements**, elimination of which would compromise safety for U.S. consumers and users of products.

D2 – These are National Differences based on **safety practices**. These are differences for IEC requirements that may be acceptable, but adopting the IEC requirements would require considerable retesting or redesign on the manufacturer's part.

DC – These are National Differences based on the **component standards** and will not be deleted until a particular component standard is harmonized with the IEC component standard.

DE – These are National Differences based on **editorial comments or corrections**.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SAFETY REQUIREMENTS FOR ELECTRICAL EQUIPMENT FOR MEASUREMENT, CONTROL, AND LABORATORY USE – Part 1: General requirements

FOREWORD

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.

3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

This standard has been prepared by Sub-Committee 66E: Safety of measuring, control and laboratory equipment of IEC Technical Committee No. 66: Electrical and electronic test measuring instruments, systems and accessories. It constitutes Part 1 of a series of publications dealing with safety requirements for electrical equipment for measurement, control, and laboratory use.

It has the status of a group safety publication in accordance with IEC Guide 104.

The text of this standard is based upon the following documents:

Six Months' Rule	Report on Voting	Two Months' Procedure	Report on Voting
66E(CO)4	66E(CO)6	66E(CO)7	66E(CO)8

Full information on the voting for the approval of this standard can be found in the Voting Reports indicated in the above table.

Annexes A, B, C, D, E, F, and G are normative and annexes H, J, K, L, and M are informative.

In this standard, the following print types are used:

– requirements and definitions: in roman type;

– NOTES: in smaller roman type;

– compliance: in italic type;

– terms used throughout this standard which have been defined in clause 3: SMALL ROMAN CAPITALS.

Amendment 1 has been prepared by Sub-Committee 66E: Safety of measuring, control, and laboratory equipment, of IEC Technical Committee No. 66: Electrical and electronic test and measuring instruments, systems and accessories.

It has the status of a group safety publication in accordance with IEC Guide 104.

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The text of this amendment is based on the following documents:

DIS	Report on Voting	Amendment to DIS	Report on Voting
66E(CO)12	66E(CO)14	66E(CO)15 and 15A	66E(CO)19

Full information on the voting for the approval of this amendment can be found in the Voting Reports indicated in the above table.

With this amendment, IEC 1010-1 supercedes IEC 348 which is withdrawn.

Amendment 2 has been prepared by IEC technical committee 66: Safety of measuring, control, and laboratory equipment.

It has the status of a group safety publication in accordance with IEC Guide 104.

The text of this amendment is based on the following documents:

DIS	Report on Voting
66/110 + 110A/DIS	66/115/RVD

Full information on the voting for the approval of this amendment can be found in the report on voting indicated in the above table.

With this amendment, IEC 1010-1 supercedes IEC 414 which is withdrawn.

Pressures in this standard are quoted in kilopascals (kPa) but may be converted to bars using the conversion factor 100 kPa = 1 bar.

1DV DE *Addition:*

Add the following to the end of the Foreword:

The numbering system in the standard uses a space instead of a comma to indicate thousands and uses a comma instead of a period to indicate a decimal point. For example, 1 000 means 1,000 and 1,01 means 1.01.

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INTRODUCTION

After many years of discussion and aware of the need for a General Standard for the safety of electrical equipment for measurement, control, and laboratory use, the majority of National Committees voted in 1988 in favour of the publication of IEC 1010-1.

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 a Particular Standard which must be read in conjunction with Part 1 requirements.

Particular standards are under consideration for the following types of equipment or conditions of use:

– probes;

– laboratory centrifuges;

– laboratory equipment for the heating of materials;

– laboratory flame and arc photometers, and ionizing equipment;

– laboratory sterilisers;

– laboratory mixing, crushing and shaking equipment;

– equipment for use in outdoor and harsh indoor conditions.

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SAFETY REQUIREMENTS FOR ELECTRICAL EQUIPMENT FOR MEASUREMENT, CONTROL, AND LABORATORY USE – Part 1: General requirements

1 Scope and object

1.1 *Scope*

This International Standard specifies general safety requirements for electrical equipment intended for professional, industrial process, and educational use, including equipment and computing devices for:

– measurement and test;

– control;

– laboratory use;

– accessories intended for use with the above (e.g. sample handling equipment).

This Part 1 of the standard applies to the equipment defined in a) to c) below, when used under the environmental conditions of 1.4.

a) Electrical measurement and test equipment

This is equipment which by electrical means 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 this standard unless they are panel meters designed only for building-in to other equipment. Built-in panel meters are considered as components and only need to meet the relevant requirements of IEC 1010, 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.

