भारतीय मानक

Indian Standard

IS 10242 (Part 3/Sec 2) : 2023
IEC 60092-302-2 : 2019

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(पहला पुनरीक्षण)

Electrical Installation in Ships — Specification

Part 3 Equipment

Section 2 Low Voltage Switchgear and Controlgear Assemblies - Marine Power

(First Revision)

ICS 47.020.60

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Electrical Installation Sectional Committee, ETD 20

NATIONAL FOREWORD

This Indian Standard (Part 3/Sec 2) (First Revision) which is identical to IEC 60092-302-2 : 2019 'Electrical installations in ships — Part 302-2: Low voltage switchgear and controlgear assemblies — Marine power' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Electrical Installation Sectional Committee and approval of the Electrotechnical Division Council.

The text of the IEC standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appears referring to this standard, they should be read as 'Indian Standard'; and

b) Comma (,) has been used as a decimal marker, while in Indian Standards the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to International Standards for which Indian Standards also exists. The corresponding Indian Standards, which are to be substituted, are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60092-101 Electrical installations in ships — Part 101: Definitions and general requirements	IS 10242 (Part 1/Sec 1) : 2023/ IEC 60092-101 : 2018 Electrical installations in ships — Specification: Part 1 General, Section 1 Definitions and general requirements (*second revision*)	Identical
IEC 60092-201 : 2019 Electrical installations in ships — Part 201: System design — General	IS 10242 (Part 2/Sec 1) : 2023/ IEC 60092-201 : 2019 Electrical installation in ships — Specification: Part 2 System design, Section 1 General (*first revision*)	Identical
IEC 60533 Electrical and electronic installations in ships — Electromagnetic compatibility (EMC) — Ships with a metallic hull	IS 14479 : 1998 Electrotechnical compatibility of electrical and electronic installations in ships — Specification	Technically Equivalent
IEC 61439-1 : 2011 Low-voltage switchgear and controlgear assemblies – Part 1: General rules	IEC 61439-1 : 2011 Low-voltage switchgear and controlgear assemblies: Part 1 General Rules	Identical
IEC 61439-2 : 2011 Low-voltage switchgear and controlgear assemblies – Part 2: Power switchgear and controlgear assemblies	IS/IEC 61439-2 : 2020 Low-voltage switchgear and controlgear assemblies: Part 2 Power switchgear and controlgear assemblies (*first revision*)	Identical

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

CONTENTS

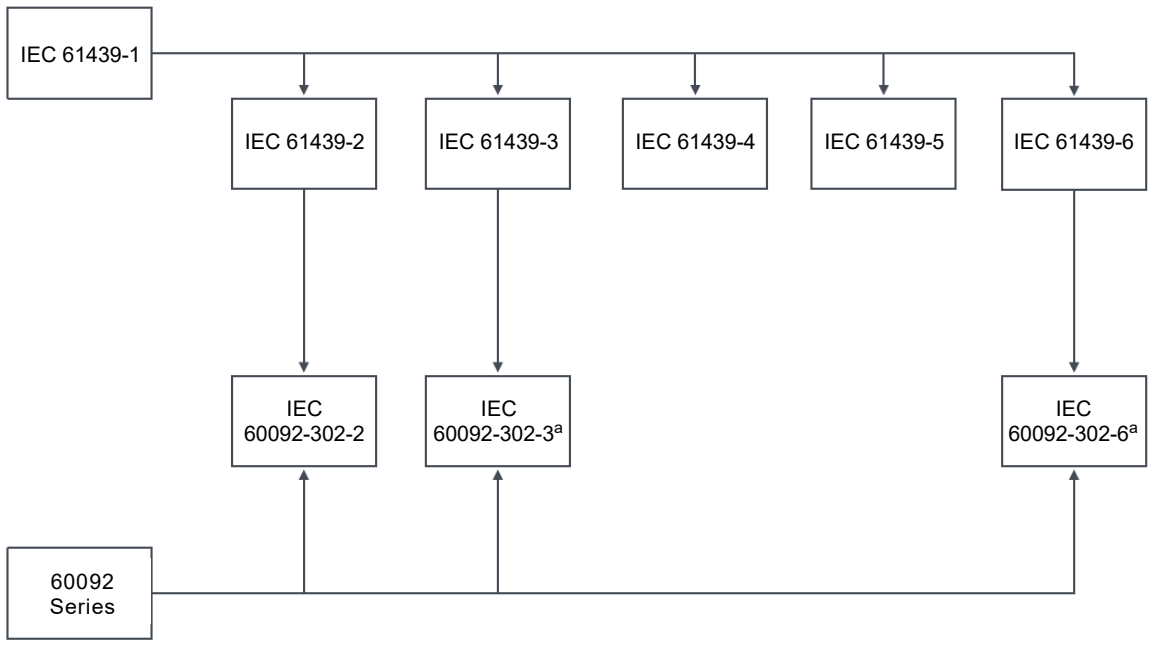
INTRODUCTION

This part of IEC 60092 forms a series of International Standards for electrical installations in sea-going ships, incorporating good practice and coordinating, as far as possible, existing rules.

