UL 61010-1

STANDARD FOR SAFETY

Safety Requirements for Electrical Equipment For Measurement, Control, and Laboratory Use; Part 1: General Requirements

UL Standard for Safety for Safety Requirements for Electrical Equipment For Measurement, Control, and Laboratory Use; Part 1: General Requirements, UL 61010-1

Third Edition, Dated May 11, 2012

Summary of Topics

This revision to ANSI/UL 61010-1 dated June 6, 2023 includes the following changes in requirements:

– UL/CSA 61010-1 – Scope Clarification; 1.1.5DV

– Addition of reference to UL 62368-1 and CAN/CSA C22.2 No. 62368-1 as an alternative to UL/CSA 60950-1 and UL/CSA 60065; 1.1.2DV, 1.1.3DV, 2DV, 5.4.4DV, 13.2.3DV, 14.1DV.0, 14.11DV.1, Annex DVA, BIBDV

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated August 19, 2022 and October 28, 2022.

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CAN/CSA-C22.2 No. 61010-1-12
Third Edition
(IEC 61010-1:2010, MOD)

ISA
ANSI/ISA-61010-1 (82.02.01)
Third Edition

ULSE Inc.
UL 61010-1
Third Edition

Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements

May 11, 2012

(Title Page Reprinted: June 6, 2023)

This standard is based on IEC 61010-1, Third Edition (2010).

ANSI/UL 61010-1-2023

Commitment for Amendments

This standard is issued jointly by the Canadian Standards Association (operating as "CSA Group"), the International Society of Automation (ISA) and ULSE Inc. (ULSE). Comments or proposals for revisions on any part of the standard may be submitted to CSA Group or ULSE at anytime. Revisions to this standard will be made only after processing according to the standards development procedures of CSA Group and ULSE. CSA Group and ULSE will issue revisions to this standard by means of a new edition or revised or additional pages bearing their date of issue. ISA will incorporate the same revisions into their edition of the standard bearing the same date of issue as the CSA and ULSE pages.

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This Standard is subject to review within five years from the date of publication, and suggestions for its improvement will be referred to the appropriate committee. The technical content of IEC and ISO publications is kept under constant review by IEC and ISO. To submit a proposal for change, please send the following information to inquiries@csagroup.org and include "Proposal for change" in the subject line: Standard designation (number); relevant clause, table, and/or figure number; wording of the proposed change; and rationale for the change.

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This ANSI/UL Standard for Safety consists of the Third Edition including revisions through June 6, 2023. The most recent designation of ANSI/UL 61010-1 as an American National Standard (ANSI) occurred on June 6, 2023. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface. The National Difference Page and IEC Foreword are also excluded from the ANSI approval of IEC-based standards.

Comments or proposals for revisions on any part of the Standard may be submitted to ULSE at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTERPRETATION SHEET 1

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

This interpretation sheet has been prepared by IEC technical committee 66: Safety of measuring, control and laboratory equipment.

The text of this interpretation sheet is based on the following documents:

ISH	Report on voting
66/497A/ISH	66/505/RVD

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

IEC 61010-1:2010 contains a requirement in 6.8.3.1 pertaining to voltage testers for type tests as follows:

"The generator shall be able to supply a power of at least 500 VA."

This has given rise to the following questions:

How does one interpret the requirement for voltage testers in 6.8.3.1 of IEC 61010-1:2010? Specifically, this subclause requires that "The generator shall be able to supply a power of at least 500 VA." Does this requirement apply throughout the rated output range of the voltage tester? What is meant by the word "generator"? Is the "generator" the power supply within the voltage tester, or the voltage tester output, or something else?

Interpretation:

"A voltage tester used for type tests must be able to deliver at least 500 VA at its full-rated output voltage. It does not necessarily need to deliver 500 VA if set for lower voltages.

For example, a voltage tester that can deliver 100 mA at any test output voltage up to 5 000 V (and a current corresponding to 500 VA above 5 000 V) would meet the requirement.

The requirements for voltage testers used for routine (production line) tests are included in Annex F. The requirements of 6.8.3.1 do not apply to these voltage testers."

