

Safety of information technology equipment

The European Standard EN 60950:2000 has the status of a
British Standard

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National foreword

This British Standard is the official English language version of EN 60950:2000, including Corrigendum February 2002. It was derived by CENELEC from IEC 60950:1999. It supersedes BS EN 60950:1992 which will be withdrawn on 2005-01-01.

The CENELEC common modifications have been implemented at the appropriate places in the text and are indicated by a side line in the margin.

The UK participation in its preparation was entrusted to Technical Committee EPL/74, Safety and energy efficiency of information technology equipment, which has the responsibility to:

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- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
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English version

Safety of information technology equipment

(IEC 60950:1999 + corr. January 2000, modified)

Sécurité des matériels de traitement de l'information
(CEI 60950:1999 + corr. janvier 2000, modifiée)

Sicherheit von Einrichtungen der
Informationstechnik
(IEC 60950:1999 + corr. Januar 2000, modifiziert)

This European Standard was approved by CENELEC on 2000-01-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

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

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

Foreword

The text of document 74/498/FDIS, future 3rd edition of IEC 60950:1999, prepared by IEC TC 74, Safety and energy efficiency of IT equipment, was submitted to the IEC-CENELEC parallel vote.

In March 1999 a new draft including common modifications, special national conditions and A-deviations from EN 60950:1992, prepared by the Technical Committee CENELEC TC 74, was submitted to the formal vote together with four draft common modification amendments prAA, prAB, prAC and prAD. In view of the comments received on the draft amendments, the CENELEC Technical Board decided to organize a BT enquiry on a revised draft European Standard including those parts of the amendment documents which had received support to become special national conditions.

This revised draft was ratified by CENELEC as EN 60950 on 2000-01-01.

This European Standard replaces EN 60950:1992 and its amendments A1, A2, A3, A4, and A11.

The following dates were fixed:

- latest date by which the
EN has to be implemented
at national level by
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national standard or by
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- latest date by which the
national standards
conflicting with the EN
have to be withdrawn (dow) 2005-01-01

Annexes designated “normative” are part of the body of the standard. Annexes designated “informative” are given only for information only. In this standard, annexes A, B, C, D, E, F, G, H, J, K, L, M, N, P, U, V, ZA and ZB are normative; annexes Q, R, S, T, W, X and ZC are informative. Annexes ZA, ZB and ZC have been added by CENELEC.

Endorsement notice

The text of International Standard IEC 60950:1999 was approved by CENELEC as a European Standard, with agreed common modifications as given below:

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INTRODUCTION

0 Principles of safety

The following principles have been adopted by technical committee 74 in the development of this standard.

These principles do not cover performance or functional characteristics of equipment.

Words printed in SMALL CAPITALS are terms that are defined in 1.2 of this standard.

0.1 General principles of safety

It is essential that designers understand the underlying principles of safety requirements in order that they can engineer safe equipment.

These principles are not an alternative to the detailed requirements of this standard, but are intended to provide designers with an appreciation of the basis of these requirements. Where the equipment involves technologies and materials or methods of construction not specifically covered, the design of the equipment should provide a level of safety not less than those described in these principles of safety.

Designers shall take into account not only normal operating conditions of the equipment but also likely fault conditions, consequential faults, foreseeable misuse and external influences such as temperature, altitude, pollution, moisture, overvoltages on the mains and overvoltages on the telecommunication lines.

The following priorities should be observed in determining what design measures to adopt:

- where possible, specify design criteria that will eliminate, reduce or guard against hazards;
- where the above is not practicable because the functioning of the equipment would be impaired, specify the use of protective means independent of the equipment, such as personal protective equipment (which is not specified in this standard);
- where neither of the above measures is practicable, or in addition to those measures, specify the provision of markings and instructions regarding the residual risks.

There are two types of persons whose safety needs to be considered, USERS (or OPERATORS) and SERVICE PERSONNEL.

USER is the term applied to all persons other than SERVICE PERSONNEL. Requirements for protection should assume that USERS are not trained to identify hazards, but will not intentionally create a hazardous situation. Consequently, the requirements will provide protection for cleaners and casual visitors as well as the assigned USERS. In general, USERS should not have access to hazardous parts, and to this end, such parts should only be in SERVICE ACCESS AREAS or in equipment located in RESTRICTED ACCESS LOCATIONS.

When USERS are admitted to RESTRICTED ACCESS LOCATIONS they shall be suitably instructed.

SERVICE PERSONNEL are expected to use their training and skill to avoid possible injury to themselves and others due to obvious hazards which exist in SERVICE ACCESS AREAS of the equipment or on equipment located in RESTRICTED ACCESS LOCATIONS. However, SERVICE PERSONNEL should be protected against unexpected hazards. This can be done by, for example, locating parts that need to be accessible for servicing away from electrical and mechanical hazards, providing shields to avoid accidental contact with hazardous parts, and providing labels or instructions to warn personnel about any residual risk.

Information about potential hazards can be marked on the equipment or provided with the equipment, depending on the likelihood and severity of injury, or made available for SERVICE PERSONNEL. In general, USERS shall not be exposed to hazards likely to cause injury, and information provided for USERS should primarily aim at avoiding misuse and situations likely to create hazards, such as connection to the wrong power source and replacement of fuses by incorrect types.

MOVABLE EQUIPMENT is considered to present a slightly increased risk of shock, due to possible extra strain on the supply cord leading to rupture of the earthing conductor. With HAND-HELD EQUIPMENT, this risk is increased; wear on the cord is more likely, and further hazards could arise if the units were dropped. TRANSPORTABLE EQUIPMENT introduces a further factor because it can be used and carried in any orientation; if a small metallic object enters an opening in the ENCLOSURE it can move around inside the equipment, possibly creating a hazard.

0.2 Hazards

Application of a safety standard is intended to reduce the likelihood of injury or damage due to the following:

- electric shock;
- energy related hazards;
- fire;
- heat related hazards;
- mechanical hazards;
- radiation;
- chemical hazards.

0.2.1 Electric shock

Electric shock is due to current passing through the human body. The resulting physiological effects depend on the value and duration of the current and the path it takes through the body. The value of the current depends on the applied voltage, the impedance of the source and the impedance of the body. The body impedance depends in turn on the area of contact, moisture in the area of contact and the applied voltage and frequency. Currents of approximately half a milliampere can cause a reaction in persons in good health and may cause injury indirectly due to involuntary reaction. Higher currents can have more direct effects, such as burn or ventricular fibrillation.

Steady state voltages up to 42,4 V peak, or 60 V d.c., are not generally regarded as hazardous under dry conditions for an area of contact equivalent to a human hand. Bare parts which have to be touched or handled should be at earth potential or properly insulated.

Some equipment will be connected to telephone and other external networks. Some TELECOMMUNICATION NETWORKS operate with signals such as voice and ringing superimposed on a steady DC VOLTAGE; the total may exceed the values given above for steady-state voltages. It is common practice for the SERVICE PERSONNEL of telephone companies to handle parts of such circuits bare-handed. This has not caused serious injury, because of the use of cadenced ringing and because there are limited areas of contact with bare conductors normally handled by SERVICE PERSONNEL. However, the area of contact of a part accessible to the USER, and the likelihood of the part being touched, should be further limited (e.g. by the shape and location of the part).

It is normal to provide two levels of protection for USERS to prevent electric shock. Therefore, the operation of equipment under normal conditions and after a single fault, including any consequential faults, should not create a shock hazard. However, provision of additional protective measures, such as protective earthing or SUPPLEMENTARY INSULATION, is not considered a substitute for, or a relief from, properly designed BASIC INSULATION.

Hazards may result from:

Contact with bare parts normally at HAZARDOUS VOLTAGES.

Breakdown of insulation between parts normally at HAZARDOUS VOLTAGES and accessible conductive parts.

Contact with circuits connected to TELE-COMMUNICATION NETWORKS which exceed 42,4 V peak or 60 V d.c.

