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REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

**Electrical installations in ships –
Part 202: System design – Protection**

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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ELECTRICAL INSTALLATIONS IN SHIPS –

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FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 60092-202 has been prepared by IEC technical committee 18: Electrical installations of ships and of mobile and fixed offshore units.

This fifth edition cancels and replaces the fourth edition published in 1994 and Amendment 1:1996. This edition constitutes a technical revision.

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

This document: Clause/subclause No. and heading	Previous document: Corresponding clause/subclause No., remark
1 Scope	1, No change
2 Normative references	2, Updated
3 Definitions	3, Several definitions changed and added
4 General requirements	4, Text changed
4.1 General	New clause/subclause
4.2 Basic protection	New clause/subclause
4.3 Studies and calculations	New clause/subclause
5 Electrical load study	New clause/subclause
6 Short-circuit current calculations	5, Heading change
-	5.1, Text changed and moved to new Clause 6
-	5.2, Text deleted, for DC-Systems reference to IEC 61660-1 added
7 Protection discrimination study	New clause/subclause
7.1 General	New clause/subclause
7.2 Current selectivity	New clause/subclause
7.3 Time-current selectivity	New clause/subclause
8 Characteristics and choice of protective devices with reference to short-circuit rating	6, Text completely revised and extended
8.1 General	6.1
8.2 Protective devices	New clause/subclause
8.3 Rated short-circuit breaking capacity	6.2
8.4 Rated short-circuit making capacity	6.3
8.5 Co-ordinated choice of protective devices with regard to discrimination requirements	6.4, Heading changed, new text
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The text of this standard is based on the following documents:

FDIS	Report on voting
18/1538/FDIS	18/1542/RVD

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

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

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

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

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

IMPORTANT – The "colour inside" logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

INTRODUCTION

The IEC 60092 series~~: Electrical installations in ships~~ includes international standards for electrical installations in sea-going ships, incorporating good practice and co-ordinating as far as possible existing rules.

These standards form a code of practical interpretation and amplification of the requirements of the International Convention ~~on~~ 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, ship builders and appropriate organizations.

ELECTRICAL INSTALLATIONS IN SHIPS –

Part 202: System design – Protection

1 Scope

This part of IEC 60092 is applicable to the main features of the electrical protective system to be applied to electrical installations for use in ships.

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 92-301:1980, *Electrical installations in ships – Part 301: Equipment – Generators and motors*~~

~~IEC 363:1972, *Short-circuit current evaluation with special regard to rated short-circuit capacity of circuit-breakers in installations in ships*~~

IEC 60909 (all parts), *Short-circuit currents in three-phase a.c. systems*

IEC 60909-0, *Short-circuit currents in three-phase a.c. systems – Part 0: Calculation of currents*

IEC TR 60909-1, *Short-circuit currents in three-phase a.c. systems – Part 1: Factors for the calculation of short-circuit currents according to IEC 60909-0*

IEC 60947-2:~~1989~~ 2006, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*
IEC 60947-2:2006/AMD1:2009
IEC 60947-2:2006/AMD2:2013

IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*

IEC 61363-1, *Electrical installations of ships and mobile and fixed offshore units – Part 1: Procedures for calculating short-circuit currents in three-phase a.c.*

IEC 61660-1, *Short-circuit currents in d.c. auxiliary installations in power plants and substations – Part 1: Calculation of short-circuit currents*

IEC 62271-100, *High-voltage switchgear and controlgear – Part 100: Alternating-current circuit-breakers*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply~~1)~~.

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

- IEC Electropedia: available at http://www.electropedia.org/

~~1) The International Electrotechnical Vocabulary (IEV) definitions for these four terms are not applicable to this standard.~~

- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
rated load
the highest value of load specified for rated conditions

3.2
overload
~~Excess of the actual load over the nominal load.~~
operating conditions in an electrically undamaged circuit, which cause an overload above the rated load

[SOURCE: IEC 60050-441:1984, 441-11-08, modified — The words "which cause an over-current" has been replaced with "which cause an overload above the rated load".]