These standards form a code of practical interpretation and amplification of the requirements of the International Convention for the Safety of Life at Sea, a guide for future regulations which may be prepared and a statement of practice for use by ship owners, shipbuilders and appropriate organizations.

IEC 61439 (all parts) identifies the requirements for land based low voltage switchgear and controlgear assemblies. IEC 60092-302 (all parts) has been developed in-line with Figure 201, which shows the future intention to develop appropriate marine standards for final distribution boards to be operated by ordinary persons; and busbar trunking systems.

IEC 60092 (all parts) remains the lead standard series for electrical installations in ships, and the applicable standards are applied accordingly. Wherever there are differences between IEC 61439 (all parts) and IEC 60092 (all parts), IEC 60092 (all parts) takes precedence.



Key

[a] Under consideration.

NOTE At the time of publication, IEC 60092-302-3 and IEC 60092-302-6 are not developed. The figure shows that these standards are potential future projects to align with the IEC 61439 series.

Figure 201 – Relationship of standards

Indian Standard

ELECTRICAL INSTALLATION IN SHIPS — SPECIFICATION

PART 3 EQUIPMENT

SECTION 2 LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLIES - MARINE POWER

(First Revision)

1 Scope

This part of IEC 60092 defines the specific requirements of low voltage marine power switchgear and controlgear assemblies (MPSC-assemblies) as follows:

- stationary assemblies with enclosure for which the rated voltage does not exceed 1 000 V AC or 1500 V DC;
- assemblies intended for use in conjunction with the power generation, distribution and conversion of electric energy, and for the control of electric energy consuming equipment.

This document applies to all assemblies whether they are designed, manufactured and verified on a one-off basis or fully standardised and manufactured in quantity.

The manufacture and/or assembly can be carried out other than by the original manufacturer.

This document does not apply to individual devices and self-contained components, such as motor starters, fuse switches, electronic equipment, which comply with the relevant product standards.

NOTE Individual devices and components include those that are covered by the IEC 60947 series.

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 60092-101:2018, *Electrical installations in ships – Part 101: Definitions and general requirements*

IEC 60092-201:2019, *Electrical installations in ships – Part 201: System design – General*

IEC 60533, *Electrical and electronic installations in ships – Electromagnetic compatibility (EMC) – Ships with a metallic hull*

IEC 61439-1:2011, *Low-voltage switchgear and controlgear assemblies – Part 1: General rules*

IEC 61439-2:2011, *Low-voltage switchgear and controlgear assemblies – Part 2: Power switchgear and controlgear assemblies*

3 Terms and definitions

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

Clause 3 of IEC 61439-2:2011 is applicable except as follows.

3.1 General terms

Additional terms and definitions:

3.1.201
MARINE POWER SWITCHGEAR AND CONTROLGEAR ASSEMBLY
MPSC-assembly
low-voltage switchgear and controlgear assembly used to distribute and control energy for all types of loads, intended for marine applications specifically, in ships, operated by skilled or instructed persons only

Note 1 to entry: It is not excluded for a MPSC-assembly to be located in an area accessible to ordinary persons.

3.1.202
MAIN SWITCHBOARD
MPSC-assembly which is directly supplied by the main source of electrical power and is intended to control and distribute electrical energy to the ships services

3.1.203
MOTOR CONTROL CENTRE
MCC
MPSC-assembly which is supplied by main or emergency switchboards and is intended to control and distribute electrical energy

Note 1 to entry: It is possible for the MCC to be a section or sections of the main switchboard.

3.1.204
EMERGENCY SWITCHBOARD
MPSC-assembly which is normally supplied by the main switchboard, but in the event of failure of the main electrical power system is directly supplied by the emergency source of electrical power and is intended to control and distribute electrical energy to the emergency services

3.1.205
DISTRIBUTION BOARD
MPSC-assembly which is supplied by a main or emergency switchboard, or distribution boards and is used to distribute and control energy to other distribution boards, final distribution boards or final sub circuits

Note 1 to entry: The definition of "section board" as defined in previous versions of IEC 60092-302 has been replaced by the one of "distribution board".

4 Symbols and abbreviations

Clause 4 of IEC 61439-2:2011 is applicable.

5 Interface characteristics

Clause 5 of IEC 61439-2:2011 is applicable except as follows.

5.2 Voltage ratings

5.2.3 Rated insulation voltage (U_i) (of a circuit of an assembly)

Replacement of 5.2.3 of IEC 61439-1:2011:

The rated insulation voltage of a circuit of an assembly is the voltage value to which dielectric test voltages and creepage distances are referred.

Due to the potential effects of the marine environment on creepage distances, the rated insulation voltage of a circuit shall be 1,5 times higher than the values stated for U_n and for U_e for the same circuit up to a final maximum of U_i 1 000 V AC or 1 250 V DC. Any DC application requiring U_i exceeding 1 250 V DC shall need to have special consideration.