Breakdown of USER-accessible insulation.

TOUCH CURRENT (leakage current) flowing from parts at HAZARDOUS VOLTAGES to accessible parts, or failure of a protective earthing connection. TOUCH CURRENT may include current due to EMC filter components connected between PRIMARY CIRCUITS and accessible parts.

Examples of measures to reduce hazards:

Prevent USER access to parts at HAZARDOUS VOLTAGES by fixed or locked covers, SAFETY INTERLOCKS, etc. Discharge accessible capacitors that are at HAZARDOUS VOLTAGES.

Provide BASIC INSULATION and connect the accessible conductive parts and circuits to earth so that exposure to the voltage which can develop is limited because overcurrent protection will disconnect the parts having low impedance faults within a specified time; or provide a metal screen connected to protective earth between the parts, or provide DOUBLE or REINFORCED INSULATION between the parts, so that breakdown to the accessible part is not likely to occur.

Limit the accessibility and area of contact of such circuits, and separate them from unearthed parts to which access is not limited.

Insulation which is accessible to the USER should have adequate mechanical and electrical strength to reduce the likelihood of contact with HAZARDOUS VOLTAGES.

Limit TOUCH CURRENT to a specified value, or provide a high integrity protective earthing connection.

0.2.2 Energy related hazards

Hazards may result from a short circuit between adjacent poles of high current supplies or high capacitance circuits, causing:

- burns;
- arcing;
- ejection of molten metal.

Even circuits whose voltages are safe to touch may be hazardous in this respect.

Examples of measures to reduce such hazards include:

- separation;
- shielding;
- provision of SAFETY INTERLOCKS.

0.2.3 Fire

Hazards may result from excessive temperatures either under normal operating conditions or due to overload, component failure, insulation breakdown or loose connections. Fires originating within the equipment should not spread beyond the immediate vicinity of the source of the fire, nor cause damage to the surroundings of the equipment.

Examples of measures to reduce such hazards include:

- providing overcurrent protection;
- using constructional materials having appropriate flammability properties for their purpose;
- selection of parts, components and consumable materials to avoid high temperature which might cause ignition;
- limiting the quantity of combustible materials used;
- shielding or separating combustible materials from likely ignition sources;
- using ENCLOSURES or barriers to limit the spread of fire within the equipment;
- using suitable materials for ENCLOSURES so as to reduce the likelihood of fire spreading from the equipment.

0.2.4 Heat related hazards

Hazards may result from high temperatures under normal operating conditions, causing:

- burns due to contact with hot accessible parts;
- degradation of insulation and of safety-critical components;
- ignition of flammable liquids.

Examples of measures to reduce such hazards include:

- taking steps to avoid high temperature of accessible parts;
- avoiding temperatures above the ignition point of liquids;
- provision of markings to warn USERS where access to hot parts is unavoidable.

0.2.5 Mechanical hazards

Hazards may result from:

- sharp edges and corners;
- moving parts which have the potential to cause injury;
- equipment instability;
- flying particles from imploding cathode ray tubes and exploding high pressure lamps.

Examples of measures to reduce such hazards include:

- rounding of sharp edges and corners;
- guarding;
- provision of SAFETY INTERLOCKS;
- providing sufficient stability to free-standing equipment;
- selecting cathode ray tubes and high pressure lamps that are resistant to implosion and explosion respectively;
- provision of markings to warn USERS where access is unavoidable.

0.2.6 Radiation

Hazards to USERS and to SERVICE PERSONNEL may result from some forms of radiation emitted by equipment. Examples are sonic (acoustic), radio frequency, infra-red, ultraviolet and ionizing radiation, and high intensity visible and coherent light (lasers).

Examples of measures to reduce such hazards include:

- limiting the energy level of potential radiation sources;
- screening radiation sources;
- provision of SAFETY INTERLOCKS;
- provision of markings to warn USERS where exposure to the radiation hazard is unavoidable.

0.2.7 Chemical hazards

Hazards may result from contact with some chemicals or from inhalation of their vapours and fumes.

Examples of measures to reduce such hazards include:

- avoiding the use of constructional and consumable materials likely to cause injury by contact or inhalation during intended and normal conditions of use;
- avoiding conditions likely to cause leakage or vaporization;
- provision of markings to warn USERS about the hazards.

0.3 Materials and components

Materials and components used in the construction of equipment should be so selected and arranged that they can be expected to perform in a reliable manner for the anticipated life of the equipment without creating a hazard, and would not contribute significantly to the development of a serious fire hazard. Components should be selected so that they remain within their manufacturers' ratings under normal operating conditions, and do not create a hazard under fault conditions.

SAFETY OF INFORMATION TECHNOLOGY EQUIPMENT –

1 General

1.1 Scope

1.1.1 Equipment covered by this standard

This standard is applicable to mains-powered or battery-powered information technology equipment, including electrical business equipment and associated equipment, with a RATED VOLTAGE not exceeding 600 V.

This standard is also applicable to such information technology equipment designed and intended to be connected directly to a TELECOMMUNICATION NETWORK, regardless of the source of power.

It is also applicable to such information technology equipment designed to use the AC MAINS SUPPLY as a telecommunication transmission medium (see note 4 of clause 6).

This standard specifies requirements intended to reduce risks of fire, electric shock or injury for the OPERATOR and layman who may come into contact with the equipment and, where specifically stated, for SERVICE PERSONNEL.

This standard is intended to reduce such risks with respect to installed equipment, whether it consists of a system of interconnected units or independent units, subject to installing, operating and maintaining the equipment in the manner prescribed by the manufacturer.

Examples of equipment which is in the scope of this standard are:

accounting machines	motor-operated files
bookkeeping machines	PABX's
calculators	paper jogging machines
cash registers	paper trimmers (punchers, cutting machines, separators)
copying machines	pencil sharpeners
data circuit terminating equipment	personal computers
data preparation equipment	photoprinting equipment
data processing equipment	plotters
data terminal equipment	point of sale terminals including associated electronic scales
dictation equipment	postage machines
document shredding machines	public information terminals
duplicators	staplers
electrically operated drawing machines	telephone answering machines
erasers	telephone sets
facsimile equipment	text processing equipment
key telephone systems	typewriters
magnetic tape handlers	visual display units
mail processing machines	
micrographic office equipment	
modems	
monetary processing machines including automated teller (cash dispensing) machines	

This list is not intended to be comprehensive, and equipment that is not listed is not necessarily excluded from the scope.

Equipment complying with the relevant requirements in this standard is considered suitable for use with process control equipment, automatic test equipment and similar systems requiring information processing facilities. However, this standard does not include requirements for performance or functional characteristics of equipment.

1.1.2 Additional requirements

Requirements additional to those specified in this standard may be necessary for:

- equipment intended for operation in special environments, for example, extremes of temperature; excessive dust, moisture or vibration; flammable gases; and corrosive or explosive atmospheres;
- electromedical applications with physical connections to the patient;
- equipment intended to be used in vehicles, on board ships or aircraft, in tropical countries, or at altitudes greater than 2 000 m;
- equipment intended for use where ingress of water is possible; for guidance on such requirements and on relevant testing, see annex T.

NOTE – Attention is drawn to the fact that authorities of some countries impose additional requirements.

1.1.3 Exclusions

This standard does not apply to:

- support equipment, such as air conditioning, fire detection or fire extinguishing systems;
- power supply systems, such as motor-generator sets, battery backup systems and transformers, which are not an integral part of the equipment;
- building installation wiring;
- devices requiring no electric power.

1.2 Definitions

For the purpose of this International Standard the following definitions apply. Where the terms "voltage" and "current" are used they imply the r.m.s. values, unless otherwise specified.

