BS EN 50110-1:2013

BSI Standards Publication

Operation of electrical installations -

Part 1: General requirements

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National foreword

This British Standard is the UK implementation of EN 50110-1:2013. It supersedes BS EN 50110-1:2004 which is withdrawn.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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CENELEC

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Europäisches Komitee für Elektrotechnische Normung

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Foreword

This document (EN 50110-1:2013) has been prepared by CLC/BTTF 62-3 "Operation of electrical installations".

The following dates are fixed:

– latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2014-02-11
– latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2016-02-11

This document supersedes EN 50110-1:2004.

EN 50110-1:2013 includes the following significant technical changes with respect to EN 50110-1:2004:

– improvement of the definitions of persons responsible and level of responsibility;

– addition of a clause on emergency arrangements;

– addition of example of level of responsibility in Annex B;

– addition of a clause on arc hazard in Annex B;

– addition of a clause on emergency arrangements in Annex B;

– update of the normative references and of the Bibliography.

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

Introduction

There are many national laws, standards and internal rules dealing with the matters coming within the scope of EN 50110 and these practices have been taken as a basis for this work.

EN 50110 consists of two parts:

– Part 1 of EN 50110 contains minimum requirements valid for all CENELEC countries and some additional informative annexes dealing with safe working on, with, or near electrical installations;

– Part 2 of EN 50110 consists of a set of normative annexes (one per country) which either specify the present safety requirements or give the national supplements to these minimum requirements.

This concept is still believed to be a decisive step to the gradual alignment in Europe of the safety levels associated with the operation of, work activity on, with, or near electrical installations. This document acknowledges the present different national requirements for safety. The intention is, over the course of time, to create a common level of safety.

Even the best rules and procedures are of no value unless all persons working on, with, or near electrical installations are thoroughly conversant with them and with all legal requirements and comply strictly with them.

1 Scope

This European Standard is applicable to all operation of and work activity on, with, or near electrical installations. These are electrical installations operating at voltage levels from and including extra-low voltage up to and including high voltage.

This latter term includes those levels referred to as medium and extra-high voltage.

These electrical installations are designed for the generation, transmission, conversion, distribution and use of electrical power. Some of these electrical installations are permanent and fixed, such as a distribution installation in a factory or office complex, others are temporary, such as on construction sites and others are mobile or capable of being moved either whilst energised or whilst not energised nor charged. Examples are electrically driven excavating machines in quarries or open-cast coal sites.

This European Standard sets out the requirements for the safe operation of and work activity on, with, or near these electrical installations. The requirements apply to all operational, working and maintenance procedures. They apply to all non-electrical work activities such as building work near to overhead lines or underground cables as well as electrical work activities, when there is a risk of electrical danger.

This European Standard does not apply to ordinary persons when using installations and equipment, provided that the installations and equipment comply with relevant standards and are designed and installed for use by ordinary persons.

This European Standard has not been developed specifically to apply to the electrical installations listed below. However, if there are no other rules or procedures, the principles of this European Standard could be applied to them

– on any aircraft and hovercraft moving under its own power, (these are subject to International Aviation laws which take precedence over national laws in these situations);
– on any sea going ship moving under its own power, or under the direction of the master, (these are subject to International Marine laws which take precedence over national laws in these situations);
– electronic telecommunications and information systems;
– electronic instrumentation, control and automation systems;
– at coal or other mines;
– on off-shore installations subject to International Marine laws;
– on vehicles;
– on electric traction systems;
– on experimental electrical research work.

2 Normative references

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

EN 50191, *Erection and operation of electrical test equipment*

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)*

EN 61243 (all parts), *Live working – Voltage detectors (IEC 61243, all parts)*

EN 61472, *Live working - Minimum approach distances for a.c. systems in the voltage range 72,5 kV to 800 kV – A method of calculation (IEC 61472)*

EN 62271-1, *High-voltage switchgear and controlgear – Part 1: Common specifications (IEC 62271-1)*

EN 62271-102, *High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches (IEC 62271-102)*

IEC 60050 (all parts), *International Electrotechnical Vocabulary* (available at www.electropedia.org)

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050 and the following apply.

NOTE The terms and definitions from IEC 60050 are available online at www.electropedia.org. See also "Electropedia" or "Glossary" on www.iec.ch website.

3.1 General

3.1.1
electrical installation
all the electrical equipment that is used for the generation, transmission, conversion, distribution and use of electrical energy

Note 1 to entry: It includes energy sources such as batteries, capacitors and all other sources of stored electrical energy.

[SOURCE: IEC 60050-651:1999, IEV 651-01-04 modified]

3.1.2
operation
all activities including *work activities* necessary to permit the *electrical installation* to function

Note 1 to entry: These activities include such matters as switching, controlling, monitoring verification of the electrical installation, inspection and maintenance. These activities include both electrical and non-electrical work.

[SOURCE: IEC 60050-651:1999, IEV 651-01-05 modified]

3.1.3
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

[SOURCE: IEC 60050-651:1999, IEV 651-01-31 modified]

3.1.4
electrical hazard
source of possible injury or damage to health in presence of electrical energy from an *electrical installation*

[SOURCE: IEC 60050-651:1999, IEV 651-01-30 modified]

3.1.5
electrical danger
risk of injury from an electrical origin

3.1.6
electrical injury
death or personal injury from electric shock, electric burn, arcing, or from fire or explosion initiated by electrical energy caused by any *operation* of an *electrical installation*

[SOURCE: IEC 60050-651:1999, IEV 651-01-32 modified]

3.2 Personnel, organisation and communication

3.2.1
person responsible for an electrical installation
nominated person with the overall responsibility to ensure the safe *operation* of the *electrical installation* by setting rules and organisation or framework

Note 1 to entry: This person can be the owner, employer, proprietor or a delegated person.

Note 2 to entry: Some of these duties can be delegated to others as required. For large or complex electrical installations or networks, the duties can be delegated for parts of the installations or the network (see 4.3).

Note 3 to entry: See Figure B.1, classification **a)**.

3.2.2
nominated person in control of an electrical installation during work activities
person who is responsible during work activities for the safe *operation* of the *electrical installation*

Note 1 to entry: This person has to judge the possible effects of the work activities on the electrical installation or parts of it which are in his responsibility and the effects of the electrical installation on persons carrying out the work activities. Some of these duties can be delegated to others as required (see 4.3).

Note 2 to entry: See Figure B.1, classification **b).**

3.2.3
nominated person in control of a work activity
person nominated with the ultimate responsibility for the *work activity at work location*

Note 1 to entry: Some of these duties can be delegated to others as required (see 4.3).

Note 2 to entry: See Figure B.1, classification **c).**

[SOURCE: IEC 60050-651:1999, IEV 651-01-36 modified]

3.2.4
skilled person (electrically)
person with relevant education, knowledge and experience to enable him or her to analyse risks and to avoid hazards which electricity could create

[SOURCE: IEC 60050-826:2004, IEV 826-18-01 modified]

3.2.5
instructed person
person adequately advised by a *skilled person* to enable him or her to avoid dangers which electricity may create

[SOURCE: IEC 60050-826:2004, IEV 826-18-02 modified]

3.2.6
ordinary person
person who is neither a *skilled person* nor an *instructed person*

[SOURCE: IEC 60050-826:2004, IEV 826-18-03]

3.2.7
notification
messages or instructions which are either verbal or in writing associated with *operation* of *any electrical installation*

3.3 Working zone

3.3.1
work location
site(s), place(s) or area(s) where a *work activity* is to be, is being, or has been carried out

[SOURCE: IEC 60050-651:1999, IEV 651-01-08 modified]

3.3.2
live working zone
space around live parts in which the insulation level to prevent electrical danger is not assured when reaching into or entering it without protective measures

Note 1 to entry: The outer limit of the live working zone is denoted as the distance D_L (see Figures 1 and 2).

[SOURCE: IEC 60050-651:1999, IEV 651-01-06 modified]

3.3.3
vicinity zone
limited space outside the *live working zone*

Note 1 to entry: The outer limit of the vicinity zone is denoted as the distance D_V (see Figures 1 and 2).

[SOURCE: IEC 60050-651:1999, IEV 651-01-07 modified]

3.4 Working

3.4.1
work activity
any form of *electrical* or *non-electrical work* where there is the possibility of an *electrical hazard*

3.4.2
electrical work
work on, with or near an *electrical installation* such as testing and measurement, repairing, replacing, modifying, extending, erecting, maintaining and inspecting

[SOURCE: IEC 60050-651:1999, IEV 651-01-12 modified]

3.4.3
non-electrical work
work near to an *electrical installation* such as construction, excavation, cleaning, painting, etc.

