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Responsible committee: JPEL/18 Electrical installations of ships and of mobile and fixed offshore units

Interested committees:

Title: BS IEC 60092-401 Electrical installations in ships

Part 401: Installation and test of completed installation

Please notify the secretary if you are aware of any keywords that might assist in classifying or identifying the standard or if the content of this standard

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- ii) affects other national standard(s)
- iii) requires additional national guidance or information

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



18/1854/CD

COMMITTEE DRAFT (CD)

PROJECT NUMBER:

IEC 60092-401 ED4

DATE OF CIRCULATION:

2023-08-25

CLOSING DATE FOR COMMENTS:

2023-11-17

SUPERSEDES DOCUMENTS:

18/1847/RR

IEC TC 18 : ELECTRICAL INSTALLATIONS OF SHIPS AND OF MOBILE AND FIXED OFFSHORE UNITS

SECRETARIAT:

Norway

SECRETARY:

Mr Arild Røed

OF INTEREST TO THE FOLLOWING COMMITTEES:

SC 18A, TC 20, TC 21, SC 21A, TC 64, TC 80, TC 105

PROPOSED HORIZONTAL STANDARD:

☐

Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.

FUNCTIONS CONCERNED:

☒ EMC

☐ ENVIRONMENT

☐ QUALITY ASSURANCE

☒ SAFETY

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TITLE:

Electrical installations in ships - Part 401: Installation and test of completed installation

NOTE FROM TC/SC OFFICERS:

This project was restarted according to IEC directives as the project has not reached approval stage within 5 years. This CD is the third CD in the development of this fourth edition. The last CD published was 18/1752/CD and the resolved comments for this CD can be found in 18/1464A/CC

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICAL INSTALLATIONS IN SHIPS –

Part 401: Installation and test of completed installations

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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IEC 60092-401 has been prepared by IEC technical committee 18: Electrical installations of ships and of mobile and fixed offshore units. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 1980, Amendment 1:1987 and Amendment 2:1997. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) More details about earthing in Clause 5
- b) Implementation of IEC 60092-352 in Clause 12
- c) More details about batteries and battery rooms
- d) Documentation

293

294 The text of this International Standard is based on the following documents:

Draft	Report on voting
XX/XX/FDIS	XX/XX/RVD

295

296 Full information on the voting for its approval can be found in the report on voting indicated in
297 the above table.

298 The language used for the development of this International Standard is English.

299 This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in
300 accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available
301 at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are
302 described in greater detail at www.iec.ch/publications.

303 The committee has decided that the contents of this document will remain unchanged until the
304 stability date indicated on the IEC website under webstore.iec.ch in the data related to the
305 specific document. At this date, the document will be

- 306 • reconfirmed,
- 307 • withdrawn,
- 308 • replaced by a revised edition, or
- 309 • amended.

310

311 INTRODUCTION

312 IEC 60092 forms a series of International Standards concerning electrical installations in sea-
313 going ships and fixed or mobile offshore units, incorporating good practice and co-ordinating
314 as far as possible existing rules.

315 These standards form:

- 316 – a code of practical interpretation and amplification of the requirements of the International
317 Convention on Safety of Life at Sea;
- 318 – a guide for future regulations which may be prepared and
- 319 – a statement of practice for use by owners and builders of ships and fixed or mobile and
320 offshore units and other appropriate organisations.

321 This revision of IEC 60092-401 has been prepared by Maintenance Team 2 and 6 of IEC TC 18,
322 to update and include developments identified in other parts of the 60092 series of standards.

323

ELECTRICAL INSTALLATIONS IN SHIPS –

Part 401: Installation and test of completed installations

1 Scope

This part of IEC 60092 specifies requirements to the installation of electrical equipment for use in ships and to the testing of the complete installation.

- a) It applies to all installations, whether permanent, temporary, transportable or hand-held, AC installations up to and including to 36 kV according to IEC 60092-503 and DC installations up to and including to 1500 V according to IEC 63108.

NOTE For temporary, transportable and hand-held installations or equipment local rules can have specific national rules"

- b) This document specifies requirements such as those concerning:

- protection during equipment storage and in the installation period;
- installation of generators and motors;
- installation of transformers;
- installation of switchgear and controlgear assemblies;
- installation of semiconductor converters and UPS;
- installation of secondary cells and batteries;
- installation of luminaires;
- installation of heating and cooking appliances;
- installation of trace and surface heating;
- installation of cables and wiring, both low-voltage and high-voltage cables;
- requirements in relation to protective earthing and equipotential bonding;
- lightning protection;
- testing of completed installation;
- documentation.

- c) This document does not apply to:

- fixed equipment for medical purposes;
- electrical installations of tankers;
- control of ignition sources other than those created by electrical equipment.
- Cables such as:
 - Optical fibre cable,
 - sub-sea and 10mbilical cables,
 - data, telecommunication and radio frequency cables,
 - the choice and installation of cables for use on offshore platforms.

NOTE For medical rooms, IEC 60364-7-710 provides specific requirements. Requirements for tankers are given in IEC 60092-502.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies.

