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Specification for

Safety requirements for indicating and recording electrical measuring instruments and their accessories

Spécification des règles de sécurité pour les appareils de
mesure électriques indicateurs et enregistreurs et leurs accessoires

Spezifikation für sicherheitstechnische Anforderungen an elektrische Meßgeräte
zur Anzeige und Aufzeichnung und deren Zubehör

Foreword

This British Standard has been prepared under the authority of the Power Electrical Engineering Standards Committee. It is identical with Publication 414 'Safety requirements for indicating and recording electrical measuring instruments and their accessories' published by the International Electrotechnical Commission.

Terminology and conventions. The text of the IEC Publication has been accepted as suitable for publication, without deviation, as a British Standard. Certain terminology and conventions are used, however, that are not strictly appropriate in a British Standard, and attention is therefore drawn to the following.

Wherever the word 'recommendation', relating to this publication, appears, it should be interpreted as 'British Standard'.

The comma has been used throughout as a decimal marker. In British Standards it is current practice to use a full point (full stop on the baseline) as the decimal marker.

Cross references. For each of the following references to other international publications that are given in the text, there is an appropriate British Standard; these are listed below.

Reference to Publication

CEE Publication 15 'Specification for safety isolating transformers'

IEC Publication 160 'Standard atmospheric conditions for test purposes'

ISO 306 'Determination of the Vicat softening temperature of thermoplastics'

IEC Publication 348 'Safety requirements for electronic measuring apparatus'

Appropriate British Standard

BS 3535 'Safety isolating transformers for industrial and domestic purposes'

No direct equivalent British Standard but reference may be made to BS 2011 'Methods for the environmental testing of electronic components and electronic equipment Part 1 'General', for standard atmospheric conditions for testing.

BS 2782 'Methods of testing plastics': Method 102J

BS 4743 'Safety requirements of electronic measuring apparatus'

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

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

SAFETY REQUIREMENTS FOR INDICATING AND RECORDING ELECTRICAL MEASURING INSTRUMENTS AND THEIR ACCESSORIES

1. Scope

1.1 This recommendation applies to the following electrical and electrically operated measuring instruments:

- direct acting indicating instruments,
- direct acting recording instruments,
- indirect acting instruments,
- certain accessories used with these instruments.

These instruments and accessories are or will be the subject of particular publications of the IEC, hereinafter referred to as "Relevant Publications". They contain or will contain lists of these instruments and accessories, which determine the scope of this recommendation.

1.2 This recommendation applies also to indicating and recording instruments containing electronic devices as specified in Part D.

1.3 This recommendation does not contain special requirements for instruments for use in particular environmental conditions, e.g.:

- weather-proof instruments;
- explosion-proof instruments;
- shock-proof instruments;
- vibration-proof instruments;
- intrinsically safe instruments;
- instruments for medical application.

Different or additional requirements may apply to these instruments.

1.4 This recommendation is concerned only with safety and not with the other requirements of indicating and recording instruments. It supersedes any safety requirements contained in the Relevant Publications.

1.5 Throughout this recommendation:

- a) The term "instrument" is used to cover indicating and recording instruments and their accessories as listed in Sub-clause 1.1;
- b) The terms voltage and current indicate r.m.s. or d.c. values unless otherwise specified.

1.6 This recommendation specifies requirements for indicating and recording instruments and their accessories so as to ensure reasonable personal protection and protection against damage to the surrounding area; specifies the tests for showing compliance with these requirements; specifies the terminology used for dealing with safety matters.

The safety of the instrument may also depend upon matching its design to the installation where it is used.

2. Definitions

The following definitions apply for the purpose of this recommendation.

Definitions for instruments with double or reinforced insulation are given in Part E, Sub-clause 14.1.

Further terms, which are also used to describe properties, other than safety, of instruments have also been used in this recommendation. The definitions of these terms are contained in the Relevant Publications (see Sub-clause 1.1).

2.1 Instruments

2.1.1 Fixed instrument

An instrument designed to be permanently mounted on a support and which is intended to be connected to an external circuit(s) by means of permanently installed leads.

2.1.2 Portable instrument

An instrument specifically designed to be easily carried by hand.

The instrument is intended to be connected and disconnected easily by the user.

2.1.3 Electronic device

A part or an assembly of parts which uses electron or hole conduction in semiconductors, gases or in vacuum.

2.1.4 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.

2.1.5 Protective earth terminal

A terminal connected to specified conductive parts of an instrument for safety purposes, to be connected to an external protective system.

2.2 Circuit terms

2.2.1 Supply mains

Any power source which is not used solely to supply one instrument.

This definition does not relate to the measured quantity but to the supply mains when it is used to energize auxiliary circuits of the instrument.

