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INTERNATIONAL STANDARD

Electrical installations in ships –
Part 509: Operation of electrical installations

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ELECTRICAL INSTALLATIONS IN SHIPS –

Part 509: Operation of electrical installations

FOREWORD

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International Standard IEC 60092-509 has been prepared by IEC technical committee 18: Electrical installations of ships and of mobile and fixed offshore units.

The text of this standard is based on the following documents:

FDIS	Report on voting
18/1196/FDIS	18/1207/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 60092 series, published under the general title *Electrical installations in ships,* can be found on the IEC web site.

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The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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INTRODUCTION

The different parts of IEC 60092 form a series of international standards for electrical installations in sea-going ships, incorporating good practice and co-ordinating, as far as possible, existing rules. These standards form a code of practical interpretation and amplification of the requirements of the International Convention on Safety of Life at Sea (SOLAS 74/88) a guide for future regulations which may be prepared and a statement of practice for use by ship owners, shipbuilders and appropriate organizations.

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ELECTRICAL INSTALLATIONS IN SHIPS –

Part 509: Operation of electrical installations

1 Scope

This part of IEC 60092 is applicable to all operation of and work activity on electrical generation, conversion and distribution systems and electrical equipment in ships, including all a.c and d.c voltages.

This standard sets out the requirements for the safe operation of work and activity on, with, or near electrical installations. These requirements apply to operational, working and maintenance activities. It applies to all electrical work activities as well as non-electrical work activities such as structural work near electrical equipment and cables.

This standard does not apply to ordinary persons when using installations and equipment, provided that the installations and equipment are designed and installed for use by ordinary persons and comply with relevant requirements of the IEC 60092 series.

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.

IEC 60092-101:2002, *Electrical installations in ships – Part 101: Definitions and general requirements*

IEC 61310-2, *Safety of machinery – Indication, marking and actuation – Part 2: Requirements for marking*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60092-101:2002 and the following apply.

3.1 General

3.1.1
electrical installation
installation including all the electrical equipment which provides for the generation, transmission, conversion, distribution and use of electrical energy. It includes energy sources such as batteries, capacitors and all other sources of stored electrical energy

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

3.1.2
live part
conductor or conductive part intended to be energized in normal operation, including a neutral conductor. Not, by convention, a PEN conductor, combining the functions of both a protective earthing conductor and a neutral conductor; or a PEM conductor, combining the functions of both a protective earthing conductor and a mid-point conductor or a PEL conductor, combining the functions of both a protective earthing conductor and a line conductor

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[IEC 60050-651: 1999, 651-01-03]

[IEC 60050-195: 1998, 195-01–12, 195-01-13, 195-01-14, modified]

NOTE This concept does not necessarily imply a risk of electrical shock.

3.1.3
operation
all activities including work activities necessary to permit the electrical installation to function. These activities include such matters as switching, controlling, monitoring and maintenance as well as both electrical and non-electrical work

[IEC 60050-151:2001, 151-11-28, modified]

3.1.4
electrical 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

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

3.1.5
electrical hazard
source of possible injury or damage to health in the presence of electrical energy from an electrical installation

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

3.1.6
electrical danger
risk of injury from an electrical installation

3.1.7
measurement
all activities to measure physical data within electrical installations

3.1.8
inspection
process of verifying that an electrical installation is in accordance with specified technical and safety requirements of the relevant standards and may include verification of the normal state of that installation

3.1.9
survey
process of verifying that an electrical installation is in accordance with specified technical and safety requirements and regulations of the appropriate authority

3.2 Personnel, organisation and communication

3.2.1
nominated person in control of an electrical installation
that person who has been nominated in writing to be the person with direct management responsibility for the electrical installation

[IEC 60050-651:1999, 651-01-37]

NOTE Parts of this responsibility may be delegated to others as required. In general, this will be the chief engineer. The person who makes the nomination should be appropriately qualified with knowledge of electrical work practices.