367 For undated references, the latest edition of the referenced document (including any
368 amendments) applies.

369 IEC 60079 series Explosive atmospheres

370 IEC 60092-101: Electrical installations in ships - Part 101: Definitions and general requirements

371 IEC 60092-201: Electrical installations in ships – Part 201: System design – General

372 IEC 60092-202: Electrical installations in ships – Part 202: System design – Protection

373 IEC 60092-301: Electrical installations in ships. Part 301: Equipment – Generators and motors

374 IEC 60092-302-2: Electrical installations in ships – Part 302-2: Low voltage switchgear and
375 controlgear assemblies – Marine power / Applies in conjunction with

376 IEC 61439-1 (2011-08), IEC 61439-2 (2011-08)

377 IEC 60092-303: Equipment – Transformers for power and lighting

378 IEC 60092-304: Equipment – Semiconductor convertors

379 IEC 60092-305: Electrical installations in ships. Part 305: equipment – Accumulator (storage)
380 batteries

381 IEC 60092-360: Requirements for electrical, mechanical and particular characteristics of
382 insulating and sheathing materials

383 IEC 60092-503: Electrical installations in ships – Part 503: Special features – AC supply
384 systems with voltages in the range of above 1 kV up to and including 36 kV

385 IEC 60092-504: Electrical installations in ships – Part 504: Automation, control and
386 instrumentation

387 IEC 60533 Electrical and electronic installations in ships - Electromagnetic compatibility (EMC)

388 IEC 60364-1: Low-voltage electrical installations - Part 1: Fundamental principles, assessment
389 of general characteristics, definitions

390 IEC 60364-4-41: Low-voltage electrical installations - Protection for safety - Protection against
391 electric shock

392 IEC 60092-509 Electrical installations in ships - Part 509: Operation of electrical installations

393 IEC 60533: Electrical and electronic installations in ships - Electromagnetic compatibility (EMC)
394 - Ships with a metallic hull

395 IEC 62305-3:2010, Protection against lightning – Part 3: Physical damage to structures and life
396 hazard

397 IEC 62620: Secondary cells and batteries containing alkaline or other non-acid electrolytes -
398 Secondary lithium cells and batteries for use in industrial applications

399 ISO 31000: Risk management - Guidelines

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

braid armour

Covering formed from braided metal wires used to protect a cable from external mechanical effects

3.2

armour

covering consisting of metal tape(s) or wires, generally used to protect the cable from external mechanical effects

[SOURCE: IEC 461-05-06]

3.3

screen

conducting layer or assembly of conducting layers having the function of control of the electric field within the insulation

NOTE It may also provide smooth surfaces at the boundaries of the insulation and assist in the elimination of spaces at these boundaries

[SOURCE: IEC 461-03-01]

3.4

distribution board

Assembly containing different types of switchgear and controlgear associated with one or more outgoing electric circuits fed from one or more incoming electric circuits, together with terminals for the neutral and protective conductors, if required

[SOURCE: IEC 826-16-08, modified – The words “if required” have been added.]

3.5

main earth (reference earth) ground

Part of the Earth considered as conductive, the electric potential of which is conventionally taken as zero, being outside the zone of influence of any earthing arrangement

NOTE 1 to entry: The concept “Earth” means the planet and all its physical matter.

NOTE 2 to entry: The general mass of the metal structure or hull of the mobile or fixed unit.

[SOURCE: IEC 195-01-01, modified: Synonymous term “main earth” added, Note 2 added]

3.6

earthing conductor

grounding conductor, US)

Conductor forming a conductive path between a conductive part and an earth electrode.

EXAMPLE A: conductor connected between a main earthing terminal or busbar and an earth electrode

[SOURCE: IEC 195-02-03]

3.7 extra-low voltage ELV

voltage not exceeding the maximum value of the prospective touch voltage that is acceptable to be maintained indefinitely under specified conditions of external influences

[SOURCE: IEC 195-05-24]

3.8 equipotential bonding

Set of electric connections intended to achieve equipotentiality between conductive parts.

[SOURCE: IEC 195-01-10]

3.9 instrumental earth (IE)

Part of the earth that is separately connected to main earth for the purpose of reducing interference.

Note 1 to entry: Intrinsically safe earth is sometimes be combined with instrument earth.

Note 2 to entry: IE earth is a specific functional earth.

3.10 intrinsically safe earth (IS)

Part of the earth that is separately connected to main earth for the purpose of intrinsically safe circuits.

NOTE 1 to entry: Intrinsically safe earth can sometimes be combined with instrument earth.

NOTE 2 to entry: IS earth is a specific functional earth.

3.11 primary structural lightning damage

Damage which can result from a stroke of lightning to ships which do not provide a path of low resistance to earth for the passage of lightning currents, for example ships of non metallic construction or those having substantial non metallic members

3.12 secondary lightning damage

Damage to ships or to their electrical installations which can result as an indirect consequence of a lightning stroke to a ship or to its immediate vicinity. A path to earth of low resistance may not prevent the consequence of secondary damage which may occur as a result of high values of induced or resistance drop voltages produced by the passage of lightning currents

4 General requirements

4.1 General

Clause 4 covers general requirements for all types of electrical equipment. The intention is to achieve a coordinated equipment servicing layout for the entire plant.