[SOURCE: IEC 60050-651:1999, IEV 651-01-13 modified]

3.4.4
live working
all work in which a worker deliberately makes contact with live parts or reaches into the *live working zone* with either parts of his or her body or with tools, equipment or devices being handled

Note 1 to entry: At low voltage, live working is carried out by the worker, when making contact with bare live parts. At high voltage, live working is carried out by the worker, when entering the live working zone, regardless of whether contact is made with bare live parts or not.

[SOURCE: IEC 60050-651:1999, IEV 651-01-01 modified]

3.4.5
working in the vicinity of live parts
all *work activity* in which a worker with part of his or her body, with a tool or with any other object enters into the *vicinity zone* without encroaching into the *live working zone*

[SOURCE: IEC 60050-651:1999, IEV 651-01-02 modified]

3.4.6
isolate
disconnect completely a device or circuit from other devices and circuits by creating a physical separation able to withstand the anticipated voltage differences between the device or circuit and other circuits

[SOURCE: IEC 60050-151:2001, IEV 151-15-37 modified]

3.4.7
dead
at or about zero voltage that is without voltage and/or charge present

[SOURCE: IEC 60050-651:1999, IEV 651-01-15 modified]

3.4.8
dead working
work activity on *electrical installations*, which are neither live nor charged, carried out after having taken all measures to prevent *electrical danger*

3.4.9
authorisation
formal approval in writing or instruction

3.4.10
permission to start work
direct instruction to the workers at *work location* to commence work after all safety measures are taken

3.5 Protective devices

3.5.1
screen
any device, which may be insulated or not, which is used to prevent approach to any equipment or part of *electrical installation* which presents *electrical danger*

[SOURCE: IEC 60050-651:1999, IEV 651-01-29 modified]

3.5.2
barrier
part providing protection against direct contact from any usual direction of access

[SOURCE: IEC 60050-826:2004, IEV 826-12-23]

3.5.3
insulating covering
rigid or flexible cover made of insulating material used to cover live and/or unenergised parts and/or adjacent parts in order to prevent accidental contact

3.5.4
enclosure
part providing protection of equipment against certain external influences and, in any direction, protection against direct contact

3.5.5
voltage detector
portable device used to detect reliably the presence or the absence of the operating voltage and used to verify that the installation is ready for earthing

Note 1 to entry: These devices are generally described as either capacitive types or resistive types.

[SOURCE: IEC 60050-651:1999, IEV 651-10-04]

3.5.6
portable equipment for earthing and short-circuiting
equipment that is portable and is manually connected with insulating component(s) to parts of an electrical installation for earthing and short-circuiting purposes

Note 1 to entry: This equipment comprises earthing components, short-circuiting components and one or more insulating components, for instance earthing sticks.

[SOURCE: IEC 60050-651:1999, IEV 651-14-01]

3.6 Nominal voltages

3.6.1
extra-low voltage
ELV
normally not exceeding 50 V alternating current (a.c.) or 120 V ripple free direct current (d.c.) whether between conductors or to earth

Note 1 to entry: This includes SELV, PELV and FELV (see HD 60364-4-41).

[SOURCE: IEC 60050-826:2004, IEV 826-12-30 modified]

3.6.2
low voltage
LV
normally not exceeding 1 000 V a.c. or 1 500 V d.c.

[SOURCE: IEC 60050-151:2001, IEV 151-15-03 modified]

3.6.3
high voltage
HV
normally exceeding 1 000 V a.c. or 1 500 V d.c.

4 Basic principles

4.1 Safe operation

Before carrying out any operation on an electrical installation an assessment of the electrical risks shall be made. This assessment shall specify how the operation shall be carried out and what safety measures and precautions are to be implemented to ensure safety.

4.2 Personnel

The responsibilities placed upon persons for the safety of those engaged in a work activity and those who are or may be affected by the work activity shall be in accordance with national legislation.

All personnel involved in a work activity on, with, or near an electrical installation shall be instructed in the safety requirements, safety rules and company instructions applicable to their work. These instructions shall be repeated during the course of the work where the work activity is of long duration or is complex. The personnel involved shall be required to comply with these requirements, rules and instructions.

Personnel shall wear clothing suitable for the locations and conditions where they are working. This could include the use of close-fitting clothing or additional PPE (personal protective equipment).

Before any work activity is started and during that work activity, the nominated person in control of a work activity shall ensure that all relevant requirements, rules and instructions are complied with.

The nominated person in control of a work activity shall instruct all persons engaged upon the work activities of all reasonably foreseeable dangers that are not immediately apparent to them.

No person shall undertake any work activity where technical knowledge or experience is needed to prevent electrical danger or injury, unless that person has such technical knowledge or experience, or is under such supervision as is necessary for the work undertaken.

National legislation can set out the minimum age and the criteria for competence of persons.

Where there are no national requirements for competence, the following criteria shall be used in assessing the competence of persons:

– knowledge of electricity;
– experience of electrical work;
– understanding of the installation to be worked on and practical experience of that work;
– understanding the hazards which can arise during the work and the precautions to be observed;
– ability to recognise at all times whether it is safe to continue working.

The complexity of the work activity shall be assessed before the activity starts such that the appropriate choice of skilled, instructed, or ordinary person is made for carrying out the work activity.

4.3 Organisation

4.3.1 Each electrical installation shall be placed under the responsibility of a person, the person responsible for an electrical installation.

In absence of national regulations, the following applies:

The person responsible for an electrical installation can be a natural person from the own organisation or a third party organisation. In the case of a person from another organisation, it is recommended to document the nomination, the part of the installation the person is responsible for and the timescale of nomination in writing.

The person responsible for an electrical installation can delegate a part of his duties to other persons. This should be documented.

Nominated persons in control of an electrical installation during work activities shall control their part of the installation giving authorisation to the nominated person in control of a work activity.

The nominated person in control of an electrical installation during work activities can for assistance delegate some of his duties to other persons as required.

The duties of the person responsible for an electrical installation, the nominated person in control of an electrical installation during work activities and nominated person in control of a work activity may be combined in a single person.

Where two or more installations come together, it is essential that there are formal arrangements for consultation and cooperation between the nominated persons responsible for an electrical installation of each of those installations to ensure safety.

Access to all places where ordinary persons are exposed to electrical hazards shall be regulated. The method of regulation and control of access shall be the responsibility of the nominated person responsible for an electrical installation and shall comply with any national requirements.

Each work activity shall be the responsibility of the nominated person in control of a work activity. Where the work activity is subdivided, it may be necessary to nominate a person to be responsible for the safety of each subdivision, all under the responsibility of one coordinating person.

The nominated person in control of a work activity and the nominated person in control of an electrical installation during work activities shall agree both the arrangements of the electrical system to allow the work to take place and a description of the work activity on, with or near the electrical installation before any changes to the arrangements of the electrical installation are made or work takes place.

Where the work activity is complex, the preparation shall be made in writing.

4.3.2 Any skilled person can specify how the work shall be carried out safely in non-complex installations or non-complex parts of installations under clearly understood or non-complex circumstances and

a) either where non-complex work activities are to take place,

b) or in maintenance work, which is done according to agreed procedures.

4.3.3 There shall be arrangements in place such that any worker who objects for reasons of safety to carrying out any instruction or work activity can report those objections immediately to the nominated person in control of a work activity. That nominated person shall have the matters investigated, and if necessary consult a higher authority for a decision.

4.4 Communication (transmission of information)

This includes every way in which information is passed or exchanged between persons i.e. by spoken word (including telephone, personal radio, and person to person), in writing (including, e. g. fax or e-mail), and visually (including visual display units, warning panels, lights etc.).

Before any work activity starts, the nominated person in control of an electrical installation during work activities shall be informed of the intended work.

All necessary information such as network arrangements, the status of switchgear (on, off, earthed), and the position of safety devices, to permit safe operation of the electrical installation shall be transmitted by a notification.

Where it is necessary to use other means of transmitting information, for example radio signals, computers, lights, etc. such means shall only be used when precautions are taken and are in place to ensure that the information path is reliable and that no misunderstandings can arise or false signals are given.

All notifications shall include the name and, if necessary, the location of the person providing the information.

To avoid errors when information is transmitted verbally the recipient shall repeat the information back to the sender, who shall confirm it has been correctly received and understood.

Permission to start work and re-energising of the electrical installation on completion of work that is controlled by signals or prearranged understanding after an agreed interval of time shall not be permitted.

In the case of the personnel in a work location speaking different languages, and to ensure understanding and comprehensibility, the agreed language that relevant parties understand shall be granted in advance.

4.5 Work location

The work location shall be defined and marked clearly. Adequate working space, means of access and lighting shall be provided at all parts of an electrical installation on, with, or near which any work activity is to be carried out. Where necessary the safe access to the work location shall be clearly marked.

Suitable precautions shall be taken to prevent injury to persons from other hazards that are present in the work location and work activity such as mechanical or pressure systems or falls.