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Preface

This is the harmonized CSA Group, ISA, and ULSE standard for Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements. It is the third edition of CAN/CSA-C22.2 No. 61010-1, the third edition of ANSI/ISA-61010-1 (82.02.01), and the third edition of UL 61010-1. This edition of CAN/CSA-C22.2 No. 61010-1 supersedes the previous edition published as CAN/CSA-C22.2 No. 61010-1 in 2004. This harmonized standard has been jointly revised on June 6, 2023. For this purpose, CSA Group and ULSE are issuing revision pages dated June 6, 2023, and ISA is issuing the changes to the edition dated June 6, 2023.

This harmonized standard is based on IEC Publication 61010-1: third edition Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General requirements issued June 2010, as revised by IEC Corrigendum 1 issued May 2011, AMD1 issued December 2016, and Corrigendum 1 to AMD1 issued March 2019. IEC publication 61010-1 is copyrighted by the IEC.

This harmonized standard was prepared by CSA Group, the International Society of Automation (ISA), and ULSE.

This standard is considered suitable for use for conformity assessment within the stated scope of the standard.

This standard was reviewed by the CSA Subcommittee on Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, under the jurisdiction of the CSA Technical Committee on Consumer and Commercial Products and the CSA Strategic Steering Committee on Requirements for Electrical Safety, and has been formally approved by the CSA Technical Committee. This standard has been developed in compliance with the Standards Council of Canada requirements for National Standards of Canada. It has been published as a National Standard of Canada by CSA Group.

Application of Standard

Where reference is made to a specific number of samples to be tested, the specified number is to be considered a minimum quantity.

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.

This is CAN/CSA-C22.2 No. 61010-1, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General requirements. This CAN/CSA-C22.2 No. 61010 Part 1 is to be used in conjunction with the appropriate CAN/CSA-C22.2 No. 61010 Part 2, which contains clauses to supplement or modify the corresponding clauses in the Part 1, to provide relevant requirements for each type of product.

This is the UL Standard for Safety for Electrical Equipment for Measurement, Control, and Laboratory Use; 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 the Part 1, to provide relevant requirements for each type of product.

CAN/CSA-C22.2 No. 61010-1, ANSI/ISA-61010-1 (82.02.01), and UL 61010-1 contain identical requirements and identical publication dates. The presentation and format of the standards material may differ between the three published standards.

Level of Harmonization

This standard adopts the IEC text with national differences.

This standard is published as an identical standard for CSA Group, ISA, and ULSE.

An identical standard is a standard that is exactly the same in technical content except for national differences resulting from conflicts in codes and governmental regulations. Presentation is word for word except for editorial changes.

All national differences from the IEC text are included in the CSA Group, ISA, and ULSE versions of the standard. While the technical content is the same in each organization's version, the format and presentation may differ.

Reasons for Differences from IEC

National Differences from the IEC are being added in order to address regulatory and safety situations present in the US and Canada.

Interpretations

The interpretation by the standards development organization of an identical or equivalent standard is based on the literal text to determine compliance with the standard in accordance with the procedural rules of the standards development organization. If more than one interpretation of the literal text has been identified, a revision is to be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

IEC Copyright

For CSA Group, the text, figures, and tables of International Electrotechnical Commission Publication 61010-1, Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements, copyright 2010, are used in this standard with the consent of the International Electrotechnical Commission. The IEC Foreword and Introduction are not a part of the requirements of this standard but are included for information purposes only.

NATIONAL DIFFERENCES

In the CSA Group, ISA and ULSE publications of this standard, 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 2010, are indicated by notations (differences) and are presented in bold text. The national difference type is included in the body.

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 regulatory requirements**.

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

D2 – These are National Differences from IEC requirements based on existing **safety practices**. These requirements reflect national safety practices, where empirical substantiation (for the IEC or national requirement) is not available or the text has not been included in the IEC standard.

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**.

Each national difference contains a description of what the national difference entails. Typically one of the following words is used to explain how the text of the national difference is to be applied to the base IEC text:

Addition / Add - An addition entails adding a complete new numbered clause, subclause, table, figure, or annex. Addition is not meant to include adding select words to the base IEC text.

Modification / Modify - A modification is an altering of the existing base IEC text such as the addition, replacement or deletion of certain words or the replacement of an entire clause, subclause, table, figure, or annex of the base IEC text.

Deletion / Delete - A deletion entails complete deletion of an entire numbered clause, subclause, table, figure, or annex without any replacement text.