This equipment may also be used in areas other than laboratories.

1.1DV.1 DE *Modification:*

Delete ″industrial process″ and delete the second and third dashes from the first paragraph (UL 61010A-1 and UL 61010C-1 apply).

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1.1DV.2 DR *Addition of the following referencing the National Electrical Code:*

This Part 1 of the standard applies to equipment to be employed in accordance with the National Electrical Code, NFPA 70.

1.1.1 *Aspects excluded from scope*

This Part 1 of the standard does not cover:

– reliable function, performance or other properties of the equipment;

– effectiveness of transport and packaging;

– servicing (repair);

– 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 against unexpected hazards.

1.1.2 *Equipment excluded from scope*

This Part 1 does not apply to:

– electric power equipment, for example power electronics;

– machine TOOLS and their controls (see IEC 204);

– Class 0, 5, 1 and 2 alternating current watt-hour meters (see IEC 521);

– medical electrical equipment within the scope of IEC 601;

– biological amplifies which link humans to equipment in research or teaching contexts;

– TYPE-TESTED and partially TYPE-TESTED assemblies of low-voltage switchgear and controlgear (see IEC 439-1);

– circuits and equipment which are part of the building electrical installation (see IEC 364);

– computers, processors and similar equipment, except as specified in 1.1.3 (see IEC 950);

– transformers separate from the equipment (see IEC 742);

– equipment intended for household use (see IEC 335);

– equipment intended for use in explosive gas atmospheres (see IEC 79).

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1.1.3 *Computing equipment*

This Part 1 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 950 and complying with its requirements are considered to be suitable for use with equipment within the scope of this Part 1. However, some of the requirements of IEC 950 for resistance to moisture and liquids are less stringent than those in this standard. Where hazards from moisture or liquids could affect equipment which complies with IEC 950 and is used with equipment which complies with this standard, the instructions for use should specify any additional precautions required.

1.2 *Object*

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:

– electric shock or burn (see clauses 6, 10 and 11);

– mechanical hazards (see clauses 7, 8 and 11);

– excessive temperature (see clause 9);

– spread of fire from the equipment (see clause 9);

– effects of radiation, including lasers sources, sonic and ultrasonic pressure (see clause 12);

– 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 health and safety of labor forces.

1.3 *Verification*

This Part 1 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 K.

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1.4 *Environmental conditions*

This Part 1 applies to equipment designed to be safe at least under the following conditions:

– indoor use;

– altitude up to 2 000 m, or above 2 000 m if specified by the manufacturer (see clause D.9 for further information);

– temperature 5°C to 40°C;

– maximum relative humidity 80% for temperatures up to 31°C decreasing linearly to 50% relative humidity at 40°C;

– mains supply voltage fluctuations not to exceed ±10% of the nominal voltage;

– other supply voltage fluctuations as stated by the manufacturer;

– transient overvoltages according to INSTALLATION CATEGORIES (OVERVOLTAGE CATEGORIES) I, II and III (see Annex J). For mains supply the minimum and normal category is II;

– POLLUTION DEGREE 1 or 2 in accordance with IEC 664 (see 3.7.3).

1.4DV DC *Addition of the following addressing requirements for extended environments:*

Equipment used in extended environments, e.g. outdoors or sheltered locations, shall comply with additional requirements not found in this standard, such as UL 840.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Part 1 of IEC 1010. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Part 1 of IEC 1010 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

2.1 *IEC standards*

50 (151): 1978,
International Electrotechnical Vocabulary – Chapter 151: Electrical and magnetic devices.

50 (351): 1975,
International Electrotechnical Vocabulary – Chapter 351: Automatic control.

51,
Direct acting indicating analogue electrical measuring instruments and their accessories.

60,
High-voltage test techniques.

60-2: 1973,
High-voltage test techniques – Part 2: Test procedures.

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65: 1985,
Safety requirements for mains operated electronic and related apparatus for household and similar general use.

68-2-3: 1969,
Environmental testing – Part 2: Tests – Test Ca: Damp heat, steady state.

68-2-31: 1969,
Environmental testing – Part 2: Tests – Test Ec: Drop and topple, primarily for equipment-type specimens.

68-2-63: 1991,
Environmental testing – Part 2: Tests – Test Eg: Impact, spring hammer.

71,
Insulation coordination.

85: 1984,
Thermal evaluation and classification of electrical insulation.

227,
Polyvinyl chloride insulated cables of rated voltages up to an including 450/750 V.

245,
Rubber insulated cables of rated voltages up to and including 450/750 V.

