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Electrical installations in ships -
Part 352: Selection, installation, and operating conditions of cables

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Electrical installations in ships - Part 352: Selection, installation, and operating conditions of cables

FOREWORD

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IEC 60092-352 has been prepared by IEC subcommittee 18A: Cables and cable installations, of IEC technical committee TC 18: Electrical installations of ships and of mobile and fixed offshore units. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2005. This edition constitutes a technical revision.

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

a) modification of the part title;
b) complete review of the document and establishment of the match with all other standards from the group IEC 60092-350 to IEC 60092-379;
c) addition of terms and definitions;

d) addition of technical requirements for the installation of symmetrical category cables with transmission characteristics up to 1 000 MHz;

e) addition of the technical requirements for the installation of fibre optic cables;

f) addition of technical requirements for the installation of cables for installation between areas with and without explosive atmospheres;

g) addition of technical requirements for Special safety requirements from SOLAS regulations.

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

Draft	Report on voting
18A/505/FDIS	18A/508/RVD

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

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

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

A list of all parts in the IEC 60095, 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 document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

– reconfirmed,

– withdrawn, or

– revised.

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 can be prepared;

– 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 60092-352 has been prepared by Maintenance Team 2 of IEC SC 18A, to update and include developments identified in other parts of the 60092 series of standards applicable to cables for installations in ships.

NOTE Guidance for the use and installation of cables for offshore applications is being prepared jointly by SC18A, MT 2 and TC 18, MT 18, and will be issued by TC 18, MT 18.

1 Scope

This part of IEC 60092 provides the basic requirements for the selection, installation and operating conditions of electrical cables intended for fixed electrical systems on board ships at voltages (U) up to and including U_m 18/30 (36) kV, symmetrical category cables and fibre optic cables.

The reference to fixed systems includes those that are subjected to vibration (due to the movement of the ship) or movement (due to motion of the ship) and not to those that are intended for frequent flexing.

Cables subject to frequent or continual flexing use, which can withstand the mechanical stress and the environment they are exposed to, are detailed in other IEC specifications such as IEC 60227 and IEC 60245. Flexible cables are frequently used for retractable thrusters, elevators, moving decks, cranes, shore connections and other moving applications on board ships.

The following cable types and applications are not included:

– sub-sea and umbilical cables;
– telecommunication and radio frequency cables;
– selection and installation of cables for use on offshore platforms.

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 60079 series, *Explosive atmospheres*

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

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

IEC 60092-302-2, *Electrical installations in ships - Part 302-2: Low voltage switchgear and controlgear assemblies - Marine power*

IEC 60092-350:2020, *Electrical installations in ships - Part 350: General construction and test methods of power, control and instrumentation cables for shipboard and offshore applications*

IEC 60092-353:2024, *Electrical installations in ships - Part 353: Power cables for rated voltages 1 kV and 3 kV*

IEC 60092-354, *Electrical installations in ships - Part 354: Single and three-core power cables with extruded solid insulation for rated voltages 6 kV (U_m = 7,2 kV); up to 30 kV (U_m = 36 kV)*

IEC 60092-360, *Electrical installations in ships - Part 360: Insulating and sheathing materials for shipboard and offshore units, power, control, instrumentation and telecommunication cables*

IEC 60092-376, *Electrical installations in ships - Part 376: Cables for control and instrumentation circuits 150/250 V (300 V)*

IEC 60092-378, *Electrical installations in ships - Part 378: Optical fiber cables*

IEC 60092-379:2024, *Electrical installations in ships - Part 379: Symmetrical category cables with transmission characteristics up to 1 000 MHz*

IEC 60092-401, *Electrical installations in ships - Part 401: Installation and test of completed installation*

IEC 60228, *Conductors of insulated cables*

IEC 60287 (all parts), *Electric cables - Calculation of the current rating*

IEC 60331-1:2018, *Tests for electric cables under fire conditions - Circuit integrity - Part 1: Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage up to and including 0,6/1,0 kV and with an overall diameter exceeding 20 mm*