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FOREWORD

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.

3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.

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6) All users should ensure that they have the latest edition of this publication.

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8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

This Consolidated version of IEC 61010-1 bears the edition number 3.1. It consists of the third edition (2010-06) [documents 66/414/FDIS and 66/423/RVD], its corrigenda 1 (2011-05) and 2 (2013-10) and its interpretation sheet (2013-02), and its amendment 1 (2016-12) [documents 66/612/FDIS and 66/620/RVD]. The technical content is identical to the base edition and its amendment.

International Standard IEC 61010-1 has been prepared by IEC technical committee 66: Safety of measuring, control and laboratory equipment.

It has the status of a group safety publication, as specified in IEC Guide 104.

This third edition cancels and replaces the second edition published in 2001. It constitutes a technical revision.

This edition includes the following significant changes from the second edition, as well as numerous other changes.

• The scope of the standard has been expanded to include all locations where these products may be used, so that both professional and non-professional versions of these products are within the scope.

• The requirements for testing and measuring circuits (in various subclauses and the entirety of Clause 16) have been removed and included in a particular standard IEC 61010-2-030.

• Insulation requirements (6.7) have been completely rewritten.

  • Specific requirements have been added for solid insulation and thin-film insulation.

  • Subclause 6.7 now contains only the insulation requirements for MAINS CIRCUITS of OVERVOLTAGE CATEGORY II up to 300 V, and for secondary circuits.

  • The insulation requirements for all other circuits have been moved to a new Annex K.

• Additional requirements for protection against mechanical HAZARDS (Clause 7) have been included.

• Surface temperature limits (Clause 10) have been modified to conform to the limits of EN 563.

• Radiation requirements (Clause 12) have been modified, and take into account a distinction between intended emission and unintended emission.

• Requirements for reasonably foreseeable misuse and ergonomic aspects have been added (Clause 16).

• A new clause (Clause 17) has been added to deal with HAZARDS and environments not covered by the standard, along with a new informative annex (Annex J) dealing with RISK assessment.

• A new informative annex (Annex E) addresses methods of reducing the POLLUTION DEGREE of a micro-environment.

• Requirements for the qualification of coatings for protection against POLLUTION have been added (Annex H).

• A new informative annex (Annex I) has been added to further explain how to determine the WORKING VOLTAGE of a MAINS CIRCUIT.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61010 series, under the general title: *Safety requirements for electrical equipment for measurement, control, and laboratory use*, may be found on the IEC website.

In this standard, the following print types are used:

– requirements and definitions: in roman type;

– NOTES: in smaller roman type;

– *conformity and tests: in italic type;*

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

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

• reconfirmed,

• withdrawn,

• replaced by a revised edition, or

• amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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.

This edition incorporates Corrigendum 1 to IEC 61010-1, 3rd edition.

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INTRODUCTION

This International Standard 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.

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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

1.1.1 Equipment included in scope

This group safety publication is primarily intended to be used as a product safety standard for the products mentioned in the scope, but shall also be used by technical committees in the preparation of their publications for products similar to those mentioned in the scope of this standard, in accordance with the principles laid down in IEC Guide 104 and ISO/IEC Guide 51.

This part of IEC 61010 specifies general safety requirements for the following types of electrical equipment and their accessories, wherever they are intended to be used.

a) Electrical test and measurement equipment

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

NOTE 1 This includes bench-top power supplies intended to aid a testing or measuring operation on another piece of equipment. Power supplies intended to power equipment are within the scope of IEC 61558 (see 1.1.2 h)).

This standard also applies to test equipment integrated into manufacturing processes and intended for testing manufactured devices.

NOTE 2 Manufacturing test equipment is likely to be installed adjacent to and interconnected with industrial machinery in this application.

b) Electrical industrial process-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, inspects or analyses materials, or is used to prepare materials, and includes in vitro diagnostic (IVD) equipment.

This equipment may also be used in areas other than laboratories; examples include self-test IVD equipment to be used in the home and inspection equipment to be used to check people or material during transportation.

