



DPC: 21/30350331 DC

BSI Group Headquarters

389 Chiswick High Road London W4 4AL

Tel: +44 (0)20 8996 9000

Fax: +44 (0)20 8996 7400

www.bsigroup.com

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Interested committees:

Title: Draft BS IEC 60092-401 Electrical installations in ships. Part 401: Installation and test of completed installation.

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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

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Submission of Comments

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- All comments should be submitted online at <https://standardsdevelopment.bsigroup.com/>. You will need to register in order to comment.

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.	



18/1752/CD

COMMITTEE DRAFT (CD)

PROJECT NUMBER:

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2021-11-12

CLOSING DATE FOR COMMENTS:

2022-02-04

SUPERSEDES DOCUMENTS:

18/1554A/CD, 18/1564B/CC

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 31,TC 44,TC 64,TC 80,TC 105,TC 120

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

This document is still under study and subject to change. It should not be used for reference purposes.

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

TITLE:

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

NOTE FROM TC/SC OFFICERS:

This second CD includes the content of IEC 60092-352, which is to be withdrawn. Please also pay attention to the section about battery rooms, as this section should include installation requirements that are not included in battery standards developed for battery manufacturers. On the other hand there should not be any duplication of requirements either.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICAL INSTALLATIONS IN SHIPS –**Part 401: Installation and test of completed installations****FOREWORD**

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International Standard IEC 60092-401 has been prepared by IEC technical committee 18: Electrical installations of ships and of mobile and fixed offshore units.

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) Implementation of IEC 60092-352
- b) Batteries
- c) Documentation

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

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

269

270 Full information on the voting for the approval of this International Standard can be found in the
271 report on voting indicated in the above table.

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

273 The committee has decided that the contents of this document will remain unchanged until the
274 stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to
275 the specific document. At this date, the document will be

- 276 • reconfirmed,
- 277 • withdrawn,
- 278 • replaced by a revised edition, or
- 279 • amended.

INTRODUCTION

IEC 60092 forms a series of International Standards concerning electrical installations in sea-going ships and fixed or mobile offshore units, 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;
- a guide for future regulations which may be prepared and
- a statement of practice for use by owners and builders of ships and fixed or mobile and offshore units and other appropriate organisations.

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

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, to AC installations and DC installations up and including to 15 kV.

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 earthing and 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.

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

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

IEC 60092-201: System design - General

IEC 60092-202: System design - Protection

333 IEC 60092-301: Generators and motors

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

336 IEC 60092-504: Special features – Control and instrumentation.

337 IEC 60364-1: Low-voltage electrical installations

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

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

341 ISO31000: Risk management

342 **3 Terms and definitions**

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

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

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

349 **3.1**

350 **earth-continuity conductor**

351 A wire, cable or other conductor connecting to each other or to the earthing lead those parts
352 which have to be earthed.

353 EXAMPLE 1 For example it may be in whole or in part the metal conduit or the metal sheath of the cables, or the
354 special earth continuity conductor of a cable or flexible cord incorporating such a conductor

355 **3.2**

356 **Earthing lead**

357 A conductor by which the connection is made to the metal hull of the ship

358 **3.3**

359 **primary structural lightning damage**

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

363 **3.4**

364 **secondary lightning damage**

365 Damage to ships or to their electrical installations which can result as an indirect consequence
366 of a lightning stroke to a ship or to its immediate vicinity. A path to earth of low resistance may
367 not prevent the consequence of secondary damage which may occur as a result of high values
368 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 and to control, cooling, lubrication, heat and pressure exchange circuitry, shall be confirmed by the system designer.

4.4 Documentation

All equipment shall be delivered with the schematics, wiring diagrams and other documentation, including instructions for safe installation, operation and maintenance of the equipment.

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 and labels 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 recognised glue may be accepted.

Equipment marking/labelling shall be found in the relevant documentation for the electrical installation.

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).

Identification of terminals should comply with IEC 60445.

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 a number identical to the component and terminal to which it is connected ("Component ID" – "terminal number"). This is also applicable to the single conductors used for cross wiring between terminal blocks in panels.