2.2.2 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. (For explanations, see Appendix.)

2.2.3 Safety extra-low voltage

A nominal voltage not exceeding 42 V between conductors, or, for three-phase circuits, not exceeding 24 V between conductors and neutral.

When safety extra-low voltage is obtained from a supply mains of higher voltage, a safety (isolating) transformer or a convertor with separate windings is used. (See CEE Publication 15.) The voltage limits are then based on the assumption that the safety transformer is supplied at its rated voltage.

The IEC has under consideration the values of the upper limits of extra-low voltage. Until the final decision has been taken, values between 42 V and 50 V specified in National Standards may be used.

2.2.3.1 *Extra-low voltage*

A voltage generally having the same limits as safety extra-low voltage but without any restriction on the method of obtaining it.

2.3 *Constructional terms*

2.3.1 *Clearance*

The shortest distance measured in air between conductive parts.

2.3.2 *Creepage distance*

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

2.3.3 *By hand*

An operation which does not require the use of a tool, coin or any other object.

2.4 *Safety terms*

2.4.1 *Accessible part of an instrument*

A part which can be touched by the standard test finger (see Figures 1a and 1b, page 48) when the instrument is ready for use.

“Ready for use” for a fixed instrument denotes that it is appropriately mounted on its support. Therefore, fixed instruments are characterized by the fact that one part of the instrument may be accessible when ready for use, while the other part is inaccessible.

2.4.2 *Instrument without accessible conductive parts*

An instrument in which all parts other than terminals, that are accessible when the instrument is ready for use, are made of insulating material, except minor parts such as name plates, screws or rivets which are isolated from measuring and/or auxiliary circuits (see Sub-clause 6.1.1).

2.4.3 *Instrument with accessible conductive parts*

An instrument in which conductive parts are accessible when the instrument is ready for use.

Small parts, such as name plates, screws or rivets, which are isolated from measuring and/or auxiliary circuits, and also terminals are not considered to be accessible conductive parts (see Sub-clause 6.1.1).

2.4.4 *Live part*

A part, contact with which may cause a significant electric shock (see Sub-clause 6.1.2).

2.4.5 *Inactive part*

A part which is capable of carrying voltage or current but is not so used during correct operation of the instrument.

2.4.6 *Unsafe temperature*

A temperature likely to cause burns and/or which may cause the operator to perform an involuntary dangerous movement.

3. General requirements and test procedure

3.1 General requirements

The instrument shall be so designed and constructed as not to present danger either in normal use or under specified overload conditions and especially to ensure personal safety against:

- electric shock,
- unsafe temperature,
- spread of fire.

3.2 General test conditions

3.2.1 Compliance with the requirements shall be checked by carrying out all the tests specified.

Whenever particular tests are indicated in more than one of the following clauses, this does not necessarily imply that the test shall be carried out more than once.

3.2.2 The tests are type tests unless otherwise specified. A type test once carried out successfully on a particular type of instrument may be held to be valid for other instruments of the same design, having different measuring ranges. The type test shall be carried out on an instrument having the measuring range which is the most liable to fail of that design of instrument.

3.2.3 The tests specified in the following clauses shall be carried out on unused instruments in the condition as supplied.

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

- ambient temperature between 15 °C to 35 °C
- relative humidity not outside the range of 45% to 75%
- air pressure between 86 kN/m² to 106 kN/m² (860 mbar to 1 060 mbar)
- without dew, hoar-frost, percolating water, rain, solar irradiation, etc.

3.2.5 Tests shall be carried out on the complete instruments, i.e. with case and covers in position and the necessary accessories appropriately connected.

When an instrument has non-interchangeable accessories, they shall be connected to the instrument in the normal manner of use, and the tests shall be carried out on the combination. Interchangeable accessories and accessories of limited interchangeability shall be subjected to separate tests relating to their own characteristics.

PART A — COMMON SAFETY REQUIREMENTS FOR ALL INSTRUMENTS

The requirements of this Part apply to all instruments within the scope of this recommendation.

4. Marking

4.1 General

In respect of safety, the instrument shall be marked according to Sub-clauses 4.2 to 4.4.

The marking on the instrument shall be easily discernible, legible and indelible.

The information shall be shown on the scale plate or on the exterior surface of the instrument. Marking according to Sub-clause 4.3 shall be visible when the instrument is ready for use.

Compliance is checked by inspection as a routine test.

4.2 *Nominal circuit voltage (circuit insulation voltage) and corresponding test voltage of the measuring circuits*

The test voltage corresponding to each nominal circuit voltage (circuit insulation voltage) is given in Table II, page 27.

