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Specification for Safety requirements for electronic measuring apparatus

[IEC title: Safety requirements for electronic measuring apparatus]

Spécification relative aux exigences de sécurité
pour les appareils de mesure électroniques

Spezifikation für die Sicherheitsbestimmungen
für elektronische Meßgeräte

British Standards Institution

National foreword

This British Standard is identical with IEC Publication 348 'Safety requirements for electronic measuring apparatus' (second edition) published in 1978 by the International Electrotechnical Commission (IEC). This British Standard is published under the direction of the Electronic Equipment Standards Committee and is a revision of BS 4743 first published in 1971 with the title 'Safety requirements for electronic measuring apparatus'.

Terminology and conventions. The text of the international standard has been approved as suitable for publication, without deviation, as a British Standard. Some terminology and certain conventions are not identical with those used in British Standards; attention is especially drawn to the following.

Wherever page numbers are quoted in connection with reference to figures or tables, they are IEC page numbers.

Wherever unit symbols appear in the test specification parts (*italic type*) of this standard they should be read as if printed in upright type.

Clause 1 of the international standard does not present the 'scope' as is customary for a British Standard. The main scope of the standard is described in subclause 1.2, entitled 'Object', i.e. to specify requirements for electronic measuring apparatus so as to ensure reasonable personal protection and protection of the surrounding area against damage and to specify the test methods for showing compliance with these requirements and the terminology used for dealing with safety matters.

NOTE. The safety of apparatus may also depend upon matching its design to the installations of the location where it is used.

The full titles of all IEC Publications referred to in the standard are given in appendix D. The corresponding British Standards are given below under the heading 'Cross-references'.

Cross-references

International standard*	Corresponding British Standard
IEC 68-2-6 : 1970	BS 2011 Basic environmental testing procedures Part 2.1 Fc : 1977 Test Fc. Vibration (sinusoidal) (Identical)
IEC 85 : 1957	BS 2757 : 1956 Classification of insulating materials for electrical machinery and apparatus on the basis of thermal stability in service (Technically equivalent)
IEC 108 : 1967	BS 2133A : 1966 (withdrawn, superseded by BS 9070 : Section 5 : 1971) Ceramic dielectric capacitors (Technically equivalent)
IEC 117	BS 3939 Graphical symbols for electrical power, telecommunications and electronics diagrams (published in Sections 1 to 28) (Technically equivalent)
IEC 127 : 1974	BS 4265 : 1977 Specification for cartridge fuse links for miniature fuses (Identical)
IEC 163-1 : 1968	BS 9562 : 1970 Microswitches (sensitive switches) of assessed quality : generic data and methods of test (Technically equivalent)
IEC 278 : 1968	BS 4308 : 1979 Specification for documentation to be supplied with electronic apparatus (Identical)
IEC 359 : 1971	BS 4889 : 1973 Method for specifying the performance of electronic measuring equipment (Technically equivalent)
IEC 414 : 1973	BS 5458 : 1977 Specification for safety requirements for indicating and recording electrical measuring instruments and their accessories (Identical)
IEC 601-1 : 1977	BS 5724 Safety of medical electrical equipment Part 1 : 1979 General requirements (Technically equivalent)

There are no British Standard equivalents for IEC 27, IEC 28, IEC 65, IEC 80, IEC 116, IEC 131, IEC 160, IEC 166, IEC 187, IEC 202, IEC 227, IEC 245, IEC 260, IEC 335-1, IEC 405, IEC 417, IEC 536.

The technical committee has reviewed their provisions, and has decided that they are acceptable for use in conjunction with this standard.

Related British Standards for IEC 27-1 and 27-2, IEC 202, IEC 227 and IEC 245, IEC 260, IEC 335-1 are BS 1991 : Part 6 and Supplement No. 1 to Part 6, BS 2401, BS 6500, BS 3718, BS 3456 : Part 101, respectively.

*Undated in the text.

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Note. — In this standard, the following print types are used:

- Requirements proper: in roman type.
- *Test specifications and headings: in italic type.*
- Explanatory matter: in smaller roman type.

British Standard Specification for

Safety requirements for electronic measuring apparatus

1. General

1.1 Scope

1.1.1 This standard applies to the following apparatus, whether or not designed for mains supply:

- electronic measuring apparatus;
- accessories used with electronic measuring apparatus, including auxiliary apparatus and supply apparatus;
- electronic accessories for non-electronic measuring instruments.