Objects which impede access and/or flammable materials shall not be placed adjacent to nor in or on access ways, escape routes to and from electrical switchgear and controlgear nor in those areas where personnel have to operate that equipment. Flammable materials stored next to or adjacent to electrical plant shall be kept away from all sources of ignition.

4.6 Tools, equipment and devices

Tools, equipment and devices shall comply with the requirements of relevant European, National or International Standards where these exist.

EXAMPLES Examples of tools, equipment and devices are:

– insulating boots, gloves and overshoes;
– eye or face protection;
– head protection;
– suitable protective clothing;
– insulating mats, platforms and stands;
– insulating flexible and rigid screening materials;
– insulated and insulating tools;
– operating poles and rods;
– locks, notices, signs;
– voltage detectors and voltage detecting systems;
– cable locating equipment;
– earthing and short-circuiting equipment;
– barriers, flags, supports.

Tools, equipment and devices shall be used in accordance with the instructions and/or guidance provided by the manufacturer or supplier. These instructions and/or guidance shall be in the language or languages of the country of use.

Any tools, equipment and devices provided for the purpose of safe operation of, or work on, with, or near electrical installations shall be suitable for that use, be maintained in a condition suitable for that use, and be properly used.

NOTE 1 "Maintained in a condition suitable for use" means periodic visual inspections and electrical testing where necessary including after repairs and/or modification to verify the electrical integrity and mechanical properties of the tools, equipment and devices.

NOTE 2 Equipment includes personal protective equipment.

All special tools, equipment and devices used during operation of or work on, with, or near an electrical installation shall be properly stored.

4.7 Drawings and records

There shall be available up-to-date drawings and records for the electrical installation.

4.8 Signs

When necessary, during any work or operations adequate signs shall be displayed to draw attention to any relevant hazard. The signs shall comply with relevant European, National or International Standards where these exist.

4.9 Emergency arrangements

Suitable emergency arrangements shall be developed and implemented by the person overall responsible for electrical installations and safety at work for the case an electrical accident or incident takes place. For some guidelines, see B.7.

A sufficient number of persons who are required to work on with or near an electrical installation shall be provided with training and information so that they are able to give appropriate first aid treatment for electric shock and/or burns. It is recommended that guidance on first aid be provided on posters or charts displayed at the work location or in leaflets or safety documents issued to workers as appropriate to the circumstances

5 Operational procedures

5.1 General

In the case of activities as specified in 5.2 and 5.3, as appropriate, suitable tools and equipment shall be used so that electrical danger to persons is prevented. These activities shall be subject to agreement of the nominated person responsible for an electrical installation or if necessary the nominated person in control of an electrical installation during work activities. The nominated person responsible for an electrical installation or if necessary the nominated person in control of an electrical installation during work activities shall be informed when those agreed operational procedures have been completed.

5.2 Operating activities

5.2.1 Operating activities are designed to change the electrical state of an electrical installation.

There are two kinds of operating activities:

– operations intended to modify the electrical state of an electrical installation, to use an equipment, connect, disconnect, start or stop equipment designed to be used without risks so far as is reasonably practical;

– disconnecting or reconnecting installations for working.

Operating activities may be carried out locally or by remote control.

5.2.2 Disconnecting before or reconnecting after dead working shall be carried out by skilled or instructed persons as prescribed in 6.2.

5.2.3 Means for cutting off supply of electricity to equipment in an emergency shall be provided in accordance with national or local requirements.

5.2.4 Only skilled or instructed persons shall carry out emergency operations on electrical distribution installations.

5.2.5 If an earth fault is not disconnected on an electrical installation with a rated operating voltage exceeding 1 kV, measures shall be taken to locate the earth fault and adequate safety measures shall be taken for the protection and safety of personnel.

NOTE The adequate measures to be taken are dependent on the technology used and the design of the installation.

5.3 Functional checks

5.3.1 Measurement

5.3.1.1 In this European Standard, measurement is defined as all activities to measure physical data within electrical installations. Only skilled or instructed persons, or ordinary persons under the immediate control or supervision of a skilled person shall carry out measurement.

5.3.1.2 When carrying out measurements within electrical installations, suitable and safe measuring instruments shall be used. These instruments shall be checked before use and where necessary after use.

5.3.1.3 Where there is a risk of contact with bare live parts, the personnel carrying out the measurements shall use personal protective equipment and take precautions against electric shocks, and the effects of short circuit and arcing.

5.3.1.4 Where necessary, the rules for dead working (6.2), live working (6.3) or working in the vicinity of live parts (6.4) shall apply.

5.3.2 Testing

5.3.2.1 Testing includes all activities designed to check the operation or the electrical, mechanical or thermal condition of an electrical installation. Testing includes also activities to prove the effectiveness of, for example, electrical protective and safety circuits. Testing may include measurement activities that shall be carried out according to 5.3.1. Testing shall be carried out by skilled or instructed persons, or ordinary persons under the immediate control or supervision of a skilled person only.

5.3.2.2 Testing an installation that has been made dead shall be carried out in accordance with the rules of dead working. If it is necessary to open or remove earthing and short-circuiting devices, suitable precautions shall be taken to prevent the installation being re-energised from any possible source of supply and to prevent electric shock for the personnel.

5.3.2.3 When testing under normal supply the relevant requirements of 6.1, 6.3 and 6.4 shall apply.

5.3.2.4 When testing using an external source of supply precautions shall be taken to ensure that

– the installation is isolated from any possible normal source of supply (see 6.2.2),

– the installation cannot be re-energised by any other source of supply than a dedicated external source of supply,

– safety measures against electrical hazards are taken during the tests for all the personnel present,

– the points of disconnection have adequate insulation characteristics to withstand simultaneous application of the test voltage on one side with working voltage on the other side.

5.3.2.5 Some specialised forms of electrical tests, for example in high voltage test laboratories, where bare live parts are exposed shall be carried out by skilled persons who have received appropriate specialised training. Additional protective precautions based on EN 50191 and Clause 6 of this European Standard shall be implemented as necessary.

5.3.3 Inspection

5.3.3.1 The purpose of inspection is to verify that an electrical installation is in accordance with safety regulations and the specified technical requirements of the relevant standards; the inspection may include verification of the normal state of that installation. New electrical installations as well as modifications and extensions of existing installations shall be inspected prior to their being brought into operation. Electrical installations shall be inspected at suitable intervals. The purpose of periodic inspections is to discover defects that can occur after commissioning and may impede the operation or generate hazards.

5.3.3.2 The inspection may include

– visual examination,

– measuring and/or testing in accordance with the requirements of 5.3.1 and 5.3.2.

5.3.3.3 Inspections shall be carried out with reference to relevant electrical drawings (see 4.7) and specifications.

5.3.3.4 If defects constitute an immediate danger, these shall be rectified without delay, or these faulty parts shall be disconnected without delay and secured against reconnection.

5.3.3.5 Inspections shall be carried out by skilled persons with experience in the inspection of similar installations. Inspections shall be carried out with suitable equipment in such a way as to prevent danger whilst taking into account, if necessary, the constraints imposed by the presence of bare live parts.

5.3.3.6 The result of an inspection shall be recorded. Suitable corresponding remedial actions shall be taken where necessary and the results recorded in accordance with national and local requirements.

6 Working procedures

6.1 General

6.1.1 General requirements

Before starting any work, a suitable risk assessment shall be completed and the necessary protective measures shall be applied (see also 4.1).

Only the nominated person in control of an electrical installation during work activities shall give authorisation. This shall be repeated in case of any interruption of the work activity except short breaks on which work location is not left.

In order to give support to the nominated person in control of an electrical installation during work activities, the nominated person in control of a work activity should inform him of the nature, place and consequences to the electrical installation of the intended work. It is preferable that this information is given in writing, especially for complex work.

According to the basic principles, either the nominated person in control of an electrical installation during work activities or the nominated person in control of a work activity shall ensure that specific and detailed instructions are given to the personnel carrying out the work before starting and on completion of the work.

Working procedures are divided into three different procedures: dead working (see 6.2), live working (see 6.3), working in the vicinity of live parts (see 6.4). All these procedures are based on the use of protective measures against electric shock and/or the effects of short-circuits and arcing. For further details on arc hazard, see B.6.

If the requirements of 6.2 (dead working) or 6.4 (working in the vicinity of live parts) cannot be fully met then the requirements of 6.3 (live working) shall be observed.

The level of insulation for working shall be ensured by, for example applying solid insulation material or maintaining a sufficient distance in air (see 6.3 and 6.4). Table A.1 gives guidance for the minimal acceptable distances in air.

6.1.2 Specific requirements in case of induction

Conductors or conductive parts in the proximity of live conductors may be electrically influenced. In addition to the following requirements of 6.2 and 6.4, specific precautions shall be taken when working on electrical systems influenced by induction (this is particularly so for work on overhead lines):

– by earthing at adequate intervals in order to reduce the potential between conductors and earth at a safe level;

– by equipotential bonding at the work location in order to avoid the possibility of workers inserting themselves in an induction loop.