For single-phase circuits derived from IT systems (see IEC 60364-5-52), the rated insulation voltage should be at least equal to the voltage between phases of the supply.

While it is advisable to use the above safety factor for all internal components and devices; those that have been tested in accordance with their own product standard need not have this safety factor applied.

5.6 Other characteristics

Replacement of item g) of IEC 61439-1:2011:

g) operated by skilled and instructed persons only;

6 Information

Clause 6 of IEC 61439-2:2011 is applicable except as follows.

6.1 Assembly designation marking

Replacement of item d):

d) IEC 60092-302-2;

Addition of item e):

e) ambient air temperature (see 7.1.1.1 and 7.1.1.2).

6.3 Device and/or component identification

Addition:

Individual circuits and their devices shall have the following durable and permanent markings and meet the requirements of IEC 60092-201:2019, 5.3.

a) The rated current of the circuit I_{nc} and assigned settings of adjustable protective devices (see 6.2.2 of IEC 61439-1:2011 for documentation of settings requirements).
b) When, for fuse systems above 500 V, the fuseholders permit the insertion of fuse links for lower rated voltage, special warning labels or symbols, for example "Caution 690 V fuse links only".
c) Arranging warning labels where polarized circuit-breakers are installed in DC systems so as to guard against the possibility of incorrect connections during maintenance or replacement.
d) Withdrawable and/or removable parts along with relevant fixed parts of an assembly shall be provided with permanent markings in order to identify where the parts can be correctly reassembled.

Compliance is checked according to the test of 10.2.7 of IEC 61439-1 2011 and by inspection.

7 Service conditions

Clause 7 of IEC 61439-1:2011 is applicable except as follows.

7.1.1.1 Ambient air temperature for indoor installations

Replacement:

The ambient air temperature does not exceed +45 °C, and its average over a period of 24 h does not exceed +40 °C.

The lower limit of the ambient air temperature is 5 °C.

NOTE Where the ambient air temperature of the assembly is different, details of calculation methods are given in 10.10.3.201.

7.1.1.2 Ambient air temperature for outdoor installations

Replacement:

The ambient air temperature does not exceed +45 °C, and its average over a period of 24 h does not exceed +40 °C.

The lower limit of the ambient air temperature is –25 °C.

NOTE Where the ambient air temperature of the assembly is different, details of calculation methods are given in 10.10.3.201.

7.1.2.1 Humidity conditions for indoor installations

Replacement:

In other parts of the IEC 60092 series, where no "high air temperature" has been specified as a design parameter for equipment, the relative humidity of the air does not exceed 95 % at a maximum temperature of +45 °C.

Moderate condensation should be borne in mind which can occasionally occur due to variations in temperature.

Additional subclauses:

7.1.201 Vibration

MPSC-assemblies shall be unaffected by vibration likely to occur under normal service. Design parameters are detailed in 4.6.3.5 of IEC 60092-101:2018.

7.1.202 Angular deviation and motion

MPSC-assemblies shall be unaffected by movement of the ship likely to occur under normal service. Design parameters are detailed in 4.6.3.4 of IEC 60092-101:2018.

8 Constructional requirements

Clause 8 of IEC 61439-2:2011 is applicable except as follows.

8.2.2 Protection against contact with live parts, ingress of solid foreign bodies and water

Deletion of Note 1 in 8.2.2 of IEC 61439-1:2011.

8.3.2 Clearances

Deletion of the note in 8.3.2 of IEC 61439-1:2011.

8.3.3 Creepage distances

Replacement of the third paragraph in 8.3.3 of IEC 61439-1:2011:

Creepage distances shall correspond to a pollution degree as specified in 7.1.3 and to the corresponding material group at the rated insulation voltage given in Table 2. Devices that have been tested in accordance with their own product standard need not have this safety factor applied.

Deletion of Note 2 in 8.3.3 of IEC 61439-1:2011.

8.4.3 Fault protection

8.4.3 of IEC 61439-1:2011 is applicable except as follows.

Additional paragraph:

8.4.3.201 Protection against electric shock for accessibility maintenance

If earth bars (protective conductor) are installed in main and emergency switchboards, MCCs and distribution boards shall be installed and located to ensure their easy access and access to their terminations, during and after installation.

8.4.6 Operating and servicing conditions

8.4.6 of IEC 61439-1:2011 is applicable except as follows.

8.4.6.2.3 Requirements related to accessibility for maintenance

Addition:

It shall be possible to replace or maintain all devices used for isolation of the main source of electrical power without complete blackout of the main source of electrical power.

Where polarized circuit breakers are installed in DC systems, and in all other similar cases, warning labels shall be arranged so as to guard against the possibility of incorrect connection during maintenance.

8.5 Incorporation of switching devices and components

8.5 of IEC 61439-1:2011 is applicable except as follows.

8.5.4 Installation of switching devices and components

Addition:

Wherever possible, components of main circuits with different nominal voltages shall be installed separate from each other.