1.1.2 This standard applies to apparatus for indoor use.

The conditions for indoor use are specified by the Usage Group I of IEC Publication 359, the basic climatic conditions of which are:

- temperature from $+5^{\circ}\text{C}$ to $+40^{\circ}\text{C}$;
- altitude up to 2 200 m;
- relative humidity up to 80%.

These values indicate the conditions of safe operation of apparatus designed and tested in accordance with this standard. Such apparatus may occasionally be subjected to temperatures between $+5^{\circ}\text{C}$ and -10°C without degradation of their safety.

Requirements for apparatus to be used under the more severe environmental conditions of Usage Group II or III may be dealt with in the future.

For apparatus to be used in special areas, such as coal mines or aircraft, also to drip-proof or splash-proof apparatus, different or additional requirements may apply.

1.1.3 This standard does not apply to electronic measuring apparatus in medical diagnostic and therapeutic applications. The requirements for such apparatus are contained in IEC Publication 601-1: Safety of Medical Electrical Equipment, Part 1: General Requirements.

1.1.4 For electronic measuring apparatus used in connection with ionizing radiation, additional requirements are contained in IEC Publication 405.

1.1.5 This standard may not be appropriate for:

- a) some types of direct indicating instruments and some types of recording instruments, or parts of them, containing electronic devices (see Sub-clause 3.2);
- b) apparatus designed for a rated supply voltage exceeding:
 - 480 V (r.m.s.) between phases for apparatus for three-phase supply,
 - 250 V (r.m.s.) for all other apparatus;
- c) electronic apparatus whose measuring function is used exclusively for control purposes

1.1.6 This standard is concerned with safety only and not with the other properties of electronic measuring apparatus (see Clause 3).

1.1.7 Throughout this standard:

- a) the term "apparatus" is used to cover any apparatus or accessories specified in Sub-clause 1.1.1;
- b) the terms voltage and current indicate r.m.s. or d.c. values unless otherwise specified;
- c) reference should be made to Appendix D for the full titles of IEC publications.

1.2 Object

The object of this standard is:

- to specify requirements for electronic measuring apparatus so as to ensure reasonable personal protection and protection of the surrounding area against damage;
- to specify the test methods for showing compliance with these requirements;
- to specify the terminology used for dealing with safety matters.

The safety of apparatus may also depend upon matching its design to the installations of the location where it is used. For further explanations, see Appendix A.

2. Definitions

The following definitions apply for the purpose of this standard.

2.1 Apparatus

2.1.1 Electronic measuring apparatus

Apparatus which, by means of incorporated electronic devices, serves to measure or to observe quantities, or to supply electrical quantities for measuring purposes.

Electronic devices are parts or assemblies of parts which use electron or hole conduction in semiconductors, gases, or a vacuum.

2.1.2 Auxiliary apparatus

Apparatus which is used for measurement purposes but which is not itself measuring apparatus.

Examples: measuring amplifier, frequency divider.

2.1.3 Supply apparatus

Apparatus which takes energy from an electrical supply, in general from the supply mains, and supplies it, in a modified form, to one or more other apparatus.

2.1.4 Substitute power supply

Supply apparatus which may be used instead of the battery supply of an electronic measuring apparatus.

2.1.5 Fixed apparatus

Apparatus designed to remain permanently fixed to a supporting device, whether or not permanently wired.

2.1.6 *Portable apparatus*

Apparatus specifically designed to be carried easily by hand and weighing less than about 15 kg.

Apparatus designed to be permanently mounted in racks, or apparatus supplied with accessories for permanent mounting are not considered to be portable apparatus.

2.2 *Parts and accessories*

2.2.1 *Terminal device*

A part of the apparatus by which connection is made to external conductors or other apparatus; it may contain several terminal contacts.

2.2.2 *Measuring earth terminal*

A terminal directly connected to a point of a measuring or control circuit or to a screening part which is intended to be earthed for measurement purposes.

For other than measuring equipment, this terminal is often termed a "functional earth terminal".

2.2.3 *Protective earth terminal*

A terminal connected to conductive parts of an apparatus for safety purposes.