Definitions in alphabetical order of nouns

Area, operator access	1.2.7.1
Area, service access	1.2.7.2
Body	1.2.7.5
Cable, interconnecting	1.2.11.6
Circuit, ELV	1.2.8.5
Circuit, limited current	1.2.8.7
Circuit, primary	1.2.8.2
Circuit, secondary	1.2.8.3
Circuit, SELV	1.2.8.6
Circuit, TNV	1.2.8.9
Circuit, TNV-1	1.2.8.10
Circuit, TNV-2	1.2.8.11
Circuit, TNV-3	1.2.8.12
Clearance	1.2.10.1
Conductor, protective bonding	1.2.13.11
Conductor, protective earthing	1.2.13.10
Cord, detachable power supply	1.2.5.4
Cord, non-detachable power supply	1.2.5.5
Creepage distance	1.2.10.2
Current, protective conductor	1.2.13.13
Current, rated	1.2.1.3
Current, touch	1.2.13.12
Cut-out, thermal	1.2.11.3
Cut-out, thermal, automatic reset	1.2.11.4
Cut-out, thermal, manual reset	1.2.11.5
Earthing, functional	1.2.13.9
Enclosure	1.2.6.1
Enclosure, electrical	1.2.6.4
Enclosure, fire	1.2.6.2
Enclosure, mechanical	1.2.6.3
Energy level, hazardous	1.2.8.8
Equipment, Class I	1.2.4.1
Equipment, Class II	1.2.4.2
Equipment, Class III	1.2.4.3
Equipment, direct plug-in	1.2.3.6
Equipment, for building-in	1.2.3.5
Equipment, hand-held	1.2.3.2
Equipment, movable	1.2.3.1
Equipment, permanently connected	1.2.5.3
Equipment, pluggable, type A	1.2.5.1
Equipment, pluggable, type B	1.2.5.2
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1.2.1 Equipment electrical ratings

1.2.1.1 RATED VOLTAGE: The supply voltage (for a three-phase AC MAINS SUPPLY, the line-to-line voltage) as declared by the manufacturer.

1.2.1.2 RATED VOLTAGE RANGE: The supply voltage range as declared by the manufacturer, expressed by its lower and upper RATED VOLTAGES.

1.2.1.3 RATED CURRENT: The input current of the equipment as declared by the manufacturer.

1.2.1.4 RATED FREQUENCY: The supply frequency as declared by the manufacturer.

1.2.1.5 RATED FREQUENCY RANGE: The supply frequency range as declared by the manufacturer, expressed by its lower and upper RATED FREQUENCIES.

1.2.2 Operating conditions

1.2.2.1 NORMAL LOAD: The mode of operation which approximates as closely as possible the most severe conditions of normal use in accordance with the operating instructions. However, when the conditions of actual use can obviously be more severe than the maximum recommended load conditions, a load is used that is representative of the maximum that can be applied.

NOTE – NORMAL LOAD conditions for some types of equipment are given in annex L.

1.2.2.2 RATED OPERATING TIME: The operating time assigned to the equipment by the manufacturer.

1.2.2.3 CONTINUOUS OPERATION: Operation under NORMAL LOAD for an unlimited period.

1.2.2.4 SHORT-TIME OPERATION: Operation under NORMAL LOAD for a specified period, starting from cold, the intervals after each period of operation being sufficient to allow the equipment to cool down to room temperature.

1.2.2.5 INTERMITTENT OPERATION: Operation in a series of specified identical cycles, each composed of a period of operation under NORMAL LOAD followed by a rest period with the equipment switched off or running idle.

1.2.3 Equipment mobility

1.2.3.1 MOVABLE EQUIPMENT: Equipment which is either:

- 18 kg or less in mass and not fixed, or
- equipment with wheels, castors or other means to facilitate movement by the OPERATOR as required to perform its intended use.

1.2.3.2 HAND-HELD EQUIPMENT: MOVABLE EQUIPMENT, or a part of any kind of equipment, that is intended to be held in the hand during normal use.

1.2.3.3 TRANSPORTABLE EQUIPMENT: MOVABLE EQUIPMENT that is intended to be routinely carried by a USER.

NOTE – Examples include laptop personal computers, pen-based tablet computers, and their portable accessories such as printers and CD-ROM drives.

1.2.3.4 STATIONARY EQUIPMENT: Equipment that is not MOVABLE EQUIPMENT.

1.2.3.5 EQUIPMENT FOR BUILDING-IN: Equipment intended to be installed in a prepared recess, such as in a wall, or similar situation.

NOTE – In general, EQUIPMENT FOR BUILDING-IN does not have an ENCLOSURE on all sides, as some of the sides will be protected after installation.

1.2.3.6 DIRECT PLUG-IN EQUIPMENT: Equipment that is intended to be used without a power supply cord; the mains plug forms an integral part of the equipment ENCLOSURE so that the weight of the equipment is taken by the socket-outlet.

1.2.4 Classes of equipment – Protection against electric shock

NOTE – Some information technology equipment cannot be identified as conforming to one of the following classes.

1.2.4.1 CLASS I EQUIPMENT: Equipment where protection against electric shock is achieved by:

- using BASIC INSULATION, and also
- providing a means of connection to the PROTECTIVE EARTHING CONDUCTOR in the building wiring those conductive parts that are otherwise capable of assuming HAZARDOUS VOLTAGES if the BASIC INSULATION fails.

NOTE – CLASS I EQUIPMENT may have parts with DOUBLE INSULATION or REINFORCED INSULATION.

1.2.4.2 CLASS II EQUIPMENT: Equipment in which protection against electric shock does not rely on BASIC INSULATION only, but in which additional safety precautions, such as DOUBLE INSULATION or REINFORCED INSULATION are provided, there being no reliance on either protective earthing or installation conditions.

1.2.4.3 CLASS III EQUIPMENT: Equipment in which protection against electric shock relies upon supply from SELV CIRCUITS and in which HAZARDOUS VOLTAGES are not generated.

NOTE – For CLASS III EQUIPMENT, although there is no requirement for protection against electric shock, all other requirements of the standard apply.

1.2.5 Connection to the supply

1.2.5.1 PLUGGABLE EQUIPMENT TYPE A: Equipment which is intended for connection to the building installation wiring via a non-industrial plug and socket-outlet or a non-industrial appliance coupler, or both.

1.2.5.2 PLUGGABLE EQUIPMENT TYPE B: Equipment which is intended for connection to the building installation wiring via an industrial plug and socket-outlet or an appliance coupler, or both, complying with IEC 60309 or with a comparable national standard.

1.2.5.3 PERMANENTLY CONNECTED EQUIPMENT: Equipment which is intended for connection to the building installation wiring using screw terminals or other reliable means.

1.2.5.4 DETACHABLE POWER SUPPLY CORD: A flexible cord, for supply purposes, intended to be connected to the equipment by means of a suitable appliance coupler.

1.2.5.5 NON-DETACHABLE POWER SUPPLY CORD: A flexible cord, for supply purposes, fixed to or assembled with the equipment.

Such a cord may be:

Ordinary: a flexible cord which can be easily replaced without special preparation of the cord or special TOOLS, or

Special: a flexible cord which is specially prepared, or requires the use of specially designed TOOLS for replacement, or is such that it cannot be replaced without damage to the equipment.

The term "specially prepared" includes provision of an integral cord guard, the use of cable lugs, formation of eyelets, etc., but not the re-shaping of the conductor before introduction into a terminal or the twisting of a stranded conductor to consolidate the end.

1.2.6 Enclosures

1.2.6.1 ENCLOSURE: A part of the equipment providing one or more of the functions described in 1.2.6.2, 1.2.6.3 or 1.2.6.4.

NOTE – One type of ENCLOSURE can be inside another type (e.g. an ELECTRICAL ENCLOSURE inside a FIRE ENCLOSURE or a FIRE ENCLOSURE inside an ELECTRICAL ENCLOSURE). Also, a single ENCLOSURE can provide the functions of more than one type (e.g. those of both an ELECTRICAL ENCLOSURE and a FIRE ENCLOSURE).