6.1.3 Specific requirements according to weather conditions

Restrictions on starting and/or continuing work shall be applied in the event of adverse environmental conditions e.g. lightning, heavy rain, fog, high winds etc.

When lightning is seen or thunder is heard or in the event of a near approach of a lightning storm, work on exposed conductors of electrical installations, or an apparatus directly connected to exposed conductors, shall cease immediately where necessary to prevent danger and the nominated person in control of an electrical installation during work activities shall be notified.

When there is poor visibility at the work location, no work activity shall start and any work in progress shall be suspended having made the work site safe.

6.2 Dead working

6.2.1 General

This subclause deals with the essential requirements (“the five safety rules”) for ensuring that the electrical installation at the work location is dead and secure for the duration of the work. This shall require clear identification of the work location. After the respective electrical installations have been identified, the following five essential requirements shall be undertaken in the specified order unless there are essential reasons for doing otherwise:

– disconnect completely;

– secure against re-connection;

– verify absence of operating voltage;

– carry out earthing and short-circuiting;

– provide protection against adjacent live parts.

Authorisation shall be given by the nominated person in control of an electrical installation during work activities to any nominated person or persons in control of a work activity. Any person engaged in this work activity shall be skilled or instructed, or shall be supervised by such a person.

6.2.2 Disconnect completely

The part of the installation on which work is to be carried out shall be disconnected from all sources of supply. The disconnection shall take the form of an air gap or equally effective insulation that will ensure that the point of disconnection does not fail electrically.

6.2.3 Secure against re-connection

All switching devices that have been used to disconnect the electrical installation for the work activity shall be secured against re-connection, preferably by locking the operating mechanism. In the absence of locking facilities, equivalent prohibitive actions, in accordance with established practice, shall be taken in order to secure against re-connection. If an auxiliary power source is required for operation of the switching device, this power source shall be made inoperative. Notices, e.g. warning sign(s), shall be attached to forbid interference. Where remote control devices are used to secure against re-connection local operation of the devices shall be prevented. All signalling and interlocking systems used for this purpose shall be reliable.

Parts of the electrical installation still remaining charged after complete disconnection of the installation and securing against re-connection, for example capacitors and cables, shall be discharged using suitable devices.

6.2.4 Verify absence of operating voltage

6.2.4.1 General

The absence of operating voltage shall be verified on all phases or poles of the electrical installation at or as near as practicable to the work location. This condition for parts of the installation that have been switched off shall be verified in accordance with the practice laid down in local instructions. These include for example the use of voltage detectors, voltage detecting systems built into the equipment and/or the use of separately applied voltage detecting systems. Voltage detectors and separately applied voltage detecting systems shall be proved immediately before and where possible after use.

In the case of cable connected electrical installations, if cables that have been isolated cannot be positively identified at the work location, other means of ensuring safety shall be adopted in accordance with established local practice. This may include the use of suitable cable cutting or piercing devices.

Verification of the absence of operating voltage shall always be completed prior to commencement of work. In case of using voltage detectors or voltage detecting systems (VDS), those shall comply with EN 61243-1, EN 61243-2, EN 61243-3 or EN 61243-5.

If, at any time, the work is interrupted or the work group has to leave the work location and as a consequence cannot continuously control the electrical installation, absence of voltage shall be verified once again prior to recommencement of the work, however if the work location is still earthed and short-circuited verification is not required.

6.2.4.2 Special application

Where remotely controlled earthing switches, suitable for short-circuiting, are used to ensure that an electrical installation is dead, the switch position of the earthing switch shall be reliably signalled by the remote control system.

In case this earthing switch is to be switched locally and the function of the earthing switch can be observed visually, the earthing operation of all conductors of the switch shall be verified.

Earthing switches in HV-installations shall comply with EN 62271-1 and EN 62271-102.

6.2.5 Earthing and short-circuiting

6.2.5.1 General

At the work location for all high and some low voltage installations (see 6.2.5.2), all parts that are to be worked on shall be earthed and short-circuited. Earthing and short-circuiting equipment or devices shall be first connected to the earthing point and then to the components to be earthed and in reverse order when removing.

The earthing and short-circuiting equipment or devices shall be visible, whenever possible, from the work location. Otherwise, the earth connections shall be applied as close to the work location as is reasonably practical.

Where during the course of the work activity conductors are to be broken or joined and there is danger from potential differences on the installation, suitable measures such as bonding and/or earthing shall be taken at the work location before the conductors are broken or joined.

Earthing and short-circuiting equipment shall comply with EN 61219 or EN 61230.

In all cases, it shall be ensured that the earthing and short-circuiting equipment or devices and cables and connectors for bonding used for this purpose are suitable and adequately matched to the fault rating of the electrical installation where they are installed.

Precautions shall be taken to ensure that the earths remain secure during the time the work is in progress. If, during measurement or testing, the earth connections are removed, additional or alternative special precautions to prevent danger shall be taken.

Where remotely controlled earthing switches, suitable for short-circuiting, are used to earth and short circuit an electrical installation the position of the earthing switch shall be reliably signalled by the remote control system.

In case this earthing switch is to be switched locally and the function of the earthing switch can be observed visually, the earthing and short circuiting operation of all conductors of the switch shall be verified.

6.2.5.2 Requirements for extra low and low voltage installations

Earthing and short-circuiting may not be necessary in extra low and low voltage installations, except if there is a risk of the installation being made live, for example:

– on overhead lines crossed by other lines or electrically influenced;

– by a stand-by-generator.

At work on low voltage overhead lines, except for electrical insulated overhead lines, all conductors should be earthed as close as practicable to the work location including the neutral conductor as well as the switching and control wires e. g. for streetlights. In every case, all conductors specified in the sentence before shall be short-circuited.

6.2.5.3 Requirements for high voltage installations

For bare overhead lines and bare conductors, earthing and short-circuiting shall be carried out on all sides of the work location on all conductors entering this location; at least one of the earthing and short-circuiting equipment or device shall be visible from the work location. These rules have the following exceptions:

– for a specific work activity, where there is no break in conductors during work, the installation of a single earthing and short-circuiting device at the work location is acceptable;

– where it is not possible to see earthing and short-circuiting equipment or device at the limits of the work location locally applied earthing and short-circuiting equipment or device or additional signalling devices or any other equivalent identification shall be provided.

When working on only one conductor of an overhead line, no short-circuiting is required at the work location, provided all the following conditions are fulfilled:

– all points of separation are earthed and short-circuited in accordance with 6.2.5.1;

– the conductor upon which the work is being carried out and any conducting parts within the work location are bonded and earthed by suitable equipment or devices;

– the earthed conductor, the work location and the worker are at a distance greater than D_L (see Figures 1 and 2) from the remaining conductors of the same electrical circuit.

For insulated overhead lines, cables or other insulated conductors, earthing and short-circuiting shall be carried out on the bare part of the points of separation of the installation or as close as possible to those points on all sides of the work location.

6.2.6 Protection against adjacent live parts

If there are parts of an electrical installation in the vicinity of the work location that cannot be made dead, then special additional precautions are necessary and shall be applied before work starts as detailed in "working in the vicinity of live parts" (see 6.4).

6.2.7 Permission to start work

The authorisation given by the nominated person in control of an electrical installation during work activities is a necessary condition.

The permission to start work shall be given to the workers only by the nominated person in control of a work activity and only after the measures detailed in 6.2.2 to 6.2.6 have been carried out.

Normally for HV work, formal written details of disconnections and earthing, where appropriate, should be used to avoid misunderstandings.

6.2.8 Re-energising after work

After the work has been completed and inspected, persons no longer required shall be notified that work is completed, no more work is permitted and they shall be withdrawn. All tools, equipment and devices used during the work shall be removed. Only then shall the procedure for re-energising be commenced.

All earthing and safety equipment and/or devices at the work location shall be removed. Starting from the work location and progressing outwards, the earthing equipment and/or devices that were applied to the electrical installation shall be removed and all the locks or other devices, which were used to prevent re-connection shall also be removed. All signs used for the work activity shall be removed.

As soon as one of the actions taken to make the electrical installation safe for work has been reversed this part of the electrical installation shall be regarded as live.

When the nominated person in control of a work activity has verified that the electrical installation is ready to be re-energised, notification shall be made to the nominated person in control of an electrical installation during work activities, stating that the work is finished and the electrical installation is available for reconnection.

6.3 Live working

6.3.1 General

6.3.1.1 Live working shall only be carried out according to national requirements and practices. The requirements of 6.3 may not apply to activities such as voltage detection and the application of earthing and short-circuiting devices, etc.

