BS EN 50191:2010

BSI Standards Publication

Erection and operation of electrical test equipment

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National foreword

This British Standard is the UK implementation of EN 50191:2010. It supersedes BS EN 50191:2001 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PEL/99, Erection and operation of power installations.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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EUROPÄISCHE NORM

EN 50191

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English version

Erection and operation of electrical test equipment

Installation et exploitation des équipements électriques d'essais

Errichten und Betreiben elektrischer Prüfanlagen

This European Standard was approved by CENELEC on 2010-10-01. 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.

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CENELEC

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

Management Centre: Avenue Marnix 17, B - 1000 Brussels

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Foreword

This European Standard was prepared by CENELEC BTTF 128-2, Erection and operation of electrical test equipment. It was submitted to the formal vote and was approved by CENELEC as EN 50191 on 2010-10-01.

This document supersedes EN 50191:2000.

The principal changes compared to EN 50191:2000 are as follows (minor changes are not listed):

- Update of the normative references;
- 3.12 electrically skilled person (modified definition);
- 4.1 Structure of test installation changed;
- 4.2.1 Electro-optical safety device specified;
- 4.3.5 Requirements for RCM specified;
- 4.7 associate the additional requirements when using safety test probes;
- 5.2 time of repetition of instruction specified to one year.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2011-10-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2013-10-01

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Introduction

With reference to Clause 5 of this European Standard, prepared in the field of application of Article 137 of the EC Treaty, the user should be aware that standards have no formal legal relationship with Directives which may have been made under Article 137 of the Treaty. In addition, national legislation in the Member States may contain more stringent requirements than the minimum requirements of a Directive based on Article 137 of the Treaty. Information on the relationship between the national legislation implementing Directives based on Article 137 of the Treaty and this European Standard may be given in a national foreword of the national standard implementing this European Standard.

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1 Scope

1.1 This European Standard is applicable to the erection and operation of fixed and temporary electrical test installations.

1.2 Compliance with this European Standard is not necessary, if contact with live parts presents no danger. This is the case when one of the following conditions is satisfied at live exposed points:

a) the voltage at frequencies above 500 Hz does not exceed 25 V a.c. or 60 V d.c. and complies with the requirements for SELV or for PELV in accordance with HD 60364-4-41;

b) in case of voltages at frequencies up to 500 Hz exceeding 25 V a.c. or 60 V d.c., the resultant current through a non-inductive resistance of 2 kΩ does not exceed 3 mA a.c. (r.m.s.) or 12 mA d.c;

c) at frequencies above 500 Hz the national determined current and voltage values shall be applied. If there are no national requirements determined reference values for permissible body currents and contact voltages can be taken from Table A.1;

d) the discharge energy does not exceed 350 mJ.

NOTE 1 Even though compliance with the requirements of this European Standard is not necessary, if one of the above-mentioned conditions is satisfied, other potential risks e. g. risk of fire and explosion shall be considered and appropriate measures be taken.

NOTE 2 Ref. 1.2 b) & 1.2 d): The values for the resultant current of 3 mA a.c. or 12 mA d.c. and the discharge energy of 350 mJ comply with the values for live working specified in EN 50110-1. These values also comply with the values specified in IEC/TS 60479-1.

1.3 This European Standard does not apply to the power supply to the test installations. In this case, the documents of the HD 60364 series (for nominal voltages up to 1 000 V) or HD 637 (for nominal voltages exceeding 1 kV) are applicable to erection and EN 50110-1 is applicable to operation.

1.4 Where no requirements are given in this European Standard, the documents of the HD 60364 series (for nominal voltages up to 1 000 V) or HD 637 (for nominal voltages exceeding 1 kV) apply to the erection of electrical test installations and EN 50110-1 applies to the operation of electrical test installations.

2 Normative references

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

EN ISO 13850:2008, Safety of machinery – Emergency stop – Principles for design (ISO 13850:2006)

EN 574:1996 + A1:2008, Safety of machinery – Two-hand control devices – Functional aspects – Principles for design

EN 999, Safety of machinery – The positioning of protective equipment in respect of approach speeds of parts of the human body

EN 50110-1, Operation of electrical installations

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

EN 61140, Protection against electric shock – Common aspects for installation and equipment (IEC 61140)

EN 61219, Live working – Earthing or earthing and short-circuiting equipment using lances as short-circuiting device – Lance earthing (IEC 61219)

EN 61230, Live working – Portable equipment for earthing or earthing and short-circuiting (IEC 61230)

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EN 61310-1, Safety of machinery – Indication, marking and actuation – Part 1: Requirements for visual, acoustic and tactile signals (IEC 61310-1)

EN 61558 series, Safety of power transformers, power supplies, reactors and similar products (IEC 61558 series)

HD 60364 series, Electrical installations of buildings/Low-voltage electrical installations (IEC 60364 series, mod.)

HD 60364-4-41:2007 , Electrical installations of buildings – Part 4: Protection for safety – Chapter 41: Protection against electric shock (IEC 60364-4-41:2005, mod.)

HD 637, Power installations exceeding 1 kV a.c.