4.2 Access for installation, setting to work and inspection

Equipment and system installations shall provide safety to personnel and safe operation during installation, setting to work, testing, and inspection in accordance with IEC 60092-509 and mandatory national safety regulations.

Provisions shall be identified for easy handling of equipment assemblies or parts.

Assemblies or equipment parts weighing more than 25 kg shall have lifting provisions. This may be a lifting point on a component which is designed to lift the weight of the component.

4.3 Access to interface

External interfaces of the equipment shall be identified, and measures to ensure free access to the connection of power, control, cooling, lubrication, heat and pressure exchange circuitry, shall be confirmed by the system designer.

4.4 Documentation

All equipment and systems shall be delivered with documentation, including instructions for safe installation, operation and maintenance. Systems, cabinets and equipment allowing repairs on board shall be delivered with also the schematics and wiring diagrams included.

4.5 Nameplates and labels

Each unit, subassembly and main assembly shall have nameplates clearly and indelibly marked with the data specified in the appropriate IEC standard.

An installed (pulled) cable during installation shall be temporary uniquely marked at both ends.

All nameplates shall be engraved or embossed on plastic-laminated or metallic material and be permanently fixed on non-removable parts.

Labels on enclosures are to be fixed by means of screws or rivets. Fastening by equally robust and glue or adhesive can be accepted.

All applied nameplates and labels shall be documented in relevant documentation of the electrical installation stating the position where they should be applied and the information to be shown on them.

4.6 Component and wiring identification (inside cabinet)

4.6.1 Marking of components inside cabinet

Inside the cabinet, it shall be possible to identify all individual components and devices.

Identification marking of components shall be made both on components and where each component is located (fixed place in cabinet), marking size shall considering the availability of space and readability.

Identification of terminals should comply with IEC 60445.

NOTE It is allowed to place the label underneath the component on the mounting plate. When the component is removed the marking where the component needs to be installed will be visible.

4.6.2 Internal wiring and marking of supplier's standard equipment

The supplier's standard for internal wiring and marking of wires and components should be accepted for those parts of the supplier's standard equipment, provided that all individual components and devices can be identified.

4.6.3 Marking of internal wiring in project specific parts of equipment

Individual conductors and wires in project specific parts inside the cabinet shall be identified with easily readable markers carrying either an unique number at both ends or a unique alpha-

numeric identifier identical to the component and terminal to which it is connected ("Component ID" – "terminal number") or an unique wire number.

4.6.4 Marking of AC busbars

Phase 1: L1

Phase 2: L2

Phase 3: L3

Neutral: N

NOTE Older marking can be U/V/W or A/B/C or R/S/T.

4.6.5 Marking of DC busbars

Positive pole: (+)

Negative pole: (–)

Centre tap in three-wire systems (0) with earth symbol, if earthed.

4.6.6 Marking of earth bars

Earth bars shall be marked to unambiguously state their purpose:

Protective earth; PE bar marked yellow/green and PE label.

4.7 Cabinet doors

Doors that have mounted components (lamps, push buttons, etc.) shall be bonded to the cabinet or earth bar. The same requirement applies for removable hatches. An earthing symbol shall be on the door or hatch.

NOTE The voltage band for ELV in IEC 61140 is equal or less than 50 V AC and equal and less than 120 V DC.

Hinged doors on equipment shall have a device for securing the door in open position in the following cases:

- a) when located in outdoor areas exposed to wind;
- b) when electrical components are located on the door;
- c) when there are components located behind the door that should be accessible under normal conditions, for example for maintenance or inspection.

4.8 Termination of external cables / terminal design

Apparatus terminals shall be effectively secured and be spaced and/or shielded to minimize the risk of accidental earthing or short-circuiting.

Only one cable conductor in an external cable is allowed in each terminal of a block/row. This is not applicable for terminals designed for the connection of two conductors in one clamping point for internal components (e.g. relays, contactors). Also, two conductors may in certain cases be used in one approved ferrule connected to one terminal.

Cable glands or bushings, or fittings for screwed conduits, shall be suitable for the intended cables and shall facilitate the cable entrance into the equipment. All entries shall maintain the degree of protection provided by the enclosure of the associated equipment.

Adequate clearance shall be allowed between the cable entries and terminals so that cables can be drawn in and connected without damage. The terminations shall be arranged, or provided with means, to allow easy termination of cables without the risk of any damage to the apparatus.

It shall be possible to disconnect and reconnect the wire on all terminals for external cables. The terminals shall be of spring clamp type or of screwed type, correctly dimensioned. Terminal blocks for different voltages shall be segregated and marked with voltage levels. The interconnections of adjoining terminals shall be made by purpose-made jumper bars.

Terminal blocks for different voltages from safety point of view shall be segregated and marked with voltage levels.

NOTE When there are separated, but adjacent terminals with different voltage levels the voltage level should be indicated.