8.6 Internal electrical circuits and connections

8.6 of IEC 61439-1:2011 is applicable except as follows.

8.6.2 Auxillary circuits

Addition:

Wiring shall comply with the relevant requirements given in the cable standards within the IEC 60092 series.

8.6.3 Bare and insulated conductors

Addition:

Cables shall comply with the relevant requirements given in the cable standards within the IEC 60092 series.

Additional subclauses:

8.6.3.201 Busbars

8.6.3.201.1 General

Busbars shall be of a composition suited for operation in a salt-laden atmosphere.

EXAMPLE Electrolytic copper or copper-clad aluminium.

8.6.3.201.2 Sub-division of main switchboard main busbar

The MPSC-assembly shall meet the specific requirement of the system as detailed in IEC 60092-201:2019, Clause 8.

Where there is a functional requirement for more than one incoming device within the assembly, the main busbars of the assembly shall be subdivided into at least two isolated parts; this is to be done by a multipole switch or circuit breaker.

8.6.3.201.3 Busbar phase or polarity arrangements

Where practicable, a standard pattern of busbar phase and polarity arrangements shall be used. Examples for such a pattern as viewed from the front of the assembly are as follows:

a) for AC MPSC-assemblies – busbar L1, L2, L3... counting from front to rear, top to bottom or left to right (when viewed from the front of the switchgear assembly);
b) polarities on DC switchgear and controlgear busbars and connections to be: positive, neutral, negative, counting from front to rear, top to bottom or left to right.

8.8 Terminals for external conductors

Deletion of Note 1 of IEC 61439-1:2011.

8.101 Internal separation of PSC-assemblies

8.101 of IEC 61439-2:2011 is applicable except as follows.

Addition after the second paragraph:

Incoming and section interconnection devices and any circuit with I_{nc} above 600 A used within main and emergency switchboards shall be contained in their own compartment providing at least a degree of protection of IP XXB.

Replacement of Note 1:

NOTE 1 The degree of protection IP 2X covers the degree of protection IP XXB.

Additional subclauses:

8.201 Constructional requirements for marine applications

8.201.1 Structural parts of aluminium alloy

If aluminium alloy is used in construction, the material shall be suitable for the use in the marine environment, and precautions shall be taken to avoid galvanic corrosion.

8.201.2 Handrails or handles

Every main or emergency switchboard, MCC and distribution board, required for essential and emergency services shall be provided with an insulated handrail or insulated handles to enable these assemblies to be operated safely during the vessels possible motion. These should be suitably located on a fixed part on the front of the assemblies. Where access to the rear of the above mentioned switchboards is necessary for operational, maintenance, or similar purposes, an insulated handrail or insulated handles should be suitably located on a fixed part of the assembly.

8.201.3 Door latching

Hinged doors which may be opened for operation, maintenance or similar purposes shall be provided with a latching or locking facility to keep the door open during normal movement of the ship.

9 Performance requirements

Clause 9 of IEC 61439-2:2011 is applicable except as follows.

9.1.3.1 Impulse withstand voltages of main circuits

Addition at the end of 9.1.3.1 of IEC 61439-1:2011:

The rated impulse withstand voltage for a given rated operational voltage shall not be less than that corresponding in Annex G to the nominal voltage of the supply system of the circuit at the point where the assembly is to be used and with the overvoltage category III.

9.2 Temperature rise limits

Delete Note 2 of IEC 61439-1:2011.

Addition at the end of 9.2 of IEC 61439-1:2011:

The temperature rise limits given in Table 6 apply for a mean ambient air temperature up to 40 °C. MPSC-assemblies are required to operate in a higher ambient temperature under service conditions (see 7.1). A reduction of the permissible rises shown to reflect the raised ambient should be made. During verification, a different ambient air temperature is permissible (see 10.10.2.3.4).

10 Design verification

Clause 10 of IEC 61439-1:2011 is applicable with the following additions.

10.10.2.3.1 General

Addition:

To reduce the testing required to determine the rated current of a circuit I_1 at the maximum permissible temperature rise ΔT_1, the current rating may be calculated from the actual test current I_2 if the measured temperature rise ΔT_2 of the current carrying parts (e.g. busbars and terminals) deviates from the permissible value by not more than ±5 K, using the following formula[1]:

$$\frac{I_1}{I_2} = \left(\frac{\Delta T_1}{\Delta T_2} \right)^{0.61}$$

where

I_1 is the current at which the temperature rise test is carried out;

I_2 is the current rating to be determined at the specific ambient air temperature between 20 °C and 55 °C;

ΔT_1 is the temperature rise measured by test with a current of I_1;

ΔT_2 is the maximum permissible temperature rise at the specific ambient air temperature between 20 °C and 55 °C.

NOTE The formula can only be applied if the power loss of the devices and conductors is substantially proportional to I^2.

Care shall be taken to ensure that all other measurement points will not reach their maximum temperature at this higher current. The most critical location of highest temperature point shall be identified either by test or thermal simulation.