309,
Plugs, socket-outlets and couplers for industrial purposes.

335,
Safety of household and similar electrical appliances.

359: 1987,
Expression of the performance of electrical and electronic measuring equipment.

417: 1973,
Graphical symbols for use on equipment. Index, survey and compilation of the single sheets.

529: 1989,
Degrees of protection provided by enclosures (IP Code).

617-2: 1983,
Graphical symbols – Part 2: Symbol elements, qualifying symbols and other symbols having general applications.

651: 1979,
Sound level meters.

664,
Insulation coordination for equipment within low-voltage systems.

707: 1981,
Methods of tests for the determination of the flammability of solid electrical insulating materials when exposed to an igniting source.

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799: 1984,
Cord sets.

804: 1985,
Integrating-averaging sound level meters.

825: 1984,
Radiation safety of laser products, equipment classification, requirements and user's guide.

947-1: 1988,
Low-voltage switchgear and controlgear – Part 1: General rules.

947-3: 1990,
Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch disconnectors and fuse-combination units.

990: 1990,
Methods of measurement of touch-current and protective conductor current.

2.2 *ISO standards*

306: 1987,
Plastics – Thermoplastic materials. Determination of Vicat softening temperature.

3746: 1979,
Acoustics – Determination of sound power levels of noise sources - Survey method.

3864: 1984,
Safety colours and safety signs.

4126-1: 1991,
Safety valves – Part 1: General requirements.

9614-1: 1993,
Acoustics – Determination of sound power levels of noise sources using sound intensity – Part 1: Measurement at discrete points.

2.3DV DC ***Addition of the following:***

ANSI/CGA V-1
Compressed Gas Cylinder Valve Outlet and Inlet Connections.

ANSI/NFPA 70
National Electrical Code.

UL 94
Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

UL 498
Attachment Plugs and Receptacles.

UL 746C
Polymeric Materials – Use in Electrical Equipment Evaluations.

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UL 817
Cord Sets and Power Supply Cords.

UL 1310
Class 2 Power Units.

3 Definitions

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

For the definitions of further terms used in this standard see IEC 50 (351), IEC 51 and IEC 359. Unless otherwise specified, the terms ″voltage″ and ″current″ mean the r.m.s. values of an alternating, direct or composite voltage or current.

3.1 *Equipment and states of equipment*

3.1.1 FIXED EQUIPMENT: Equipment fastened to a support or otherwise secured in a specific location.

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: An 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].

NOTE – It may contain one or several TERMINAL contacts.

3.2.2 FUNCTIONAL EARTH TERMINAL: A TERMINAL by which electrical connection is made directly 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: A 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: A part providing protection of equipment against certain external influences and, in any direction, protection against direct contact.

3.2.5 BARRIER: A 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 9.1 and annex F).

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3.2.6DV D2 ***Addition of a new definition for*** ***FIELD WIRING TERMINAL:***

FIELD WIRING TERMINAL: Any TERMINAL to which a mains circuit wire is intended to be connected by an installer in the field.

3.3 *Electrical quantities*

3.3.1 RATED (VALUE): A quantity value assigned, generally by a manufacturer, for a specified operating condition of a component, device or equipment [IEV 151-04-03].

3.3.2 RATING: The set of RATED values and operating conditions [IEV 151-04-04].

3.4 *Tests*

3.4.1 TYPE TEST: A 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.

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

3.4.2 ROUTINE TEST: A test to which each individual device (equipment) is subjected during or after manufacture to ascertain whether it complies with certain criteria (see annex K [IEV 151-04-16].

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 HAZARDOUS LIVE: Capable of rendering an electric shock or electric burn in NORMAL CONDITION or SINGLE FAULT CONDITION (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).

3.5.3 HIGH INTEGRITY: Not liable to become defective in such a manner as to cause a risk of hazard within the sense of this standard; a HIGH INTEGRITY part is considered as not subject to failure when tests under fault conditions are made.

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

3.5.5 PROTECTIVE BONDING: Electrical connection of ACCESSIBLE conductive parts and/or of protective screening to provide electrical continuity to the means for connection of an external protective conductor.

3.5.6 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.

3.5.7 NORMAL CONDITION: Condition in which all means for protection against hazards are intact.

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3.5.8 SINGLE FAULT CONDITION: Condition in which one means for protection against hazard is defective or one fault is present which could cause a hazard (see 1.2).

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

3.5.9 OPERATOR: Person operating equipment for its intended purpose.

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

3.5.10 RESPONSIBLE BODY: Individual or group responsible for the use and maintenance of equipment, and for ensuring that OPERATORS are adequately trained.