In switchboards and distribution boards, adequate space shall be provided for the use of a clip-on ampere meter without causing undue stress on the cable conductors or connections.

4.9 Protection from condensation

During storage, provisions shall be made to avoid condensation in transport boxes and stored equipment. Ingress of water into open cable ends shall be avoided

4.10 Protection during equipment storage

Where the installation phase requires storage of equipment and materials, instructions contained in 'the supplier's documentation shall be followed to avoid damage or deterioration of equipment or materials.

Particular attention should be given to the storage of batteries to preserve their service lifetime, or the batteries should be purchased and fitted shortly before tow out.

The batteries shall be delivered with information of the stored capacity, the maximum storage limit and environmental storage conditions.

4.11 Protection during installation period

Electrical equipment shall be well protected during the installation period to prevent damage from welding, painting, and similar injurious operations. If the installation phase forecasts a long-time schedule, appropriate protection against damage due to weather conditions shall be provided.

After activation equipment and components shall be kept maintained and controlled according to manufacturer's instructions to avoid life impairment.

5 Earthing

5.1 Parts for which earthing is required

All metal parts of the electrical installation shall be earthed unless specifically exempted, such as the following exemptions,

- shades, reflectors and guards, supported on lampholders or luminaires constructed of, or shrouded in, non-conducting material;
- portable appliances having double and/or reinforced insulation (provided that the appliances conform with recognized safety requirements);
- bearing housings which are insulated in order to prevent circulation of current in the bearings;
- clips for fluorescent lighting tubes;
- apparatus supplied at safety voltage;
- cable clips.

To minimize the risk on shock induced by radio transmitters (high frequency sources) or wind, metal handles, handrails, etc., on the bridge or upper decks, shall have a good electrical (high frequency) connection with the hull or superstructure. See also 5.8.

Secondary windings of instrument transformers shall be earthed.

5.2 Earthing connections

Every earthing connection shall be of copper or corrosion-resistant material and shall be securely installed and protected where necessary against damage and, where necessary, against galvanic corrosion. If other materials are used, the maximum galvanic potential between the different materials should not exceed 0,6 V.

The nominal cross-sectional area of every copper earthing connection shall be not less than required by Table 1. Every other earthing connection shall have a conductance not less than that specified for a copper earthing connection

Metal parts of portable appliances, other than current-carrying parts and parts exempted in 5.1, shall be earthed by means of an earthing conductor in the flexible cable or cord, which complies with

and which is earthed for example through the associated plug and socket-outlet.

Under no circumstances shall the sheathing of cables be relied upon as the sole means for safety earthing.

5.3 Equipotential bonding

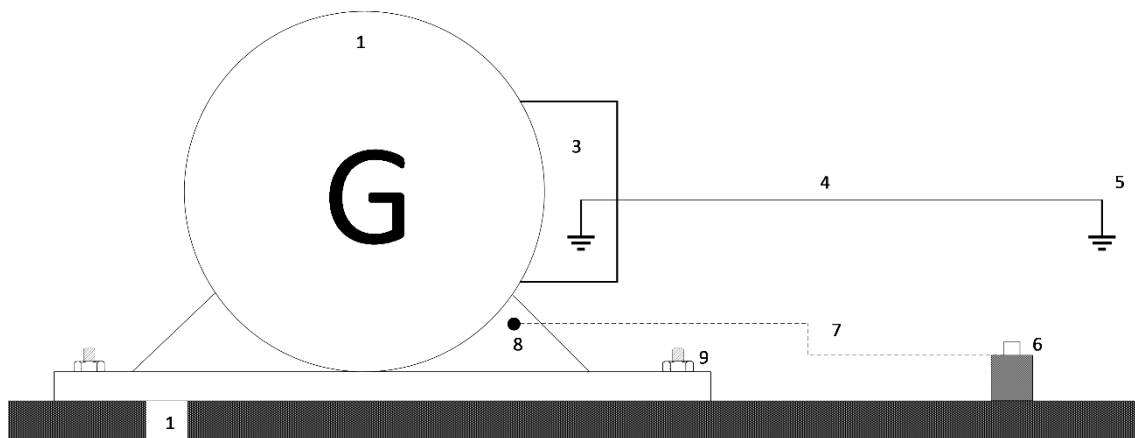
5.3.1 General

The purpose of equipotential bonding is to ensure that the bonded parts have equal potential.

Equipotential bonding shall be provided for exposed conductive parts, construction elements of conductive material, pipes etc., to avoid differences in potential and electrostatic charges.

5.3.2 Bonding connections

Direct bonding should be made with fixing bolts. See Figure 1.



Key

- | | |
|--|---|
| 1 Source of power | 6 Local earth / Earth boss |
| 2 Main earth (structure) | 7 Equipotential bonding conductor from chassis to |
| 3 Earthing terminal for power cable | 8 Equipotential bonding connection to chassis |
| 4 Power cable with protective earthing conductor | 9 Equipotential bonding with bolts |
| 5 Earth bar in switchboard | |

NOTE Metal frames or enclosures of equipment mounted (i.e. bolted) in metallic contact with the structure need no supplementary equipotential bonding, provided that the surfaces in contact are clean and free from corrosion, scale or paint when installed and are firmly bolted together

Figure 1 – Bonding through fixing bolts

Separate equipotential bonding conductor should be as short as possible. For HF bonding, a bonding conductor with a sufficient surface area shall be used. The relation between width and length should be at least 1:5.