1.2.6.2 FIRE ENCLOSURE: A part of the equipment intended to minimize the spread of fire or flames from within.

1.2.6.3 MECHANICAL ENCLOSURE: A part of the equipment intended to reduce the risk of injury due to mechanical and other physical hazards.

1.2.6.4 ELECTRICAL ENCLOSURE: A part of the equipment intended to limit access to parts that may be at HAZARDOUS VOLTAGES or HAZARDOUS ENERGY LEVELS or are in TNV CIRCUITS.

1.2.6.5 DECORATIVE PART: A part of the equipment, outside the ENCLOSURE, which has no safety function.

1.2.7 Accessibility

1.2.7.1 OPERATOR ACCESS AREA: An area to which, under normal operating conditions, one of the following applies:

- access can be gained without the use of a TOOL, or
- the means of access is deliberately provided to the OPERATOR, or
- the OPERATOR is instructed to enter regardless of whether or not a TOOL is needed to gain access.

The terms "access" and "accessible", unless qualified, relate to OPERATOR ACCESS AREA as defined above.

1.2.7.2 SERVICE ACCESS AREA: An area, other than an OPERATOR ACCESS AREA, where it is necessary for SERVICE PERSONNEL to have access even with the equipment switched on.

1.2.7.3 RESTRICTED ACCESS LOCATION: A location for equipment where both of the following paragraphs apply:

- access can only be gained by SERVICE PERSONNEL or by USERS who have been instructed about the reasons for the restrictions applied to the location and about any precautions that shall be taken; and
- access is through the use of a TOOL or lock and key, or other means of security, and is controlled by the authority responsible for the location.

NOTE – The requirements for equipment intended for installation in RESTRICTED ACCESS LOCATIONS are the same as for OPERATOR ACCESS AREAS, except as given in 1.7.17, 2.1.3 and 4.5.1.

1.2.7.4 TOOL: A screwdriver or any other object which may be used to operate a screw, latch or similar fixing means.

1.2.7.5 BODY: All accessible conductive parts, shafts of handles, knobs, grips and the like, and metal foil in contact with all accessible surfaces of insulating material.

1.2.7.6 SAFETY INTERLOCK: A means either of preventing access to a hazardous area until the hazard is removed, or of automatically removing the hazardous condition when access is gained.

1.2.8 Circuits and circuit characteristics

1.2.8.1 AC MAINS SUPPLY: The external a.c. power distribution system supplying power to the equipment. These power sources include public or private utilities and, unless otherwise specified in the standard (e.g. 1.4.5), equivalent sources such as motor-driven generators and uninterruptible power supplies.

NOTE – See annex V for typical examples of a.c. power distribution systems.

1.2.8.2 PRIMARY CIRCUIT: A circuit which is directly connected to the AC MAINS SUPPLY. It includes, for example, the means for connection to the AC MAINS SUPPLY, the primary windings of transformers, motors and other loading devices.

NOTE Conductive parts of an INTERCONNECTING CABLE may be part of a PRIMARY CIRCUIT as stated in 1.2.11.6.

1.2.8.3 SECONDARY CIRCUIT: A circuit which has no direct connection to a PRIMARY CIRCUIT and derives its power from a transformer, converter or equivalent isolation device, or from a battery.

NOTE – Conductive parts of an INTERCONNECTING CABLE may be part of a SECONDARY CIRCUIT as stated in 1.2.11.6.

1.2.8.4 HAZARDOUS VOLTAGE: A voltage exceeding 42,4 V peak, or 60 V d.c., existing in a circuit which does not meet the requirements for either a LIMITED CURRENT CIRCUIT or a TNV CIRCUIT.

1.2.8.5 ELV CIRCUIT: A SECONDARY CIRCUIT with voltages between any two conductors of the circuit, and between any one such conductor and earth (see 1.4.9), not exceeding 42,4 V peak, or 60 V d.c., under normal operating conditions, which is separated from HAZARDOUS VOLTAGE by BASIC INSULATION, and which neither meets all of the requirements for an SELV CIRCUIT nor meets all of the requirements for a LIMITED CURRENT CIRCUIT.

1.2.8.6 SELV CIRCUIT: A SECONDARY CIRCUIT which is so designed and protected that under normal operating conditions and single fault conditions, its voltages do not exceed a safe value.

NOTE 1 – The limit values of voltages under normal operating conditions and single fault conditions (see 1.4.14) are specified in 2.2. See also table 1A.

NOTE 2 – This definition of an SELV CIRCUIT differs from the term “SELV system” as used in IEC 61140.¹⁾

¹⁾ A list of informative references is given in annex Q: “Bibliography”.

1.2.8.7 LIMITED CURRENT CIRCUIT: A circuit which is so designed and protected that, under both normal operating conditions and single fault conditions, the current which can be drawn is not hazardous.

NOTE – The limit values of currents under normal operating conditions and single fault conditions (see 1.4.14) are specified in 2.4.

1.2.8.8 HAZARDOUS ENERGY LEVEL: A stored energy level of 20 J or more, or an available continuous power level of 240 VA or more, at a potential of 2 V or more.

1.2.8.9 TNV CIRCUIT: A circuit which is in the equipment and to which the accessible area of contact is limited and that is so designed and protected that, under normal operating conditions and single fault conditions (see 1.4.14), the voltages do not exceed specified limit values.

A TNV CIRCUIT is considered to be a SECONDARY CIRCUIT in the meaning of this standard.

NOTE 1 – The specified limit values of voltages under normal operating conditions and single fault conditions (see 1.4.14) are given in 2.3.1. Requirements regarding accessibility of TNV CIRCUITS are given in 2.1.1.1.

TNV CIRCUITS are classified as TNV-1, TNV-2 and TNV-3 CIRCUITS as defined in 1.2.8.10, 1.2.8.11 and 1.2.8.12.

NOTE 2 – The voltage relationships between SELV and TNV CIRCUITS are shown in table 1A.

NOTE 3 – Conductive parts of an INTERCONNECTING CABLE may be part of a TNV CIRCUIT as stated in 1.2.11.6.

Table 1A –Voltage ranges of SELV and TNV circuits

Overvoltages from TELECOMMUNICATION NETWORKS possible?	Normal operating voltages	
	Within SELV CIRCUIT limits	Exceeding SELV CIRCUIT limits but within TNV CIRCUIT limits
Yes	TNV-1 CIRCUIT	TNV-3 CIRCUIT
No	SELV CIRCUIT	TNV-2 CIRCUIT

1.2.8.10 TNV-1 CIRCUIT: a TNV CIRCUIT:

- whose normal operating voltages do not exceed the limits for an SELV CIRCUIT under normal operating conditions; and
- on which overvoltages from TELECOMMUNICATION NETWORKS are possible.

1.2.8.11 TNV-2 CIRCUIT: a TNV CIRCUIT:

- whose normal operating voltages exceed the limits for an SELV CIRCUIT under normal operating conditions; and
- which is not subject to overvoltages from TELECOMMUNICATION NETWORKS.

1.2.8.12 TNV-3 CIRCUIT: a TNV CIRCUIT:

- whose normal operating voltages exceed the limits for an SELV CIRCUIT under normal operating conditions; and
- on which overvoltages from TELECOMMUNICATION NETWORKS are possible.

1.2.9 Insulation

1.2.9.1 FUNCTIONAL INSULATION: Insulation that is necessary only for the correct functioning of the equipment.

NOTE – FUNCTIONAL INSULATION by definition does not protect against electric shock. It may, however, reduce the likelihood of ignition and fire.

1.2.9.2 BASIC INSULATION: Insulation to provide basic protection against electric shock.

1.2.9.3 SUPPLEMENTARY INSULATION: Independent insulation applied in addition to BASIC INSULATION in order to reduce the risk of electric shock in the event of a failure of the BASIC INSULATION.