6.3.1.2 During live working procedures, workers make contact with bare live parts or reach into the live working zone, either with parts of their body or with tools, equipment or devices being handled.

Recommended values of the minimum acceptable distance in air defining the outer limit of the live working zone D_L can be found in Table A.1.

6.3.1.3 Live working procedures shall only be carried out after having suppressed fire and explosion risks (see B.4 and B.5).

6.3.1.4 Care shall be taken to ensure that a stable location is provided which leaves the worker with both hands free.

6.3.1.5 Personnel shall wear suitable and adequate personal protective equipment. They should wear no metallic items for example personal jewellery if this is likely to cause a hazard.

6.3.1.6 For live working protective measures to prevent electric shock and short circuit shall be used. All different potentials (voltages) in the surroundings of the work location shall be considered.

Depending on the kind of work, the personnel working in such conditions shall be instructed or skilled, and specifically trained for this task.

Live working requires the use of specific procedures as set out in 6.3.4. Instructions shall be given on how to maintain tools, equipment and devices in good working state and on how to verify them before working (see 6.3.6).

Environmental conditions (see 6.3.7) such as humidity and air pressure may affect performance. Corresponding limitations shall be specified.

6.3.2 Training and qualification

A specific training programme shall be set out to develop and maintain the capacity of skilled or instructed persons to perform live working. This programme shall comply with special requirements for live working and shall be based on theoretical and practical exercises.

These exercises shall be representative of the work to be done after training or, if different from the work itself, shall be based on the same safety principles.

On successful completion of the training, a certificate of training shall be given to the participant to confirm that the personnel are able to undertake live working for which they have been trained and according to their level of training.

The level of ability should be confirmed by a live working certificate.

6.3.3 Maintenance of personnel ability

The ability to carry out live working safely shall be maintained either by practice or by new or refresher training.

The validity of live working certificate should be revised whenever necessary, according to the level of ability of the person concerned (see B.2.1).

6.3.4 Working methods

6.3.4.1 General

At present, there are three recognised working methods that depend upon the position of the worker in relation to live parts and upon the means used to prevent electric shock and short-circuit.

6.3.4.2 Hot stick working – Safe clearance working

The method of live working by which the worker remains at a specified distance from the live parts and carries out his work by means of insulating sticks.

6.3.4.3 Insulating glove working

The method of live working in which the worker, whose hands are electrically protected with insulating gloves and possibly insulating arm sleeves, carries out his work in direct mechanical contact with live parts.

For low voltage installations, the use of insulating gloves does not exclude the use of insulating and insulated hand tools and suitable isolation from earth.

6.3.4.4 Bare hand working

The method of live working in which the worker carries out his work in electrical contact with live parts, having been raised to the voltage and suitably isolated from the surrounding.

6.3.5 Working conditions

According to the complexity of the work, the working conditions shall define the rules to be followed in accordance with 6.3.4. They establish the procedures for the work taking into account the preparation and the specific tools and equipment to be used.

The working conditions may include one or more of the following items:

– description of the relationship between personnel involved in live working, such as the nominated person in control of an electrical installation during work activities, the nominated person in control of a work activity and the workers;

– measures to be taken to limit switching over-voltages at the work location, such as prohibition of automatic reclosure of circuit-breakers;

– specified working distances in air for personnel and for conductive devices used during work. These distances are based on phase-to-earth voltage but shall also be given for phase-to-phase voltage and related to the required insulation level (see B.2.2).

6.3.6 Tools, equipment and devices

In addition to 4.6, the characteristics, use, storage, maintenance, transportation and inspections of the tools, equipment and devices shall be specified.

Tools, equipment and devices shall be clearly identified. An instruction for use given by the manufacturer shall be required.

In some cases, national regulations require the specifications for tools, equipment and devices to be provided in writing – a "technical datasheet". These are used to approve a specified level of quality.

Even where there is no requirement under national regulations a technical sheet should be prepared for all high voltage tools, equipment and devices.

6.3.7 Environmental conditions

Restrictions shall be applied to live working in the event of adverse environmental conditions. These restrictions are based on the reduction of insulating properties and on reduced visibility and impaired movement of the worker.

For outdoor work weather conditions shall be considered, where necessary to prevent danger, such as precipitation, thick fog, thunderstorm, violent wind, salt storm and extra low temperature (see B.3). Live working shall be forbidden or suspended, when there is heavy rain, poor visibility or when the workers cannot move their tools easily. When a thunderstorm occurs, live working shall not be started or shall be suspended.

For indoor work, weather conditions need not be considered provided that there are no overvoltages likely to result from the connected outdoor installations and the visibility at the work location is adequate.

Other parameters such as altitude, adverse environment and pollution particularly in the case of work on or near high voltage installations shall be considered if they reduce the insulation quality of tools, equipment and devices.

When environmental conditions require the work to be interrupted, personnel shall leave the installation together with all installed insulating and insulated devices in a safe state. They shall also leave the work location in a safe manner. Before restarting the interrupted work, they shall verify that the insulating parts are clean and intact. Where insulating parts require to be cleaned, the cleaning procedure to be used shall be specified and implemented.

6.3.8 Organisation of work

6.3.8.1 Preparation for work

If there is any doubt about the procedures to be used, preliminary trials shall be carried out before starting work. All aspects of safety, electrical or otherwise shall be studied in order to make suitable preparation for the work.

For complex work, this preparation shall be made in writing and in advance.

6.3.8.2 Action of the nominated person in control of an electrical installation during work activities

The installation, or the part where the work is to be carried out, shall be put into and kept in a defined state as a result of the preparation required. This state can include the inhibition of automatic resets and/or modification of the settings of electrical protection.

The place where auto-reclosure is forbidden should be identified and a sign warning of live working in progress should be installed in the correct place.

According to the complexity of the work, direct lines of communication shall be used between the work location and the relevant control position.

6.3.8.3 Action of the nominated person in control of a work activity

The nominated person in control of a work activity shall inform the nominated person in control of an electrical installation during work activities what the work is and the position on the installation at which it will take place.

Before work begins, explanations shall be given to the workers, on what the work consists of, what the safety aspects are, what the role of each of them is, and what the tools and equipment to be used are.

The level of supervision shall correspond to the complexity of the work activity and/or the voltage level.

The nominated person in control of a work activity shall consider and take account of the environmental conditions during the work activity at the work location.

The permission to start work shall be given to the workers only by the nominated person in control of a work activity.

At the end of the work, the nominated person in control of a work activity shall inform the nominated person in control of an electrical installation during work activities in the required manner.

If the work has been suspended, adequate safety measures shall be taken and the nominated person in control of an electrical installation during work activities shall be notified.

6.3.9 Specific requirements for extra-low voltage installations

For SELV installations work on live parts is permitted without precaution against direct contact, but precautions against short-circuit shall be taken. For PELV and FELV installations, work on live parts shall be in accordance with national requirements, or in the absence of such requirements in accordance with 6.3.10.

6.3.10 Specific requirements for low voltage installations

For low voltage installations (normally not exceeding 1 000 V a.c. or 1 500 V d.c.) protected against over-currents and short-circuits, the only requirements shall be to use protective insulating devices against adjacent live parts, insulated or insulating tools and adequate personal protective equipment for the worker.

Supervision is not mandatory, but when working alone, the worker shall be able to consider and control all risks encountered.

When the short-circuit current may reach a dangerous level, the general requirements (6.3.1 to 6.3.8) shall apply.

6.3.11 Specific requirements for high voltage installations

It shall be verified that all methods and tools chosen are suitable for the installation to be worked on.

Dielectric and mechanical characteristics shall be specified by the standards taking into account the physical parameters at the work location.

If the size of the work location does not enable the nominated person in control of a work activity to provide total supervision, he shall delegate a person to assist him. Depending on risk analysis, this person shall be skilled or instructed to do this assistance.

6.3.12 Specific works on live parts

Works such as cleaning, spraying and removing of hoarfrost deposits on insulators shall be covered by specific working instructions. The personnel employed to carry out these tasks shall be skilled or instructed.

6.4 Working in the vicinity of live parts

6.4.1 General

6.4.1.1 Working in the vicinity of live parts shall be carried out in accordance with national legislation (see also Annex A).

6.4.1.2 Work activities in the vicinity of live parts with nominal voltages above 50 V a.c. or 120 V d.c. shall only be carried out, when safety measures ensure that live parts cannot be touched or the live working zone cannot be reached.

6.4.1.3 In order to control the electrical hazards in the vicinity of live parts, protection may be provided by either screens, barriers, enclosure or insulating covering (see 6.4.2).

If those measures cannot be carried out protection shall be provided by maintaining a safe distance greater than D_L (see Table A.1) to bare live parts and when necessary, providing appropriate supervision.

6.4.1.4 Care shall be taken to ensure that a stable working location is provided which leaves the worker with both hands free.