Fixing lugs for EMC filters shall have metallic connection to the structure. The pin connector normally provided for earthing is not sufficient. This connection is only intended as protective earthing if a fault should occur. HF currents are to be “drained” by means of large area in contact between filter housing and structure.

5.3.3 Bonding of equipment

Equipotential bonding should be limited to what is strictly necessary.

To avoid dangerous potential differences between equipment and surroundings in hazardous areas, it should be ensured that the equipment has metallic connections to earth (bonding), in addition to earthing through the feeder cable.

Equipment connected to the protective conductor and which are connected to the main earth through fixing bolts or similar do not need separate bonding.

A separate bonding connection shall be considered for equipment in hazardous areas, which are earthed by means of a protective conductor isolated from main earth.

For isolated, non-current carrying metallic parts, located in hazardous areas, and which may become charged, e.g. due to static electricity, bonding shall be considered. This applies to ventilation ducts and similar.

Earthing conductors are to be connected and arranged in such a way that the earthed components themselves do not form a series connection as earthing conductor.

- Only one earthing cable/conductor lug has to be connected to each bolt.
- Every earthing conductors or equipotential bonding conductors shall have separately connection bolts at the earth-bar.
- Earthing conductors/Equipotential bonding conductors shall not use conductive chassis of switchboard or enclosure as part of earthing conductor or equipotential bonding conductor.

If components, with voltage beyond safety voltage, such as instruments, signal etc. lamps, switches, are mounted on hinged doors of switchboards or other enclosures, the doors are to be connected by equipotential bonding conductor to the earth-bar in the switchboard or earth-bar in the enclosure.

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Table 1 – Sizes of earth continuity conductor and equipment earthing connections

Arrangement of earth conductor		Cross-section Q of associated current carrying conductor (One phase or pole) mm^2	Minimum cross-section of earth conductor
1.	a) Insulated earth conductor in cable for fixed installation.	$Q \leq 16$	Q
	b) Copper braid of cable for fixed installation according to IEC 60092-350. c) Separate, insulated earth conductor for fixed installation in pipes in dry accommodation spaces, when carried in the same pipe as the supply cable. d) Separate, insulated earth conductor when installed inside enclosures or behind covers or panels, including earth conductor for hinged doors as specified in IEC 60092-302-2.	$Q > 16$	50 % of the current-carrying conductor, but not less than 16 mm^2
2.	Uninsulated earth conductor in cable for fixed installation, armour or copper braid and in metal-to-metal contact with this.	$Q \leq 2,5$	1 mm^2
		$2,5 < Q \leq 6$	$1,5 \text{ mm}^2$
		$Q > 6$	Not permitted
3.	Separately installed earth conductor for fixed installation other than specified in 1 iii) and 1 iv).	$Q < 2,5$	Same as current-carrying conductor subject to min. $1,5 \text{ mm}^2$ for stranded earthing connection or $2,5 \text{ mm}^2$ for unstranded earthing connection
		$2,5 < Q \leq 120$	50 % of current-carrying conductor, but not less than 4 mm^2
		$Q > 120$	70 mm^2
4.	Insulated earth conductor in flexible cable.	$Q \leq 16$	Same as current-carrying conductor
		$Q > 16$	50 % of current-carrying conductor, but minimum 16 mm^2
NOTE See 12.4.1 for a method based on the rating of fuses.			

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5.4 Protective earth connections to the ship's structure

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Every connection of a protective earthing conductor to the ship's structure shall be made in an accessible position and shall be secured by a screw of brass or other corrosion-resistant material of diameter not less than 8 mm, which has at least the same diameter as used for the protective earth connection within the equipment and shall be used for protective earth only. Care shall be taken to ensure bright metallic surfaces, clean and free from corrosion, at the contact areas immediately before the screw is tightened.

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5.5 Aluminium superstructures

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Methods of securing aluminium superstructures to the steel hull of a ship often include insulation to prevent galvanic corrosion between these materials. In such case, a separate bonding connection should be provided between superstructure and hull which should be made in such a manner that galvanic corrosion is avoided, and the points of connection may be readily inspected.

5.6 Instrument earthing (IE earthing)

The intention with earthing of instrumentation systems is to ensure:

- a) supply voltage reference
- b) protection by failure
- c) that precautions against noise suppression are efficient and are not jeopardized by inadequate earthing.

Such precautions may be:

- earthing of cabinets and enclosures
- earthing of cable screens
- earthing of EMC-filters

NOTE 1 Electromagnetic noise (interference) is present at frequencies from a few Hz and up to the GHz range. If this noise enters wires or conductor paths, a noise of undefined magnitude will be present in the system. Even if the noise signal has much higher frequencies than the working signal, the noise power will sooner or later meet an unilinear element which will convert this into a DC signal. This DC component will be added to the working signal.