The value of the test voltage shall be marked on the instrument, inside a star, in accordance with Table II. In the absence of such a number inside the star, the test voltage is 0.5 kV. The figure "0" within the star indicates that no voltage test is to be carried out.

Symbols C-1 to C-3 of Table IV, page 43, shall be used.

4.3 *Warning symbols*

Warning symbols shall be discernible on the instrument when ready for use and shall contrast well with the background.

4.3.1 If, to ensure that there is no danger to the instrument in use, it is necessary for the user to refer to the instruction manual, the instrument shall be marked with Symbol F-33 of Table IV.

Marking with this symbol does not exempt the instrument from any safety requirements contained in this recommendation.

4.3.2 When it is known that the instrument may be dangerous to touch when in use, because the voltage to earth of the measuring circuit is greater than the nominal circuit voltage (circuit insulation voltage) of the instrument, the instrument shall be marked with the symbol of the high voltage flash (Symbol C-4 of Table IV).

The colour of the symbol shall be non-fading, contrasting and preferably red.

Caution should be used when handling such an instrument, and with fixed instruments, particular care should be taken in their installation so as to ensure safety.

4.3.2.1 Instruments shall be subjected to a voltage test in accordance with their nominal circuit voltage (circuit insulation voltage) even when marked with Symbol C-4 in accordance with Sub-clause 4.3.2. The minimum test voltage shall be 2 kV.

4.3.2.2 The exemption given in Sub-clause 4.3.2 dealing with the use of Symbol C-4 does not apply to instruments which are intended to be opened during normal operation, e.g. recording instruments (see Sub-clause 6.5.3). It may, however, apply to their accessories.

4.3.2.3 Symbol C-4 shall be marked adjacent to the terminals of instruments with a built-in voltage generator (e.g. ohmmeters) and to the enclosure of instruments (e.g. electrostatic instruments) with one terminal connected to the enclosure (see also Sub-clause 6.3), if they are intended to be operated at voltages exceeding the limit of extra-low voltage.

4.3.3 When the voltage to earth of a measuring circuit of a portable instrument can be changed using an accessory of limited interchangeability, so that it operates at a voltage higher than its nominal circuit voltage (circuit insulation voltage), the accessory shall be marked with Symbol C-7 of Table IV. This symbol shall also be applied to interchangeable accessories when their voltage rating exceeds 650 V in order to warn the user of the instrument.

When such accessories are used with wattmeters, VA-meters, var-meters, and power-factor indicators, care should be taken that the voltage between the current and voltage circuits remains compatible with the voltage test of Sub-clause 6.5.2.2.

4.3.4 If accessible parts of an instrument may attain higher temperatures than specified in Sub-clause 5.2, the instrument shall be marked with Symbol C-5 of Table IV.

4.4 *Protective earth terminals*

Protective earth terminals shall be marked with Symbol F-31 of Table IV, page 43.

If this symbol for the protective earth terminal is not used in a national standard, it may be modified provisionally 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. It may also be used to mark other means for connection to a protective system (see Sub-clause 6.4.1).

5. **Heating**

5.1 *General*

When under continuous load or overload, no part of the instrument shall reach a temperature that may cause fire, or a hazard by physical contact with accessible parts, or deformation of the enclosure (including transparent windows) when subjected to external forces.

Compliance shall be checked under the overload conditions specified in the Relevant Publications.

Instruments which are not designed for continuous operation or overload are to be operated in their permissible mode of operation in such a manner that the greatest possible heating occurs.

5.2 *Accessible parts*

When the instrument is under the conditions specified in Sub-clause 5.1, the temperature rise of any part which is accessible when the instrument is ready for use shall be measured.

The temperature rise shall not exceed

- for accessible metal parts: 25 °C,
- for other accessible parts: 35 °C.

See Sub-clause 4.3.4 if a higher temperature occurs.

5.3 *Permanence of insulation*

Neither the insulation strength nor the creepage distances and clearances, if specified, shall be permanently and inadmissibly reduced, when the instrument is operated under the conditions specified in Sub-clause 5.1.

After the test, and also when the instrument has cooled down to its initial temperature, it shall show no damage which might impair its safety as specified in this recommendation.

Compliance shall be checked by inspection and by performing the tests specified in Sub-clauses 6.5 and 6.6 and Clause 10.

5.4 *Mechanical strength at elevated temperatures*

When the instrument is under the conditions specified in Sub-clause 5.1, the rigid test finger specified in Figure 1b shall be applied with a force of 30 N directed inwards to different points of the surface for 10 s each time.

For instruments with a door, this test is not to be applied to delicate parts (e.g. the mechanism of recording instruments) which become accessible when the door is opened.

The instrument shall show no deformation which might impair its safety as specified in this recommendation.