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3.2.2
nominated person in control of a work activity
that person who has been nominated in writing to be the person with management responsibility for the work activity

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

NOTE Parts of this responsibility may be delegated to others as required. In general, this will be the chief engineer or the electrical officer, if available on board, or the head of the service team. The person who makes the nomination should be appropriately qualified with knowledge of electrical work practices.

3.2.3
electrically skilled person
electrically qualified person (US)
person with relevant education and experience to enable him or her to perceive risks and to avoid hazards which electricity can create

[IEC 60050-651:1999, 651-01-33]

3.2.4
(electrically) instructed person
(electrically) trained person (US)
person adequately advised or supervised by electrically skilled persons to enable him or her to perceive electrical risks and to avoid hazards which electricity can create

[IEC 60050-651:1999, 651-01-34]

3.2.5
ordinary person
person who is neither a skilled person nor an instructed person

[IEC 60050-651:1999, 651-01-35]

3.2.6
supervision
to watch over, by an electrically skilled or nominated person, an activity or task being carried out by personnel and to ensure that it is performed correctly and safely

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

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

3.3.2
vicinity zone
limited space surrounding the live working zone (see Figures 1 and 2)

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

3.3.3
live working zone
space around live parts in which the insulation level to prevent electrical danger is not assured when encroaching it without protective measures (see Figures 1 and 2)

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[IEC 60050-651:1999, 651-01-06, 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, erection and inspection

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

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

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

3.4.4
live working
all work in which a worker 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

[IEC 60050-651:1999, 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

[IEC 60050-651:1999, 651-01-02]

3.4.6
isolate
disconnect completely a device or circuit from other devices and circuits

[IEC 60050-151:2001, 151-15-37]

3.4.7
dead
qualifies a conductive part when it is not energized

[IEC 60050-151:2001, 151-15-59]

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
earthing
grounding (US)
short circuit proof connection from de-energized live parts to the ship's hull or protective conductor so that work may be performed without danger of electrical shock

[adapted from IEC 60050-195:1998, 195-01-12]

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3.4.10
earthing for work
grounding for work (US)
earthing de-energized live parts so that work may be performed without danger of electric shock

[IEC 60050-195:1998, 195-01-12]

3.5 Protective devices

3.5.1
(electrically) protective 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

[Adapted from IEC 60050-826:2004, 826-12-23]

3.5.2
(electrically) protective barrier
part providing protection against direct contact from any usual direction of access

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

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

3.5.4
(electrically) protective enclosure
electrical enclosure surrounding internal parts of equipment to prevent access to hazardous-live-parts from any direction

[IEC 60050-826:2004, 826-12-22]

3.6 Nominal voltages

3.6.1
extra-low voltage (ELV)
not exceeding 50 V alternating current (a.c.) or 120 V ripple free direct current (d.c.) whether between conductors or to earth, this includes SELV, PELV and FELV

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

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

3.6.4 SELV system
electric system in which the voltage cannot exceed the value of extra-low voltage:

– under normal conditions and

– under single fault conditions, including earth faults in other electric circuits

NOTE SELV is the abbreviation for safety extra low voltage.

[IEC 60050-826:2004, 826-12-31]

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3.6.5 PELV system

electric system in which the voltage cannot exceed the value of extra-low voltage:

– under normal conditions and

– under single fault conditions, except earth faults in other electric circuits

NOTE PELV is the abbreviation for protective extra low voltage.

[IEC 60050-826:2004, 826-12-32]

3.7 Distances

3.7.1
minimum working distance
minimum working distance in air to be maintained between any part of the body of a worker, including any conductive tool being directly handled

[IEC 60050-651:1999, 651-01-20, modified]

3.7.2
electrical distance
the distance in air which protects against electrical breakdown during live working

NOTE In generic terms, the electrical distance is the minimum distance between two electrodes, which represent live and/or earthed parts, required to ensure that the probability of electrical breakdown is negligible when subjected to the most severe electrical stress likely to arise under the conditions prescribed.