This terminal is intended to be connected to an external protective system.

As an equivalent to earthing, a connection to a protective circuit or the supply neutral is allowed in some countries.

2.2.4 *Thermal cut-out*

A device which prevents the maintenance of excessively high temperature in certain parts of the apparatus by disconnecting those parts from their supply.

2.2.5 *Safety switch*

A device which interrupts the supply before access is given to parts which are live.

2.2.6 *Remote control device*

A device for controlling an apparatus from a distance.

2.2.7 *Plug-in unit*

A removable part of an apparatus, connected by plug and socket connection, used to provide for a particular function or type of measurement.

2.3 *Electrical quantities*

2.3.1 *Rated value*

The value (or one of the values) of a quantity which occurs in the designation of the apparatus.

2.3.2 *Measuring circuit voltage*

The voltage either across two terminals of a measuring circuit or between one of these terminals and earth.

2.3.3 *Supply mains*

Any power source which is not used solely to supply equipment consisting of either one apparatus or a combination (e.g. in a rack) of several apparatus as specified in Sub-clause 1.1.1.

2.3.4 *Rated supply voltage*

The supply voltage (for three-phase supply, the line-to-line voltage) for which the manufacturer has designed the apparatus.

2.3.5 *Safety extra-low voltage (SELV)*

A voltage which does not exceed 50 V a.c. r.m.s. (see Note 1) between conductors, or between any conductor and earth, in circuit which is isolated from the supply mains by means such as a safety isolating transformer or converter with separate windings.

Notes 1. — The d.c. value is under consideration. The value of 50 V is known to be acceptable to some National Committees.

2. — The voltage limit should not be exceeded either at full load or no-load, but it is assumed, for the purpose of this definition, that any transformer or converter is operated at its rated supply voltage.

2.3.6 *Nominal circuit voltage (circuit insulation voltage)*

The highest voltage with respect to earth which may be applied to a circuit(s) of the instrument so that the instrument is unlikely to become dangerous to touch.

This is the voltage for which the instrument has been constructed from the point of view of insulation.

2.3.7 *Substantially sinusoidal waveform*

A waveform with a distortion factor not exceeding 5%.

2.4 *Constructional terms*

2.4.1 *Clearance*

The shortest distance, measured in air, between conductive parts.

2.4.2 *Creepage distance*

The shortest distance, measured over the surface of insulation, between conductive parts.

2.4.3 *By hand*

Denotes that an operation does not require the use of a tool, coin or any other object.

2.5 *Tests*

2.5.1 The *type test* of apparatus is the complete series of tests to be carried out on a number of specimens representative of the type, with the object of determining whether a particular manufacturer can be considered able to produce apparatus meeting this standard.

2.5.2 *Routine tests* are those tests which are carried out on all units of the same consignment.

2.6 *Safety terms*

2.6.1 *Accessible part*

A part which can be touched by a standard test finger (see Sub-clause 9.1).

Any accessible area of a non-conducting part is considered as being covered with a conductive layer (see Sub-clause 9.5.4a)).

2.6.2 *Live part*

A part, contact with which may cause a significant electric shock.

The significance of the shock is determined by the limits specified in Sub-clause 9.2.

2.6.3 *Part directly connected to the supply mains*

A part of an apparatus which is in electrical connection with the supply mains in such a way that a current equal to or greater than 9 A would flow through a connection if it were made between the part and either pole of the supply mains, while the apparatus is not connected to earth.

A current of 9 A is chosen as the minimum rupturing current of a 6 A fuse.

In tests to determine which parts are directly connected to the supply mains, fuses in the apparatus are not short-circuited. Therefore, if a part is connected to the supply mains through an incorporated fuse having a rating of less than 6 A, then that part is not considered to be directly connected to the supply mains.

2.6.4 *Conductively connected parts*

2.6.4.1 *Part conductively connected to the supply mains*

A part of an apparatus is considered to be conductively connected to the supply mains if a current greater than 0.7 mA (peak) flows in a resistor of 2 k Ω when such a resistor is connected between that part and any one supply circuit terminal, while the apparatus is not connected to earth.