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.

3.7 *Insulation co-ordination*

3.7.1 INSTALLATION CATEGORY (OVERVOLTAGE CATEGORY): Classification of parts of installation systems or circuits with standardized limits for transient overvoltages, dependent on the nominal line voltage to earth (see annex J and IEC 664).

3.7.2 POLLUTION: Any addition of foreign matter, solid, liquid or gaseous (ionized gases), that my produce a reduction of dielectric strength or surface resistivity.

3.7.3 POLLUTION DEGREE: For the purpose of evaluating CLEARANCES the following two degrees of POLLUTION in the micro-environment are recognized for use with this Part 1.

3.7.3.1 POLLUTION DEGREE 1: No POLLUTION or only dry, non-conductive POLLUTION occurs. The POLLUTION has no influence.

3.7.3.2 POLLUTION DEGREE 2: Normally only non-conductive POLLUTION occurs. Occasionally, however, a temporary conductivity caused by condensation must be expected.

3.7.4 CLEARANCE: The shortest distance in air between two conductive parts.

3.7.5 CREEPAGE DISTANCE: The shortest distance along the surface of the insulating material between two conductive parts [IEV 151-03-37].

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3.8 *Mains*

Where the term ″mains″ is used in this Part 1 it refers to the electricity supply (above the values of 6.3.2.1) which is available to the consumer from the distribution system or systems for which the equipment concerned is designed.

4 Tests

4.1 *General*

Tests in this Part 1 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 compliance with this Part 1. In addition, manufacturers shall perform the ROUTINE TESTS of annex K on 100% of equipment produced which has both HAZARDOUS LIVE parts and ACCESSIBLE conductive parts.

Tests on components or parts of the equipment meeting the requirements of the relevant standards specified in this Part 1 and used in accordance with them, need not be repeated during TYPE TESTS of the whole equipment.

Compliance with the requirements of this Part 1 is checked by carrying out all applicable tests, except that a test my be omitted where examination of the equipment demonstrates conclusively that the equipment would pass the test. Tests are carried out under:

– reference test conditions (see 4.3);

– fault conditions (see 4.4).

NOTES

1 If the RATED range of environmental conditions for equipment is wider than that stated in 1.4, the manufacturer should make sure (e.g. by suitable alteration of test requirements or additional tests) that the safety requirements of this Part 1 are still fulfilled.

2 If, when carrying out a compliance test, there is any uncertainty about the exact value of the applied or measured quantity (e.g. 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.

3 Equipment which has been TYPE TESTED may no longer be suitable for its intended function because of the residual effect of stresses resulting from some of the tests. For this reason TYPE TESTS should not be carried out (for example by the RESPONSIBLE BODY) after the equipment has left the manufacturer.

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4.2 *Sequence of tests*

The sequence of tests is optional unless otherwise specified in the Part 1. 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. Where 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 Part 1, the following environmental conditions (but not conflicting with those of 1.4) shall exist in the test location:

– a temperature of 15°C to 35°C;

– a relative humidity of not more than 75%;

– an air pressure of 75 kPa to 106 kPa;

– no hoar-frost, dew, percolating water, rain, solar irradiation, etc.

4.3.2 *State of equipment*

Unless otherwise specified, tests shall be carried out on the equipment assembled for NORMAL USE and under the least favourable combination of the conditions given in 4.3.3 to 4.3.16.

When 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 be in accordance with this Part 1.

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

4.3.3 *Position of equipment*

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

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4.3.4 *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.

4.3.5 *Covers and removable parts*

Covers or parts which can be removed without using a TOOL shall be removed or not removed. Covers which do not require the use of a TOOL for removal need not be removed if they have interlock systems meeting the requirements of clause 15.

4.3.6 *Mains supply*

The following requirements apply:

– 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, then any supply voltage within the fluctuation range;

– the frequency shall be any RATED frequency;

– equipment for both a.c. and d.c. shall be connected to an a.c. or d.c. supply;

– equipment for d.c. or single-phase supply shall be connected both with normal and reverse polarity;

– 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;

– where the means of connection permits reversal, battery operated equipment shall be connected with both reverse and normal polarity.

4.3.7 *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.

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4.3.8 *Earth* TERMINALS

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

4.3.9 *Controls*

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

– mains selection devices shall be set to the correct value;

– combinations of settings shall not be made if they are prohibited by the manufacturer by marking on the equipment.