[IEC 60050-651:1999, 651-01-21, modified]

4 Basic principles

4.1 Safe operation

Routine operations shall be covered by general/standard instructions.

An assessment of the electrical risks shall be made before carrying out any complex operation of or work activity on, with, or near an electrical installation. This assessment shall specify how the operation or work activity shall be carried out to ensure safety.

Before any work activity starts, the nominated person in control of the electrical installation shall be informed and shall agree to the intended work.

4.2 Personnel

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 is long or complex. The personnel shall be required to comply with these requirements, rules and instructions.

Before any work activity is started and during that work activity, the nominated person in control of that work activity shall ensure that all relevant requirements, rules and instructions are complied with and the bridge or engine room watchkeeper notified as appropriate.

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.

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Where there are no requirements for competence set out by the appropriate authority, i.e. the Flag State Administration, the following criteria shall be used in assessing the competence of persons:

- knowledge of electricity;
- experience of electrical work;
- understanding the types of installations 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 recognize at all times whether it is safe to continue working.

NOTE This assessment should result in a written authority, for each person, according to 3.2.2 to 3.2.5.

4.3 Organization

Each electrical installation shall be placed under the responsibility of a person, the nominated person in control of the electrical installation. Where two or more installations come together, it is essential that there are formal arrangements between the nominated persons in control of each of those installations.

The nominated person in control of the electrical installation and the nominated person in control of the work activity can be one and the same person, except on high voltage installations.

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.

NOTE It is recommended that guidance on first-aid is provided on posters or charts displayed at the work location or in leaflets or safety documents issued to workers as appropriate to the circumstances.

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 the work activity. The nominated person shall have the matters investigated, and if necessary consult a higher authority for a decision.

4.4 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. When necessary, the access to the work location shall be marked clearly. Ordinary persons shall be restricted from entering the working location.

4.5 Tools, equipment and devices

Tools, equipment, devices and personal protective equipment shall be used in accordance with the instructions and/or guidance provided by the manufacturer, the supplier or national requirements. These instructions and/or guidance shall be in the language or languages appropriate to the users.

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 "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.

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

4.6 Drawings and records

There shall be available up-to-date drawings and records for the electrical installation. Where changes are made to the ship's electrical system, drawings and records shall be updated.

NOTE Drawings and records should be in a language appropriate to the users.

4.7 Signs

During any work or operations, adequate signs shall be displayed to draw attention to any relevant hazard as necessary. The signs shall comply with IEC 61310-2 or those of the appropriate authority where such signs exist.

4.8 Emergency Situations

The principles of this standard are to be followed in emergency situations, as far as is practicable.

5 Standard operational procedures

5.1 General

In the case of activities as specified in 5.2 and 5.3, as appropriate, tools and equipment as specified in 4.5 shall be used so that electrical danger to persons is prevented.

5.2 Operating activities

5.2.1 Standard ship operation

This operation is intended to start or stop equipment in normal use.

The equipment shall be designed to be used without risk as far as reasonable and practical.

5.2.2 Isolating for maintenance and earthing

This operation is meant to ensure safe work on electrical installations.

Isolating for maintenance and earthing of equipment shall be carried out exclusively by skilled persons.

5.3 Functional checks

5.3.1 Measurement

Measurement shall be carried out by skilled or instructed persons, or ordinary persons under the control and supervision of a skilled person only.

When carrying out measurements within electrical installations, suitable and calibrated measuring instruments shall be used.

If 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. The person carrying out the tests shall be accompanied by a person, trained to recognise danger, how to switch off and if necessary give assistance in the event of an emergency.

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NOTE In some cases it may be possible to make only a section of the electrical installation dead, secure this section, prove the absence of voltage on this section and connect the measuring devices, then restore power and do the measurements if it can be done safely without adverse effects on the ship's operations.

5.3.2 Testing

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.

Test instruments, equipment and accessories shall be rated for circuits and equipment to which they will be connected.

Test instruments, equipment and accessories shall be designed for the environment to which they will be exposed, and for the manner in which they will be used.