Care is required when determining the number of points where this calculation is applied so as to ensure the effects of changing several currents having an influence on other measuring points (including internal air temperature) due to the changed power loss.

10.10.3.5 Functional units – Device substitution

Replacement of 10.10.3.5 of IEC 61439-1:2011, including its title

10.10.3.5 Functional units – Temperature-rise considerations for device substitution

A device within a circuit may be substituted with a similar device from another series from the same or a different device manufacturer to that used in the original verification, provided that the power loss and terminal temperature rise of the substituting device is the same or lower than the device used in the original verification, when both are tested in accordance with the devices' product standard.

Alternatively, the substitution is possible if the following conditions are met.

[1] Formula reproduced from Copper Development Association, Publication No. 22:1996, with the permission of Copper Development Association Inc.

a) The temperature rise at the terminals of the original device, when tested in the assembly, is at least 10 K below the limit permitted by the assembly standard.

b) The substituting device has a temperature rise limit on the terminals declared by the manufacturer of the substituting device, no less than the temperature rise limit on the terminals declared by the manufacturer of the original device. If there is no declared temperature rise limit, the default temperature rise limit is that permitted by the device standard.

c) The power loss of the substituting device does not exceed that of the original device.

Alternatively, when the original device and the substituted device are from the same device manufacturer, the device manufacturer may issue a declaration of temperature rise performance. The declaration shall confirm that the substituting device can replace the original device with no further need for verification in respect of temperature rise.

In addition, for each of the above options, the physical arrangement within the functional unit shall be maintained. The rating of a functional unit shall not be increased. The physical arrangements shall include terminal shields, conductor type, material, and connection sizes, mounting orientation, clearances to other parts, ventilation arrangements and terminal arrangement.

The performance data on terminal temperatures and power loss may be obtained from the device manufacturer or from comparison tests undertaken by those responsible for the substitution. Any test shall be conducted on new samples.

Refer to Table D.1 for other design characteristics, including short-circuit withstand, that require consideration when substituting devices.

Additional subclause:

10.10.3.201 Calculation of currents based on adjustment of ambient air temperature

To facilitate the probable variation of locations of an assembly in the vessel, the following methodology may be used the adjust the rated current of the assembly. Once a temperature rise test has been carried out applying the temperature rise limits for a daily average ambient air temperature of 40 °C, then up to a daily average ambient air temperature of 55 °C, the rated currents verified by testing can be adjusted by calculation, assuming that the over-temperature of each component or device is proportional to the power loss generated in this component.

Caution should be taken to ensure the devices being assessed have a power loss substantially proportional to I^2 and which is not applied to devices that have substantially fixed losses. By agreement between the user and the manufacturer, in assemblies where the power loss of conductors and devices is substantially proportional to I^2, the rated current of the circuits at ambient air temperatures (outside the enclosure) between 20 °C and 55 °C may be calculated using the following formula[2]:

$$\frac{I_1}{I_2} = \left(\frac{\Delta T_1}{\Delta T_2} \right)^{0.61}$$

where

I_1 is the current at which the temperature rise test is carried out;

I_2 is the current rating to be determined at the specific ambient air temperature between 20 °C and 55 °C;

2 Formula reproduced from Copper Development Association, Publication No. 22:1996, with the permission of Copper Development Association Inc.

ΔT_1 is the temperature rise measured by test with a current of I_1;

ΔT_2 is the maximum permissible temperature rise at the specific ambient air temperature between 20 °C and 55 °C.

I_2 cannot exceed 95 % of the rated current of any device within the circuit being considered, for example a circuit including a 1 600 A circuit-breaker cannot be assigned a current rating greater than 1 520 A.

11 Routine verification

Clause 11 of IEC 61439-2:2011 is applicable.

Table 1 – Minimum clearances in air (8.3.2)

Replace Table 1 of IEC 61439-1:2011 with the following

Table 1 – Minimum clearances in air (8.3.2)

Rated impulse withstand voltage, U_{imp} kV	Minimum clearance[a] mm
≤ 2,5	4
4,0	8
6,0	14
8,0	20
12,0	35
[a] Based on inhomogeneous field conditions and pollution degree 3. NOTE This table reflects a safety multiplication factor to take into account the marine environment.	

Table 2 – Minimum creepage distances (8.3.3)

Replace Table 2 of IEC 61439-1:2011 with the following

Table 2 – Minimum creepage distances (8.3.3)