IEC 60331-2:2018, *Tests for electric cables under fire conditions - Circuit integrity - Part 2: Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage up to and including 0,6/1,0 kV and with an overall diameter not exceeding 20 mm*

IEC 60332-1-2:2025, *Tests on electric and optical fibre cables under fire conditions - Part 1-2: Test for vertical flame propagation for a single insulated wire or cable - Procedure for 1 kW pre-mixed flame*

IEC 60332-3-22, *Tests on electric and optical fibre cables under fire conditions - Part 3-22: Test for vertical flame spread of vertically-mounted bunched wires or cables - Category A*

IEC 60332-3-24, *Tests on electric and optical fibre cables under fire conditions - Part 3-24: Test for vertical flame spread of vertically-mounted bunched wires or cables - Category C*

IEC 60332-3-25, *Tests on electric and optical fibre cables under fire conditions - Part 3-25: Test for vertical flame spread of vertically-mounted bunched wires or cables - Category D*

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

IEC 60684-2, *Flexible insulating sleeving - Part 2: Methods of test*

IEC 60754-1, *Test on gases evolved during combustion of materials from cables - Part 1: Determination of the halogen acid gas content*

IEC 60754-2, *Test on gases evolved during combustion of materials from cables - Part 2: Determination of acidity (by pH measurement) and conductivity*

IEC 61034-2:2005+AMD1:2013+AMD2:2019, *Measurement of smoke density of cables burning under defined conditions - Part 2: Test procedure and requirements*

3 Terms and definitions

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

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

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

3.1
braid
covering formed from braided metallic or non-metallic material

[SOURCE: IEC 60092-350:2020, 3.2]

3.2
braid armour
covering formed from braided metal wires used to protect a cable from external mechanical effects

[SOURCE: IEC 60092-350:2020, 3.3, modified – The notes to entry have been deleted]

3.3
armour
covering consisting of a metal tape(s) or wires, generally used to protect the cable from external mechanical effects

[SOURCE: IEC 60050-461:2008, 461-05-06]

3.4
screen
conducting layer or assembly of conducting layers having the function either of control of the electric field within the insulation or to reduce the coupling of an electric, magnetic or electromagnetic field with the internal wires and to conduct common mode currents

Note 1 to entry: It may also provide smooth surfaces at the boundaries of the insulation and assist in the elimination of spaces at these boundaries

[SOURCE: IEV 461-03-01, modified – " either of control of the electric field within the insulation or to reduce the coupling of an electric, magnetic or electromagnetic field with the internal wires and to conduct common mode currents" has been added.]

3.5
earthing conductor
grounding conductor, US
conductor forming a conductive path between a conductive part and an earth electrode

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

[SOURCE: IEV 195-02-03]

3.6
extra low voltage
ELV
voltage not exceeding the maximum value of the prospective touch voltage that is acceptable to be maintained indefinitely under specified conditions of external influences

[SOURCE: 60050-461:2021, 195-05-24]

4 Types, construction, installation, and operating conditions of cables

4.1 Types of cables

Cables constructed in accordance with IEC 60092-350, IEC 60092-353, IEC 60092-354, IEC 60092-376, IEC 60092-378 and IEC 60092-379 shall be used on board ships.

NOTE The use of other types of cables can be agreed.

4.2 Voltage rating

4.2.1 Power cables

In the voltage designation of cables $U_0/U/(U_m)$:

U_0 is the rated voltage between conductor and earth or metallic screen for which the cable is designed;

U is the rated voltage between conductors for which the cable is designed;

U_m is the maximum value of the highest system voltage which can be sustained under normal operating conditions at any time and at any point in the system. It excludes transient voltage conditions and rapid disconnection of loads.

U_m is chosen to be equal to or greater than the highest voltage of the three-phase system. Where cables are permitted for use on circuits where the nominal system voltage exceeds the rated voltage of the cables, the nominal system voltage shall not exceed the maximum system voltage (U_m) of the cable.

Cables subjected to voltage surges associated with highly inductive circuits shall be checked to ensure that they are of a suitable voltage rating.