1.1.2 Equipment excluded from scope

This standard does not apply to equipment within the scope of:

a) IEC 60065 (Audio, video and similar electronic apparatus);

b) IEC 60204 (Safety of machinery – Electrical equipment of machines);

c) IEC 60335 (Household and similar electrical appliances);

d) IEC 60364 (Electrical installations of buildings);

e) IEC 60439 (Low-voltage switchgear and controlgear assemblies);

f) IEC 60601 (Medical electrical equipment);

g) IEC 60950 (Information technology equipment including electrical business equipment, except as specified in 1.1.3);

h) IEC 61558 (Power transformers, power supply units and similar);

i) IEC 61010-031 (Hand-held probe assemblies);

j) IEC 61243-3 (Live working – Voltage detectors – Part 3: Two-pole low-voltage type).

1.1.2DV DR *Modification of Clause 1.1.2 to add the following as new items kDV) and lDV):*

kDV) IEC 62368-1 (Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements).

lDV) UL/ULC 1389 Plant Oil Extraction Equipment and Systems.

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 (see 5.4.4 second paragraph)).

1.1.3DV DR *Modification of Clause 1.1.3 NOTE to revise as follows:*

Replace “IEC 60950” with “IEC 60950 or IEC 62368-1” in two places.

1.1.4DV DR *Addition of the following referencing the National Electrical Code and the Canadian Electrical Code:*

This standard applies to equipment:

a) To be employed in accordance with ANSI/NFPA 70, National Electrical Code® (NEC);

b) Designed to comply with the general requirements of CAN/CSA C22.2 No. 0 and to be installed in accordance with the Canadian Electrical Code (CEC), Part I, CSA C22.1; or

c) Both (a) and (b).

1.1.5DV DR *Addition of the following new sub-clause:*

1.1.5DV.1 Gas, vapor and voltage detectors or sensors

Equipment intended to measure, sense or detect one or more electrical or physical quantities that identify an imminent hazard and used for signalling, may use this standard only when no alternative standard exists.

Note 1 This standard is considered not to apply to gas detectors and similar equipment within the scope of ANSI/UL 2034, ANSI/UL 2075, CSA C22.2 No. 205, or ULC-S588.

Note 2 Examples of standards providing additional safety requirements for gas or vapor detectors or sensors, which can be used in conjunction with this standard, are ANSI/UL 60079-29-1, ANSI/UL 920001, ANSI/UL 920004, CSA C22.2 No. 60079-29-1, or CSA C22.2 No. 62990-1.

Note 3 Clause 1.2.1 specifies the use of Clause 17 to assess conformity for hazards or environments not fully covered in Clauses 6 to 16, including aspects not covered by this document in Clause 1.2.2.

Note 4 Local and national codes may have additional requirements based on the end products' intended use.

Note 5 This standard is considered not to apply to voltage detectors and similar equipment within the scope of UL 1436, CAN/ULC 61243 series, or CSA C22.2 No 160.

1.2 Object

1.2.1 Aspects included in scope

The purpose of the requirements of this standard is to ensure that HAZARDS to the OPERATOR and the surrounding area are reduced to a tolerable level.

Requirements for protection against particular types of HAZARD are given in Clauses 6 to 13, as follows:

a) electric shock or burn (see Clause 6);

b) mechanical HAZARDS (see Clauses 7 and 8);

c) spread of fire from the equipment (see Clause 9);

d) excessive temperature (see Clause 10);

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).

Requirements for protection against HAZARDS arising from REASONABLY FORESEEABLE MISUSE and ergonomic factors are specified in Clause 16.

RISK assessment for HAZARDS or environments not fully covered above is specified in Clause 17.

NOTE Attention is drawn to the existence of additional requirements regarding 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 (see the IEC 61326 series);

d) protective measures for explosive atmospheres (see the IEC 60079 series).

1.3 Verification

This standard also specifies methods of verifying that the equipment meets the requirements of this standard, through inspection, TYPE TESTS, ROUTINE TESTS, and RISK assessment.

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;

f) TRANSIENT OVERVOLTAGES up to the levels of OVERVOLTAGE CATEGORY II;

NOTE 1 These levels of transient overvoltage are typical for equipment supplied from the building wiring.

g) TEMPORARY OVERVOLTAGES occurring on the MAINS supply.

h) applicable POLLUTION DEGREE of the intended environment (POLLUTION DEGREE 2 in most cases).

NOTE 2 Manufacturers may specify more restricted environmental conditions for operation; nevertheless the equipment must be safe within these normal environmental conditions.