IEC 60050-826, International Electrotechnical Vocabulary – Part 826: Electrical installations

3 Terms and definitions

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

3.1
electrical test installations
(referred to in the following as **test installations**)
the entirety of all the test devices, test appliances and facilities combined for test purposes, by means of which electrical tests are performed on test objects.

Types of test installations:

- test station;
- test laboratory or experimental station;
- temporary test installation

3.2
test station
appropriately identified test installation within a defined area. In test stations a distinction is made between those with and those without automatic positive protection against direct contact

3.2.1
test station with automatic protection against direct contact
test station in which the test object and all live parts of the test installation have automatically activated full protection against direct contact in an energized condition

NOTE 1 At a test station with automatic protection against direct contact, there is generally only one person employed, e. g. in the line of series production or in electric workshops, repair and service shops.

NOTE 2 Automatic protection means that voltages can only occur when the safety devices are effective, e.g. when the cover or door of the test station is closed.

3.2.2
test station without automatic protection against direct contact
test station in which parts of the test object or live parts of the test installation are not fully protected against direct contact during testing. This includes, for instance, test areas in electric workshops, laboratories, measurement and experimental areas

3.3
test laboratory
test installations with minimum one test station in a securely enclosed space or within an area separated from adjacent work areas, in which several persons are generally employed on test work on larger test objects remaining there for a longer period of time

3.4
experimental station
test installations with minimum one test station for performing experiments or tests within the scope of research and development work. In general, no routine tests are performed in experimental stations

3.5
temporary test installation
test installation with minimum one test station erected for a short time in order to perform tests on individual test objects

3.6
prohibition zone
volume around live parts which should not be breached if full protection against direct contact with these parts is not provided

3.7
test area
area around the test assembly which is separated from the surrounding area

3.8
signal lights
lights which are clearly visible from outside the boundaries of the test area giving red or green signals to indicate the operational status inside the test area

3.9
indicator lights
serve to indicate the switching status on the control panels. They are not an alternative to required signal lights

3.10
risk
combination of the probability and the degree of the possible injury or damage to health of a person exposed to a hazard or to hazards

3.11
electrical hazard
source of possible injury or damage to health in presence of electrical energy from an electrical installation

3.12
(electrically) skilled person
person with relevant education, knowledge and experience to enable him or her to analyse risks and to avoid hazards which electricity could create

[IEV 826-18-01, mod.]

3.13
(electrically)instructed person
person adequately advised by skilled persons to enable him or her to avoid dangers which electricity may create

[IEV 826-18-02, mod.]

3.14
nominated person in control of a work activity
nominated person with ultimate responsibility for the work activity. Some of these duties can be delegated to others as required

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3.15 Operational status

3.15.1
out of operation
status when

a) all power supplies, signalling and control circuits are switched off and secured against unauthorized switching-on,

b) all safety precautions necessary before entering the test area (for voltages exceeding 1 kV, e.g. earthing, short-circuiting) have been taken

3.15.2
ready for operation
status when

a) the power supplies for the switchgear signalling and control circuits of the test installations are switched on,

b) the green signal lights, where these are required in accordance with the provisions in Clause 4, are on,

c) all power supplies for the test voltage are switched off and secured against unintentional switching,

d) the safety precautions specified in 3.15.1 b) ("out of operation") are in force

3.15.3
ready to switch on
status when

a) all power supplies for the test voltage are switched off,

b) all entries to the test area are closed,

c) the red signal lights are switched on,

d) the safety precautions specified in 3.15.1 b) ("out of operation") are no longer in force

3.15.4
in operation
status when

a) all entries to the test area are closed,

b) the red signal lights are switched on,

c) one or more power supplies for the test voltage are switched on

NOTE In Clauses 4 and 5, the technical devices for setting up the operational status “ready for operation” and “ready to switch on” are only required for certain test installations with voltages exceeding 1 kV.

4 Erection of test installations

4.1 General

Test installations shall be performed and erected as a

- test station,
- test laboratory or experimental station,
- temporary test installation.

4.1.1 Protection against electric shock

4.1.1.1 Test assembly

The test assembly shall be so arranged and designed that the protection against direct contact is secured by insulation of live parts, covers, enclosures, obstacles or safe distances. A safe distance is ensured, when the person carrying out the tests cannot reach the prohibition zone with parts of his/her body or tools. Safety can also be satisfied by means of a two-hand control device or the use of two safety test probes to apply the test voltage. Test leads with full protection against direct contact shall be used. Two-hand control devices shall comply with EN 574:1996 + A1:2008, Type II or IIIB. Where several persons are involved in a test, a two-hand control device shall be provided for each person of the test personnel and which are so connected that all the two hand controls are required to be operated before the test supplies can be energised.

Safety test probes shall have the adequate insulation level for the applied test voltage. No clamping devices shall be permitted for this purpose.

In case of measuring instruments and auxiliary appliances of protection Class I EN 61140 (e.g. cathode ray oscilloscope, sine wave generator), where the protective conductor is interrupted to facilitate testing, e.g. because the enclosure has to be isolated from earth potential, the appliance shall be supplied from an isolating transformer in accordance with EN 61558 series.

If a circuit and/or the enclosure of a measuring instrument or an auxiliary appliance designed for mains connection is connected to live parts of the test assembly which can carry voltage to earth, then the internal insulation of the supplying isolating transformer shall be rated at least for this voltage.