Test instruments and equipment and all associated test leads, cables, power cords, probes and connectors shall be visually inspected for external defects and damage before the equipment is used. If there is a defect or evidence of damage, such as cracked cases, cut or pinched leads, or damaged probe tips, the instrument shall be removed from service, repaired and tested before it is used. Test leads shall be fused for energy limitation and the probe tips of the insulated type. The use of multimeters, which can be set to the wrong function, is not recommended for proving dead. Instruments shall be tested before and after use.

Testing shall be carried out by skilled or instructed persons, or ordinary persons under the control and supervision of a skilled person only.

Testing an installation which 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-energized from any possible source of supply and to prevent electric shock for the personnel.

When testing under normal supply the relevant requirements of 6.2 shall apply.

5.3.3 Inspection and survey

New electrical installations as well as modifications and extensions of existing installations shall be inspected and surveyed prior to their being brought into operation.

Electrical installations shall be inspected at suitable intervals. The purpose of periodic inspections is to discover defects which can occur after commissioning and may impede the operation or generate hazards.

The inspection may include:

- visual examination;
- measuring and/or testing in accordance with the requirements of 5.3.1 and 5.3.2.

Inspections shall be carried out with reference to required electrical drawings (see 4.6) and specifications and scheduled on the basis of manufacturer's maintenance instructions or the results of condition based maintenance assessments.

Defective equipment or parts which constitute an immediate danger shall be isolated and secured against re-connection without delay.

Inspections shall be carried out by at least electrically instructed persons with experience in the inspection of similar installations.

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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.

The result of an inspection shall be recorded. Suitable corresponding remedial actions shall be taken.

6 Working procedures

6.1 General

6.1.1 Overview

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.

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.

6.1.2 Induction and electrical influence

Conductors or conductive parts in the proximity of live conductors may be electrically influenced. Where working on electrical cables and equipment which may be influenced by induction, in addition to the requirements of 6.2 and 6.4, specific precautions, such as earthing, in order to reduce the potential between cables and/or equipment and earth to a safe level, shall be taken.

6.1.3 Work on open deck

Work shall not be carried out in the event of adverse environmental conditions, for example a near approach of a lightning storm and/or bad visibility.

6.1.4 Movement of the ship

For all working procedures, the influences of movements of the ship shall be taken into account.

6.2 Dead working

6.2.1 General

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:

- isolate completely;
- secure against re-connection;
- verify that the installation is dead;
- carry out earthing and short-circuiting;
- provide protection against adjacent live parts.

Permission to start work shall be given by the nominated person in control of the electrical installation to the nominated person or persons in control of any work activity. Any person engaged in this work activity shall be skilled or instructed or shall be supervised by such a person.

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6.2.2 Isolate completely

The part of the installation on which work is to be carried out shall be isolated from all sources of supply.

NOTE To isolate completely, i.e. electrical isolation from all sources of supply, these three essential steps as follows:

- determine all possible sources of electrical supply to the specific equipment or installation;
- after properly interrupting the load current, open the isolating device(s) for each source, and
- wherever possible, visually verify that all blades of the isolating device(s) are fully open or that drawout-type circuit breakers are withdrawn to the fully isolated position.

6.2.3 Secure against re-connection

All switching devices that have been used to isolate the electrical installation for the work activity shall be secured against re-connection, preferably by locking the operating mechanism. If an auxiliary power source is required for operation of the switching device, this power source shall be made inoperative. If a means of locking is not provided, tagging can be used as an option.

NOTE The application of any lockout devices should be in accordance with a documented and established procedure.

6.2.4 Verify that the installation is dead

The dead condition shall be verified on all phases of the electrical installation, at, or, as near as, practicable to the work location.

In the case of cable connected electrical installations the cables shall be positively identified at the work location.

6.2.5 Earthing and short-circuiting

6.2.5.1 General

At the work location for all high and some low voltage installations and extra low voltage (see 6.2.5.2), all parts which 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. The earthing and short-circuiting equipment or devices shall be visible, whenever possible, from the work location.