The choice of standard cables of appropriate voltage designations for particular systems depends upon the system voltage and the system earthing arrangements.

The rated voltage of any cable shall not be lower than the nominal voltage of the circuit for which it is used. To facilitate the choice of the cable, the values of U recommended for cables to be used in three-phase systems are listed in Table 1, in which systems are divided into the following three categories:

– Category A

  This category comprises those systems in which any phase conductor that comes in contact with earth or an earth conductor is automatically disconnected from the system.

– Category B

  This category comprises those systems that under fault conditions are operated for a short time, not exceeding 8 h on any single occasion, with one phase earthed. For example, for a 13,8 kV system of Category A or Category B, the cable should have a rated voltage not less than 8,7/15 kV.

In a system where an earth fault is not automatically and promptly eliminated, the increased stresses on the insulation of cables during the earth fault are likely to affect the life of the cables to a certain degree. If the system is expected to be operated fairly often with a sustained earth fault, cables suitable for Category C should be used. In any case, for Category B, the expected total duration of earth faults shall not exceed 125 h.

– Category C

  This category comprises all systems that do not fall into category A and category B.

The nominal system voltages from 1,8/3 kV to 12/20 kV given in Table 1 are generally in accordance with Series I specified in IEC 60038. For nominal system voltages intermediate between these standard voltages and between 0,6/1 kV and 1,8/3 kV, the cables should be selected with a rated voltage not less than the next higher standard value.

For example: a first earth fault with one phase earthed causes a $\sqrt{3}$ higher voltage between the phases and earth during the fault. If the duration of this earth fault exceeds the times given for category B, then according to Table 1, for a 6 kV system, the cable shall have a rated voltage not less than 6/10 kV.

A DC voltage to earth of up to a maximum of 1,5 times the AC U_0 RMS voltage can be used. However, consideration should be given to the peak value when determining the voltage of DC systems derived from rectifiers, bearing in mind that smoothing does not modify the peak value when the semiconductors are operating on an open circuit.

Table 1 – Selection of cables for AC systems

System voltage		System category	Minimum rated voltage of cable U_0/U	
Nominal voltage U kV	Maximum sustained voltage U_m kV		Unscreened kV	Single-core or screened kV
up to 0,25	0,30	A, B or C	0,15/0,25	–
1	1,2	A, B or C	0,6/1,0	0,6/1,0
3	3,6	A or B	1,8/3,0	1,8/3,0
3	3,6	C		3,6/6,0
6	7,2	A or B		3,6/6,0
6	7,2	C		6,0/10
10	12	A or B		6,0/10
10	12	C		8,7/15
15	17,5	A or B		8,7/15
15	17,5	C		12/20
20	24	A or B		12/20
20	24	C		18/30
30	36	A or B		18/30

4.2.2 Control and instrumentation cables

The maximum rated voltage (U) for control and instrumentation cables considered in this document is 250 V.

In some instances, for conductor sizes of 1,0 mm^2 and larger, or when circuits must be supplied from a low impedance source, 0,6/1 kV rated cables are specified for use as control or instrumentation cables.

4.3 Current carrying capacities

4.3.1 Cross-sectional areas of conductors

The cross-sectional area of each conductor shall be selected to be large enough to comply with the following conditions.

– The highest load to be carried by the cable shall be calculated from the load demands and diversity factors.

– The "corrected current rating" calculated by applying the appropriate correction factors to the "current rating for continuous services" shall not be lower than the highest current likely to be carried by the cable. The applicable correction factors are given in 4.3.4, 4.3.5 and 4.3.6.

– The voltage drop in the circuit shall not exceed the limits for the circuits concerned – further guidance is given in 4.4.

– The cross-sectional area of the conductor shall be able to accommodate the mechanical and thermal effects of a short circuit current (see 4.8) and the effects upon voltage drop of motor starting currents (see NOTE 3 of 4.4).