4.3.10 *Connections*

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

4.3.11 *Load on motors*

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

4.3.12 *Output*

For equipment giving an electrical output:

– the equipment shall be operated in such a way as to provide the RATED output power to the RATED load;

– the RATED load impedance of any output shall be connected or not connected.

4.3.13 *Duty cycle*

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

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4.3.14 *Loading and filling*

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

NOTES

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

2 If the specified material would 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.

4.3.15 *Heating equipment*

When measuring temperatures to evaluate the spread of fire, heating equipment shall be tested in a test corner as required by 9.2.1.

4.3.16 *Built-in equipment*

When measuring temperatures to evaluate the spread of fire, equipment intended for installation in a cabinet or a wall shall be built in as required by 9.2.2.

4.4 *Testing in SINGLE FAULT CONDITION*

4.4.1 *General*

The following requirements apply:

– examination of the equipment and its circuit diagram will generally show the fault conditions which are liable to result in hazards within the meaning of this Part 1 and which, therefore, shall be applied;

– fault tests shall be made except where it can be demonstrated that no hazard could arise from a particular fault condition;

– 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 should be recorded for each test;

– annex F provides an alternative to testing for protection against spread of fire under fault condition (see 9.1).

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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 the most 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

The following requirements apply:

– If a PROTECTIVE IMPEDANCE is formed by a combination of components, each component shall be short-circuited or disconnected, whichever is the less favourable;

– 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 short-circuited 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 309.

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.

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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 tested as part of the equipment shall be short-circuited and also subjected to any overloads arising from any fault condition according to 4.4.

Windings, and sections of tapped windings, which are loaded in NORMAL USE, shall be tested in turn, one at a time, to simulate short circuits in the load. All other windings are loaded or not loaded, whichever load condition of NORMAL USE is the least favourable.

Short-circuits shall be made on the load side of any current-limiting impedance or over-current protective device which is connected directly to the winding.

Requirements and tests for mains transformers tested as separate components are specified in 14.7.

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:

– air-holes with filters shall be closed;

– forced cooling by motor-driven fans shall be stopped;

– cooling by circulation of water or other coolant shall be stopped.

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4.4.2.10 *Heating devices*

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

– timers which limit the heating period shall be overridden to energize the heating circuit continuously;

– temperature controllers, except for overtemperature protection devices meeting the requirements of 14.3, shall be overridden to energize the heating circuit continuously;

–loss of cooling liquid shall be simulated.

4.4.2.11 *Insulation between circuits and parts*

The insulation between circuits and parts listed in annex G shall be short-circuited unless it has been checked as specified in 9.1.

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 (see 1.2) 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 any secondary fault arising from a SINGLE FAULT CONDITION will usually manifest itself within that time. If at the end of 1 h 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.

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.

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4.4.4 *Compliance*

4.4.4.1 Compliance with requirements for electric shock protection is checked:

– By making the measurements of 6.3.2;

– by a voltage test as specified in 6.8.4 for DOUBLE INSULATION *or* REINFORCED INSULATION*, but with the test voltage for* BASIC INSULATION *only.*

NOTE – The test of BASIC INSULATION simulates the SINGLE FAULT CONDITION of failure of one level of DOUBLE INSULATION or partial failure of REINFORCED INSULATION.

4.4.4.2 Compliance 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 in an ambient temperature of 40°C (see 1.4).

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

4.4.4.3 Compliance 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 which is not of importance according to the requirements of this Part 1 shall be ignored.

4.4.4.4 Compliance with the requirements for protection against the hazards listed in 1.2 is checked as specified in clause 7 to 15.

5 Marking and documentation

5.1 *Marking*

5.1.1 *General*

Equipment shall bear markings in accordance with 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 any 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 27. Graphic symbols shall be in accordance with table 1.

NOTE – Except on HAND-HELD EQUIPMENT or where space is limited, markings should not be on the bottom of the equipment.