An effective protective measure for fault protection (protection against indirect contact) shall be provided (see HD 60364-4-41,Clause 411.3).

The test object shall be isolated from earth. If this is technically not possible e.g. due to the weight of the test object, than the test assembly shall be so designed and arranged in order to prevent the transfer of voltage to extraneous conductive parts.

Test table boards shall be made of insulating materials.

4.1.1.2 Prohibition zone

The boundary of the prohibition zone shall be determined in accordance with Table A.2 and is dependent on the test voltage.

In case of voltages up to 1 000 V, the surface of the live part is considered to be the boundary of the prohibition zone. In case of voltages exceeding 1 kV, reaching the prohibition zone is considered equal to touching live parts.

4.1.1.3 Barriers, test area

Test areas shall be separated from work areas and passageways. The barriers shall be so designed as to

- prevent access to the test area by persons other than the test persons,
- prevent persons, other than the test persons, from reaching the prohibition zone,
- prevent persons outside the barrier from reaching the operating devices of test installations which are located inside the barrier.

The minimum distance between the barrier enclosing the test area and the boundary of the prohibition zone or operation devices shall be determined in accordance with Figure A.1 and Table A.3. In case of grid barriers, the minimum distance between the barrier and the prohibition zone shall comply with Table A.4 at any opening, where it is possible to reach through the barrier.

Barriers made of conductive materials shall be earthed or other measures shall be taken for fault protection (protection against indirect contact).

4.1.1.4 Mechanical means of protection

Mechanical means of protection shall be adequately strong.

4.1.2 Indicator lights, signal lights and signs

4.1.2.1 The test installations controls and test circuits shall be clearly identified.

4.1.2.2 Test installations shall have devices which indicate the switching status (e.g. by indicator lights) and the operational status (by signal lights).

4.1.2.3 Test installations and test areas shall be clearly and visibly indicated by means of warning signs.

4.1.3 Emergency switching off

Test installations shall be provided with means for emergency switching off in order to cut off all electrical energy which could result in danger. The devices or equipment shall be in accordance with the requirements of EN ISO 13850:2008. An adequate number of manual controls shall be provided inside and outside the test area as appropriate to the size of the area and complexity of layout. Connection points, e.g. outlets of the general power supply within the test area, shall be identified accordingly, if they are not interrupted by the emergency switching off equipment.

4.1.4 Preventing unauthorized and unintentional switching-on

Test installations shall be secured against unauthorized and unintentional switching-on of test circuits. Manual controls shall be clearly correlated to the respective test circuits.

4.1.5 Preventing automatic energizing

Automatic energizing of test circuits shall be prevented when mains voltage recovers after a power failure.

4.1.6 Protection against residual voltages and transfer of voltages

4.1.6.1 If there is a likelihood of danger due to residual voltages after switching-off test circuits, suitable devices or equipment shall be provided for a safe discharge of energy.

4.1.6.2 Transfer of voltage to accessible conductive parts outside the test area shall be prevented by adequate measures – e.g. earthing, shielding, appropriate cable routing – or these conductive parts shall be protected against direct contact.

4.1.7 Protective measures against other hazards

Appropriate means of protection shall be provided, in cases where in addition to dangers due to voltages other hazards are to be expected, e.g. due to arcs, noise, explosion, radiation, flying parts, formation of gas, fire, dangerous substances.

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4.2 Test stations with automatic protection against direct contact

4.2.1 The protection against direct contact in accordance with 4.1.1.1 must be satisfied by insulation of live parts, covers or enclosures. The means of protection against direct contact shall guarantee at least the defined degree of protection IP3X in accordance with EN 60529 and include all parts of the test object.

It shall not be possible to switch on the test voltages until the means of protection are fully operational and functioning correctly. Opening the means of protection must disconnect the test voltage automatically. Residual voltages shall be automatically reduced to a non-hazardous level before live parts can be touched.

Single fault conditions shall not prevent the test voltages from being switched-off when the means of protection are opened. The fault occurrence shall ensure that it is impossible to switch on the test voltages again. It shall not be possible to bypass the means of protection in an easy way.

If parts of the enclosure at the operation side are replaced by an electro-optical safety device (light barrier) with a beam distance of not more than 14 mm, then in this case, the degree of protection IP3X may be omitted for this part of the enclosure. The safety distance between the detection zone and prohibition zone shall be large enough, so that the prohibition zone cannot be reached while breaching into the detection zone. While investigating the safety distances at least the test probe for the degree of protection IPXXC in accordance with EN 60529 (test probe 2,5) shall be applied. In addition, the approach speed and the required used tools and materials within the installation, the respond time of the protection device and switching devices shall be considered (EN 999).

4.2.2 The degree of protection against direct contact IP3X may be omitted if the enclosure complies with the following requirements:

- means of protection for the automatic protection against direct contact shall be solid walls or barrier grids (side length or diameter of the openings not exceeding 40 mm) at least 1 800 mm high;
- the test enclosure must be equipped with devices which do not permit doors to the test area to be opened until the test voltage has been switched off and secured against being switched on again and – if necessary – earthed and short-circuited. It shall not be possible to disable these protective measures until the doors have been closed.