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 as RATED by the manufacturer of the equipment:

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;

f) WET LOCATION;

g) TRANSIENT OVERVOLTAGES up to the levels of OVERVOLTAGE CATEGORY III or IV (see Annex K).

2 Normative references

The following referenced documents, where applicable, are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60027 (all parts),
Letter symbols to be used in electrical technology

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

IEC 60068-2-14,
Environmental testing – Part 2-14: Tests – Test N: Change of temperature

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

IEC 60073,
Basic and safety principles for man-machine interface, marking and identification – Coding principles for indicators and actuators

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

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

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

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

IEC 60332-1-2,
Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW premixed flame

IEC 60332-2-2,
Tests on electric and optical fibre cables under fire conditions – Part 2-2: Test for vertical flame propagation for a single small insulated wire or cable – Procedure for diffustion flame

IEC 60335-2-24,
Household and similar electrical appliances – Safety – Part 2-24: Particular requirements for refrigerating appliances, ice-cream appliances and ice-makers.

IEC 60335-2-89,
Household and similar electrical appliances – Safety – Part 2-89: Particular requirements for commercial refrigerating appliances with an incorporated or remote refrigerant condensing unit or compressor

IEC 60364-4-44:2007,
Low-voltage electrical installations – Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances
IEC 60364-4-44:2007/AMD1:2015

IEC 60417,
Graphical symbols for use on equipment

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

IEC 60664-3,
Insulation coordination for equipment within low-voltage systems – Part 3: Use of coating, potting or moulding for protection against pollution

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

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

IEC 60825-1,
Safety of laser products – Part 1: Equipment classification and requirements

IEC 60947-1,
Low-voltage switchgear and controlgear – Part 1: General rules

IEC 60947-2,
Low-voltage switchgear and controlgear – Part 2: Circuit-breakers

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

IEC 61010-031,
Safety requirements for electrical equipment for measurement, control and laboratory use – Part 031: Safety requirements for hand-held probe assemblies for electrical measurement and test

IEC 61180 (all parts),
High-voltage test techniques for low-voltage equipment

IEC 61180-1,
High-voltage test techniques for low-voltage equipment – Part 1: Definitions, test and procedure requirements

IEC 61180-2,
High-voltage test techniques for low-voltage equipment – Part 2: Test equipment

IEC 61672-1,
Electroacoustics – Sound level meters – Part 1: Specifications

IEC 61672-2,
Electroacoustics – Sound level meters – Part 2: Pattern evaluation tests

IEC 62262,
Degrees of protection provided by enclosures for electrical equipment against external impacts (IK code)

IEC 62471,
Photobiological safety of lamps and lamp systems

IEC TR 62471-2,
Photobiological safety of lamps and lamp systems – Part 2: Guidance on manufacturing requirements relating to non-laser optical radiation safety

IEC 62598,
Nuclear instrumentation – Constructional requirements and classification of radiometric gauges

IEC Guide 104,
The preparation of safety publications and the use of basic safety publications and group safety publications

ISO/IEC Guide 51,
Safety aspects – Guidelines for their inclusion in standards

ISO 306:2013,
Plastics – Thermoplastic materials – Determination of Vicat softening temperature (VST)

ISO 361,
Basic ionizing radiation symbol

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 7000,
Graphical symbols for use on equipment

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

ISO 13857,
Safety of machinery – Safety distances to prevent hazard zones being reached by upper and lower limbs

EN 378-2,
Refrigerating systems and heat pumps – Safety and environmental requirements. Design, construction, testing, marking and documentation

2DV DC ***Addition of the following:***

ANSI/NFPA 70,
National Electrical Code

ANSI/UL 50,
Enclosures for Electrical Equipment, Non-Environmental Considerations

ANSI/UL 50E,
Enclosures for Electrical Equipment, Environmental Considerations

ANSI/UL 94,
Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

ANSI/UL 498,
Attachment Plugs and Receptacles

ANSI/UL 746C,
Polymeric Materials – Use in Electrical Equipment Evaluations

ANSI/UL 817,
Cord Sets and Power Supply Cords

ANSI/UL 1310,
Class 2 Power Units

ANSI/UL 60950-1,
Information Technology Equipment – Safety – Part 1: General Requirements