To decide precautions correctly it is, among others, necessary with exact knowledge about:

- the electromagnetic environmental in the area where the equipment are to be installed.
- the equipment integrity regarding the electromagnetic compatibility (EMC).

NOTE 2 Those parameters are difficult to get exactly because they will only in particular cases be analysed or measured. An instrumentation system is often built up of equipment from several suppliers which have different requirements regarding EMC integrity. See also IEC 60533.

5.7 Earthing in potential explosive atmospheres (IS earthing)

In potential explosive atmospheres the earthing shall be designed and installed considering the risk of ignition of explosive gases or liquids. See Figure 2 and Figure 3 for connection of IS earthing bar.

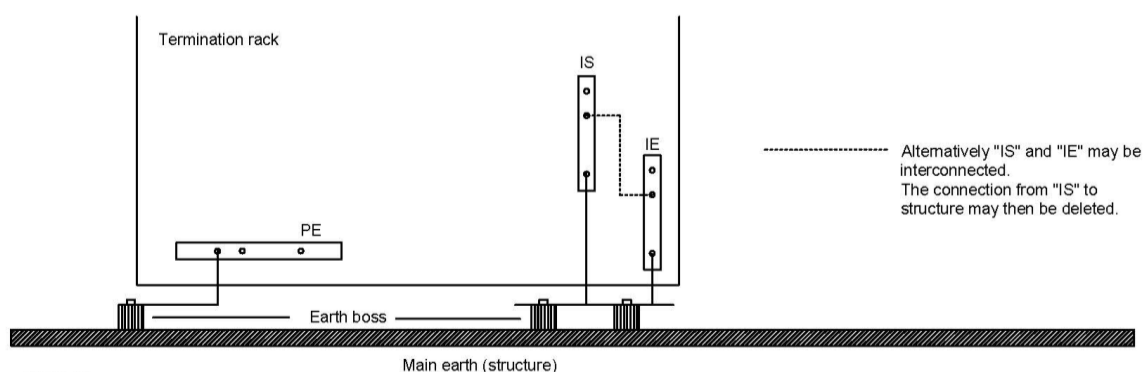


Figure 2 – Example of IE and IS earthing

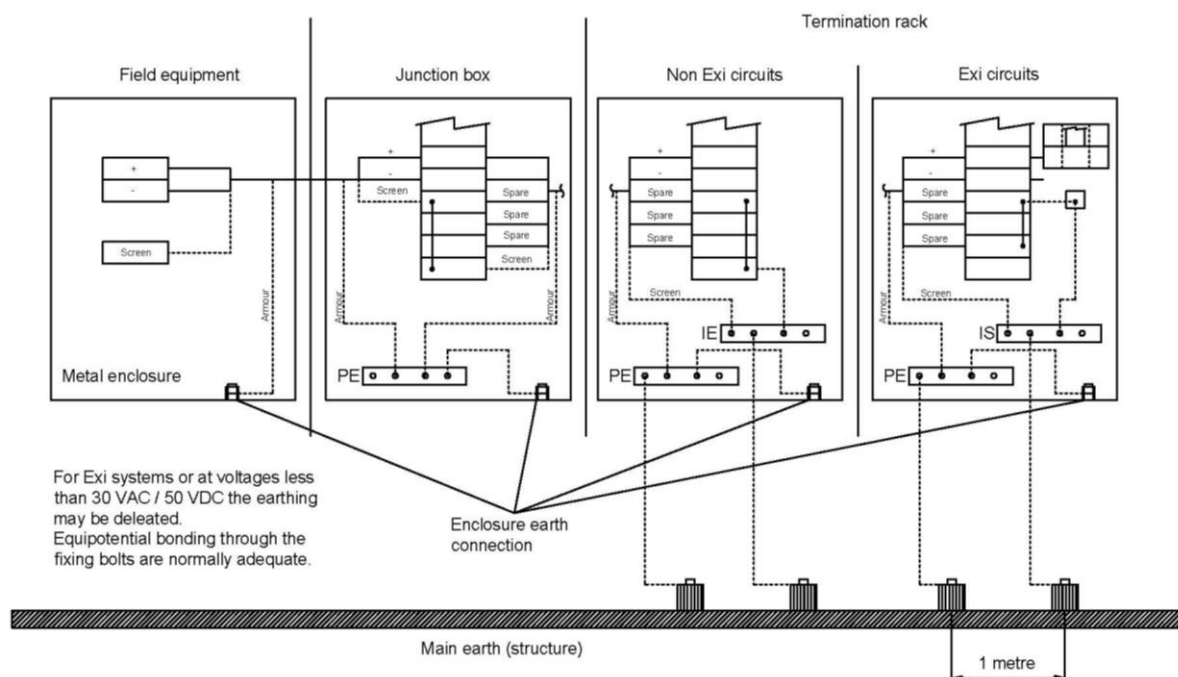


Figure 3 – Example of IE and IS earthing connections

5.8 Earthing of high frequency installations

On communication systems it is necessary to take precautions with respect to EMC. It is therefore required that the earthing of radio installations is carried out correctly to ensure correct function of the equipment and safety of personnel.