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Table 1

Number	Symbole	Publication	Description
1	⎓	IEC 417, No. 5031	Direct current
2	∼	IEC 417, No. 5032	Alternating current
3	≂	IEC 417, No. 5033	Both direct and alternating current
4	3∼	IEC 617-2, No. 02-02-06	Three-phase alternating current
5	⏚	IEC 417, No. 5017	Earth (ground) TERMINAL
6	⏚	IEC 417, No. 5019	PROTECTIVE CONDUCTOR TERMINAL
7	⏚	IEC 417, No. 5020	Frame or chassis TERMINAL
8	⏚	IEC 417, No. 5021	Equipotentiality
9	|	IEC 417, No. 5007	On (Supply)
10	○	IEC 417, No. 5008	Off (Supply)
11	⧈	IEC 417, No. 5172	Equipment protected throughout by DOUBLE INSULATION or REIN-FORCED INSULATION (equivalent to Class II of IEC 536-see annex H)
12	Background colour – yellow; symbol and outline – black (see note)	ISO 3864, No. B.3.6	Caution, risk of electric shock
13	Background colour – yellow; symbol and outline – black (see note)	IEC 417, No. 5041 (417 – IEC – 5041)	Caution, hot surface
14	Background colour – yellow; symbol and outline – black (see note)	ISO 3864, No. B.3.1	Warning (refer to accompanying documents)
15		IEC 417, No. 5268-a (417 – IEC – 5268-a)	In-position of a bistable push control
16		IEC 417, No. 5269-a (417 – IEC – 5269-a)	Out-position of a bistable push control

I13B

NOTE 1 – Colour requirements for symbols 12, 13 and 14 do not apply to markings on equipment, provided that the symbol is moulded or engraved to a depth or raised height of 0,5 mm, or that the symbol and outline are contrasting in colour with the background.

NOTE 2 – See 5.4.1 relating to the requirement that documentation shall include a statement about the need to consult documentation.

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5.1.2 *Identification*

The equipment shall, as a minimum, be identified by:

– manufacturer's name or registered trade mark;

– model number, name or other means to identify the equipment.

Compliance is checked by inspection.

5.1.2DV.1 D1 *Addition of the following after the last dash in 5.1.2:*

– factory identification

If equipment bearing the same distinctive designation (model number) is manufactured at more than one location, equipment from each manufacturing location shall bear an identification of such location. Such identification may be in code and need not be on the equipment exterior.

5.1.2DV.2 DE *Addition of the following clarification for the term ″manufacturer″:*

The term ″manufacturer″ may refer to the distributor or other supplier of the equipment.

5.1.3 *Mains supply*

The equipment shall be marked with the following information;

a) Nature of supply:

– a.c.: RATED mains frequency or range of frequencies;

– d.c.: with symbol 1 of table 1.

NOTE – The documentation should give the INSTALLATION CATEGORY (OVERVOLTAGE CATEGORY) for which the equipment is intended (this is related to the ability to withstand transient overvoltages). For information purposes it may also be useful to mark:

– a.c. equipment 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 – the permitted fluctuation from the RATED value(s) 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.

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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 OPERATOR can alter the supply voltage setting 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, and maximum permitted leakage current shall be marked, or symbol 14 or table 1 placed beside the outlet with the full details included in the documentation.

Compliance 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 in such a manner as to exclude the measurement of any initial inrush current and after the current has reached a stationary stage (usually after 1 min). The equipment shall be in the condition of maximum power consumption. The measured value shall not exceed the marked value by more than 10%.

5.1.4 *Fuses*

For any fuses which may be replaced by an OPERATOR there shall be a marking beside the fuseholder specifying the current RATING and type, such as indication of rupturing speed, for example by the codes of IEC 127 (see note below). For fuses not replaceable by the OPERATOR the same information shall be provided in the documentation (see 5.4.5).

NOTE – the letter and colour codes of IEC 127 are as follows:

– very quick acting: FF, or black;

– quick acting: F, or red;

– medium time-lag: M, or yellow;

– time-lag: T, or blue;

– long time-lag: TT, or grey.

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5.1.5 *Measuring circuit* TERMINALS

Voltage and current measuring circuit TERMINALS shall be marked with the RATED maximum working voltage (see D.1.1) or current as applicable.

Unless a clear indication is provided on a measuring instrument that it is not intended to be connected to voltages to earth above 50 V a.c. or 120 V d.c., the measuring input circuit TERMINALS for connection by an OPERATOR and used for voltage or current measurement shall be marked with the maximum RATED voltage to earth. An exception is permitted for circuit TERMINALS (connectors) which are dedicated only for connection to specific TERMINALS of other equipment if a means for identifying these TERMINALS is provided.

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:

– the full scale deflection marking of a simple range indicating voltmeter or maximum marking of a multi-range voltmeter;

– the maximum range marking of a voltage selector switch;

– the marked intended function of the instrument (e.g. ″millivoltmeter″).

Marking 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.

Measuring circuit TERMINALS used for voltage or current measurement shall be marked with the INSTALLATION CATEGORY (OVERVOLTAGE CATEGORY). This marking is done by adding CAT @ to the value of the maximum RATED voltage to earth. A roman I, II or III shall replace @ to indicate the appropriate INSTALLATION CATEGORY (OVERVOLTAGE CATEGORY) (see table J.1).