ANSI/UL 62368-1
Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements

CSA C22.1,
Canadian Electrical Code, Part I

CAN/CSA C22.2 No. 0,
General Requirements – Canadian Electrical Code, Part II

CAN/CSA C22.2 No. 0.17,
Evaluation of Properties of Polymeric Materials

CAN/CSA C22.2 No. 0.4,
Bonding of electrical equipment

CSA C22.2 No. 21,
Cord Sets and Power Supply Cords

CSA C22.2 No. 42,
General Use Receptacles, Attachment Plugs, and Similar Wiring Devices

CSA C22.2 No. 94.1,
Enclosures for Electrical Equipment, Non-Environmental Considerations

CSA C22.2 No. 94.2,
Enclosures for Electrical Equipment, Environmental Considerations

CSA C22.2 No. 182.1,
Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve Type

CSA C22.2 No. 182.2,
Industrial Locking Type, Special Use Attachment Plugs, Receptacles, and Connectors

CSA C22.2 No. 182.3,
Special Use Attachment Plugs, Receptacles, and Connectors

CAN/CSA C22.2 No. 223,
Power Supplies With Extra-Low Voltage Class 2 Outputs

CAN/CSA C22.2 No. 60950-1,
Information Technology Equipment – Safety – Part 1: General Requirements

CAN/CSA C22.2 No. 62368-1,
Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements

3 Terms and definitions

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

3.1 Equipment and states of equipment

3.1.1 **FIXED EQUIPMENT** : equipment fastened to a support, or otherwise secured in a specific location

[IEC 60050-826:2004, 826-16-07, modified]

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

3.1.6 **DIRECT PLUG-IN EQUIPMENT** : equipment with a MAINS plug that is attached to the equipment housing without the use of a MAINS supply cord so that the equipment is supported by the MAINS socket-outlet

3.2 Parts and accessories

3.2.1 **TERMINAL** : component provided for the connection of a device to external conductors

[IEC 60050-151:2001, 151-12-12, 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 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 called the measuring earth TERMINAL.

3.2.3 **PROTECTIVE CONDUCTOR TERMINAL** : TERMINAL which is bonded to conductive parts of 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

NOTE ENCLOSURES may also provide protection against the spread of fire (see 9.3.2 c)).

3.2.5 **PROTECTIVE BARRIER** : part providing protection against direct contact from any usual direction of access

[IEC 60050-195:1998, 195-06-15]

NOTE Depending on its construction, a PROTECTIVE BARRIER can be called a casing, cover, screen, door, guard, etc.

A PROTECTIVE BARRIER can act alone; it is then only effective when it is in place. A PROTECTIVE BARRIER can also act in conjunction with an interlocking device with or without guard locking; in this case, protection is ensured whatever the position of the PROTECTIVE BARRIER.

3.3 Quantities

3.3.1 **RATED (VALUE)** : quantity value assigned, generally by a manufacturer, for a specified operating condition of a component, device or equipment

[IEC 60050-151:2001, 151-16-08, modified]

3.3.2 **RATING** : set of RATED values and operating conditions

[IEC 60050-151:2001, 151-16-11]

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 and voltage fluctuations are not considered to be part of the WORKING VOLTAGE.

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

NOTE This is an amplification of the IEC 60050-151:2001, 151-16-16 definition to cover design as well as construction.

3.4.2 **ROUTINE TEST** : conformity test made on each individual item during or after manufacture

[IEC 60050-151:2001, 151-16-17]

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

3.5.4 **MAINS** : low-voltage electricity supply system to which the equipment concerned is designed to be connected for the purpose of powering the equipment

3.5.5 **MAINS CIRCUIT** : circuit which is intended to be directly connected to the MAINS for the purpose of powering the equipment

3.5.6 **PROTECTIVE IMPEDANCE** : component or assembly of components whose impedance, construction and reliability are suitable to provide protection against electric shock

3.5.7 **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

3.5.8 **NORMAL USE** : operation, including stand-by, according to the instructions for use or for the obvious intended purpose

3.5.9 **NORMAL CONDITION** : condition in which all means for protection against HAZARDS are intact

3.5.10 **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 one or more other fault conditions, all the failures are considered as one SINGLE FAULT CONDITION [IEC Guide 104].