2.6.4.2 *Part conductively connected to a measuring or control circuit*

A part of an apparatus is considered to be conductively connected to a measuring or control circuit if a current greater than 0.7 mA (peak) flows in a resistor of 2 k Ω when such a resistor is connected between that part and any one measuring or control circuit terminal, while the apparatus is not connected to earth.

Equality of potential of the earth points of a measuring or control circuit and the part under investigation is not deemed sufficient to establish conductive connection for the purpose of this definition.

2.6.5 *Functional insulation*

Insulation necessary for the proper functioning of equipment and for basic protection against electric shock.

2.6.6 *Supplementary insulation (protective insulation)*

Independent insulation provided in addition to the functional insulation in order to ensure protection against electric shock in the case of failure of the functional insulation.

2.6.7 *Double insulation*

Insulation comprising both functional insulation and supplementary insulation.

2.6.8 *Reinforced insulation*

Improved functional insulation with mechanical and electrical qualities providing the same degree of protection against electric shock as double insulation.

2.6.9 *Protective impedance*

Impedance having a value high enough to ensure protection against electric shock under conditions of normal and abnormal use, and having a reliability comparable to that of supplementary insulation or reinforced insulation.

Apparatus with double or reinforced insulation is provided with two safety barriers by its design. For apparatus using protective impedance the component parts or assemblies concerned are to be tested in respect of their reliability (see Clause 14).

2.6.10 *Safety Class I apparatus*

Apparatus having at least functional insulation throughout and provided with a terminal or contact for protective earthing and, with apparatus designed for mains supply connected by means of a flexible cable or cord, provided with either an appliance inlet with earthing contact or a non-detachable flexible cable or cord with protective earthing conductor and a plug with earthing contact.

2.6.11 *Safety Class II apparatus*

Apparatus without provision for protective earthing, but with one of the provisions *a)* or *b)* below.

a) Double insulation and/or reinforced insulation throughout, such apparatus being of one of the following types:

- 1) Apparatus having a durable and substantially continuous enclosure of insulating material which envelops all conductive parts, with the exception of small parts such as name plates, screws and rivets, which are isolated from live parts by insulation at least equivalent to reinforced insulation; such apparatus is called *insulation-encased Safety Class II apparatus*.

The enclosure of insulation-encased Safety Class II apparatus may form a part or the whole of the supplementary or of the reinforced insulation.

- 2) Apparatus having a substantially continuous metal enclosure, in which double insulation is used throughout, except for those parts where reinforced insulation is used because the application of double insulation is manifestly impracticable; such apparatus is called *metal-encased Safety Class II apparatus*.

- 3) Apparatus which is a combination of the types described in Items 1) and 2) above.

b) Double and/or reinforced insulation as far as practicable and, where this is not practicable, protective impedance between accessible conductive parts or lightly insulated circuits, and parts of the supply circuit and other live parts which might result in the risk of electric shock in the event of a failure.

The provision of protective impedance applies only to those types of apparatus whose performance requirements preclude the application of Safety Class I design.

If apparatus with one of the provisions *a)* or *b)* above has a terminal or a contact for protective earthing, it is considered to be of Safety Class I construction, even if the design otherwise complies with the principles applicable to Safety Class II apparatus.

2.6.12 *Safety Class III apparatus*

Apparatus in which protection against electric shock relies on supply at safety extra-low voltage (SELV) and in which voltages higher than those of SELV are not generated.

3. General requirements

3.1 *Basic purpose of this standard*

The apparatus shall be so designed and constructed as to present no danger, either in normal use or under fault conditions, providing particularly:

- personal protection against electric shock;
- personal protection against the effects of excessive temperature;
- personal protection against the effects of harmful ionizing and microwave radiation, of liberation of poisonous gases, and of ultrasonic pressure;
- personal protection against the effects of implosion and explosion;
- protection against spread of fire.

In general, compliance is checked by carrying out all the tests indicated under reference test conditions and under fault conditions, as they may occur in practical use and as specified in Sub-clauses 4.2 and 4.3.

As all electronic measuring apparatus are likely to be used in electrically hazardous locations, Safety Class 0 apparatus cannot be deemed to provide sufficient protection and is deprecated in the sense of this standard (see Appendix A, Sub-clauses A1.2 and A2.1).