Voltage and current measuring circuit TERMINALS that are permanently connected and not ACCESSIBLE need not be marked. Information regarding the INSTALLATION CATEGORY (OVERVOLTAGE CATEGORY), RATED maximum working voltage (see D.1.1) or current for such TERMINALS shall be in the equipment installation instructions (see 5.4.3).

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5.1.6 TERMINALS *and operating devices*

Where necessary for safety, an indication shall be given of the purpose of TERMINALS, connectors, controls, and indicators, including any sequence of operations. Where there is insufficient space, symbol 14 of table 1 may be used.

NOTE – For additional information see IEC 445 and 447.

TERMINALS for connection to the mains supply shall be identifiable.

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 6.12.3.1). A lamp alone is not considered to be a satisfactory marking. Symbols 9 and 10 shall not be used for switches other than the main switch.

If a push-button switch is used as the main switch, symbols 9 and 15 of table 1 can 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.

The following TERMINALS and operating devices 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 where 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.

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5.1.7 *Equipment protected by* DOUBLE INSULATION *or* REINFORCED INSULATION

Equipment protected throughout by DOUBLE INSULATION or REINFORCED INSULATION (see annex H) 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.

Compliance is checked by inspection.

5.1.8 *Battery charging*

Equipment which has means for charging rechargeable batteries, and where nonrechargeable cells could be fitted and connected in the battery compartment, shall be marked in or near the compartment to warn against the charging of non-rechargeable batteries and to indicate the type of rechargeable battery that can be used with the recharging circuit.

NOTE – An acceptable marking is symbol 14 of table 1.

Compliance is checked by inspection.

5.2 *Warning markings*

Warning markings shall be visible when the equipment is ready for NORMAL USE.

If it is necessary for the OPERATOR to refer to the instruction manual to preserve the protection afforded by the equipment, the equipment shall be marked with the symbol 14 of table 1. If a warning applies to a particular part of the equipment, the marking shall be placed on or near to this part.

If the instructions for use state that an OPERATOR is permitted to gain access, using a TOOL, to any 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.

A warning shall advise the OPERATOR of precautions to be taken to avoid contact with HAZARDOUS LIVE parts which are ACCESSIBLE according to the exceptions of 6.1.1. See also 7.2, relating to access to hazardous moving parts.

TERMINALS which are supplied from the interior of the equipment at a voltage exceeding 1 kV, or allow connection to a voltage exceeding 1 kV (see 6.6.2) shall be marked with symbol 12 of table 1. An additional marking in certain cases is required by 6.6.2.

Unless their heated state is self-evident or is obvious from the function of the equipment, parts which are easily touched and are also permitted by 9.1 to exceed the temperature limits of table 3 shall be marked with symbol 13 of table 1.

NOTE 1 – Warnings necessary for safety should contrast well with the background (see table 1).

NOTE 2 – Warning markings relating to batteries are specified in 5.1.8 and 13.2.2.

Compliance is checked by inspection.

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5.2DV D1 ***Addition of the following paragraph to Clause 5.2:***

Warning markings shall have lettering in which:

a) the precautionary signal word shall be at least 2,75 mm high;

b) the text shall be at least 1,5 mm high and contrasting in color to the background; or

c) if molded or stamped in a material, the text shall be at least 2,0 mm high and, if not contrasting in color, a depth or raised height of at least 0,5 mm.

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.

Compliance 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, first for 15 s with a cloth soaked with the specified cleaning agent (or, if not specified, with water) and then for 15 s with a cloth soaked 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:

– technical specification;

– instructions for use;

– name and address of manufacturer or supplier from whom technical assistance may be obtained;

– the information specified in 5.4.2 to 5.4.5.

– definition of the relevant INSTALLATION CATEGORY (OVERVOLTAGE CATEGORY) when marking of terminals is required on the equipment (see 5.1.5).

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

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 it's constituents and the correct disposal procedure should also be given.

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5.4.2 *Equipment* RATINGS

Documentation shall include the following:

– the supply voltage or voltage range, frequency or frequency range, and power or current RATING;

– a description of all input and output connections;

– the RATING of the insulation of external circuits, appropriate for SINGLE FAULT CONDITIONS, when such circuits are nowhere ACCESSIBLE (see 6.6).

– a statement of the range of environmental conditions for which the equipment is designed (see 1.4 and note 1 of 4.1).

Compliance is checked by inspection.