4.2.3 The measures, required in 4.2.1, may be omitted in exceptional cases, if the test object and all live parts are fully protected against direct contact and a measure for fault protection (protection against indirect contact) is efficient for the test object and the test installation during the test.

4.2.4 In the case of test stations with automatic protection against direct contact in accordance to 4.2.1 and 4.2.3, barriers in accordance with 4.1.1.3, emergency switching off devices in accordance with 4.1.3 and signal lights in accordance to 4.1.2.2 may be omitted.

4.3 Test stations without automatic protection against direct contact

4.3.1 Test stations without automatic protection against direct contact shall only be installed if the erection of test stations with automatic protection against direct contact is not practicable, e.g.:

- due to frequently changing test duties;
- in case of varying types of test objects;
- in case of serious difficulties in performing the work;
- when test duties occur only occasionally.

4.3.2 The barriers in accordance with 4.1.1.3 may be e.g. walls, grids, tapes, ropes, chains or bars subject to national regulations. They shall be so designed that visual and audible contact with the operator can be maintained from outside at all times.

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4.3.3 At least one emergency switching device shall be installed outside the test areas.

4.3.4 An adequate number of red and green signal lights (see Annex B), indicating the operational status, shall be installed. The green signal lights are not required in case of voltages up to 1 000 V.

4.3.5 If test circuits are electrically connected to the general power supply system, additional protection shall be provided by means of a residual current protective device (RCD) at a rated residual current $I_{\Delta N} \leq 30$ mA. If the residual current includes d.c. components, an appropriate RCD shall be used.

If, due to test tasks, an additional protection by means of a RCD is not possible, than a residual current monitoring device (RCM) with a rated residual current $I_{\Delta N} \leq 30$ mA shall be used. By exceeding the rated residual current the switch off time shall not exceed the switch off time of a RCD. A supply voltage breakdown of RCM must cause a swich off of the test circuit.

4.3.6 Electrical equipment, e.g. measuring instruments, variable resistors, shall be incorporated in an effective protective measure for fault protection (protection against indirect contact). This also applies to the exposed conductive parts of test objects unless these parts of the test object are also included in the test, e.g. insulation test, leakage current test, see Figure 1. Electrical equipment with protective insulation or supplied by means of isolating transformers shall preferably be used.

4.3.7 The working area of test stations shall be such that movement of test personnel is not impeded. National regulations shall be taken into consideration.

4.3.8 In case of test stations in electric workshops, laboratory stands, measurement and experimental stands, barriers in accordance with 4.3.2 and red signal lights in accordance with 4.3.4 may be omitted, if the safety of bystanders is obtained otherwise by means of the arrangement or design of the test station and the test station is reliably controlled by the test person.

4.4 Test laboratories and experimental stations

4.4.1 The variety of test assemblies as well as different hazards shall be anticipated and the following requirements shall be met under all circumstances.

4.4.2 The barriers in accordance with 4.1.1.3 shall be solid walls or grids (see Table A.4) at least 1 800 mm high. Entrances shall be provided with a warning sign “Not access for unauthorized persons” in accordance with Council Directive 92/58/EEC.

In case of test voltages up to 1 000 V, the barriers may also be tapes, ropes, chains or bars which shall be fixed between 1 000 mm and 1 400 mm distance from the floor. The minimum distance to the floor (sag) shall not drop below 800 mm. Solid walls or grids shall be at least 1 000 mm high.

4.4.3 An adequate number of red and green signal lights (see Annex B), indicating the operational status, shall be installed. The green signal lights are not required in case of voltages up to 1 000 V.

When there are separate test areas within the test laboratory

- the operational status of each of the test areas shall be indicated by means of signal lights,
- red signal lights shall indicate "danger" for the entire test laboratory whenever the operational status **ready to switch on** or **in operation** exists in at least one of the test areas. In this case care should be taken if access is required in other test areas.

NOTE 1 A test laboratory may be subdivided into separate test areas in which mutually independent tests are carried out.

NOTE 2 If the risk assessment requires the differentiation of operational status “ready to switch on” and “in operation”, it is recommended in this case to indicate the operational status “in operation” by a blinking red signal light. The blink frequency shall not be below 1 Hz.

4.4.4 Emergency escape doors, gates, etc. shall be able to be opened from the inside of the test area. National regulations on escape routes and emergency exits shall be taken into account.

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4.4.5 In test laboratories measures are required to prevent unauthorized entry and shall not hinder persons from leaving.

4.4.6 In test laboratories with voltages exceeding 1 kV devices or provisions for earthing shall be available (see EN 50110-1, EN 61219 and EN 61230).

4.4.7 Where the test voltages exceed 1 kV, all areas including those outside the test area where capacitive charging is likely to take place, shall be separated by additional barriers for the duration of the testing. These additional barriers shall meet as a minimum the requirements for temporary test installations in 4.5.1.

4.4.8 For experimental stations, the requirements of 4.4.1 to 4.4.7 are generally applicable. If, however, compliance with individual safety measures required by these subclauses should not be appropriate with regard to the type of construction, the protection of personnel required in test areas shall be secured by equally effective other means or measures.

NOTE One such measure is, e.g. with reference to 4.4.5, continuous supervision of access.