This standard specifies requirements imposed on the apparatus so as to ensure protection against particular dangers. Attention is drawn to the fact that it will not cover some dangers which might result from the handling of the apparatus, especially not dangers which might arise from the transport of heavy apparatus, defective wall fastenings, fatigue of the operator, etc. However, the apparatus should be designed to protect from, or to reduce, these dangers as far as possible, and the relevant specifications for the protection of workers should be considered.

3.2 *Exemptions from this standard*

As a general rule, measuring apparatus containing electronic devices shall comply with this standard.

As an alternative, some types of direct indicating instruments and some types of recording instruments, or parts of them, may at the choice of the manufacturer be designed in accordance with IEC Publication 414, provided that the choice is clearly stated and that, in respect of their performance and accuracy, these instruments comply also with the "relevant publications" specified in the scope of that publication.

This applies to instruments of one of the designs, specified in Sub-clauses 3.2.1 to 3.2.3 and to parts specified in Sub-clause 3.2.4.

3.2.1 Instruments neither having an incorporated supply source nor needing an external supply source.

The electronic devices of these instruments are energized by the measured quantity, and will in some cases be used for the overload protection of the moving element.

3.2.2 Instruments having an incorporated supply source, in general a battery, provided that the electronic devices are used for processing the indicated or recorded value only, and that the voltage of the source, and any voltage generated from that source, does not exceed the limits of extra-low voltage.

An external supply source is allowed when the nominal circuit voltage (circuit insulation voltage) of the measuring circuit does not exceed the limits of extra-low voltage.

3.2.3 Instruments in which the electronic device is used solely to supply an auxiliary voltage, for example in ohmmeters, provided that the voltage of the source does not exceed the limits of extra-low voltage. The voltage generated from that source may exceed these limits provided that the maximum current output at the measuring terminals is limited to 5 mA a.c., 10 mA d.c. or, for a combined current, 10 mA peak value.

These instruments may have an incorporated supply source or may be fed by an external source.

3.2.4 Those parts of an instrument which do not contain any electronic device and are permanently and substantially separated from the parts which contain electronic devices.

Requirements concerning the separation are contained in IEC Publication 414.

4. General indications regarding tests

4.1 *Conduct of tests*

4.1.1 *Tests specified in this standard are type tests, unless otherwise indicated.*

Where routine tests are specified, they constitute the minimum requirement.

If this standard requires that tests on components or parts of apparatus are to be made in accordance with their relevant specifications, such tests need not necessarily be performed during the type test of the apparatus laid down in this standard.

4.1.2 *Tests shall be carried out on one and the same apparatus in the order of the clauses, as far as this is possible.*

When dimensions or mass make it impossible to carry out particular tests on a whole apparatus, separate performance of these tests on each of its assemblies is allowed.

4.2 *Reference test conditions (reference conditions for test purposes)*

Unless otherwise specified, the following conditions shall prevail in the test location (see IEC Publication 160):

- *temperature not outside the range of 15 °C to 35 °C;*
- *relative humidity not outside the range of 45% to 75%;*
- *air pressure not outside the range of 86 kPa to 106 kPa (860 mbar to 1 060 mbar);*
- *without hoar-frost, dew, percolating water, rain, solar irradiation and the like.*

The apparatus is expected to remain safe after having been stored or transported under the conditions indicated by the manufacturer. In case of doubt, testing under the present reference test conditions may be useful.

Tests shall be carried out under the most unfavourable combination of the following conditions:

4.2.1 *Any position of normal use of the apparatus, normal ventilation not impeded, and the apparatus mounted in accordance with the manufacturer's instructions.*

4.2.2 *A supply voltage between 0.9 times and 1.1 times any rated supply voltage for which the apparatus can be set.*

- *Any rated frequency of the supply voltage.*
- *For a.c./d.c. apparatus, a.c. or d.c. supply.*
- *For apparatus for d.c. or single-phase supply, line and neutral either connected normally (or at random) or interchanged.*

4.2.3 *Any voltage, except the supply voltage, between zero and the rated input voltage, if not otherwise indicated by the manufacturer.*

For floating inputs and outputs, any potential between zero and the maximum rated floating voltage.

4.2.4 *Any position of the controls which are accessible to the user for adjustment by hand, except voltage setting devices complying with Sub-clause 13.8.*

Any remote control device connected or not.