1.2.9.4 DOUBLE INSULATION: Insulation comprising both BASIC INSULATION and SUPPLEMENTARY INSULATION.

1.2.9.5 REINFORCED INSULATION: A single insulation system which provides a degree of protection against electric shock equivalent to DOUBLE INSULATION under the conditions specified in this standard.

NOTE – The term "insulation system" does not imply that the insulation has to be in one homogeneous piece. It may comprise several layers which cannot be tested as SUPPLEMENTARY or BASIC INSULATION.

1.2.9.6 WORKING VOLTAGE: The highest voltage to which the insulation or the component under consideration is, or can be, subjected when the equipment is operating under conditions of normal use.

1.2.9.7 PEAK WORKING VOLTAGE: The highest peak or d.c. value of a WORKING VOLTAGE, including repetitive peak impulses generated in the equipment, but not including external transients.

1.2.9.8 REQUIRED WITHSTAND VOLTAGE: The peak voltage that the insulation under consideration is required to withstand.

1.2.9.9 MAINS TRANSIENT VOLTAGE: The highest peak voltage expected at the power input to the equipment, arising from external transients on the AC MAINS SUPPLY.

1.2.9.10 TELECOMMUNICATION NETWORK TRANSIENT VOLTAGE: The highest peak voltage expected at the TELECOMMUNICATION NETWORK connection point of the equipment, arising from external transients on the network.

1.2.10 Clearances and creepage distances

1.2.10.1 CLEARANCE: The shortest distance between two conductive parts, or between a conductive part and the BOUNDING SURFACE of the equipment, measured through air.

1.2.10.2 CREEPAGE DISTANCE: The shortest path between two conductive parts, or between a conductive part and the BOUNDING SURFACE of the equipment, measured along the surface of the insulation.

1.2.10.3 BOUNDING SURFACE: The outer surface of the ELECTRICAL ENCLOSURE, considered as though metal foil were pressed into contact with accessible surfaces of insulating material.

1.2.11 Components

1.2.11.1 THERMOSTAT: A cycling temperature-sensing control, which is intended to keep a temperature between two particular values under normal operating conditions and which may have provision for setting by the OPERATOR.

1.2.11.2 TEMPERATURE LIMITER: A temperature-sensing control which is intended to keep a temperature below or above one particular value during normal operating conditions and which may have provision for setting by the OPERATOR.

NOTE – A TEMPERATURE LIMITER may be of the automatic reset or of the manual reset type.

1.2.11.3 THERMAL CUT-OUT: A temperature-sensing control intended to operate under abnormal operating conditions and which has no provision for the OPERATOR to change the temperature setting.

NOTE – A THERMAL CUT-OUT may be of the automatic reset or of the manual reset type.

1.2.11.4 THERMAL CUT-OUT, AUTOMATIC RESET: A THERMAL CUT-OUT which automatically restores the current after the relevant part of the equipment has cooled down sufficiently.

1.2.11.5 THERMAL CUT-OUT, MANUAL RESET: A THERMAL CUT-OUT which requires resetting by hand, or replacement of a part, in order to restore the current.

1.2.11.6 INTERCONNECTING CABLE: A cable that is external to the equipment and that is used to electrically connect an accessory to a unit of information technology equipment, to interconnect units in a system or to connect a unit to a TELECOMMUNICATION NETWORK. Such a cable may carry any type of circuit from one unit to another.

1.2.12 Flammability

1.2.12.1 FLAMMABILITY CLASSIFICATION OF MATERIALS: The recognition of the burning behaviour of materials and their ability to extinguish if ignited. Materials are classified as in 1.2.12.2 to 1.2.12.9 when tested in accordance with annex A.

NOTE 1 – When applying the requirements in this standard, HF-1 CLASS FOAMED MATERIALS are regarded as better than those of CLASS HF-2, and HF-2 better than HBF.

NOTE 2 – Similarly, other MATERIALS, including rigid (engineering structural) foam of CLASSES 5V or V-0 are regarded as better than those of CLASS V-1, V-1 better than V-2, and V-2 better than HB.

1.2.12.2 V-0 CLASS MATERIAL: A material that, when tested in accordance with A.6, may flame or glow but will meet certain criteria for times to extinguish; glowing particles or flaming drops released do not ignite surgical cotton.

1.2.12.3 V-1 CLASS MATERIAL: A material that, when tested in accordance with A.6, may flame or glow but will meet certain criteria for times to extinguish; glowing particles or flaming drops released do not ignite surgical cotton.

1.2.12.4 V-2 CLASS MATERIAL: A material that, when tested in accordance with A.6, may flame or glow but will meet certain criteria for times to extinguish; glowing particles or flaming drops released may ignite surgical cotton.

1.2.12.5 5V CLASS MATERIAL: A material that, when tested in accordance with A.9, may flame or glow but will extinguish within a prescribed period of time; glowing particles or flaming drops released do not ignite surgical cotton.

1.2.12.6 HF-1 CLASS FOAMED MATERIAL: A foamed material that, when tested in accordance with A.7, may flame or glow but will extinguish within a prescribed period of time; flaming or glowing particles, or flaming drops released do not ignite surgical cotton.

1.2.12.7 HF-2 CLASS FOAMED MATERIAL: A foamed material that, when tested in accordance with A.7, may flame or glow but will extinguish within a prescribed period of time; flaming or glowing particles, or flaming drops released may ignite surgical cotton.

1.2.12.8 HB CLASS MATERIAL: Material that, when tested in accordance with A.8, does not exceed a specified maximum burning rate.

1.2.12.9 HBF CLASS FOAMED MATERIAL: A foamed material that, when tested in accordance with A.7, does not exceed a specified maximum burning rate.

1.2.12.10 EXPLOSION LIMIT: The lowest concentration of a combustible material in a mixture containing any of the following: gases, vapours, mists or dusts, in which a flame is able to propagate after removal of the ignition source.

1.2.13 Miscellaneous

1.2.13.1 TYPE TEST: A test on a representative sample of the equipment with the objective of determining if the equipment, as designed and manufactured, can meet the requirements of this standard.

1.2.13.2 SAMPLING TEST: A test on a number of samples taken at random from a batch. [IEV 151-04-17, modified]¹⁾

1.2.13.3 ROUTINE TEST: A test to which each individual sample is subjected during or after manufacture to check if the sample complies with certain criteria. [IEV 151-04-16, modified]

1.2.13.4 DC VOLTAGE: The average value of a voltage (as measured by a moving coil meter) having a peak-to-peak ripple not exceeding 10 % of the average value.

NOTE – Where peak-to-peak ripple exceeds 10 % of the average value, the requirements related to peak voltage are applicable.

¹⁾ A list of normative références is given in annex P.

1.2.13.5 SERVICE PERSONNEL: Persons having appropriate technical training and experience necessary to be aware of hazards to which they may be exposed in performing a task and of measures to minimize the risks for themselves or other persons.

1.2.13.6 USER: Any person, other than SERVICE PERSONNEL. The term USER in this standard is the same as the term OPERATOR and the two terms can be interchanged.

1.2.13.7 OPERATOR: See USER (1.2.13.6).

1.2.13.8 TELECOMMUNICATION NETWORK: A metallically terminated transmission medium intended for communication between equipments that may be located in separate buildings, excluding:

- the mains system for supply, transmission and distribution of electrical power, if used as a telecommunication transmission medium;
- television distribution systems using cable;
- SELV CIRCUITS connecting units of data processing equipment.

NOTE 1 – The term TELECOMMUNICATION NETWORK is defined in terms of its functionality, not its electrical characteristics. A TELECOMMUNICATION NETWORK is not itself defined as being either an SELV CIRCUIT or a TNV CIRCUIT. Only the circuits in the equipment are so classified.

NOTE 2 – A TELECOMMUNICATION NETWORK may be:

- publicly or privately owned;
- subject to transient overvoltages due to atmospheric discharges and faults in power distribution systems;
- subject to longitudinal (common mode) voltages induced from nearby power lines or electric traction lines.