In all cases it shall be ensured that the earthing and short-circuiting equipment or devices and cables and connectors for earthing 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, special precautions to prevent danger shall be taken.

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

- back feed from a transformer;
- by a stand-by-generator.

Any transformer or bus-tie/transfer breaker which can back feed the equipment in question shall be isolated in accordance with the requirements of 6.2.

Any stand-by-generator which can directly feed the equipment on which work is to be carried out shall be prevented from starting.

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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 6.4.

6.2.7 Permission to start work

The permission to start work shall be given to the workers by the nominated person in control of the work activity only and after the measures detailed in 6.2.1 to 6.2.5 have been carried out.

NOTE Normally for work on equipment and systems of 1 000 V a.c. and 1 500 V d.c. or more, formal written details of isolations and earthing in the form of a permit to work, as exemplified in Annex C, should be used to avoid misunderstandings.

6.2.8 Re-energizing after work

After the work has been completed and inspected, persons no longer required shall be withdrawn. All tools, equipment and devices used during the work shall be removed. Only then shall the procedure for re-energizing 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 the work activity is satisfied about the electrical installation being ready to be re-energized, notification shall be made to the nominated person in control of the electrical installation, stating that the work is finished and the electrical installation is available for reconnection.

6.3 Live working

6.3.1 General

Live working shall be forbidden unless the nominated person and electrically skilled person in control of the electrical installation can demonstrate that de-energizing introduces additional hazards or is infeasible due to equipment design or operational limitations (see Note 1). It shall be prohibited with voltages of 1 000 V a.c. and 1 500 V d.c. or more. The requirements of 6.3 will not apply to activities such as diagnostic testing (see 5.3) using suitable voltage detection and measuring equipment

During live working procedures, workers make contact with bare live parts or reach into the live working zone, with either parts of their body or with tools, equipment or devices being handled. The outer limit of the live working zone is given by the distance D_L (see Figures 1 and 2).

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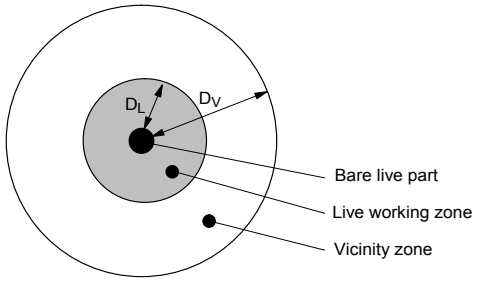

D_L Distance defining the outer limit of the live working zone

D_V Distance defining the outer limit of the vicinity zone

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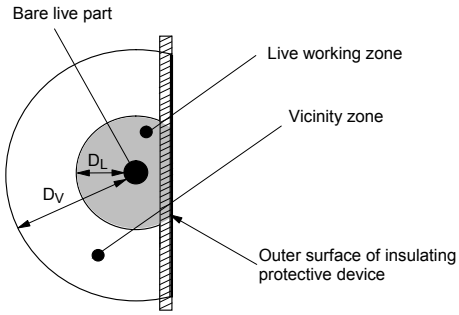
Figure 1 – Air distances and zones for working procedures



D_L Distance defining the outer limit of the live working zone

D_V Distance defining the outer limit of the vicinity zone

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

NOTE 1 Examples where live working may be considered are deactivation of emergency alarm systems, shutdown of hazardous location, ventilation equipment, where loss of electrical power could result in an environmental spill, performing diagnostics and testing, setting up of complex control systems, interruption of a continuous process, etc.

NOTE 2 Values of distances D_L can be found in Figure 1 and Figure 2 and in Annex A.

NOTE 3 If there are no national requirements, guidance for values for D_L can be found in Annex A.

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 have been assessed competent for such work.

6.3.2 Tools, equipment and devices

Tools, equipment and devices shall be clearly identified and shall be appropriate for the work to be undertaken.