4.2.5 *Protective earth terminals, if any, connected to earth. Measuring earth terminals connected to earth or not.*

4.2.6 *The apparatus being used for its intended measuring purpose, or not connected for any use whatsoever.*

4.2.7 *For motor-driven parts of the apparatus, load conditions in accordance with the intended purpose.*

When testing motor-driven parts, other parts of the apparatus which are intended to operate at the same time are not disconnected.

4.2.8 *In addition, for apparatus supplying electrical quantities for measuring purposes:*

- *the apparatus operated in such a way as to provide the rated output power to the rated load impedance;*
- *the rated load impedance of any output circuit connected or not.*

4.2.9 In addition, for substitute power supply and apparatus operated together with substitute power supply:

- substitute power supply connected to the load specified by the manufacturer or not loaded.
- substitute power supply having the dimensions specified for a standard battery or an assembly of such batteries are tested in a battery compartment of the most unfavourable design.
- substitute power supply to be used inside apparatus are tested within such apparatus, for which they are intended, in accordance with the manufacturer's instructions.
- substitute power supply connected to the most unfavourable load, including short circuit.

4.3 Fault conditions

Testing under fault conditions denotes that, in addition to the reference test conditions mentioned in Sub-clause 4.2, the breakdown of particular components or insulations is simulated one after the other. Testing under fault conditions is described in Clause 10.

5. Marking

The apparatus shall be marked as follows:

5.1 General

5.1.1 The marking shall be:

- easily discernible on the apparatus when ready for use, in such a way that there can be no misunderstanding;
- indelible and legible.

Compliance is checked by inspection and by the following test.

The marking shall not be removed when rubbed lightly with a piece of cloth soaked with either petroleum spirit or water.

The information should preferably be put on the exterior of the apparatus, excluding the bottom. It is, however, permissible to put it in another place that is easily accessible, e.g. under the lid or on the exterior of the bottom of a small and light apparatus, provided that location of the marking is given in the instruction manual.

Marking which applies to interior parts only is always placed adjacent to these parts.

5.1.2 Letter symbols for quantities and units shall be in accordance with IEC Publication 27.

Graphical symbols shall be in accordance with IEC Publications 417 or 117.

Fuse-holders shall be marked in accordance with Sub-clause 13.6.2.

Compliance is checked by inspection.

5.2 Identification

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

- manufacturer's name or registered trade-mark;
- model number or name.

Compliance is checked by inspection.

5.3 Warning symbols

- a) If, to preserve the apparatus from damage, it is necessary for the user to refer to the instruction manual, the apparatus shall be marked with the symbol:



The symbol shall be placed adjacent to the device to which it applies.

Marking with this symbol does not exempt the apparatus from any requirement contained in this standard.

- b) Apparatus containing radioactive sources shall be marked in accordance with relevant specifications, for example by the international radiation symbol and the prescribed additional markings.

For details, reference is made to IEC Publication 405.

- c) Apparatus containing laser sources shall be marked in accordance with relevant specifications.
- d) Apparatus containing toxic substances shall be marked with a suitable warning notice.
Compliance is checked by inspection.

5.4 Mains supply

The apparatus shall be marked with the following information:

- a) Nature of supply:

— a.c. only: rated mains frequency (or range of frequencies);

— d.c. only: with the symbol — or ===.

- b) Rated supply voltage (or range of voltages) that can be applied without the adjustment of a voltage setting device.

For apparatus having a consumption of 25 VA or more:

— the maximum rated consumption or input current.

For information purposes, it may be useful:

- to mark a.c. apparatus with the symbol
- to mark apparatus suitable for both a.c. and d.c. with the symbol
- to give the maximum consumption or input current if the consumption is less than 25 VA.

- c) Apparatus which can be set to different rated supply voltages shall be so constructed that the indication of the voltage to which the apparatus is set is discernible on the apparatus when ready for use. If the apparatus is so constructed that the user can alter the supply voltage setting by hand, the action of changing the setting shall also change the indication.

If the apparatus is provided with more than one voltage setting device, it shall be clear whether all devices shall be set to the same voltage.

- d) If there is a socket-outlet to provide power to other equipment, the voltage (if different from the supply voltage) and the power or current which may be drawn.

Compliance with Items a) to d) is checked by inspection.