NOTE 3 – Examples of TELECOMMUNICATION NETWORKS are:

- a public switched telephone network;
- a public data network;
- an Integrated Services Digital Network (ISDN);
- a private network with electrical interface characteristics similar to the above.

1.2.13.9 FUNCTIONAL EARTHING: The earthing of a point in equipment or in a system, which is necessary for a purpose other than safety. [IEV 195-01-13, modified]

1.2.13.10 PROTECTIVE EARTHING CONDUCTOR: A conductor in the building installation wiring, or in the power supply cord, connecting a main protective earthing terminal in the equipment to an earth point in the building installation.

NOTE – In some countries, the term "grounding conductor" is used instead of "PROTECTIVE EARTHING CONDUCTOR".

1.2.13.11 PROTECTIVE BONDING CONDUCTOR: A conductor in the equipment, or a combination of conductive parts in the equipment, connecting a main protective earthing terminal to a part of the equipment that is required to be earthed for safety purposes.

1.2.13.12 TOUCH CURRENT: Electric current through a human body when it touches one or more accessible parts. [IEV 195-05-21 modified]¹⁾

NOTE – TOUCH CURRENT was previously included in the term "leakage current".

1.2.13.13 PROTECTIVE CONDUCTOR CURRENT: Current flowing through the PROTECTIVE EARTHING CONDUCTOR under normal operating conditions.

NOTE – PROTECTIVE CONDUCTOR CURRENT was previously included in the term "leakage current".

1.3 General requirements

1.3.1 Application of requirements

The requirements detailed in this standard shall be applied only if safety is involved.

In order to establish whether or not safety is involved, the circuits and construction shall be carefully investigated to take into account the consequences of possible failures.

1.3.2 Equipment design and construction

Equipment shall be so designed and constructed that, under all conditions of normal use and under likely abnormal use or single fault conditions (see 1.4.14), protection is provided to reduce the risk of personal injury from electric shock and other hazards, and against spread of fire originating in the equipment.

Compliance is checked by inspection and by the relevant tests.

1.3.3 Supply voltage

Equipment shall be designed to be safe at any supply voltage to which it is intended to be connected.

Compliance is checked by inspection and by carrying out the relevant tests of this standard under the conditions specified in 1.4.5.

1.3.4 Constructions not specifically covered

Where the equipment involves technologies and materials or methods of construction not specifically covered in this standard, the equipment shall provide a level of safety not less than that generally afforded by this standard and the principles of safety contained herein.

NOTE – The need for additional detailed requirements to cope with a new situation should be brought promptly to the attention of the appropriate committee.

1.3.5 Equivalent materials

Where the standard specifies a particular grade of insulation, the use of a better grade of insulation is permitted. Similarly, where the standard requires material of a particular FLAMMABILITY CLASS, the use of a better class is permitted.

¹⁾ To be published.

1.3.6 Orientation during transport and use

Where it is clear that the orientation of use of equipment is likely to have a significant effect on the application of the requirements or the results of tests, all orientations of use permitted in the installation or USER instructions shall be taken into account. For TRANSPORTABLE EQUIPMENT, all orientations of transport and use shall be taken into account.

NOTE – The above may apply to 4.1, 4.5, 4.6, and 5.3.

1.3.7 Choice of criteria

Where the standard permits a choice between different criteria for compliance, or between different methods or conditions of test, the choice is specified by the manufacturer.

1.3.8 Examples mentioned in the standard

Where examples of equipment, parts, methods of construction, design techniques and faults are given in the standard, prefaced by "e.g." or "such as", other examples are not excluded.

1.3.9 Conductive liquids

For the electrical requirements of this standard, conductive liquids shall be treated as conductive parts.

1.4 General conditions for tests

1.4.1 Application of tests

The tests detailed in this standard shall be carried out only if safety is involved.

If it is evident from the design and construction of the equipment that a particular test is not applicable, the test is not made.

Unless otherwise stated, upon conclusion of the tests, the equipment need not be operational.

1.4.2 Type tests

Except where otherwise stated, the tests specified in this standard are TYPE TESTS.

1.4.3 Test samples

Unless otherwise specified, the sample or samples under test shall be representative of the equipment the USER would receive, or shall be the actual equipment ready for shipment to the USER.

As an alternative to carrying out tests on the complete equipment, tests may be carried out separately on circuits, components or subassemblies outside the equipment, provided that inspection of the equipment and circuit arrangements indicates that the results of such testing will be representative of the results of testing the assembled equipment. If any such test indicates a likelihood of non-conformance in the complete equipment, the test shall be repeated in the equipment.

If a test specified in this standard could be destructive, it is permitted to use a model to represent the condition to be evaluated.

NOTE 1 – The tests should be carried out in the following order:

- component or material pre-selection;
- component or subassembly bench tests;
- tests where the equipment is not energized;
- live tests:
 - under normal operating conditions;
 - under abnormal operating conditions;
 - involving likely destruction.

NOTE 2 – In view of the resources involved in testing and in order to minimize waste, it is recommended that all parties concerned jointly consider the test programme, the test samples and the test sequence.

1.4.4 Operating parameters for tests

Except where specific test conditions are stated elsewhere in the standard and where it is clear that there is a significant impact on the results of the test, the tests shall be carried out under the most unfavourable combination within the manufacturer's operating specifications of the following parameters:

- supply voltage (see 1.4.5);
- supply frequency (see 1.4.6);
- physical location of equipment and position of movable parts;
- operating mode;
- adjustment of THERMOSTATS, regulating devices or similar controls in OPERATOR ACCESS AREAS, which are:
 - adjustable without the use of a TOOL; or
 - adjustable using a means, such as a key or a TOOL, deliberately provided for the OPERATOR.

1.4.5 Supply voltage for tests

In determining the most unfavourable voltage for the power to energize the equipment under test (EUT), the following variables shall be taken into account:

- multiple RATED VOLTAGES;
- tolerances on RATED VOLTAGE as specified below;
- extremes of RATED VOLTAGE ranges.

If the equipment is intended for direct connection to an AC MAINS SUPPLY, the tolerances on RATED VOLTAGE shall be taken as +6 % and –10 %, unless:

- the RATED VOLTAGE is 230 V single-phase or 400 V three-phase, in which case the tolerance shall be taken as +10 % and –10 %; or
- a wider tolerance is declared by the manufacturer, in which case the tolerance shall be taken as this wider value.

If the equipment is intended only for connection to an a.c. mains equivalent source, such as a motor-driven generator or an uninterruptible power supply (see 1.2.8.1), or a source other than an AC MAINS SUPPLY, the tolerances on RATED VOLTAGE shall be declared by the manufacturer.

When testing equipment designed for d.c. only, the possible influence of polarity shall be taken into account.

1.4.6 Supply frequency for tests

In determining the most unfavourable frequency for the power to energize the EUT, different RATED FREQUENCIES within the RATED FREQUENCY RANGE shall be taken into account (e.g. 50 Hz and 60 Hz) but consideration of the tolerance on a RATED FREQUENCY (e.g. 50 Hz $\pm$ 0,5 Hz) is not normally necessary.

1.4.7 Electrical measuring instruments

Electrical measuring instruments shall have adequate bandwidth to provide accurate readings, taking into account all components (d.c., AC MAINS SUPPLY frequency, high frequency and harmonic content) of the parameter being measured. If the r.m.s. value is measured, care shall be taken that measuring instruments give true r.m.s. readings of non-sinusoidal waveforms as well as sinusoidal waveforms.

1.4.8 Normal operating voltages

For the assessment of voltages in ELV CIRCUITS, SELV CIRCUITS and TNV CIRCUITS:

- consideration shall be given both to normal operating voltages generated internally in the equipment and to those generated externally; and
- voltages other than normal operating voltages, such as earth potential rises and induced voltages from power lines and from electric traction lines, shall not be considered.