6.4.1.5 Before commencement of work, the nominated person in control of a work activity shall instruct personnel, particularly those who are not familiar with working in the vicinity of live parts, on the maintenance of safety distances, on the safety measures that have been put into force and on the need for continual awareness of safety at all time. The boundary of the work location shall be defined precisely and clearly (see 6.4.1.6) and attention shall be drawn to unusual circumstances or conditions. These instructions shall be repeated at suitable periods or after a change in working conditions.

6.4.1.6 The work location should be marked out by suitable barriers, ropes, flags, lamps, signs etc. Adjacent live switch panels shall be distinguished by additional, clearly visible means, for example clear warning signs secured to the front of doors.

6.4.1.7 The worker himself shall ensure, whatever the movements he can do, that he does not reach the live working zone neither with parts of his or her body nor with tools nor things he handles. Particular care shall be taken when handling long objects, for example tools, cable ends, pipes, ladders etc.

6.4.2 Protection by screen, barrier, enclosure or insulating covering

6.4.2.1 These protective devices shall be selected and installed to provide sufficient protection against the expected electrical and mechanical stresses.

6.4.2.2 When these protective devices are being installed within the live working zone either dead working or live working procedures shall be adopted.

6.4.2.3 When these protective devices are being installed outside the live working zone they shall be set up either using dead working procedures or by using devices preventing the personnel installing them from encroaching into the live working zone. If necessary, live working procedures shall be used.

6.4.2.4 When the above conditions are fulfilled, working in the zone, where protective devices have been installed (the former vicinity zone), can be carried out under normal procedures by skilled, instructed or ordinary persons and no additional special requirements are to be followed. The devices used for the barriers, enclosures, or insulating coverings shall be suitably maintained and kept secured during the work activity. If those devices do not ensure a full protection of the bare live parts (for low-voltage installations a degree of ingress protection of not less than IP2X… or IPXXB /the corresponding level of protection for high voltage is IP3X or IPXXC) ordinary persons working near these parts shall be supervised.

6.4.3 Protection by safe distance and supervision

When protection by safe distance and supervision is used, this method of working shall at least include

– the safe distance not less than D_L to be maintained taking into account the nature of the work activity and the nominal voltage of the electrical installation,

– the criteria to be adopted for nominating the personnel who may be required to carry out the work activity,

– the procedures to be adopted during the work activity to prevent encroaching into the live working zone.

6.4.4 Construction work and other non-electrical work

For construction work and other non-electrical work, such as

– staging work,

– work with lifting equipment, construction machines and conveyors,

– installation work,
– transport work,
– painting and renovating,
– positioning of other equipment and building equipment,

a specified distance shall be maintained at all times, particularly when swinging out loads, carrying and lifting equipment. This distance shall be measured from the nearest conductors or bare live parts.

The specified distance shall be derived from D_V (Table A.1) and additionally a further distance taking account of

– the system voltage,
– the nature of work,
– the equipment to be used,
– the persons involved are ordinary persons.

It is strongly advised that this specified distance is not less than or preferable greater than D_V.

For overhead lines, it shall take into account all possible movements of the lines and all movements, displacement, swinging out, whipping or fall of the equipment used to carry out the work.

Due to the wide variations in these work activities, **no** recommendations for these distances are given in this European Standard (see local regulation).

7 Maintenance procedures

7.1 General

7.1.1 The purpose of maintenance is to keep the electrical installation in the required condition. Maintenance may consist of "preventive maintenance" which is carried out on a routine basis with the intention of preventing breakdown and keeping equipment in good condition, or "corrective maintenance" which is carried out to repair or replace a defective part.

7.1.2 There are two types of maintenance work:

– work where the risk of electric shocks, short-circuit or arcing is present and therefore the appropriate working procedures (see Clause 6) shall applied;
– work where the design of equipment enables certain maintenance (for example replacement of fuses or light bulbs) to be undertaken safely without full working procedures as described in 7.4 shall be applied.

7.1.3 Where necessary, the rules for dead working (6.2), live working (6.3) or working in the vicinity of live parts (6.4) shall apply.

7.2 Personnel

7.2.1 All maintenance procedures to be carried out shall be approved by the nominated person in control of an electrical installation during work activities.

7.2.2 When maintenance work is carried out on an electrical installation:

– the part of the installation concerned shall be clearly defined;

– the person in charge of the maintenance work shall be nominated. This person is a nominated person in control of a work activity

7.2.3 Personnel who have to carry out the work shall be adequately instructed or skilled i.e. they shall be competent for the task to be undertaken. They shall be equipped with and they shall use appropriate tools, measuring and testing devices and personal protective equipment that shall be maintained in a good condition.

7.2.4 All necessary safety measures shall be taken including where necessary precautions to prevent danger to other persons and the protection of livestock and property.

7.3 Repair work

7.3.1 Repair work may consist of the following stages:

– fault location;

– fault rectification and/or replacement of components;

– recommissioning the repaired part of the installation.

Different procedures may need to be applied at each stage of the work.

7.3.2 Specific working conditions shall be defined when locating and confining defects with the installation energised or during application of test voltages according to Clause 5 or based on Clause 6.

7.3.3 Elimination of defects shall be carried out in accordance with the rules of working procedures (see Clause 6).

7.3.4 Appropriate functional and verification tests and necessary adjustments shall be performed to ensure that the repaired parts of the installation are suitable for re-energisation.

7.4 Replacement work

7.4.1 Replacement of fuses

Generally, the replacement of fuses should be carried out dead unless a safe procedure is followed to replace them live.

For low voltage installations, if the fuse is fitted in a device protecting the person against direct contact and the possible occurrence of short-circuit, the replacement may be carried out without verifying the absence of voltage and by an ordinary person.

For high voltage installations, the replacement shall be carried out according to the appropriate working procedures (see Clause 6) by an instructed or skilled person.

7.4.2 Replacement of lamps and accessories

The replacement of lamps and withdrawable accessories such as starters should be carried out dead – but where necessary, based on risk assessment, it may be done live.

For low voltage installations, these replacements may be carried out live by an ordinary person where the equipment provides protection against contact (minimum IP2X or IPXXB).

In all other cases and especially in the case of high voltage installations replacement shall be carried out in accordance with repair procedures (see 7.3).

Replacement of non-withdrawable accessories shall be carried out in accordance with the working procedures set out in Clause 6.

Care shall be taken to ensure that the replacement parts used are suitable for use in the equipment being maintained.

7.5 Temporary interruption

In the event of temporary interruption of maintenance work, the nominated person in control of a work activity shall take all necessary measures to prevent access to bare live parts and non-authorised operation of the electrical installation.

Where necessary the nominated person in control of an electrical installation during work activities shall be informed of any such interruption.

7.6 End of maintenance work

At the end of the maintenance work, the nominated person in control of a work activity shall hand over the installation to the nominated person in control of an electrical installation during work activities. The status of the maintained electrical installation at handover shall be notified to the nominated person in control of an electrical installation during work activities.