3.5.11 **OPERATOR** : person operating equipment for its intended purpose

3.5.12 **RESPONSIBLE BODY** : individual or group responsible for the safe use and maintenance of equipment

3.5.13 **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

3.5.14 **REASONABLY FORESEEABLE MISUSE** : use of a product in a way not intended by the supplier, but which may result from readily predictable human behaviour

3.5.15 **RISK** : combination of the probability of occurrence of harm and the severity of that harm

3.5.16 **TOLERABLE RISK** : RISK which is accepted in a given context based on the current values of society

[ISO/IEC Guide 51:1999, 3.7]

3.5.17 **OVERVOLTAGE CATEGORY** : numeral defining a TRANSIENT OVERVOLTAGE condition (see Annex K)

3.5.18 **TRANSIENT OVERVOLTAGE** : short duration overvoltage of a few milliseconds or less, oscillatory or non-oscillatory, usually highly damped

[IEC 60050-604, Amendment 1:1998, 604-03-13]

3.5.19 **TEMPORARY OVERVOLTAGE** : power frequency overvoltage of relatively long duration

[IEC 60050-604, Amendment 1:1998, 604-03-12]

3.6 Insulation

3.6.1 **BASIC INSULATION** : insulation of HAZARDOUS LIVE parts which provides basic protection

[IEC 60050-195:1998, 195-06-06]

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

[IEC 60050-195:1998, 195-06-07, modified]

3.6.3 **DOUBLE INSULATION** : insulation comprising both BASIC INSULATION and SUPPLEMENTARY INSULATION

[IEC 60050-195:1998, 195-06-08]

3.6.4 **REINFORCED INSULATION** : insulation which provides protection against electric shock not less than that provided by DOUBLE INSULATION

NOTE REINFORCED INSULATION may be composed of several layers which cannot be tested singly as SUPPLEMENTARY INSULATION or BASIC INSULATION.

[IEC 60050-195:1998, 195-06-09, modified]

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** : numeral indicating the level of POLLUTION that may be present in the environment

3.6.7 **POLLUTION DEGREE 1** : no POLLUTION or only dry, non-conductive POLLUTION occurs, which has no influence

3.6.8 **POLLUTION DEGREE 2** : only non-conductive POLLUTION occurs except that occasionally a temporary conductivity caused by condensation is expected

3.6.9 **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.

3.6.10 **POLLUTION DEGREE 4** : continuous conductivity occurs due to conductive dust, rain or other wet conditions

3.6.11 **CLEARANCE** : shortest distance in air between two conductive parts

3.6.12 **CREEPAGE DISTANCE** : shortest distance in air between two conductive parts

shortest distance along the surface of a solid insulating material between two conductive parts

[IEC 60050-151:2001, 151-15-50]

3.6.12DV D2 *Modification to replace with the following:*

CREEPAGE DISTANCE : shortest distance along the surface of a solid insulating material between two conductive parts

[IEC 60050-151:2001, 151-15-50]

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.

The equipment shall at least meet the requirements of this standard. It is permissible to exceed the requirements. If, in this standard, a lower limit is specified for a conformity value, then the equipment may demonstrate a larger value. If an upper limit is specified for a conformity value, the equipment may demonstrate a lower value.

Tests on subassemblies that meet 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 and design documentation demonstrates conclusively that the equipment would pass the test. Tests are carried out both under reference test conditions (see 4.3) and under fault conditions (see 4.4).

Where conformity statements in this standard require inspection, this may include examination of the equipment by measurement, examination of the markings on the equipment, examination of the instructions supplied with the equipment, examination of the data sheets of the materials or components from which the equipment is manufactured, etc. In each case, the inspection will either demonstrate that the equipment meets the applicable requirements, or will indicate that further testing is required.

Tests needed to support a RISK assessment (see Clause 17) are carried out in the combinations of conditions and operations determined during the RISK assessment.

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:

a) manufacturers should ensure that at least the specified test value is applied;

b) test houses 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. 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.

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

4.3.2.1 General

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 4.3.2.2 to 4.3.2.13.

NOTE In case of doubt, tests should be performed in more than one combination of conditions.

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

4.3.2.2 Position of equipment

The equipment shall be in any position of NORMAL USE and with any ventilation unimpeded. Equipment intended to be built into a wall, recess, cabinet, etc., shall be installed as specified in the manufacturer's instructions.

4.3.2.3 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.