1.4.9 Measurement of voltage to earth

Where the standard specifies a voltage between a conductive part and earth, all of the following earthed parts are considered:

- the protective earthing terminal (if any); and
- any other conductive part required to be connected to protective earth (for example, see 2.6.1); and
- any conductive part that is earthed within the equipment for functional reasons.

Parts that will be earthed in the application by connection to other equipment, but are unearthed in the equipment as tested, shall be connected to earth at the point by which the highest voltage is obtained. When measuring a voltage between earth and a conductor in a circuit that will not be earthed in the intended application of the equipment, a non-inductive resistor of 5 000 $\Omega \pm 10 \%$ shall be connected across the voltage measuring instrument.

Voltage drop in the PROTECTIVE EARTHING CONDUCTOR of the power supply cord, or in an earthed conductor in other external wiring, is not included in the measurements.

1.4.10 Loading configuration of the EUT

In determining the input current, and where other test results could be affected, the following variables shall be considered and adjusted to give the most unfavourable results:

- loads due to optional features, offered or provided by the manufacturer for inclusion in or with the EUT;
- loads due to other units of equipment intended by the manufacturer to draw power from the EUT;
- loads which could be connected to any standard supply outlets in OPERATOR ACCESS AREAS on the equipment, up to the value indicated in the marking required by 1.7.5.

It is permitted to use artificial loads to simulate such loads during testing.

1.4.11 Power from a telecommunication network

For the purpose of this standard, the power available from a TELECOMMUNICATION NETWORK is considered to be limited to 15 VA.

1.4.12 Temperature measurement conditions

Where a maximum temperature ($T_{\max}$) or a maximum temperature rise ($\Delta T_{\max}$) is specified for compliance with tests, it is based on the assumption that the room ambient air temperature will be 25 °C when the equipment is operating. However, the manufacturer is permitted to specify a higher ambient air temperature.

It is not necessary to control the ambient temperature (T_{amb}) at a specific value during tests, but it shall be monitored and recorded.

Temperatures measured on the equipment shall conform to one of the following conditions, all temperatures being in °C.

If $T_{\max}$ is specified: $(T - T_{\text{amb}}) \leq (T_{\max} - T_{\text{mra}})$

If $\Delta T_{\max}$ is specified: $(T - T_{\text{amb}}) \leq (\Delta T_{\max} + 25 - T_{\text{mra}})$

where

T is the temperature of the given part measured under the prescribed test conditions;

T_{mra} is the maximum room ambient temperature permitted by the manufacturer's specification or 25 °C, whichever is greater.

During the test, the room ambient temperature should not exceed T_{mra} unless agreed by all parties involved.

1.4.13 Temperature measurement methods

Unless a particular method is specified, the temperatures of windings shall be determined either by the thermocouple method or by the resistance method (see annex E). The temperatures of parts other than windings shall be determined by the thermocouple method. Any other suitable method of temperature measurement which does not noticeably influence the thermal balance and which achieves an accuracy sufficient to show compliance is also permitted. The choice of and position of temperature sensors shall be made so that they have minimum effect on the temperature of the part under test.

1.4.14 Simulated faults and abnormal conditions

Where it is required to apply simulated faults or abnormal operating conditions, these shall be applied in turn and one at a time. Faults which are the direct consequence of a simulated fault or abnormal operating condition are considered to be part of that simulated fault or abnormal operating condition.

When applying simulated faults or abnormal operating conditions, parts, supplies, consumable materials, media and recording materials shall be in place if they are likely to have an effect on the outcome of the test.

Where there is a specific reference to a single fault, the single fault consists of a single failure of any insulation (excluding DOUBLE INSULATION or REINFORCED INSULATION) or a single failure of any component (excluding components with DOUBLE INSULATION or REINFORCED INSULATION).

The equipment, circuit diagrams and component specifications are examined to determine those fault conditions that might reasonably be expected to occur. Examples include:

- short circuits and open circuits of semiconductor devices and capacitors;
- faults causing continuous dissipation in resistors designed for intermittent dissipation;
- internal faults in integrated circuits causing excessive dissipation;
- failure of BASIC INSULATION between current-carrying parts of the PRIMARY CIRCUIT and
 - accessible conductive parts;
 - earthed conductive screens;
 - parts of SELV CIRCUITS;
 - parts of LIMITED CURRENT CIRCUITS.

1.5 Components

1.5.1 General

Where safety is involved, components shall comply either with the requirements of this standard or with the safety aspects of the relevant IEC component standards.

NOTE 1 – An IEC component standard is considered relevant only if the component in question clearly falls within its scope.

A component which is to be connected to an SELV CIRCUIT and also to an ELV CIRCUIT or to a part at HAZARDOUS VOLTAGE shall comply with the requirements of 2.2.

NOTE 2 – An example of such a component is a relay with different supplies connected to different elements (coils and contacts).

1.5.2 Evaluation and testing of components

Evaluation and testing of components shall be carried out as follows:

- *a component that has been demonstrated to comply with a standard harmonized with the relevant IEC component standard shall be checked for correct application and use in accordance with its rating. It shall be subjected to the applicable tests of this standard as part of the equipment with the exception of those tests which are part of the relevant IEC component standard;*
- *a component that has not been demonstrated to comply with a relevant standard as above shall be checked for correct application and use in accordance with its specified rating. It shall be subjected to the applicable tests of this standard, as part of the equipment, and to the applicable tests of the component standard, under the conditions occurring in the equipment;*

NOTE The applicable test for compliance with a component standard is, in general, carried out separately.

- *where no relevant IEC component standard exists, or where components are used in circuits not in accordance with their specified ratings, the components shall be tested under the conditions occurring in the equipment. The number of samples required for test is, in general, the same as required by an equivalent standard.*

1.5.3 Thermal controls

Thermal controls shall be tested in accordance with annex K.

1.5.4 Transformers

Transformers shall comply with the relevant requirements of this standard, including those of annex C.

1.5.5 Interconnecting cables

INTERCONNECTING CABLES provided as part of the equipment shall comply with the relevant requirements of this standard and shall not present a hazard in the meaning of this standard whether they are detachable or non-detachable.

1.5.6 Capacitors in primary circuits

A capacitor connected between two line conductors of the PRIMARY CIRCUIT, or between one line conductor and the neutral conductor, shall comply with IEC 60384-14:1993, subclass X1 or X2. The duration of the damp heat, steady state test as specified in 4.12 of IEC 60384-14:1993 shall be 21 days.

A capacitor connected between the PRIMARY CIRCUIT and protective earth shall comply with IEC 60384-14:1993, subclass Y1, Y2 or Y4, as applicable.

NOTE – The above requirement does not apply to capacitors connected from a HAZARDOUS VOLTAGE SECONDARY CIRCUIT to earth. For such capacitors, the electric strength test of 5.2.2 is considered sufficient.

Compliance is checked by inspection.

1.5.7 Double or reinforced insulation bridged by components

Compliance with 1.5.7.1 to 1.5.7.3 is checked by inspection and relevant tests.

1.5.7.1 Bridging capacitors

It is permitted to bridge DOUBLE or REINFORCED INSULATION by:

- a single capacitor complying with IEC 60384-14:1993, subclass Y1; or
- two capacitors in series, each complying with IEC 60384-14:1993, subclass Y2 or Y4.

A Y1 capacitor is considered to have REINFORCED INSULATION.

Where two capacitors are used in series, they shall each be rated for the total WORKING VOLTAGE across the pair and shall have the same nominal capacitance value.

1.5.7.2 Bridging resistors

It is permitted to bridge DOUBLE or REINFORCED INSULATION by two resistors in series. They shall each comply with the requirements of 2.10.3 and 2.10.4 between their terminations for the total WORKING VOLTAGE across the pair and shall have the same nominal resistance value.