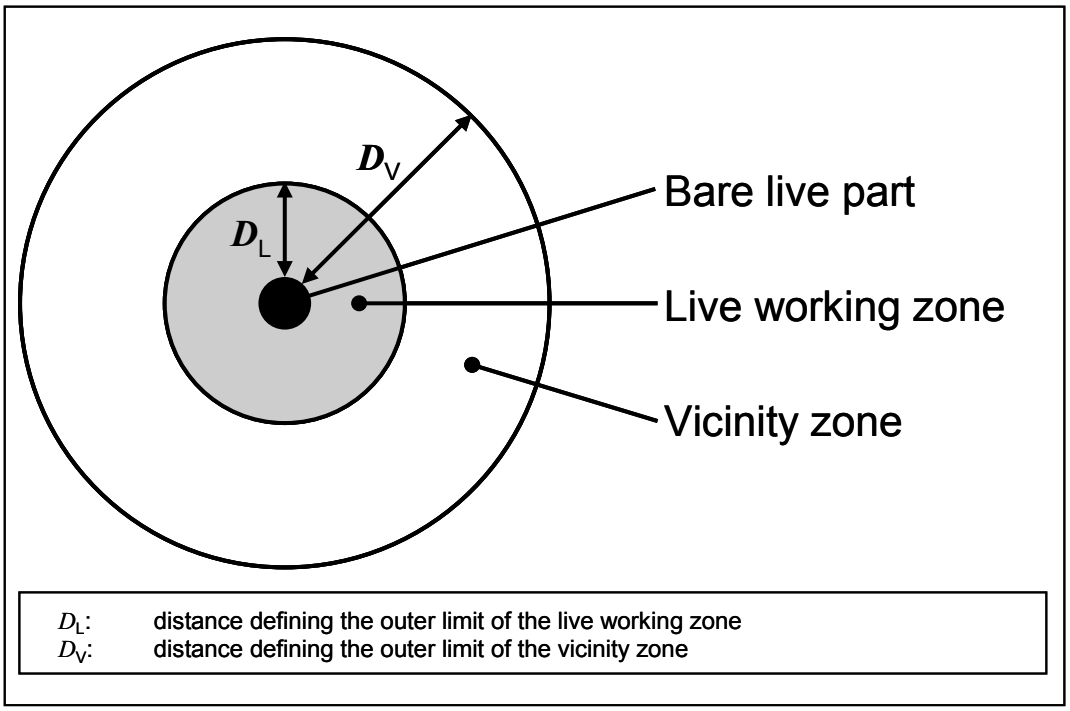


Figure 1 – Distances in air and zones for working procedures

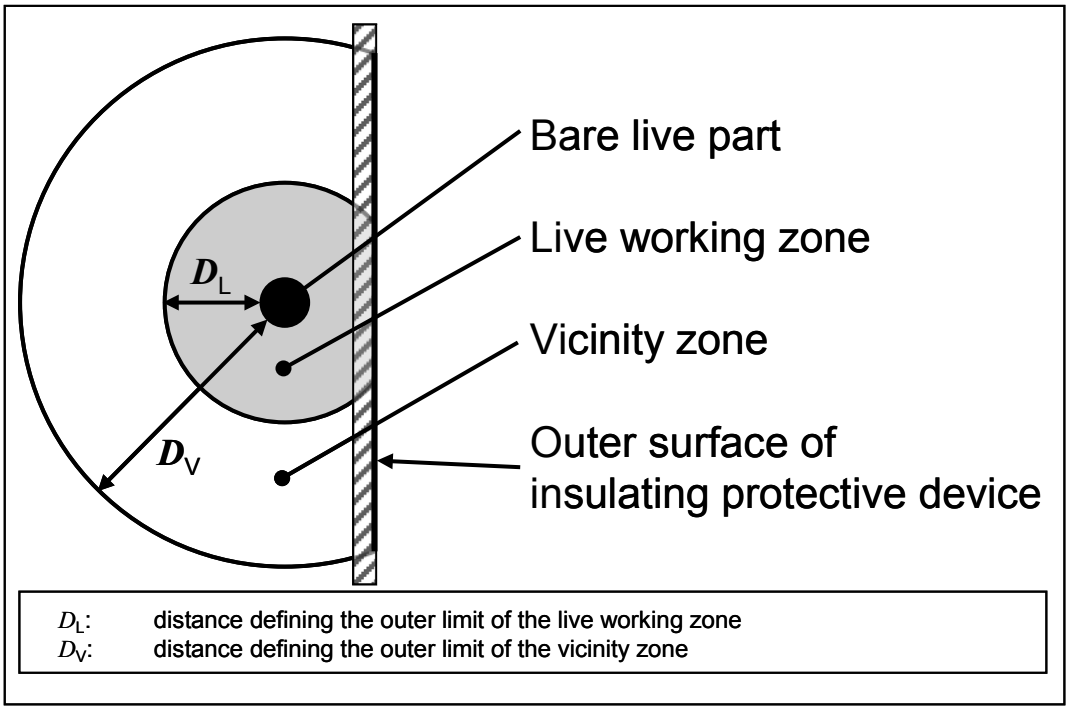


Figure 2 – Limitation of the live working zone by the use of an insulating protective device

Annex A
(informative)

Guidance for distances in air for working procedures

A.1 General

The purpose of Annex A is to provide those users of this European Standard who do not have national requirements with recommended minimum distances for both live working and working in the vicinity of live electrical installations, and with guidance on the use of the data set out in Table A.1.

A.2 Live working

The live working zone is a zone surrounding live parts. The outer boundary of this zone is measured from the live part. The distance D_L applies to the outer boundary of the zone. Live working is all work where the worker either makes contact with live parts or is inside or reaches with parts of the body or with tools (see B.2.2), equipment and devices being handled into this zone.

A.3 Work in the vicinity

The vicinity zone is a zone surrounding a live working zone. The outer boundary of this zone is measured from the live part. The distance D_V applies to the outer boundary of the zone. The distance from the live working zone boundary D_L to the outer boundary of the vicinity zone depends upon the voltage of the live part. Work in the vicinity is all work where a worker is either inside or reaches with parts of the body, or tools, equipment and devices being handled, into this zone but does not reach into the live working zone.

Table A.1 – Guidance for distances D_L and D_V

Nominal system voltage U_N kV r.m.s.	**Minimum acceptable distance in air defining the outer limit of the live working zone** D_L mm	**Minimum acceptable distance in air defining the outer limit of the vicinity zone** D_V mm
≤ 1	no contact	300
3	60	1 120
6	90	1 120
10	120	1 150
15	160	1 160
20	220	1 220
30	320	1 320
36	380	1 380
45	480	1 480
60	630	1 630
70	750	1 750
110	1 000	2 000
132	1 100	3 000
150	1 200	3 000
220	1 600	3 000
275	1 900	4 000
380	2 500	4 000
480	3 200	6 100
700	5 300	8 400

The figures of D_L and D_V have been set out to be a set of minimum administrative values, with respect to those existing in European countries.

Up to 70 kV: a wide range of values exists for D_L, because ergonomic considerations prevail on the calculation of the electrical component.

Consequently, the lowest value among the set of European figures is picked up.

Above 70 kV: the electrical component becomes predominant.

Accordingly, the minimum values of D_L given in Table A.1 are confirmed by computation method of EN 61472.

In the absence of computation methods for DC-systems, the values for distance D_L and D_V for AC-systems could also be used for DC-systems up to 70 kV.

NOTE 1 Intermediate values for D_L and D_V may be determined by linear interpolation.

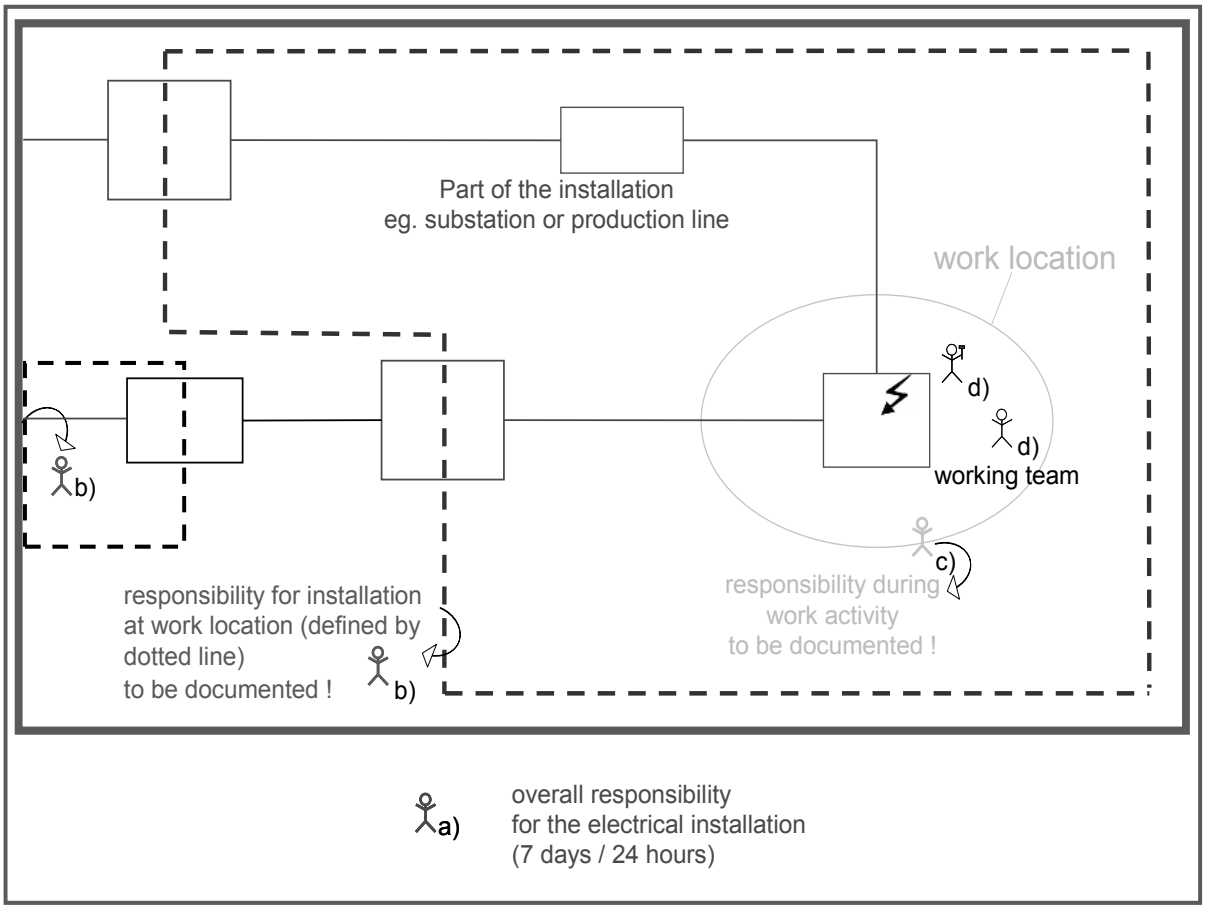
NOTE 2 The values of Table A.1 intend to give guidance for future harmonisation between countries. Nevertheless, lower values can be accepted temporarily.