4.5 Temporary test station

4.5.1 Unauthorized persons shall be prevented from access to temporary test areas by means of walls, grids, tapes, ropes, chains, bars or similar barriers. Entrances shall be provided with a warning sign “No unauthorized persons beyond this point” in accordance with EN 61310-1.

4.5.2 Escape facilities shall be provided.

4.5.3 In case of voltages exceeding 1 kV, devices or provisions for earthing shall be available (see EN 50110-1, EN 61219 and EN 61230).

4.5.4 For tests with voltages exceeding 1 kV, in which capacitive charging is likely to occur even outside the test area, this area shall be separated by an additional barrier for the duration of the test.

4.5.5 An adequate number of red and green signal lights (see Annex B), indicating the operational status shall be installed. The green signal lights are not required in case of voltages up to 1 000 V.

4.6 Test station without test personnel in permanent attendance

If a test station is intended for operation without the permanent presence of test personnel (e.g. for endurance tests) it shall be erected in compliance with 4.2 (test stations with automatic protection against direct contact) or 4.4.1 to 4.4.8 (test laboratories). Emergency stop equipment in accordance with the requirements of EN ISO 13850:2008 with an adequate number of manual controls shall be provided. Prevention of automatic energizing in accordance with 4.1.5 may be omitted, provided that this will not cause any hazards.

4.7 Additional requirements when using safety test probes

When safety test probes are used with voltages exceeding 1 kV, the high voltage side of the test apparatus shall be electrically isolated from the supply mains and insulated from earth, same applying to test probes and their leads. The test object shall also be isolated from earth where practicable.

The r.m.s. value of the leakage current (see IEC 60050-826) on the high voltage side of the test apparatus shall not exceed 3 mA. This value shall not be exceeded even when a highly resistive connection is made between the high voltage side and earth, e.g. for adjustment of potential of a measuring instrument (see Figure 1).

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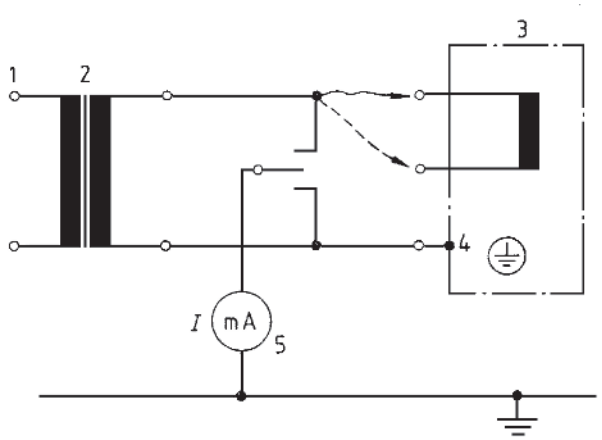

Key

1 Supply mains

2 High voltage measuring instrument

3 Test object (isolated from earth)

4 Protective conductor (connecting point) of the test object

5 Ammeter with an internal resistance (including a necessary external resistance) of 2 000 Ω (equivalent resistance for test personnel)

Figure 1 – Measurement of discharge current

5 Operation of test installations

5.1 General

5.1.1 Test installations may only be operated under the control and supervision of a skilled person. This does not apply to test stations which have automatic protection against direct contact and comply with requirements of 4.2.1.

5.1.2 Test installations shall be provided with operating instructions. These shall contain the information required for safe operation.

5.1.3 The test installations used shall be inspected for externally visible damage or defects before use.

5.1.4 Test installations shall not be operated if there are signs of damage or defects liable to cause danger.

5.1.5 Only skilled persons shall be employed to maintain the test installations.

5.1.6 The proper condition and efficiency of the safety devices shall be checked by a skilled person at suitable intervals of time. The result on these inspections shall be recorded.

5.2 Personnel

5.2.1 Only skilled or instructed persons may work with test installations. All personnel involved shall be instructed in the safety requirements, safety rules and company instructions applicable for their work. These instructions shall be repeated as necessary but minimum once a year. The personnel shall be required to comply with the requirements, rules and instructions. The complexity of the work activity shall be assessed before the activity starts such the appropriate choice of a skilled or instructed person is made for carrying out the activity. A written record of the training shall be kept.

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5.2.2 Personnel using safety test probes shall receive additional training regarding special risks involved.

5.2.3 Personnel working in test laboratories, experimental stations and temporary test stations may work only under the overall supervision of a nominated person in control of the work activities.

5.2.4 Test areas shall only be entered by the personnel employed there and other persons who have received adequate instruction regarding the hazards.

If other persons have to enter these areas, they shall be accompanied by a skilled person and their attention shall be drawn to the risks. In case of test stations with voltages exceeding 1 kV, the permission of the nominated person in control of the work activities is also required.

5.2.5 Any person working in test laboratories, experimental stations or in areas with temporary test stations shall be fully aware of the existing hazards and has the duty to take safety precautions in his / her work in order to protect both himself / herself and other persons against hazards.

5.3 Preparation of tests, switching operations in test stations

5.3.1 If the enclosure of a measuring instrument or an auxiliary appliance is connected to live parts of the test assembly and if as a result the enclosure can be exposed to a voltage exceeding 25 V a.c. or 60 V d.c. to earth, then adequate external insulation of the enclosure including the control device shall be provided. In special cases, procedures for live working shall be used (see EN 50110-1).