~~**3.3**~~
~~**nominal load, full load**~~
~~Power for which a machine has been designed.~~

3.3
over-current
~~Abnormal current greater than the full load~~
current exceeding the rated current

[SOURCE IEC 60050-441:1984, 441-11-06]

3.4
short-circuit
~~Intentional or accidental connection of two points of a circuit through a negligible impedance. The term is often applied to the group of phenomena which accompany a short circuit between points at different potentials.~~
accidental or intentional conductive path between two or more conductive parts forcing the electric potential differences between these conductive parts to be equal to or close to zero

[SOURCE IEC 60050-195:1998, 195-04-11]

3.5
backup protection
protection equipment or system which is intended to operate when a system fault is not cleared in due time because of:

- failure or inability of a protective device closest to the fault to operate or
- failure of a protective device other than the protective device closest to the fault to operate

Note 1 to entry: This definition differs from the one given in IEC 60050-448:1995, 448-11-14.

3.6
over-current discrimination
selectivity
co-ordination of the operating characteristics of two or more over-current protective devices such that, on the incidence of over-currents within stated limits, the device intended to operate within these limits does so, while the other(s) does (do) not

Note 1 to entry: Distinction is made between series discrimination, involving different over-current protective devices passing substantially the same over-current, and network discrimination involving identical protective devices passing different proportions of the over-current.

[SOURCE 60050-441:1984, 441-17-15, modified — The term "selectivity" has been added as an equivalent term.]

3.7
total discrimination
total selectivity
selectivity (over-current discrimination) where, in the presence of two over-current protective devices in series, the protective device on the load side effects the protection without causing the other protective device to operate

[SOURCE IEC 60947-2:2006/AMD2:2013, 2.17.2, modified — The term "total discrimination" has been added as an equivalent term and the term "over-current discrimination" has been replaced by "selectivity (over-current discrimination)" in the definition.]

3.8
partial discrimination
partial selectivity
selectivity (over-current discrimination) where, in the presence of two or more over-current protective devices in series, the protective device closest to the fault at the load side effects the protection up to a given level of short-circuit current without causing the other protective devices to operate

[SOURCE IEC 60947-2:2006/AMD2:2013, 2.17.3, modified —The term "partial discrimination" has been added as an equivalent term and the definition has been rephrased..]

3.9
continuity of service
condition where, after a fault in a circuit has been cleared, the supply to the healthy circuits is re-established

3.10
continuity of supply

condition where during and after a fault in a circuit, the supply to the healthy circuits is permanently ensured

Note 1 to entry: This definition is different from that given in IEC 60050-614:2016, 614-01-22.

3.11
basic protection
minimum required protection for equipment

3.12
electrical load study
study reflecting the different operational modes and their respective load requirements

Note 1 to entry: Typical examples of operational modes are harbour, manoeuvre, seagoing mode.

4 General requirements

4.1 General

Electrical installations shall be protected against accidental over-currents, up to and including short-circuit, by appropriate devices. Choice, arrangement and performance of the various protective devices shall provide complete and co-ordinated automatic protection in order to ~~ensure as far as possible~~ obtain

– elimination of the effects of faults to reduce damage to the system and the hazard of fire ~~as much as possible~~, and

– continuity of ~~service through discrimination or another system of co-ordinated action of the protective devices to maintain supply to healthy circuits in the event of a fault elsewhere~~ supply.

Under these conditions, the elements of the healthy system shall be designed and constructed to withstand the thermal and electrodynamic stresses caused by the possible over-current, including short-circuit, for the admissible durations.

4.2 Basic protection

Devices provided for ~~overcurrent~~ basic protection shall be ~~chosen according to the requirements~~ suitable for the equipment they are protecting, especially with regard to

~~– overload;~~

– over-current,

– short-circuit, and

– earth fault, as appropriate.

The complexity of the protections is driven by a number of factors such as improved system performance, reliability, and reduction of the damage to the equipment for economical reason. Additional protection features shall not interfere with the basic protection requirements of this standard.

Electrical installation shall be provided with protections against electric shock in accordance with IEC 61140.

4.3 Studies and calculations

Studies and calculations shall demonstrate the proper coordination of power ratings, load requirements, system dynamics and protection.

In order to confirm the design of the electrical system and to confirm the ratings of the equipment selected, system studies shall be carried out. The system studies and calculation shall include

– an electrical load study (see Clause 5),
– short-circuit current calculations (see Clause 6), and
– a protection discrimination study (see Clause 7).