1.5.7.3 Accessible parts

Where accessible conductive parts or circuits are separated from other parts by DOUBLE or REINFORCED INSULATION that is bridged by components in accordance with 1.5.7.1 or 1.5.7.2, the accessible parts shall comply with the requirements for LIMITED CURRENT CIRCUITS in 2.4. These requirements shall apply after electric strength testing of the insulation has been carried out.

1.5.8 Components in equipment for IT power systems

For equipment to be connected to IT power systems, components connected between line and earth shall be capable of withstanding the stress due to the line-to-line voltage. However, capacitors rated for the applicable line-to-neutral voltage are permitted in such applications if they comply with IEC 60384-14:1993, subclass Y1, Y2 or Y4.

NOTE 1 – The above capacitors are endurance tested at 1,7 times the voltage rating of the capacitor.

Compliance is checked by inspection.

1.6 Power interface

1.6.1 AC power distribution systems

AC power distribution systems are classified as TN, TT or IT (see annex V).

1.6.2 Input current

The steady state input current of the equipment shall not exceed the RATED CURRENT by more than 10 % under NORMAL LOAD.

Compliance is checked by measuring the input current of the equipment at NORMAL LOAD under the following conditions:

- *where an equipment has more than one RATED VOLTAGE, the input current is measured at each RATED VOLTAGE;*
- *where an equipment has one or more RATED VOLTAGE RANGES, the input current is measured at each end of each RATED VOLTAGE RANGE. Where a single value of RATED CURRENT is marked (see 1.7.1), it is compared with the higher value of input current measured in the associated voltage range. Where two values of RATED CURRENT are marked, separated by a hyphen, they are compared with the two values measured in the associated voltage range.*

In each case, the readings are taken when the input current has stabilized. If the current varies during the normal operating cycle, the steady-state current is taken as the mean indication of the value, measured on a recording r.m.s. ammeter, during a representative period.

1.6.3 Voltage limit of hand-held equipment

The RATED VOLTAGE of HAND-HELD EQUIPMENT shall not exceed 250 V.

Compliance is checked by inspection.

1.6.4 Neutral conductor

The neutral conductor, if any, shall be insulated from earth and from the BODY throughout the equipment as if it were a line conductor. Components connected between neutral and earth shall be rated for the line-to-neutral voltage.

Compliance is checked by inspection.

1.7 Markings and instructions

NOTE – Additional requirements for markings and instructions are contained in the following subclauses:

- 2.1.1.2 USER access within battery compartments
- 2.6.1 Unearthed parts in SERVICE ACCESS AREAS
- 2.7.1 Protection provided by the building installation
- 2.7.6 Neutral fusing
- 3.4.11 Multiple power sources
- 4.1 Equipment stability
- 4.3.3 Adjustable controls
- 4.3.5 Connection of plugs and sockets
- 4.4.2 Hazardous moving parts
- 4.6.2 Stationary equipment on non-combustible floors
- 5.1.7 TOUCH CURRENT exceeding 3,5 mA
- 5.1.8.2 Summation of TOUCH CURRENTS
- 6.1.2.2 Earthing of equipment connected to the TELECOMMUNICATION NETWORK

1.7.1 Power rating

Equipment shall be provided with a power rating marking, the purpose of which is to specify a supply of correct voltage and frequency, and of adequate current-carrying capacity.

If a unit is not provided with a means for direct connection to the AC MAINS SUPPLY, it need not be marked with any electrical rating, such as its RATED VOLTAGE, RATED CURRENT or RATED FREQUENCY.

For equipment intended to be installed by an OPERATOR, the marking shall be readily visible in an OPERATOR ACCESS AREA, including any area that is directly visible only after an OPERATOR has opened a door or cover. If a manual voltage selector is not OPERATOR-accessible, the marking shall indicate the RATED VOLTAGE for which the equipment is set during manufacture; a temporary marker is permitted for this purpose. Marking is permitted on any outer surface of the equipment, except the bottom of equipment having a mass exceeding 18 kg. Additionally, on STATIONARY EQUIPMENT, the marking shall be visible after the equipment has been installed as in normal use.

For equipment intended to be installed by SERVICE PERSONNEL, and if the marking is in a SERVICE ACCESS AREA, the location of the permanent marking shall be indicated in the installation instructions or on a readily visible marker on the equipment. It is permitted to use a temporary marker for this purpose.

The marking shall include the following:

- RATED VOLTAGE(S) or RATED VOLTAGE RANGE(S), in volts;
 - the voltage range shall have a hyphen (-) between the minimum and maximum RATED VOLTAGES. When multiple RATED VOLTAGES or RATED VOLTAGE RANGES are given, they shall be separated by a solidus (/).

NOTE 1 – Some examples of rated voltage markings are:

- RATED VOLTAGE RANGE: 220-240 V. This means that the equipment is designed to be connected to an AC MAINS SUPPLY having any voltage between 220 V and 240 V.
- Multiple RATED VOLTAGE: 120/230/240 V. This means that the equipment is designed to be connected to an AC MAINS SUPPLY having a voltage of 120 V or 230 V or 240 V, usually after internal adjustment.
- if equipment is to be connected to both of the line conductors and to the neutral conductor of a single-phase, 3-wire power system, the marking shall give the line-to-neutral voltage and the line-to-line voltage, separated by a solidus (/), with the added notation "Three wires plus protective earth", "3W + PE" or equivalent.

NOTE 2 – Some examples of the above system rating markings are:

120/240 V; 3 wire + PE

120/240 V; 3W +  (60417-1-IEC-5019)

100/200 V; 2W + N + PE

- symbol for nature of supply, for d.c. only;
- RATED FREQUENCY or RATED FREQUENCY RANGE, in hertz, unless the equipment is designed for d.c. only;
- RATED CURRENT, in milliamperes or amperes;
 - for equipment with multiple RATED VOLTAGES, the corresponding RATED CURRENTS shall be marked such that the different current ratings are separated by a solidus (/) and the relation between RATED VOLTAGE and associated RATED CURRENT appears distinctly;

- equipment with a RATED VOLTAGE RANGE shall be marked with either the maximum RATED CURRENT or with the current range;
- the marking for RATED CURRENT of a group of units having a single supply connection shall be placed on the unit which is directly connected to the AC MAINS SUPPLY. The RATED CURRENT marked on that unit shall be the total maximum current that can be on circuit at the same time and shall include the combined currents to all units in the group that can be supplied simultaneously through the unit and that can be operated simultaneously.

NOTE 3 – Some examples of RATED CURRENT markings are:

- for equipment with multiple RATED VOLTAGES;
120/240 V; 2,4/1,2 A
- for equipment with a RATED VOLTAGE RANGE.
100-240 V; 2,8 A
100-240 V; 2,8-1,1 A
100-120 V; 2,8 A
200-240 V; 1,4 A

It is recognized that in some regions it is customary to use a point (.) as a decimal marker instead of a comma.

- manufacturer's name or trade-mark or identification mark;
- manufacturer's model or type reference;
- symbol  60417-1-IEC-5172, for CLASS II EQUIPMENT only.

Additional markings are permitted, provided that they do not give rise to misunderstanding.

Where symbols are used, they shall conform to ISO 7000 or IEC 60417-1 where appropriate symbols exist.

1.7.2 Safety instructions

Sufficient information shall be provided to the USER concerning any condition necessary to ensure that, when used as prescribed by the manufacturer, the equipment is unlikely to present a hazard within the meaning of this standard.

If it is necessary to take special precautions to avoid the introduction of hazards when operating, installing, servicing, transporting or storing equipment, the necessary instructions shall be made available.

NOTE 1 – Special precautions may be necessary, for example for connection of the equipment to the supply and for the interconnection of separate units, if any.

NOTE 2 – Where appropriate, installation instructions should include reference to national wiring rules.

NOTE 3 – Servicing instructions are normally made available only to SERVICE PERSONNEL.

The operating instructions and, for PLUGGABLE EQUIPMENT intended for USER installation, also the installation instructions, shall be made available to the USER.