5.3.2 When using safety test probes, the person carrying out the test shall visually check the test probes and their leads before starting work to ensure that they are safe to use.

5.3.3 If there is a likelihood of danger due to arcing, adequate measures shall be taken for the protection of personnel.

5.3.4 If, in addition to electrical hazards, other risks are likely to occur during tests and experiments, e.g. noise, explosions, radiations, flying parts, gas formation, fire or hazardous materials, additional safety measures shall be taken to ensure adequate protection.

5.3.5 The nominated person in control of the work activity shall make sure that their instructions are carried out correctly before the equipment

- is switched on, in case of voltages up to 1 kV,
- is made **ready to switch on** in case of voltages exceeding 1 kV.

5.3.6 Orders for switching operations may only be given by a nominated person in control of the work activity. In test laboratories, experimental stations and temporary test installations with voltages exceeding 1 kV, switching operations may only be performed upon the personal order of the nominated person in control of the work activity, when he / she does not perform this duty himself / herself.

5.3.7 The persons mentioned in 5.3.6 shall ensure that all persons other than test persons have left the test area before the test installations is

- switched on, in case of voltages up to 1 kV,
- made **ready for operation** in case of voltages exceeding 1 kV.

In case of test stations in accordance with 4.2.2, all persons must leave the test area before the test station is switched on.

In case of test laboratories, experimental stations and temporary test installations with voltages exceeding 1 kV, all persons must leave the test area before the test installations are made **ready to switch on**.

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5.3.8 The person carrying out the test shall be able to recognize the operational status at any time, especially when several voltages are supplied.

Before leaving the test installations, the **out of operation** condition shall be established. This does not apply to test installations without the permanent presence of test personnel (see 4.6).

5.4 Performance of tests

5.4.1 Assembly work and tests shall not be performed simultaneously if this could result in danger.

5.4.2 In exceptional cases, contrary to the requirements of 5.3.7, paragraph 3, skilled persons may enter the test area in the operational status **ready to switch on** or **in operation**. Measures shall be taken to ensure that the prohibition zone is not reached (see EN 50110-1).

Work activities carried out in the prohibition zone (live working) shall comply with the requirements of EN 50110-1.

5.4.3 In the event of a fault during tests, parts of the test object and test installations which are not live during normal operation can be subjected to dangerous voltages. If, in exceptional cases, work has to be carried out on these parts, suitable insulating devices and auxiliary means shall be used (see EN 50110-1).

5.4.4 In a test station without automatic protection against direct contact, as a safety measure during the operational status **ready to switch on** and **in operation,** at least one other person shall be present in visual and audible contact with the person carrying out the test and be in the position to recognize any dangerous conditions in the test station immediately and eliminate the danger by actuating the emergency switching off device.

5.4.5 If a temporary station is separated from generally accessible areas only by means of tapes, ropes, chains or bars, the following conditions apply in addition to the other requirements of Clause 5:

a) the entire test assembly shall be under surveillance during the test procedure. If this cannot be ensured by the person carrying out the test, a sufficient number of at least instructed persons shall be present to supervise the entire test area and to take immediate action in the event of danger;

b) in case of test assemblies with several separate test areas, e.g. when testing installed cables, one person is required to guard each area. Communication with the testing person or with the nominated person in control of a work activity shall be ensured. In these cases, while testing installed cables and lines, signal lights are not required in the area under surveillance.

5.4.6 Before touching test objects which have been switched off, it shall be ensured that no dangerous voltages are present on the accessible parts by earthing and short circuiting.

5.4.7 Emergency routes and exits shall always be kept clear.

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Annex A
(normative)

Tables

The following tables are applied in Clauses 1 and 4. They are represented here for better readability.

A.1 Permissible body currents and contact voltages

Table A.1 has reference values for permissible sinusoidal body currents and contact voltages at frequencies above 500 Hz which are considered harmless under permanent exposure. If it is ensured that these values are not exceeded, measures in accordance with this European Standard are not required (1.2 c)). The permissible values in this table are the maximum permitted values under normal and dry conditions.

Table A.1 – Reference values for permissible sinusoidal body currents and contact voltages at frequencies > 500 Hz

Frequency f	**Permissible body current** mA	**Permissible contact voltage** V
500 Hz ≤ f ≤ 2 kHz	1,75 • (f / kHz) + 3,3	25
2 kHz ≤ f ≤ 3,8 kHz	1,4 • (f / kHz) + 4,2	25
3,8 kHz ≤ f ≤ 12 kHz	1,4 • (f / kHz) + 4,2	1,05 • (f / kHz) + 20,5
12 kHz ≤ f ≤ 28 kHz	1,75 • (f / kHz)	1,05 • (f / kHz) + 20,5
28 kHz ≤ f ≤ 100 kHz	50	1,05 • (f / kHz) + 20,5
100 kHz ≤ f ≤ 1 MHz	50	125

A.2 Prohibition zone and test area

Table A.2 – Prohibition zone (*s*) dependent on test voltages to earth (*U*)