4.6.4 Marking of AC busbars

Phase 1: L1

Phase 2: L2

Phase 3: L3

Neutral: N and light blue label.

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.

Manufacturer's standard marking may be accepted.

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.

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;

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.

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.

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 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,

- lamp caps;
- shades, reflectors and guards, supported on lampholders or luminaires constructed of, or shrouded in, non-conducting material;
- metal parts on, or screws in or through, non-conducting material, which are separated by such material from current-carrying parts, and from earthed non-current-carrying parts;
- 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 shock from high-frequency voltage induced by the radio transmitter, handles, handrails, etc., of metal on the bridge or upper decks shall be in good electrical high frequency connection with the hull or superstructure.

NOTE See IEC 60533: Electromagnetic Compatibility of Electrical and Electronic Installations in Ships.

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.

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 earth-continuity conductor in the flexible cable or cord, which complies with Table 1 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

Table 1 – Sizes of earth-continuity conductors and earthing connections

	Type of earthing connection	Cross-sectional area of associated current-carrying conductor	Minimum cross-sectional area of copper earthing connection
1	Earth-continuity conductor in flexible cable of flexible cord	Any	Same as current-carrying conductor up to and including 16 mm ² or one-half above 16 mm but at least 16 mm ²
2	Earth-continuity conductor incorporated in fixed cable	Any	a) For cables having an insulated earth-continuity conductor: b) across-section equal to the main conductors up to and including 16 mm ² but minimum 1,5 mm ² c) a cross-section not less than 50% of the cross-section of the main conductor when the latter is more than 16 mm, but at least 16 mm ²
		a) Not exceeding 3 mm ²	Same as current-carrying conductor subject to minimum of 1,5 mm ² for stranded earthing connection, or 3 mm ² for solid earthing connection
3	Separate fixed earthing-conductor	b) Exceeding 3 mm ² but not exceeding 125 mm ²	One-half the cross-sectional area of the current-carrying conductor, subject to a minimum of 3 mm ²

		c) Exceeding 125 mm ²	64 mm ²
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5.3 Earthed distribution systems

The system earthing connection in an earthed distribution system, in which the earthing connection does not normally carry current, shall conform with Clause 5 except that the upper limit of 64 mm² does not apply (see Table 1, Item 3 c).

The system earthing of earthed distribution systems shall be effected by means independent of any earthing arrangements of non-current-carrying parts.

5.4 Connections to the ship's structure

Every connection of an earth-continuity conductor or earthing lead 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 shall be used for this purpose only. In all circumstances, care shall be taken to ensure bright metallic surfaces at the contact areas immediately before the screw is tightened.

5.5 Aluminium superstructures

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.

NOTE See IEC 60533.

6 SWITCHGEAR AND CONTROLGEAR ASSEMBLIES

6.1 Insulating mats

When the voltage exceeds the safety voltage specified in IEC 60092-101 an insulated mat, insulated grating or isolated deck covering shall be provided in front of switchgear and control gear, HV panels and convertors assemblies 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.

6.2 Passageways in front of switchgear and control gear assemblies

An unobstructed passageway not less than 1 m wide extending from the furthest projection shall be provided in front of any assembly.

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, it shall be ample to permit maintenance 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. For nominal voltages exceeding 500 V, it is recommended to increase this space to 1 m.

Passageways behind main and emergency switchboards shall be of ample height and shall where practicable, be provided at each end with an access door fitted with an external lock which can at all times be opened from the interior. The access doors shall carry a permanent and prominent indication of the maximum voltage.

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.

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 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

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.

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

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

9 ACCUMULATOR (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 60092-202, 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 by battery manufacturer and shall describe all potential hazards. As a minimum the description 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

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).

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 electrical storage assemblies exceeding an energy of > 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;
- energy between 5 kWh ≤ 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.
- power 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

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.

9.3 Installation risk assessment

Risk assessments shall be carried out for several ship operation modes (i.e. operation at sea, operation at shore, maintenance).