Rated insulation voltage U_i	Minimum creepage distance mm							
	Pollution degree							
	1	2			3			
	Material group[b]	Material group[b]			Material group[b]			
V[c]	All material groups	I	II	IIIa and IIIb	I	II	IIIa	IIIb
32	2,25	2,25	2,25	2,25	2,25	2,25	2,25	2,25
40	2,25	2,25	2,25	2,25	2,25	2,4	2,7	2,7
50	2,25	2,25	2,25	2,25	2,25	2,55	2,85	2,85
63	2,25	2,25	2,25	2,25	2,4	2,7	3	3
80	2,25	2,25	2,25	2,25	2,55	2,85	3,15	3,15
100	2,25	2,25	2,25	2,25	2,7	3	3,3	3,3
125	2,25	2,25	2,25	2,25	2,85	3,15	3,6	3,6
160	2,25	2,25	2,25	2,4	3	3,3	3,75	3,75
200	2,25	2,25	2,25	3	3,75	4,2	4,8	4,8
250	2,25	2,25	2,7	3,75	4,8	5,4	6	6
320	2,25	2,4	3,3	4,8	6	6,75	7,5	7,5
400	2,25	3	4,2	6	7,5	8,4	9,45	9,45
500	2,25	3,75	5,4	7,5	9,45	10,65	12	12
630	2,4	4,8	6,75	9,45	12	13,5	15	15
800	3,6	6	8,4	12	15	16,5	18,75	[a]
1 000	4,8	7,5	10,65	15	18,75	21	24	
1 250	6,3	9,45	13,5	18,75	24	27	30	
1 600	8,4	12	16,5	24	30	33	37,5	

NOTE 1 The CTI values in footnote c refer to the values obtained in accordance with IEC 60112:2003, method A, for the insulating material used.

NOTE 2 Values taken from IEC 60664-1, but maintaining a minimum value of 2,25 mm.

NOTE 3 This table reflects a safety multiplication factor to take into account the marine environment.

[a] Insulation of material group IIIb is not recommended for use in pollution degree 3 above 630 V.

[b] Material groups are classified as follows, according to the range of values of the comparative tracking index (CTI) (see 3.6.16):

- Material group I 600 ≤ CTI
- Material group II 400 ≤ CTI < 600
- Material group IIIa 175 ≤ CTI < 400
- Material group IIIb 100 ≤ CTI < 175

[c] The U_i to be used in this table is the increased figure as detailed in 5.2.3

Table 6 – Temperature rise limits (9.2)

Replace Table 6 of IEC 61439-1:2011 with the following

Table 6 – Temperature rise limits (9.2)

Parts of ASSEMBLIES	Temperature-rise K
Built-in components [a]	In accordance with the relevant product standard requirements for the individual components or, in accordance with the component manufacturer's instructions[f], taking into consideration the temperature in the ASSEMBLY
Terminals for external insulated conductors	65[b]
Busbars and conductors	Limited by[f,g]: – mechanical strength of conducting material; – possible effect on adjacent equipment; – permissible temperature limit of the insulating materials in contact with the conductor; – effect of the temperature of the conductor on the apparatus connected to it; – for plug-in contacts, nature and surface treatment of the contact material
Manual operating means: – of metal – of insulating material	 10[c] 20[c]
Accessible external enclosures and covers: – metal surfaces – insulating surfaces	 25[d] 35[d]
Discrete arrangements of plug and socket-type connections	Determined by the limit for those components of the related equipment of which they form part[e]
NOTE The temperature-rise limits given in this table apply for a daily average ambient air temperature up to 40 °C[h]	

[a] The term "built-in components" means:
- conventional switchgear and controlgear;
- electronic sub-ASSEMBLIES (e.g. rectifier bridge, printed circuit);
- parts of the equipment (e.g. regulator, stabilized power supply unit, operational amplifier).

[b] The temperature-rise limit of 65 K is a value based on the conventional test of 10.10. An ASSEMBLY used or tested under installation conditions may have connections, the type, nature and disposition of which will not be the same as those adopted for the test, and a different temperature-rise of terminals may result and may be required or accepted. Where the terminals of the built-in component are also the terminals for external insulated conductors, the lower of the corresponding temperature-rise limits shall be applied. The temperature-rise limit is the lower of the maximum temperature-rise specified by the component manufacturer and 65 K. In the absence of manufacturer's instructions, it is the limit specified by the built-in component product standard but not exceeding 65 K.

[c] Manual operating means within ASSEMBLIES which are only accessible after the ASSEMBLY has been opened, for example draw-out handles which are operated infrequently, are permitted to sustain a 20 K increase on these temperature-rise limits.

[d] Unless otherwise specified, in the case of covers and enclosures, which are accessible but need not be touched during normal operation, a 10 K increase on these temperature-rise limits is permissible. External surfaces and parts over 2 m from the base of the ASSEMBLY are considered inaccessible.

[e] This allows a degree of flexibility in respect of equipment (e.g. electronic devices) which is subject to temperature-rise limits different from those normally associated with switchgear and controlgear.

[f] For temperature-rise tests according to 10.10, the temperature-rise limits have to be specified by the original manufacturer. It is the responsibility of the original manufacturer to take into account any additional measuring points and limits imposed by the component manufacturer.

[g] Assuming all other criteria listed are met, a maximum temperature-rise of 80 K for bare copper busbars and conductors shall not be exceeded. The 80 K rise (based on an ambient of 40 °C) acceptable in MPSC-Assemblies reflects the reduced air circulation anticipated in the marine environment aboard ship. Other materials may have a different maximum temperature-rise.