In some cases, national regulations require these specifications to be given in a written form - a "technical sheet". These are used to approve a specified level of quality.

6.3.3 Environmental conditions

For work on open deck, weather conditions such as precipitation, thick fog, thunder-storm, violent wind, salt storm and extra low temperature shall be considered. Live working shall be forbidden or suspended when there is heavy rain, seawater flooding the deck, bad visibility or when the workers cannot move their tools easily. When a thunderstorm occurs, live working shall not be started or shall be suspended.

When environmental conditions require the work to be interrupted, personnel shall leave the installation as well as 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. Where insulating parts are required to be cleaned, the cleaning procedure shall be specified.

6.3.4 Organization of work

6.3.4.1 Preparation for work

If there is any doubt about the procedures to be applied, 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.

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For complex work this preparation shall be made in a written form and in advance.

6.3.4.2 Action of the nominated person in control of the electrical installation

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.

The place where automatic switching operation is prevented should be identified and a sign warning of live working in progress should be installed in the correct place.

6.3.4.3 Action of the nominated person in control of the work activity

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

At the end of the work, the nominated person in control of the work activity shall inform the nominated person in control of the electrical installation in the required manner. If the work has been suspended, adequate safety measures shall be taken and the nominated person in control of the electrical installation shall be notified.

6.3.5 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 installations, work on live parts shall be in accordance with the regulations of the appropriate authority, or in the absence of such requirements in accordance with 6.3.6.

6.3.6 Low voltage installations

For low voltage installations 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.

6.4 Working in the vicinity of live parts

6.4.1 General

Values of distances, D_V, defining the outer limit of the vicinity zone, can be found in the documents listed in the Bibliography.

If there are no national requirements, guidance for values for D_V can be found by adding the following distances to D_L:

- for low voltage installation 500 mm;
- for high voltage installation up to and including 15 kV, 1 000 mm.

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 not less than D_L (see 6.3.1) to bare live parts and when necessary, providing appropriate supervision.

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Before commencement of work, the nominated person in control of the 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 which have been put into force and on the need for safety conscious behaviour. The boundary of the work location shall be precisely defined 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.

The worker himself shall ensure, whatever movements are possible for him, that he does not reach the live working zone neither with parts of his or her body, nor with tools or objects 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

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

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

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. Live working procedures shall be used where deemed necessary.

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.

7 Maintenance activities

7.1 General

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.

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) have to be applied;
- work where the design of equipment enables certain maintenance (for example replacement of fuses or light bulbs) to be undertaken without full working procedures having to be applied as described in 7.4.

7.2 Personnel

All maintenance procedures to be carried out shall be approved by the nominated person in control of the electrical installation.

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When maintenance work is carried out on an electrical installation:

- the part of the installation concerned shall be clearly defined;
- the person in control of the maintenance activity shall be nominated.

Personnel who are to carry out the work shall be adequately instructed or skilled. They shall be equipped with and use appropriate tools, measuring and testing devices and individual protective equipment which shall be maintained in a good condition.

All necessary safety measures shall be taken including, where necessary, precautions to prevent danger to other persons and property.

7.3 Repair work

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.

7.4 Replacement work

7.4.1 Replacement of fuses

Generally when there is no other possible procedure, the replacement of fuses shall be carried out dead.

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

Where necessary the replacement of lamps and withdrawable accessories such as starters shall be carried out dead.

For low voltage installations these replacements may be carried out live by an ordinary person where the equipment provides full protection against direct contact.

In all other cases, especially for 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 working procedures (see Clause 6).

7.5 End of maintenance work

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

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Annex A
(informative)

Guidance for air distances for working procedures

A.1 General

The purpose of this Annex is to provide the users of this standard who do not have national requirements, recommended distances for both live working and working in the vicinity of live electrical installations, and 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. This zone is measured from the live part. 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, 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 distance from the live working zone boundary to the outer boundary of the vicinity zone depends upon the voltage of the live part. It varies from 500 mm at <1 kV to 1 000 mm at 15 000 V and above. 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.