High power transmitters radiate high effects from antennas. This effect will have to return to the output stage of the transmitter through the structure which will be the earth plane for the transmitter. The current density around the antenna foot and the earth connection of the antenna tuner is therefore high.

The earthing of the output stage shall be given special attention to ensure a proper return path for the antenna current. This current is of high frequency, which means that a large area to earth is needed. Ineffective earthing of the output stage means that the current will find alternative return paths to the output stage, such as capacitive paths through power leads of other equipment.

See IEC 60533 for EMC requirements.

6 Switch gear and controlgear assemblies

6.1 Insulating mats

When the voltage exceeds the extra low voltage specified in IEC 60092-101 an insulated mat, insulated grating or isolated deck covering shall be permanently provided in front of switchgear and control gear, HV panels and convertors assemblies, (including propulsion convertors) and also at the rear if access from the rear is required. The insulated floor covering, grating or deck shall be oil-resistant and non-slip. Equipment installed in an engine room area or outside dedicated electrical lockers or rooms are exempted.

NOTE For low voltage system, the resistance of insulating floors at every point of measurement under the conditions specified in IEC 60364-6 shall be not less than

- 50 kΩ, where the nominal voltage of the installation does not exceed 500 V, or

- 100 kΩ, where the nominal voltage of the installation exceeds 500 V.

6.2 Passageways in front of switchgear and control gear assemblies

The free passageway in front of the switchboard with any drawers open shall be at least:

- a) < 500 V, unobstructed at least 0,6 m
- b) ≥ 500 V and ≤1000V, unobstructed at least 0,8 m
- c) > 1 000 V, unobstructed at least 1,0 m

NOTE For small vessels, the unobstructed passageway is reduced subject to agreement by the appropriate authority. Small vessels are defined by IEC 60092-507.

6.3 Space at the rear and passageways

When a space is provided at the rear of switchgear and control gear assemblies for maintenance work, it shall be ample to permit maintenance, PPE and safety tools handling, and in general shall not be less than 0,6 m in the clear, except that the width may be reduced to 0,5 m, where there are stiffeners and frames.

6.4 Position relative to pipes and tanks

In addition to complying with the appropriate requirements of IEC 60092-101 all switch-gear and control gear assemblies shall be so installed that no pipes or tanks are above them within the same space and at their rear. Where this is unavoidable, pipes shall be continuous and without openings in such locations.

6.5 Positions of section and distribution boards

Assemblies shall not be of open type.

NOTE Also, IEC 60092-201:2019 does not allow open type assemblies.

6.6 De-energising of cabinets

If more than one disconnect or fuse is required to de-energise a cabinet, the cabinet will have a warning sign to make personnel aware of the risk. This warning sign will be placed at a position that is clearly visible before any live parts can be reached.

NOTE Examples where a warning sign might be required are when a cabinet is powered by different power supplies; switches external voltages; contains batteries or large capacitors.

7 Transformers

7.1 Installation and location

7.1.1 Air-cooled transformers

Air cooled transformers shall be installed in well-ventilated compartments, accessible only to authorized personnel except that air-cooled transformers provided with means of protection against accidental contact with live parts need not be installed in special compartments.

NOTE See also IEC 60092-303

If the secondary means for the cooling of the transformer is water, a leakage detection or level measurement shall be installed to give alarm if the capacity of the containment according to 7.1.2 is reduced.

7.1.2 Liquid immersed transformers

Liquid-immersed transformers shall be housed in a metallic compartment having adequate means for the drainage of liquid leakage.

When flammable liquid such as oil is used, the space where the transformer is located shall be protected by an automatic fire-extinguishing system.

Suitable arrangements shall be provided for cooling and containing all the liquid which might escape from a damaged tank. Contamination of bilges is to be precluded by the provision of suitable drip-trays or save-ails.

7.2 Transformer connections

Transformers and their connections shall be protected against such mechanical damage, condensation and corrosion as may reasonably be expected.

8 Semiconductor convertors

8.1 Installation and location

8.1.1 General

Convertor stacks and associated equipment shall not be mounted near sources of radiant heat energy, such as resistors, steampipes and engine exhaust pipes.

Semiconductor convertor stacks or semiconductor components shall be mounted in such a manner that they may be removed from equipment without dismantling the complete unit.

8.1.2 Air-cooled semiconductor convertors

Semiconductor convertor stacks or equipment shall be installed in such a manner that the circulation of air to and from the stacks, associated equipment or enclosures (if any) is not impeded and that the temperature of the cooling inlet air to convertor stacks does not exceed the ambient temperature for which the stacks are specified.

Naturally air-cooled cabinets shall be designed with sufficient ventilating openings, or with sufficient radiating surface in the case of totally enclosed convertor equipment to operate within allowable temperature limits.

8.1.3 Liquid-cooled semiconductor convertors

For liquid-cooled convertors the same requirements of art. 7.1.1 for transformers apply.