5 Electrical load study

An electrical load list shall be prepared to establish the electrical power requirements throughout the installation.

Based on analysis, load shedding shall be applied when required in order to avoid a blackout. Load shedding can be implemented by shedding of individual/groups of consumers or by appropriate separation of switchboard busbars.

Care should be taken to ensure that the response time is sufficient to enable the load shedding system to perform its function and maintain a stable electrical system.

Load estimates should be carried out for all operational conditions, for example

– navigation at sea,
– estuary trading and navigation close to port, and
– emergency power supply.

6 Short-circuit current calculations

~~An example of the short-circuit calculation in both a.c. and d.c. systems is given in IEC 363.~~

~~5.1 *Short-circuit current in a.c. systems*~~

~~5.1.1 For the evaluation of the prospective short-circuit current, the equivalent system impedance shall be considered seen from the point of fault.~~

~~5.1.2 The source of current shall include the maximum number of generators which can be simultaneously connected, and the maximum number of motors which are normally simultaneously connected in the system. The contribution of generators and motors shall be calculated on the basis of their characteristics.~~

The fault currents that flow as a result of short-circuits shall be calculated at each system voltage under three-phase fault conditions. These calculated currents shall be used to select suitably rated equipment and to allow the selection and setting of protective devices to ensure that successful discriminatory fault clearance is achieved.

The fault current shall be calculated for maximum and minimum system supply. The contribution of induction motors should be included in the study.

For general information regarding short-circuit calculations, reference shall be made to IEC 61363-1, IEC 60909-0 and IEC TR 60909-1 for AC systems, and IEC 61660-1 for DC systems.

IEC 60909 (all parts) is written for installations in which the short-circuit behaviour is predominantly ruled by passive elements (e.g. transformers, cables). It shall therefore only be applied for small transformer-fed low voltage installations. In all other cases, IEC 61363-1, which takes generator short-circuit behaviour into account, shall be applied.

~~NOTE~~ Where precise information of their characteristics is lacking, the contribution of induction motors for determining the maximum peak value attainable by the short-circuit current (i.e. the value of the current to be added to the maximum peak value of the short-circuit due to the generators) can be taken as equal to 8 I_n where I_n is the sum of the rated currents of the motors estimated normally when simultaneously in service (I_n is an ~~r.m.s.~~ RMS value).

For more precise calculation, the following ~~r.m.s.~~ RMS values may be used:

– at the instant of short-circuit occurrence (sub-transient value): 6,25 I_n

– at the instant T, i.e. after one cycle from short-circuit inception: 2,5 I_n

– at the instant 2T, i.e. after two cycles from short-circuit inception: 1,0 I_n

~~5.2 Short-circuit current in d.c. systems~~

~~5.2.1 The prospective short-circuit current at a definite point of the system shall be evaluated by considering the equivalent system resistance seen from the point of fault.~~

~~5.2.2 The source of a short-circuit current shall include the maximum number of generators which can be simultaneously connected, and the maximum number of motors which are normally simultaneously connected in the system. The contribution of each rotating machine shall be evaluated as a function of its characteristics.~~

~~In the absence of precise information, the contribution of motors in the determination of the maximum value reached by the short-circuit current can be taken as equal to six times the sum of the rated currents of the motors estimated to be normally in se rvice simultaneously.~~

7 Protection discrimination study

7.1 General

A coordination study shall be carried out to determine the setting of the protective relays and direct acting circuit-breakers (see Clause 4).

In general, the two protection schemes described in 7.2 and 7.3 are possible.

7.2 Current selectivity

This type of selectivity is based on the observation that the closer the fault point is to the power supply of the installation, the higher the short-circuit current is. It is therefore possible to discriminate the zone the fault occurred in by setting the instantaneous protections to different current values.

The coordination of protection devices shall consider tolerances and accuracies.

Because of the large variation in short currents due to different operational conditions, current selectivity shall be used with caution and may not be achievable in all instances.

7.3 Time-current selectivity

Time-current selectivity makes trip selectivity by adjusting the protections so that the load-side protection, for all possible over-current values, trips more rapidly than the supply-side circuit-breaker. When the trip times of the two circuit-breakers are analysed, it is necessary to consider

– the tolerances over the thresholds and trip times, and