- e) If the power consumption is indicated, the actual consumption of the apparatus shall not exceed the marked value by more than 10%.

Compliance is checked by a test under reference test conditions, except that the apparatus is connected to its rated supply voltage.

- f) If a substitute power supply is to be used exclusively outside apparatus, this restriction in use shall be clearly indicated.

Compliance is checked by inspection.

Marking with a symbol is under consideration.

5.5 Terminal and operating devices

All terminals and operating devices shall be identified by inscriptions or symbols making clear, if possible, the intended purpose of the terminal or device, and corresponding to the relevant explanation in the instruction manual.

Such inscriptions and symbols may, if necessary for operating devices, also indicate the sequence of operations or the direction of movements to be followed.

The following terminals and devices shall be marked in particular:

- a) Earth terminals with the symbol .

If the use of this symbol for the protective earth terminal is not permitted by a national standard it may be modified, for example, by being placed inside a circle.

The symbol shall be placed adjacent to or on the terminal, but not on removable parts such as screws.

The marking may, depending on national rules, not be required when the protective earth terminal is a part of an approved mains connector.

- b) Terminals of measuring and control circuits connected to accessible conductive parts under the provisions of Sub-clause 9.5.9 and whose connection is not self-evident, with the symbol .

- c) Terminal devices, either input or output, which may be at live voltages exceeding 1 kV, shall be marked with the flash shown, thus indicating that connecting to or disconnecting from those devices may be dangerous. .

The flash shall be red and be placed adjacent to the terminal device.

This is — as an additional warning to the user — a particular application of the symbol since a higher voltage is assigned here to the flash than is generally applicable.

- d) The on-position or the off-position of the on/off switch, if any, shall be clearly marked. A signal lamp alone is not deemed to be sufficient.

- e) Floating inputs and outputs with their maximum rated floating voltage, if this voltage exceeds the limits of extra-low voltage.

For floating voltages exceeding 1 kV and for other terminal devices the voltage of which may rise above 1 kV due to such floating voltage, see Sub-clause 5.5c).

Compliance is checked by inspection.

5.6 Safety Class II apparatus shall be marked with the symbol .

The symbol shall be placed adjacent to, or on the supply information plate.

Apparatus which has only partial additional insulation or which is provided with a protective earth terminal shall not bear this symbol.

Compliance is checked by inspection.

Apparatus of Safety Classes I and III is immediately recognizable by its construction, and carries no safety-class symbol.

6. Hazards from emanations

The apparatus shall be so constructed that personal protection is provided against the harmful effects of radiation, of liberation of poisonous gases, and of ultrasonic pressure.

6.1 Ionizing radiation

The exposure-rate at any readily accessible point 5 cm from the outer surface shall not exceed 36 pA/kg (0.5 mR/h) under reference test conditions.

Compliance is checked by measuring the amount of radiation. The method of determining the amount of radiation shall be effective in broad and narrow beams and over the range of possible radiation energies.

In general, this applies to apparatus in which electrons are accelerated by voltages exceeding 5 kV.

The requirement does not refer to apparatus containing radioactive substances (see Sub-clause 1.1.4).

The apparatus shall be so constructed that compartments in which electrons are accelerated by voltages exceeding 5 kV cannot be opened by hand.

Compliance is checked by inspection.

6.2 Micro-wave radiation

The intensity of micro-wave radiation at all points in the vicinity of the apparatus shall not exceed 10 W/m² under reference test conditions.

This requirement applies to spurious radiation at frequencies between 10 MHz and 100 GHz. It does not apply to parts of the apparatus where micro-wave radiation is propagated intentionally, e.g. at wave guide output ports.

Compliance tests are under consideration.

6.3 Laser radiation

Under consideration.

6.4 Poisonous and injurious gases

The apparatus shall not liberate dangerous amounts of poisonous or injurious gases under reference test conditions and under fault conditions.

Due to the wide variety of such gases, no compliance tests are specified in this standard. A recommended limit for the ozone contents of the air surrounding the apparatus is 0.10 ppm (parts per million by volume).

6.5 Ultrasonic pressure

The ultrasonic pressure at all points in the vicinity of the apparatus likely to be occupied by personnel operating the equipment shall not exceed specified limits under reference test conditions.