9 Accumulators (storage) batteries

9.1 General

Battery assemblies and battery control systems for ships shall be designed and installed to comply with the relevant parts of IEC 62620, IEC 60092-101, IEC 60092-201, IEC 60092-305, IEC 60092-504 and IEC 60533.

Relevant parts of IEC 60092-302-2 apply to battery assemblies.

Battery assemblies for ships shall comply with the environmental conditions specified in IEC 60092-101.

A safety description shall be developed, where the chemistry of the battery can present potential hazards (such as lithium batteries) and shall assess all potential hazards. As a minimum the assessment shall include a safety philosophy, onboard arrangement requirements (fire extinguishing medium, ambient temperature, air conditioning, etc.) and the potential hazards represented by the battery chemistry considering the following:

- a) Potential gas development (toxic, flammable, corrosive),
- b) Safety risk including identification of gas (gas volume, release rate and gas composition) released from the cell(s) during venting or thermal runaway condition in relation to State of charge (SOC) level at time of incident,
- c) External risk (heat, fire, water ingress, flooding, collision etc);
- d) Required battery room arrangement (fire/gas detection, alarm, ventilation rates);
- e) Fire extinguishing medium;
- f) Potential chemical reaction between battery chemistry (gases, electrolyte), and recommended fire extinguishing medium resulting in toxic, flammable, corrosive chemistry;
- g) Fire extinguishing strategy/method;
- h) Fire fighting by crew or onshore search and rescue personnel;
- i) Internal cell failure/thermal runaway;
- j) Internal and external short circuit,
- k) Electrical protections (over current, over voltage and under voltage),
- l) Cooling liquid leakage,
- m) Safe charging/discharging, characteristics
- n) Short circuit characteristics (min/ max short circuit characteristics depending on SOC)
- o) Absolute maximum ratings (temperature, voltage current etc.)
- p) Rated battery capacity for the intended operation

9.2 Location

Batteries shall be located where they are not exposed to excessive heat, extreme cold, spray, steam or other conditions which would impair performance or accelerate deterioration. Batteries for emergency service, including emergency diesel-engine starting, shall be located where they are protected as far as practicable from damage caused by collision, fire or other casualty (in accordance with the International Convention for Safety of Life at Sea).

NOTE 1 For batteries it is preferred to be located in that way that their environment, such as ambient temperature and humidity remains within the manufacturer's specification at all times.

Battery rooms, lockers and boxes for batteries producing explosive atmosphere shall not be used for other purposes.

NOTE 2 It is preferred that batteries with different type of cell technology to be placed in different rooms or boxes

Starter batteries shall be located as close as practicable to the engine or engines served, to limit voltage drop in cables at the high current required.

Batteries (unless of the hermetically sealed type) shall not be placed in sleeping quarters.

A danger notice shall be permanently secured to doors or covers of battery compartments, lockers and boxes, indicating that a naked light or smoking in these rooms or in their vicinity is prohibited.

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Table 2 – Location of batteries

Type of enclosure	Vented or VRLA traditional batteries			Li-Ionen batteries		
	Charging power (kW) ^a			Capacity (kWh)		
	$P > 2$	$0,2 < P < 2$	$P < 0,2$	$P > 50$	$5 < P < 50$	$P < 5$
A dedicated battery room	X	X	X	X	X	X
A well-ventilated locker on the open deck	X	X	X	X	X	X
A dedicated battery locker		X	X		X	X
A dedicated battery box		X	X		X	X
In the machinery space in a well-ventilated compartment		X	X		X	X
Open, if protected from falling objects			X			X
^a When two or more batteries are grouped in the same compartment, the sum of output power of all charging devices shall be considered.						

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9.2.1 Location requirements for Li-Ionen batteries

Batteries connected to a charging device shall be installed dependent on the output capacity of the device (calculated from the maximum obtainable current, discharging time and the nominal voltage of the battery) as follows:

- All battery storage assemblies exceeding an energy content of more than 50 kWh or exceeding 120 VDC shall be located in a dedicated battery room, or if a room is not available, in a suitable well-ventilated locker on deck;
- Batterie assemblies with an energy content between 5 kWh and 50 kWh, may be installed in a box or locker in some suitable space, or, if protected from falling objects, in the machinery space in a similar well ventilated compartment.
- Battery assemblies with an energy content less than 5 kWh may also be installed open, if protected from falling objects, electrical connections isolated or in a battery box in any suitable space.

NOTE 1 See also IEC 60092-305

NOTE 2 See also IEC 62485

9.2.2 Location requirements for lead-acid batteries

Batteries connected to a charging device shall be installed dependent on the output power of the device (calculated from the maximum obtainable charging current and the nominal voltage of the battery) as follows:

- power more than 2 kW, in a room assigned to batteries only or if a room is not available, in a suitable well-ventilated locker on the open deck.
- power between 0,2 kW and 2 kW, as above, may be installed in a box or locker in some suitable space, or, if protected from falling objects, in the machinery space or in a similar well-ventilated compartment.
- power less than 0,2 kW as above, but may also be installed open, if protected from falling objects, or in a battery box in any suitable space.
- for ventilation requirements see clause 9.8