– Class 5 conductors, where used, shall be subject to special consideration in respect of maximum current-carrying capacity. Class 5 conductors have, in most cases, a lower conductivity than the equivalent Class 2 conductors of the same nominal cross-section.

– The nominal cross-sectional areas of the earth conductor shall comply with Table 2. One of the alternative methods of determining the cross-sectional area of each earthing conductor is that based upon the rating of the fuse or circuit protection device installed to protect the circuit. If this method is used, the nominal cross-sectional area finally selected shall be the higher of any cross-sectional areas determined by each of the methods.

Table 2 – Sizes of earth conductor and equipment earthing connections

Arrangement of earth conductor		Cross-sectional area Q of associated current carrying conductor (One phase or pole) mm^2	Minimum cross-sectional area of earth conductor
1.	a) Insulated earth conductor in cable for fixed installation. b) Copper braid of cable for fixed installation according to IEC 60092-350. c) Separate, insulated earth conductor for fixed installation in pipes in dry accommodation spaces, when carried in the same pipe as the supply cable. d) Separate, insulated earth conductor when installed inside enclosures or behind covers or panels, including earth conductor for hinged doors as specified in IEC 60092-302-2.	$Q \leq 16$	Q
		$Q > 16$	50 % of the current-carrying conductor, but not less than 16 mm^2
2.	a) Uninsulated earth conductor in cable for fixed installation. b) Armour or copper braid and in metal-to-metal contact with the uninsulated earth conductor.	$Q \leq 2,5$	1 mm^2
		$2,5 < Q \leq 6$	1,5 mm^2
		$Q > 6$	Not permitted
3.	Separately installed earth conductor for fixed installation other than specified in 1 c) and 1 d).	$Q < 2,5$	Same as current-carrying conductor subject to min. 1,5 mm^2 for stranded earthing connection or 2,5 mm^2 for unstranded earthing connection
		$2,5 < Q \leq 120$	50 % of current-carrying conductor, but not less than 4 mm^2
		$Q > 120$	70 mm^2
4.	Insulated earth conductor in flexible cable.	$Q \leq 16$	Same as current-carrying conductor
		$Q > 16$	50 % of current-carrying conductor, but minimum 16 mm^2
NOTE See 4.3.1 for a method based on the rating of fuses.			

4.3.2 Current carrying capacities

The procedure for cable selection employs rating factors to adjust the current carrying capacities for different ambient temperatures, for the mutual heating effects of grouping with other cables, methods of installation and short time duty. Guidance on the use of these factors is given below.

4.3.3 Current ratings for continuous service

4.3.3.1 General

Continuous service for a cable shall be considered as a current-carrying service with constant load and having a duration longer than three times the thermal time constant of the cable, i.e. longer than the critical duration (see Figure 2).

The current to be carried by any conductor for sustained periods during normal operation shall be such that the appropriate conductor temperature limit is not exceeded.

The selection of the method applicable to any particular installation can be subject to approval by the relevant authority or can be subject to governing regulations.

The current carrying capacity shall be calculated according to Annex A, Method B or alternative methods as described in 4.3.3.2, 4.3.3.3 and 4.3.3.4 respectively.

Annex A is more accurate than Annex B and should be used when there is an enhanced risk of overheating. For example, when bunched cables are used simultaneously under full continuous load.

Annex B is the easiest method to use but is also less accurate than Method A.

If distances between cable bunches are less than one cable outer diameter (OD), those bunches shall be considered as a single bunch.

4.3.3.2 Method A

A method for determination of current carrying capacities based upon those that have been accepted and established in other applications of cable use. This method has been derived from a technical basis established from experimental data on a number of cables and installation information. It allows for greater choice of use in different installation configurations. For further reference see IEC 60364-5-52.

The current carrying capacity is determined by the Formula (1):

$$I = A \times S^m - B \times S^n \quad (1)$$

where

I is the current carrying capacity (A);

S is the nominal cross-sectional area of conductor (mm^2);

A and B are coefficients;

m and n are exponents according to cable type and method of installation.

Values calculated using Formula (1) for various installations are given in Annex A together with guidance on selection.

or;