Annex B
(informative)

Additional information for safe working

B.1 Example for responsibility levels

B.1.1 General scheme



Key

a) person responsible for an electrical installation

b) nominated person in control of an electrical installation during work activities

c) nominated person in control of a work activity

d) member of working team

Figure B.1 – Responsibility levels

B.1.2 Domestic

Classification **a)**: owner

Classification **b)**, **c)** and **d)**: self employed electrician

B.1.3 Small company or craftsman

Classification **a)**: owner (e.g. baker as owner of a bakery)

Classification **b)**, **c)** and **d)**: self employed electrician

B.1.4 Large or Industrial company

Classification **a)**: employer or executive board or appointed person overall responsible for the electrical installation

Classification **b)**: person charged to carry out the role of responsibility for an electrical installation during work activities

Classification **c)**: Team leader of a team of the own company or a third party company

Classification **d)**: member of working team

B.2 Example of application of live working

B.2.1 Review of the live working certificate

When the live working certificate is required by regulation or practice, the validity of live working certificate should be reviewed in the following cases:

– transfer of personnel or change of management;

– change of function;

– interruption in carrying out operations for a long period of time;

– medical restrictions;

– reported non-compliance with the rules governing the operations or unsuitability;

– in the event of significant modifications to installations (changes to equipment or structure);

– in the event of changes in working or maintenance methods.

It is recommended good practice to review these certificates on at least an annual basis.

B.2.2 Calculation of the specified working distance

A basis for this calculation can be found in EN 61472.

B.3 Atmospheric conditions that are part of environmental conditions to be assessed

B.3.1 Precipitation

Precipitation is taken to mean rain, snow, hail, drizzle, spray or hoarfrost.

Precipitation is said to be insignificant where it does not hinder the visibility of the workers. Should visibility be impaired, it is said to be significant. According to the voltage level, the type of installation and the method used, when precipitation is significant the work should be interrupted.

B.3.2 Thick fog

Fog is considered thick where visibility is reduced to a level that endangers safety, particularly when the nominated person in control of a work activity cannot see the members of the team and the live parts on which, or in the vicinity of which, they should be working. Work should be interrupted in these conditions.

B.3.3 Thunderstorms

Thunderstorms consist of lightning and thunder. When one person of the site personnel sees lightning and hears thunder, they should interrupt the work, if they are working on bare conductors, overhead lines and substation equipment connected with such lines.

B.3.4 Violent wind

Wind is said to be violent when it prevents the worker using his tools with sufficient precision; in that case, the work should be interrupted.

B.3.5 Salt storms

These are strong winds that carry salt-laden moisture from the sea on to the land.

The insulation levels will be reduced or bridged over when there is subsequent fog or drizzle, or when the humidity level increases significantly.

Work should be interrupted during these winds.

B.3.6 Extra low temperature

The temperature is said to be extra low, when it makes the use of tools difficult and it decreases the durability of materials; in that case, the work should be interrupted.

B.4 Fire protection – Fire fighting

During the operation of electrical installations the possibility of fire arising cannot be excluded.

If fire breaks out, dangerous or endangered parts of the electrical installation should be switched off unless required to be live for fire fighting or where switching off would cause other dangers.

To combat fires in electrical installations, fire extinguishers or fire extinguishing equipment of a type suitable for the class of fire, and of a type and size adapted to the installation, should be kept ready and accessible.

Appropriate persons should be instructed in the operation of fire extinguishers for fire fighting, particularly on live equipment. These instructions should be repeated at adequate intervals.

When using fire extinguishers and extinguishing systems on electrical installations, the appropriate safety clearances should be observed.

Personnel should be aware that toxic substances may be given off by hot and burning materials.

Highly flammable materials and objects should be located or stored so that they are not readily ignited.

B.5 Work location presenting explosion risks

When electrical work activities are to be carried out where there may be a risk of explosion, the following recommendations should be implemented:

a) either forbid or suspend all work activities until adequate measures have been taken to suppress the explosion risk, for example, elimination of emission of flammable gases, ventilation, etc.

b) or take the appropriate measures, in accordance with the kind of risk of explosion, to control the explosion risk, such as:

   1) by continuous monitoring of the atmosphere and by forbidding any source of energy likely to ignite the explosive mixture;

   2) by continuous ventilation and monitoring of the atmosphere;

   3) by limiting the work activities to the intended use of intrinsically safe electrical equipment.

B.6 Arc hazard

B.6.1 General

Persons working in the vicinity of electrical installations are exposed to hazards caused by an electrical arc. Electrical arcs are a rare event. Nevertheless, a reliable protection is required as the appearance cannot be excluded particularly since they can be caused by actions during working. Electric arcs are not only a result of a short circuit, but also separating burdened live parts without special measures (lines, cable connector, switchgears, fuses, etc.).

B.6.2 Hazards

The thermal impact of an electric arc depends on the incident electrical energy (short-circuit capacity), that determines the energy converted in the arc (depending on the arc voltage, arc current and arc duration), and the heat flux transmission conditions including the exposure conditions and the distance to the arc. The mode and violence of heat transfer is basically not specific for certain voltage levels (low or high voltage).

Besides the thermal impact, there are some other hazards to be assessed:

– shock wave and flung fragments which are released by the explosive spreading of the electrical arc;

– high intensities of an electromagnetic radiation particularly in the range of ultraviolet (UV) and infrared (IR) radiation but also in the range of visible light which can lead to irreversible damages to skin and eye;

– acoustic shock (bang);

– poisonous gasses and particles that are caused by melting and vaporising of materials within or in the environment of the electrical arc.

Suitable personal protective equipment (PPE) reduces the thermal arc hazards of electric arcs and contributes to the protection of staff. Note that there is no PPE providing one hundred per cent protection against any electric arc. Rather, the hazards of an electric arc can be significantly reduced and oftentimes be eliminated.

B.6.3 Risk assessment

In the case that any work in the vicinity of an electrical installation or under live conditions is necessary, risk assessment should be done.

To carry out planned work the general technical preventive measures, e.g. plates and doors, should be opened or even to be removed for a certain period of time.

As these actions are part of maintenance and repair work, hazards due to electric arcs cannot be completely eliminated for the foreseeable future and suitable measures should be met.

Additionally other workers such as operators may be in reach of electrical arc hazards. These risks should be included in the risk assessment.

For example guidelines for the use of PPE, see Bibliography.

B.7 Emergency arrangements

It is recommended that the person responsible for an electrical installation should consider an assessment of the risks associated with the operation of electrical installations and, where necessary, develop and implement relevant emergency arrangements. Depending on the size of electrical installation/organisation, those emergency arrangements may include some or all of the following (list not exhaustive).

- Establish a reporting mechanism where the nominated person in control of an electrical installation during work activities and the nominated person in control of a work activity report all electrical accidents and/or Incidents. This should also include reporting to the person responsible for an electrical installation where necessary.

- Near misses whilst carrying out any activity in relation to the operation of the electrical installation should be reported. This should include during both normal and out of hours working.

- 3rd party workers may also have to comply with their own companies reporting arrangements/system requirements.

- Dependant on the size of the installation, the person responsible for an electrical installation considers establishing close cooperation with the emergency services.

- Ensure electrical installation diagrams are available and valid.

- Where a person responsible for an electrical installation use control centres then suitable arrangements (including communications) may be required to be implemented between the nominated person in control of an electrical installation during work activities, the nominated person in control of a work activity and the emergency services and control room staff.

- In the event of a fatality, it should be notified immediately to the person responsible for an electrical installation and the emergency services. The site of the accident should be left as it is unless it poses a further danger to staff, contractors or third parties.

- The emergency arrangements may include dispatching rapid response teams whose role includes making site electrically safe and liaising with on site 3rd parties to ensure they do not enter the danger zone during rescue and/or whilst ensuring site is made electrically safe.

- Following an incident, the nominated person in control of an electrical installation during work activities shall take appropriate actions to secure a safe site and preserve, as far as is reasonable practicable, the site conditions intact. This is to ensure a robust accident investigation can be conducted either internally, or, in an extreme case, by external authorities e.g. police or safety regulators.

- The provision of personal first aid and fire fighting equipment.

- The provision of suitable Personal Protective Equipment.

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