[h] Where an assembly is installed in an ambient air temperature different from a daily average of 40 °C, an agreement between the user and the manufacturer may permit calculation. The agreed temperature-rise shall not exceed the values given in this table. See also 10.10.3.201.

Table 13 – Short-circuit verification by comparison with reference design: check list (10.5.3.3, 10.11.3 and 10.11.4)

Replacement of Item no. 6 in Table 13 of IEC 61439-1:2011:

Are the short-circuit protective devices of each circuit of the assembly to be assessed equivalent, that is of the same manufacturer and series [a]?

In addition, does the short-circuit protective devices of each circuit of the assembly to be assessed

- have a breaking capacity not less than the short-circuit rating of the assembly at the rated operational voltage of the assembly?
- in the case of a current limiting protective device: have a peak let-through current and let-through energy equal or smaller than the reference design at the short-circuit rating and the rated operational voltage of the assembly?
- in the case of a non current limiting device: have a rated short-time withstand current I_{cw} equal to or higher than the reference design?
- fulfil the requirements of coordination with upstream and downstream devices (see 9.3.4 of IEC 61439-1:2011), if required?

Annexes

Annexes of IEC 61439-2:2011 and IEC 61439-1:2011 are applicable except as follows.

Annex C of IEC 61439-1:2011 is not applicable.

Annex J – Electromagnetic compatibility (EMC)

Replacement of Annex J of IEC 61439-1:2011:

IEC 60533 shall be used for ships with metallic hulls.

NOTE A standard for non-metallic hull is under consideration.

Annexes L and M of IEC 61439-1:2011 are not applicable.

Annex BB of IEC 61439-2:2011 is not applicable.

Additional annexes:

Annex AAA
(informative)

Items subject to agreement between the assembly manufacturer and the user

The following information is subject to an agreement between the assembly manufacturer and the user. In some cases, information declared by the assembly manufacturer may take the place of an agreement.

Table AAA.1 – Items subject to agreement between the assembly manufacturer and the user

Characteristics	Reference	Default arrangement [b]	Options listed in standard	User requirement [a]
Electrical system				
Earthing system	5.6, 8.4.3.1, 8.4.3.2.3, 8.6.2, 10.5, 11.4 IEC 60092-201	Manufacturer's standard, selected to suit ship requirements	TT/IT, TN-S	
Nominal voltage (V)	3.8.9.1, 5.2.1, 8.5.3	According to installation conditions	max AC 1 000 V or DC 1 500 V	
Transient overvoltages	5.2.4, 8.5.3, 9.1, Annex G	Determined by the electrical system	Overvoltage category III	
Temporary overvoltages	9.1	Nominal system voltage +1 250 V	None	
Rated frequency f_n (Hz)	3.8.12, 5.5, 8.5.3, 10.10.2.3, 10.11.5.4	According to local installation conditions	DC/50 Hz/60 Hz	
Additional on site testing requirements: wiring, operational performance and function	11.10	Manufacturer's standard, according to application	None	
Short-circuit withstand capability				
Prospective short-circuit current at supply terminals I_{cp} (kA)	3.8.7	Determined by the electrical system	None	
Short-circuit current withstand rating I_{cw} (kA)	3.8.10.3	Determined by the electrical system	No less than 1 s	
Prospective short-circuit current in the neutral	10.11.5.3.5	Max. 60 % of phase values	None	
Prospective short-circuit current in the protective circuit	10.11.5.6	Max. 60 % of phase values	None	
SCPD in the incoming functional unit requirement	9.3.2	According to local installation conditions	Yes/No	

Characteristics	Reference	Default arrangement [b]	Options listed in standard	User requirement [a]
Co-ordination of short-circuit protective devices including external short-circuit protective device details	9.3.4	According to local installation conditions	None	
Data associated with loads likely to contribute to the short-circuit current	9.3.2	No loads likely to make a significant contribution allowed for	None	
Protection of persons against electric shock in accordance with IEC 60364-4-41				
Type of protection against electric shock – Basic protection (protection against direct contact)	8.4.2	Basic protection	According to local installation regulations	
Type of protection against electric shock – Fault protection (protection against indirect contact)	8.4.3	According to local installation conditions	Automatic disconnection of supply/electrical separation/total insulation	
Installation environment				
Location type	3.5, 8.1.4, 8.2	Manufacturer's standard, according to application	Indoor/outdoor	
Protection against ingress of solid foreign bodies and ingress of water NOTE See IEC 60092-101 and IEC 60092-201 for environment	8.2.2, 8.2.3	Indoor (enclosed): IP 2X Outdoor (min.): IP 45	IP 00, 2X, 3X, 4X, 5X, 6X	
Protection after removal of withdrawable part	8.2.101	Manufacturer's standard	As for connected position Reduced protection to manufacturer's standard	
External mechanical impact (IK) NOTE IEC 61439-1 does not nominate specific IK codes.	8.2.1, 10.2.6	None	None	
Resistance to UV radiation (applies for outdoor assemblies only unless specified otherwise)	10.2.4	Indoor: not applicable Outdoor: Temperate climate	None	
Resistance to corrosion	10.2.2	Normal Indoor/outdoor arrangements	None	
Ambient air temperature – Lower limit	7.1.1	Indoor: 5 °C Outdoor: –25 °C	None	