Alternating test voltage 50/60 Hz (r.m.s. value)		**Lightning impulse voltage 1,2/50 µs** (peak value)		**Switching impulse voltage 250/2 500 µs** (peak value)	
U kV	*s* [a] mm	*U* kV	*s* mm	*U* kV	*s* mm
≤ 1	No contact	20	100	500	2 000
3	20	40	175	600	2 600
5	30	60	250	700	3 300
6	35	80	325	800	4 100
10	60	100	400	900	4 900
15	85	150	550	1 000	5 800
20	115	200	700	1 100	8 800
25	140	250	850	1 200	7 800
30	170	300	1 000	1 300	8 900
35	195	350	1 100	1 400	10 000
40	225	400	1 200	1 500	11 200
45	250	450	1 300	1 600	12 500
50	280	500	1 400		
55	305	600	1 650		
60	335	700	1 950		
70	390	800	2 200		
80	450	900	2 450		
90	510	1 000	2 700		
100	560	1 100	2 950		
110	620	1 200	3 250		
130	740	1 300	3 500		
150	860	1 400	3 750		
170	980	1 500	4 000		
190	1 100				
210	1 240				
220	1 300				
260	1 550				
300	1 850				
340	2 150				
380	2 450				
420	2 750				
460	3 100				
500	3 500				
600	4 500				
700	5 600				
800	6 900				
900	8 300				
1 000	9 900				

Intermediate values may be obtained by interpolation; however, linear extrapolation beyond the highest specified values is not permissible.

For d.c. test voltages up to 1 000 kV the distance *s* shall comply with the value for lightning impulse voltages. The table is not applicable to high-frequency voltages or any voltages other than those specified.

[a] *s* is the distance in air from live parts.

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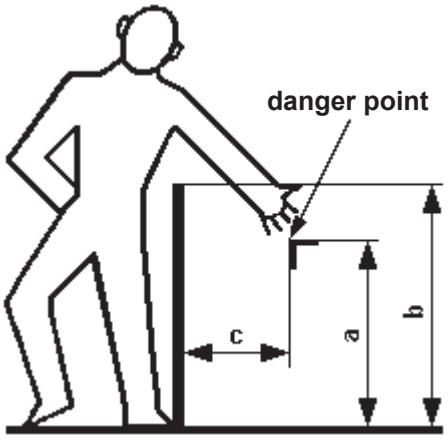
Table A.3 – Horizontal distance between the barrier and the prohibition zone in relation to the height of the barrier and the distance of the danger point from the floor

Distance of the danger point from the floor a mm	**Height of the edge of the means of protection (barrier) b** mm							
	1 000	**1 200**	**1 400**	**1 600**	**1 800**	**2 000**	**2 200**	**2 400**
	Horizontal distance c between means of protection (barrier) and the danger point mm							
2 400	100	100	100	100	100	100	100	100
2 200	600	600	500	500	400	350	250	
2 000	1 100	900	700	600	500	350		
1 800	1 100	1 000	900	900	600			
1 600	1 300	1 000	900	900	500			
1 400	1 300	1 000	900	800	100			
1 200	1 400	1 000	900	500				
1 000	1 400	1 000	900	300				
800	1 300	900	600					
600	1 200	500						
400	1 200	300						
200	1 100	200						
Values below 1 000 mm for edge b are not specified as this would not increase the arm's reach and in addition there would be a risk of falling into the test area. Barriers, e. g. tapes, ropes, chains or bars, shall be fixed between 1 000 mm and 1 400 mm distance from the floor. The minimum distance to the floor (sag) shall not drop below 800 mm.								



Key

a Distance between the danger point and the floor (danger point is the point on the boundary of the prohibition zone having the shortest distance from the edge of the means of protection)

b Height of the edge of the means of protection

c Horizontal distance between the edge of the means of protection and the danger point

Figure A.1 – Clarification of the dimensions stated in Table A.3

Table A.4 – Minimum distance between openings in the barrier and the prohibition zone in relation to the width of the opening

Width of opening (diameter or side length) mm	Minimum distance from the prohibition zone mm		
	Slot	Square	Circle
over 4 to 6	10	5	5
over 6 to 8	20	15	5
over 8 to 10	80	25	20
over 10 to 12	100	80	80
over 12 to 20	120	120	120
over 20 to 30	850	120	120
over 30 to 40	850	200	120
over 40 to 120	850	850	850

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Annex B
(informative)

Example of an application illustrating the prohibition zone and test area

The prohibition zone and the test area are illustrated by Figure B.1 showing the example of a test laboratory.

The test area is enclosed by the barriers W1, W2, W3 and W4. The distances c and d between the boundaries of the test area and the prohibition zone V shall be selected to ensure that persons are prevented from reaching the prohibition zone from outside the barrier. The total distance between the boundary of the test area and the test object results from the values stated in Table A.2 and an additional margin relating to ergonomics in accordance with Table A.3 or Table A.4.

The distance x between the test object and a solid barrier (e.g. solid wall) may be less than the distance *s* specified in Table A.2. It shall, however, be larger than the striking distance which is to be assumed at this point. Unless empirical values are available, it is recommended in case of a.c. test voltages to select the distance $x > s/2$ in accordance with Table A.2. In the event of a voltage flashover to the solid barrier, care should be taken that no hazard occurs due to the formation of parasitic voltages.