4.3.2.4 Covers and removable parts

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

4.3.2.5 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 single-phase a.c. supply shall be connected both with normal and reverse polarity.

e) If the means of connection permits reversal, battery-operated and d.c. equipment shall be connected with both reverse and normal polarity.

4.3.2.6 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.

4.3.2.7 Earth TERMINALS

PROTECTIVE CONDUCTOR TERMINALS, if any, shall be connected to earth.

FUNCTIONAL EARTH TERMINALS shall be connected or not connected to earth.

4.3.2.8 Controls

Controls which an OPERATOR can adjust without the use of a TOOL 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.

4.3.2.9 Connections

The equipment shall be connected for NORMAL USE, or not connected.

4.3.2.10 Load on motors

Load conditions of motor-driven parts of equipment shall be in accordance with the NORMAL USE.

4.3.2.11 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.

4.3.2.12 Duty cycle

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

Equipment for short-term or intermittent operation that develops significant heat during the startup phase, and that relies on continued operation to dissipate that heat, shall also be operated for the shortest RATED period followed by the shortest RATED recovery period.

4.3.2.13 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 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.

4.4 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 as specified for checking conformity, unless it can be demonstrated that no HAZARD could arise from a particular fault condition.

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. If the environmental limits of the reference test conditions (see 4.3) do not allow realistic assessment of SINGLE FAULT CONDITIONS, the test shall be conducted at the least favourable RATED environmental conditions of the equipment.

4.4.2 Application of fault conditions

4.4.2.1 General

Fault conditions shall include those specified in 4.4.2.2 to 4.4.2.14. 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.

NOTE For example, fans may be stopped one fan at a time unless they share a common power or control source. In that case, the common fans should be stopped simultaneously by interrupting the power or control source.

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

4.4.2.2 PROTECTIVE IMPEDANCE

The following requirements apply.

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 with a single component that meets the requirements of 6.5.4, it need not be short-circuited or disconnected.

4.4.2.3 Protective conductor

The protective conductor shall be interrupted, except for PERMANENTLY CONNECTED EQUIPMENT and equipment utilizing a connector meeting the requirements of IEC 60309.

4.4.2.4 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.

4.4.2.5 Motors

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

One supply phase of any multi-phase motor shall be interrupted while the motor is operating at its intended full load.

4.4.2.6 Capacitors

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

4.4.2.7 MAINS transformers

4.4.2.7.1 General

The secondary windings of MAINS transformers shall be short-circuited as specified in 4.4.2.7.2, and overloaded as specified in 4.4.2.7.3.

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 14.6.

4.4.2.7.2 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.

4.4.2.7.3 Overload

Each untapped output winding, and each section of a 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 overtemperature protection which meets the requirements of 14.3 during the short-circuit test of 4.4.2.7.2 need not be subjected to overload tests.

4.4.2.8 Outputs

Outputs shall be short-circuited one at a time.

4.4.2.9 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.

4.4.2.10 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;

d) loss of cooling liquid shall be simulated.

4.4.2.11 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 overtemperature protection devices meeting the requirements of 14.3, shall be overridden to energize the heating circuit continuously.

4.4.2.12 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 if the method of 9.1 a) is used.

4.4.2.13 Interlocks

Each part of an interlock system for the protection of the OPERATOR 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.

4.4.2.14 Voltage selectors

Voltage selectors which an OPERATOR can set for different RATED supply voltages shall be set for each possible setting with the equipment connected to each of its RATED supply circuits.

4.4.3 Duration of tests

4.4.3.1 General

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 HAZARD of electric shock, spread of fire or injury to persons may eventually occur, the test shall be continued for 4 h unless one of these HAZARDS arises before then.

4.4.3.2 Current limiting devices

If 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 those parts shall be measured, whether the device operates or not.

4.4.3.3 Fuses

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. The pre-arcing time/current characteristics of the fuse shall be evaluated to find out whether the minimum operating current is reached 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, with the fuse replaced with a short-circuit.

4.4.4 Conformity after application of fault conditions

4.4.4.1 General

Conformity with requirements for protection against electric shock after the application of single faults is checked 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 the protection is still at least at the level of BASIC INSULATION. The voltage tests are made as specified in 6.7 and 6.8 (without humidity preconditioning) with the test voltage for BASIC INSULATION;