Characteristics	Reference	Default arrangement [b]	Options listed in standard	User requirement [a]
Ambient air temperature – Upper limit	7.1.1	45 °C	None	
Ambient air temperature – Daily average maximum	7.1.1, 9.2	40 °C	None	
Maximum relative humidity	7.1.2	Indoor: 95 % at 45 °C Outdoor: 100 % at 25 °C	None	
Pollution degree (of the installation environment)	7.1.3	Industrial: 3	3, 4	
EMC environment	Annex J IEC 60533	Group D	Group D	
Special service conditions (e.g. vibration, exceptional condensation, heavy pollution, corrosive environment, strong electric or magnetic fields, fungus, small creatures, explosion hazards, heavy vibration and shocks, earthquakes)	7.2, 8.5.4, 9.3.3 Table 7	No special service conditions	None	
Installation method				
Type	3.3, 5.6	Manufacturer's standard	Various, e.g. floor standing/wall mounted	
Stationary/movable	3.5	Stationary	Stationary	
Maximum overall dimensions and weight	5.6, 6.2.1	Manufacturer's standard, according to application	None	
External conductor type(s)	8.8	Manufacturer's standard	Cable/Busbar trunking system	
Direction(s) of external conductors	8.8	Manufacturer's standard	None	
External conductor material	8.8	Copper	Copper/aluminium	
External phase conductor, cross sections, and terminations	8.8	As defined within the standard	None	
External PE, N, PEN conductors cross sections, and terminations	8.8	As defined within the standard	None	
Special terminal identification requirements	8.8	Manufacturer's standard	None	
Storage and handling				
Maximum dimensions and weight of transport units	6.2.2, 10.2.5	Manufacturer's standard	None	
Methods of transport (e.g. forklift, crane)	6.2.2, 8.1.6	Manufacturer's standard	None	

Characteristics	Reference	Default arrangement [b]	Options listed in standard	User requirement [a]
Environmental conditions different from the service conditions	7.3	As service conditions	None	
Packing details	6.2.2	Manufacturer's standard	None	
Operating arrangements				
Access to manually operated devices	8.4		Authorized persons	
Location of manually operated devices	8.5.5	Easily accessible	None	
Isolation of load installation equipment items	8.4.2, 8.4.3.3, 8.4.6.2	Manufacturer's standard	Individual/groups/ all	
Maintenance and upgrade capabilities				
Requirements related to accessibility for inspection and similar operations	8.4.6.2.2	No requirements for accessibility	None	
Requirements related to accessibility for maintenance in service by authorized persons	8.4.6.2.3	No requirements for accessibility	None	
Requirements related to accessibility for extension in service by authorized persons	8.4.6.2.4	No requirements for accessibility	None	
Method of functional units connection	8.5.1, 8.5.2	Manufacturer's standard	None	
Protection against direct contact with hazardous live internal parts during maintenance or upgrade (e.g. functional units, main busbars, distribution busbars)	8.4	No requirements for protection during maintenance or upgrade	None	
Gangways	8.4.6.2.101	Basic protection	None	
Method of functional unit's connection NOTE This refers to the capability of removal and re-insertion of functional units.	8.5.101		F fixed connections D disconnect- able connections W withdrawable connections	
Form of separation	8.101		Form 3, 4	
Capability to test individual operation of the auxiliary circuits relating to specified circuits while the functional unit is isolated	3.1.102, 3.2.102, 3.2.103, 8.5.101, Table 103		None	

Characteristics	Reference	Default arrangement [b]	Options listed in standard	User requirement [a]
Current carrying capability				
Rated current of the assembly I_{nA} (amps)	3.8.9.1, 5.3, 8.4.3.2.3, 8.5.3, 8.8, 10.10.2, 10.10.3, 10.11.5, Annex E	Manufacturer's standard, according to application	None	
Rated current of circuits I_{nc} (amps)	5.3.2	Manufacturer's standard, according to application	None	
Rated diversity factor	5.4, 10.10.2.3, Annex E	As defined within the standard	RDF for groups of circuits/RDF for whole assembly	
Ratio of cross section of the neutral conductor to phase conductors: phase conductors up to and including 16 mm^2	8.6.1	100 %	None	
Ratio of cross section of the neutral conductor to phase conductors: phase conductors above 16 mm^2	8.6.1	50 % (min. 16 mm^2)	None	

[a] For exceptionally onerous applications, the user may need to specify more stringent requirements to those in this standard.

[b] In some cases, information declared by the assembly manufacturer may take the place of an agreement.

Bibliography

IEC 60947 (all parts), *Low-voltage switchgear and controlgear*

IEC 61439 (all parts), *Low-voltage switchgear and controlgear assemblies*

Copper Development Association; Publication No. 22:1996

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