A preliminary limit is 110 dB above the reference level of 10⁻¹² W/m², applicable to frequencies between 20 kHz and 100 kHz. The inclusion of the audible range is under consideration.

Compliance is checked by measuring the pressure.

7. Heating

7.1 General

The apparatus shall operate safely under normal operating conditions.

The heating shall not cause fire or deformation, and no danger to the operator touching accessible parts.

Compliance is checked by performing the tests prescribed in Sub-clauses 7.2 to 7.4.

For apparatus having special operating conditions, such as short-term or intermittent use, this standard applies as far as compatible with these special operating conditions. A reference to the permissible operating conditions shall then be given by marking the apparatus.

For normal use, no marking is required.

TABLE I
Permissible temperature rise

Parts of the apparatus	Permissible temperature rise (°C)	
	Reference test conditions	Fault conditions of Clause 10
	I	II
External parts:		
Outer surface of enclosures ^{1) 2)}	35	65
Metallic knobs, handles, etc.	20	65
Non-metallic knobs, handles, etc. ²⁾	30	65
Inside surface of enclosures of:		
— wood	70	90
— insulating material	(See ³⁾)	(See ³⁾)
Mains transformers	(See ²⁾)	—
Thermoplastic materials used as insulation	(See ⁴⁾)	—
Other parts	(See ²⁾)	—

¹⁾ For small areas and for easily discernible heat sinks, not likely to be touched in normal use, a maximum increase of 65 °C is allowed under reference test conditions.

²⁾ The temperature rise for a given insulating material is limited to that specified in IEC Publication 85.

³⁾ The permissible temperature rises for the inside of enclosures of insulating material are those indicated for the relevant materials.

⁴⁾ Due to their wide variety, it is not possible to specify permissible temperature rises for thermoplastic materials. While the matter is under consideration, the following method is suggested:

a) An arbitrary softening temperature of the material shall be determined on a separate sample by a Vicat test:

- cross-section of penetrating needle: 1 mm²;
- load: 10 N;
- heating rate: 50 °C/h.

The softening temperature is that for which the depth of penetration is 0.1 mm.

b) The temperature limits to be considered for determining the temperature rises are:

- under reference test conditions, a temperature 10 °C lower than the softening temperature;
- under fault conditions, the softening temperature.

7.2 Permissible temperatures

Compliance with the permissible temperature limits is checked by measuring the temperature under reference test conditions when a steady state has been attained.

In general, a steady state is assumed to be attained after 4 h operation.

Temperatures shall be determined:

— *for windings, by the resistance method (for copper, see IEC Publication 28);*

— *for other parts, by any suitable method.*

Temperature rises shall not exceed the values given in the first column of Table I.

The values of the temperature rises are based upon a maximum ambient temperature of 40 °C, but the measurements are made under reference test conditions.

7.3 Preservation of insulation

Neither the insulation resistance nor the creepage distances and clearances shall be reduced inadmissibly when the apparatus is operated at elevated temperatures.

Compliance is checked under reference test conditions with the exception that the ambient temperature shall be 40 °C.

The duration of the test is 4 h, starting from the moment of switching on.

This test is only to be carried out in case of doubt, i.e. if the apparatus produces an appreciable amount of heat.

An apparatus which is not designed for continuous operation shall be operated at its specified conditions of operation in such a manner that the greatest possible heating occurs.

After the test, the apparatus shall show no damage in the sense of this standard and shall withstand the tests specified in Clause 9.

7.4 Mechanical strength at elevated temperatures

The enclosure of the apparatus shall be sufficiently resistant to external forces at elevated temperatures.

Compliance is checked at the maximum temperature attained during the test under Sub-clause 7.3.

In case of doubt, the rigid test finger of Figure 1, page 110, is applied to different points of the surface with a force of 30 N directed inwards for 10 s each.

The force shall be exerted by the tip of the test finger so as to avoid wedge and lever action.

After the test, the apparatus shall show no damage in the sense of this standard and shall withstand the tests specified in Clause 9.

8. Implosion and explosion

8.1 Implosion

Cathode-ray tubes or other display devices used in measuring apparatus with a maximum face dimension exceeding 16 cm either shall be intrinsically safe with respect to effects of implosion and to mechanical impact, or the enclosure of the apparatus shall provide adequate protection against the effects of an implosion of the tube.