A.4 Electrical distances

The values of distances are set out in Table A.1

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Table A.1 – Guidance for distances D_L and D_V

Nominal system voltage U_N kV (rms)	Highest voltage for equipment U_m kV (rms)	Highest impulse voltage U_{imp} kV (peak)	Air distance defining the outer limit of the live working zone D_L mm	Air distance defining the outer limit of the vicinity zone D_V mm
<1	1	4	no contact	500
3	3,6	40	120	1 120
6	7,2	60	120	1 120
10	12	75	150	1 150
15	17,5	95	160	1 160

NOTE 1 For values of U_N between and including 3 kV and 15 kV, the values of D_L are derived using the lightning impulse voltage.

NOTE 2 The distances D_L were calculated on the basis of phase-to-earth voltages.

NOTE 3 Intermediate values for D_L may be determined by linear interpolation.

NOTE 4 For d.c. installations the same distances corresponding to the nominal system voltage may be used.

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Annex B
(informative)

Information for safe live working

B.1 Example of application of live working

B.1.1 Review of the live working authorization

When the working authorization is required by regulation or practice, the validity of live working authorization 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 good practice to review these authorizations on an annual basis.

B.1.2 Environmental conditions

B.1.2.1 General

The following atmospheric conditions are part of environmental conditions to be assessed if work is being carried out on open deck.

B.1.2.2 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 stopped.

B.1.2.3 Thick fog

Fog is considered to be thick where visibility is reduced to a level that endangers safety, particularly when the nominated person in control of the 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 stopped in these conditions.

B.1.2.4 Thunderstorms

Thunderstorms consist of lightning and thunder. When lightning is seen and thunder is heard work should stop.

B.1.2.5 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 stop.

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B.1.2.6 Salt storms

These are strong winds which carry salt-laden moisture from the sea.

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 stopped during these winds.

B.1.2.7 Extra low temperature

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

B.1.3 Calculation of the specified working distance

A basis for this calculation can be found in the withdrawn publication ENV 50196.

B.2 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 installation, the appropriate distance should be observed.

Persons should be aware that toxic substances may be emitted by hot and burning materials.

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

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B.3 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 ;

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

- by continuous monitoring of the atmosphere and by preventing any source of energy likely to ignite the explosive mixture;
- by continuous ventilation and monitoring of the atmosphere;

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

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Annex C
(informative)

Electrical permit to work
(1 000 V a.c. and 1 500 V d.c. or more)

Electrical permit to work (1 000 V a.c. and 1 500 V d.c. or more)			**Issue details**
Date:		Time:	
Work to be done			
Location			
Nominated person in control of the electrical installation [a]			
Issued to nominated person in control of the work activity [b]			
Employed by			
Working party details			
Period of validity (not to exceed 24 hours)			
Nominated persons	[a]		
	[b]		
	Signatures	Positions	Date Time

I hereby declare that all the precautions below have been taken and that safety arrangements will be maintained for the duration of the work.	
1) It is safe to work on the following apparatus which is proven **dead**, **isolated** from all points of supply, connected to **earth and short circuited** and **caution notices** posted.	
2) The apparatus is **isolated** at the following points	
3) The apparatus is efficiently **earthed and short circuited** at the following points	
4) **Caution notices** have been posted at the following points	
NOTE In all cases the work to be carried out shall be fully discussed with the participants and a proper system of work agreed before commencement. All tools and equipment shall be of an approved type.	
Nominated person in control of the work activity (signature)	

Certificate of completion

I hereby declare that the work for which this permit was issued is now completed/suspended and that all personnel under my supervision have been withdrawn and warned that it is no longer safe to work on the apparatus specified on this permit and that all tools, equipment, safety barriers, notices and temporary earthing connections are clear.

The engine room watchkeeper has been informed.

Nominated person in control of the work activity:

(signature) Date Time

Cancellation: This Permit to work and all copies are hereby cancelled

Nominated person in control of the electrical installation and/or work activity:

(signature) Date Time

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