Documents about the risk-assessment shall be reviewed and compared to the installation before setting to work of the battery assembly or battery system.

NOTE FOR CD2 IEC 60092-305 is under revision. In the new version of IEC 60092-305 a requirement for risk assessment in accordance with ISO31000 and IEC TS 62933-5-1:2017 "Safety considerations for grid-integrated EES systems - General specification" is under consideration.

9.4 Access

Batteries shall be arranged to permit ready access for replacing, inspection, testing, replenishing and cleaning

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

Battery room shall only be accessible by authorised personal.

9.5 Electrical installation in battery compartments

9.5.1 Cables

Cables, except those appertaining to the battery or the battery compartment lighting, should, as far as possible, not be installed in the battery compartments. However, if such an installation is necessary, the cables shall have a protective covering resistant to the vapours developed by the electrolyte or shall be otherwise protected against these vapours.

9.5.2 Installation

Battery systems installations shall be IT configured from the ship structure to avoid damage caused by earth fault currents and damaging voltage pulses between chassis and battery cells.

Devices liable to arc shall not be installed in any compartment assigned principally to accumulator (storage) batteries.

Tests of the disconnecting device, control device and protection devices shall be conducted.

The complete battery or each string shall have a disconnecting device between the battery and the distribution. The disconnecting device shall be installed close to the battery and be able to withstand a short circuit.

9.5.3 Environment

The battery system shall have sufficient cooling to be able to operate in ambient conditions specified by the manufacturer.

NOTE The best operating conditions for a battery are obtained when the ambient temperature is within the range 15 °C to 25 °C. Sustained ambient temperatures outside this range can affect battery performance and lifetime and can therefore require special consideration

Tests of the battery management system and ventilation shall be conducted.

9.6 Protection against corrosion

9.6.1 Battery compartment

The interior of battery compartments including crates, trays, boxes, shelves and other structural parts therein shall be protected against the deteriorating effect of the electrolyte by:

- electrolyte-resistant coating, or
- lining of electrolyte-resistant material, for example steel for alkaline batteries.

The floor of battery compartments may be lined with electrolyte-resistant material spanning the entire floor. The lining shall be watertight and carried up to at least 150 mm on all sides. Walls and deck-heads of battery compartments shall be protected with electrolyte-resistant coating.

Interior surface of metal shelves for lead cells, whether or not grouped in crates or trays, or for alkaline batteries, shall be protected by a lining of electrolyte-resistant material. The lining shall be watertight and carried up to at least 75 mm on all sides. Linings shall have a minimum thickness of 1,5 mm if of lead sheet, and of 0,8 mm if of steel.

Exterior surfaces of metal shelves should have at least an electrolyte-resistant coating.

For other types of battery chemistries the enclosure shall not deteriorate that the mechanical stability and tightness is compromised by fluid spills, gasses or fumes.

9.6.2 Battery casing

Battery casings shall be made of metallic or flame retardant material.

Deck boxes shall be lined in accordance with the above alternative methods. Boxes for small batteries shall be lined to a depth of 75 mm consistent with the methods described above.

Materials used for coating and lining shall not be likely to emit vapours detrimental to the batteries.

9.7 Fixing and supports

Batteries shall be securely chocked, with non-conducting blocks or the equivalent, to prevent movement. The trays shall be arranged to give access of air to them from all sides. The isolating supports shall be non-absorbent to the electrolyte.

The secondary cells and batteries shall be grouped in racks, crates or trays of rigid construction and suitable material, equipped with handles to facilitate handling.

The number of cells in a crate or tray will depend on the weight and on the space available in the installation. Elements with mass greater than 25 kg shall be clearly marked and suitable mechanical handling facilities should be provided for ergonomic working, as required for cell replacement.

9.8 Ventilation

The battery system shall have sufficient cooling to be able to operate in ambient conditions specified by the manufacturer and specified life time.

All rooms, lockers and boxes for storage batteries shall be arranged and/or ventilated to -avoid accumulation of flammable gas. Particular attention shall be given to the fact that the gas emitted is lighter than air and will tend to accumulate in any pockets at the top of the space. When batteries are arranged in two or more tiers, all shelves shall have not less than 50 mm space, front and back, for circulation of air.