5.4.3 *Equipment installation*

Documentation shall include the following installation and specific commissioning instructions as appropriate:

– assembly, location and mounting requirements;

– instruction for protective earthing;

– connections to the supply;

– ventilation requirements;

– requirements for special services, for example air, cooling liquid.

– the maximum sound power level produced by equipment which emits sound, if measurement is required by 12.5.1;

– instructions relating to sound pressure level (see 12.5.1).

For PERMANENTLY CONNECTED EQUIPMENT, additional information shall include:

– supply wiring requirements;

– requirements for any external switch or circuit-breaker (see 6.12.2.1) and external overcurrent protection devices (see 9.6) and a recommendation that the switch or circuit-breaker be near the equipment.

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5.4.4 *Equipment operation*

Instructions for use shall include:

– identification of operating controls and their use in all operating modes;

– where applicable, an instruction not to position the equipment so that it is difficult to operate the disconnecting device (see 6.12);

– instructions for interconnection to accessories and other equipment, including indication of suitable accessories, detachable parts and any special materials;

– specification of limits for intermittent operation, where applicable;

– an explanation of symbols required by this Part 1 and used on the equipment;

– instructions for replacement of consumable materials;

– instructions for cleaning (see 11.2).

The RESPONSIBLE BODY shall be made aware that, if the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Compliance 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, where necessary, of any hoses or other parts containing liquids, if their failure could cause a hazard (see 1.2). See also 7.2.

For equipment using batteries, the specific battery type shall be stated (see also 5.1.8).

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 fuses used shall be stated (see 5.1.4).

Compliance is checked by inspection.

6 Protection against electric shock

6.1 *General*

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).

NOTE – Annex H relates the safety requirements of this Part 1 to equipment safety classification used in other standards.

Compliance is checked by the determination of 6.2 and the measurements of 6.3, followed by the tests of 6.4 to 6.12.

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6.1.1 *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:

– parts of lamps and lamp sockets after lamp removal;

– parts intended to be replaced by the OPERATOR (e.g. 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 in accordance with 5.2;

– TERMINALS and sockets of operating and measuring circuits. (This exception does not apply to the TERMINALS listed 6.6.2.)

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

NOTES

1 Excepted TERMINALS should be protected as far as possible against unintentional contact, by covering or recessing, or by position or arrangement.

2 See 5.2 for warning markings for ACCESSIBLE parts which are HAZARDOUS LIVE and 5.4.1 for warning statements in the documentation.

Where a charge is received from an internal capacitor, compliance is checked by the measurements of 6.3 to establish that the levels of 6.3.1.3 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 (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 any covering which is not considered to provide suitable insulation (see note to 6.4, paragraph 1). For HAZARDOUS LIVE parts at a voltage to earth exceeding 1 kV r.m.s or 1.5 kV dc, 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 of annex D for BASIC INSULATION for the working voltage (see D.1.1).

However, on equipment accepting plug-in modules, parts are not considered to be ACCESSIBLE if they cannot be touched with the jointed test finger (see 6.2.1) up to a depth of 180 mm from the opening in the equipment, nor if they are at a depth of more than 180 mm from the opening.

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:

– removing covers;

– opening doors;

– adjusting controls;

– replacing consumable material;

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– removing parts.

For rack and panel mounted equipment the equipment shall be installed according to 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 *General examination*

The jointed test finger (see annex B, figure B.2) shall be applied in every possible position. Where a part could become ACCESSIBLE by applying a force, the rigid test finger (see annex B, figure B.1 shall be applied with a force of 10 N. The force shall be exerted by the tip of the test finger so as to avoid wedge and lever action. The test shall be applied to all outer surfaces, including the bottom.

6.2.2 *Openings above parts which are HAZARDOUS LIVE*

A metal test pin 100 mm long and 4 mm in diameter shall be inserted in any openings above parts which are HAZARDOUS LIVE. The test pin shall be 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.

6.2.3 *Openings for pre-set controls*

A metal test pin 3 mm in diameter shall be inserted through holes intended to give access to pre-set controls which require the use of a screwdriver or other TOOL. The test pin shall be 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*

To ensure that ACCESSIBLE parts are not HAZARDOUS LIVE, 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.

The ACCESSIBLE voltage shall be measured. If the voltage is below the limit of 6.3.1 or 6.3.2 as applicable, ACCESSIBLE current and capacitance need not be measured. If the voltage exceeds that value, the current and capacitance shall be measured.

6.3.1 *Values in NORMAL CONDITION*

Values above the levels of 6.3.1.1 to 6.3.1.3 in NORMAL CONDITION are deemed to be HAZARDOUS LIVE.

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