The distance values for a.c. voltages ranging from 1 kV to 1 000 kV stated in Table A.2 are based on physical facts, taking into consideration extensive data published by a technical institution. The values have been increased by an additional safety margin so that an adequate safety can be guaranteed, even taking into account measurement uncertainties and an unfavourable air density.

The distance values given for the lightning impulse voltage of 1,2/50 µs are adequately rated so that these series of values allow to cover also the direct voltage up to 1 000 kV. The range selected from 20 kV to 1 500 kV covers all impulse voltage values up to 400 kV in accordance with EN/IEC 60071 series.

The distance values for the boundary of the prohibition zone given in Table A.2 are applicable only to the voltage waveforms up to the maximum values specified. These distance values may possibly not suffice for other voltages (e.g. high frequency voltages, differing switching impulse voltages, d.c. and a.c. voltages superimposed with high frequency).

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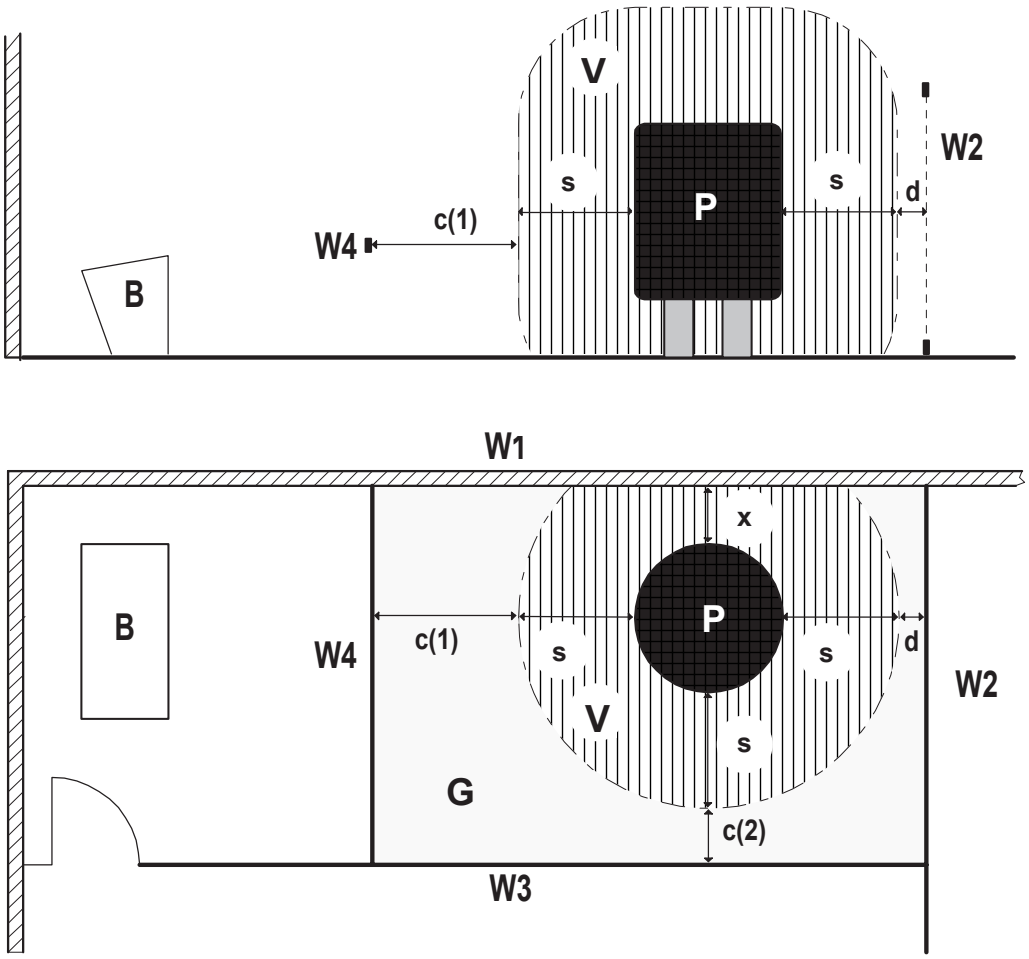

Key

P Test object, here envelope around a live object, 2 200 mm high

V Prohibition zone

G Test area

B Operator´s console

W Barriers, separating the test area:

W1 Solid wall, height = headroom

W2 Wire mesh, 2 400 mm high

W3 Wire mesh, 1 800 mm high

W4 Barrier constructed as a bar, tape, chain or rope, 1 000 mm high

s Distance according to Table A.2

c Horizontal distances according to Table A.3

d Distance according to Table A.4

x Distance > striking distance (= s/2)

Numerical example:

Distances in case of a.c. test voltage 50 Hz, 190 kV against earth:

s = 1 100 mm, c(1) = 1 400 mm, c(2) = 600 mm, mesh size 40 mm, d = 200 mm, x = e.g. 600 mm

Figure B.1 – Prohibition zone and test area in a test laboratory

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EN/IEC 60071 series, Insulation co-ordination

IEC/TS 60479-1, Effects of current on human beings and livestock – Part 1: General aspects

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