Natural ventilation may be employed if ducts can be run directly from the top of the room or locker to the open air above, with no part of the duct more than 45° from the vertical. These ducts shall not contain appliances (for example for barring flames) which may impede the free passage of air or gas mixtures.

Where lockers are provided for batteries, the duct shall terminate not less than 0,9 m above the top of the battery enclosure.

If natural ventilation is impracticable or insufficient, mechanical exhaust-ventilation shall be provided with exhaust at the top of the room. Adequate openings, whether connected to ducts or not, for air inlets shall be provided near the floor of battery rooms or the bottom of lockers or boxes.

Tests of the redundant power supply for ventilation system shall be conducted

If (over) charging can create fumes or gasses, (example: lead-acid batteries) the batteries shall be placed in a box or locker which is hermetically sealed, or of which the ventilation is set up in such a way that these gasses or fumes can only escape above deck (using ducts or similar

Rooms, lockers and boxes for batteries connected to a charging device with an energy output according to 9.1 shall be ventilated as follows:

- energy more than 50 kWh, preferably by mechanical exhaust, independent of ventilation systems for other spaces;
- energy between 15 and 50 kWh, except for batteries located open in the engine room or in a similar well ventilated compartment;
- power less than 15 kWh, boxes require openings near the top to permit escape of gas;

Deck boxes may be naturally ventilated. Natural ventilation by means of a duct of ample dimensions, terminating at least 1,25 m above in a goose-neck, mushroom-head or the equivalent will be sufficient. Holes for air inlet should be provided on at least two opposite sides of the box.

NOTE For degree of protection see IEC 60092-201

Fans of accumulator compartments shall be so constructed and be of a material such as to render sparking impossible in the event of the impeller touching the fan casing. Steel or aluminium impellers shall not be used.

Ducts shall be made of a corrosion-resisting material or their interior surfaces shall be painted with corrosion-resistant paint

Any fan motor associated with a duct used to exhaust the air from an accumulator space shall be placed external to the duct. Adequate means shall be provided to prevent entrance of gas into the motor. The duct shall be arranged to discharge into the open air.

10 LUMINAIRES

10.1 Degree of protection

Depending on their location, luminaires shall as a minimum have the degree of protection given in IEC 60092-201.

Luminaires likely to be exposed to more than ordinary risk of mechanical damage shall be protected against such damage or be of robust construction

10.2 Discharge lamp luminaires of voltage above 250 V

10.2.1 General

Discharge lamps operating at voltages above 250 V should be used only in fixed luminaires. Discharge lamp installations should, where practicable, be provided with durable and suitable notices bearing the inscription in the warning label:

WARNING HIGH VOLTAGE

The warning label shall be in accordance with IEC/ISO Guide 51, ISO 3864-2 and ISO 7010.

10.2.2 Protection of live parts

All live parts of discharge lamp luminaires shall be so designed, placed and installed that they cannot be touched accidentally or inadvertently, the creepage distance along the surface of the glass tube being taken into consideration.

10.2.3 Wiring installation

Bare metal conductors or cables, neither metal-sheathed nor armoured, should be properly supported and separated according to the voltage but not less than 20 mm from other conductors, cables or earthed metalwork and should be covered by a suitable protection.

Where otherwise not readily identifiable, cables or their protective covering, shall be distinguished by tabs or labels marked "DANGER" securely attached at intervals not greater than 1,5 m. The letters shall be red on a white background, and shall be not less than 10 mm high.

10.2.4 Earthing

All non-current-carrying metallic parts of the installation shall be effectively earthed. It is, however, not always necessary to earth metallic clips or clamps used in positions remote from terminals to support discharge lamps but it may be found desirable to earth such clips or clamps in order to reduce interference with radio reception.

10.2.5 Switches

Each discharge lamp luminaire or installation shall be provided with a multipole (all poles) disconnecting switch in an accessible location. Such switch shall be clearly marked, and a warning notice shall be placed nearby.