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REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

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)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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)

FOREWORD

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International Standard IEC 60092-354 has been prepared by subcommittee 18A: Electric cables for ships and mobile and fixed offshore units, of 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 2014. This edition constitutes a technical revision.

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

a) Editorial adaptations have been made.

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

CDV	Report on voting
18A/419/CDV	18A/424/RVC

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

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

The list of all the parts of the IEC 60092 series, 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 "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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- withdrawn,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

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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)

1 Scope

This part of IEC 60092 is applicable to shipboard and offshore power cables with extruded solid insulation, conductor and core screening, having a voltage rating of one of the following: 3,6/6 (7,2) kV,6/10 (12) kV, 8,7/15 (17,5) kV, 12/20 (24) kV, 18/30 (36) kV.

NOTE 1 Subclause 4.1 gives more details.

The cables are intended for fixed installations.

The various types of power cables are given in 5.1. The constructional requirements and test methods are aligned with those indicated in IEC 60092-350, unless otherwise specified in this document.

The object of this document is:

– to standardize cables whose safety and reliability is ensured when they are installed in accordance with the requirements of IEC 60092-352 or IEC 61892-4;
– to lay down standard manufacturing requirements and characteristics of such cables directly or indirectly bearing on safety;
– to specify test methods for checking conformity with those requirements.

NOTE 2 Only radial field cables are covered.

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 60038, *IEC standard voltages*

IEC 60228, *Conductors of insulated cables*

IEC 60092-350~~:2014~~:—, *Electrical installations in ships – Part 350: General construction and test methods of power, control and instrumentation cables for shipboard and offshore applications*[1]

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

[1] Under preparation. Stage at the time of publication: IEC/BPUB 60092-350:2019.

IEC 60332-1-2, *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 cables under fire conditions – Part 3-22: Test for vertical flame spread of vertically-mounted bunched wires or cables – Category A*

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 60885-2, *Electrical test methods for electric cables. Part 2: Partial discharge tests*

IEC 61034-1, *Measurement of smoke density of cables burning under defined conditions – Part 1: Test apparatus*

IEC 61034-2, *Measurement of smoke density of cables burning under defined conditions – Part 2: Test procedure and requirements*

3 Terms and definitions

For the purpose of this document, the definitions given in IEC 60092-350 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

4 General requirements

4.1 Rated voltage

The standard method of designating the rated voltages of cables covered by this document shall take the form

$$U_0/U\ (U_m)$$

where

U_0 is the rated power-frequency voltage between phase conductor and earth or metallic screen, for which the cable is designed;

U is the rated power-frequency voltage between phase conductors for which the cable is designed;

U_m is the maximum value of the "highest system voltage" for which the equipment (including cable) may be used (see IEC 60038).

All voltages are given as RMS values.

~~The standard rated voltages U_e/U (U_m) of the cables considered in this standard are: 3,6/6 (7,2) kV, 6/10 (12) kV, 8,7/15 (17,5) kV, 12/20 (24) kV, and 18/30 (36) kV.~~

The standard rated voltages U_0/U (U_m) of the cables considered in this document are:

U_0/U (U_m) = 3,6/6 (7,2) – 6/10 (12) – 8,7/15 (17,5) – 12/20 (24) – 18/30 (36) kV

4.2 Markings

4.2.1 Indication of origin and voltage identification

Cables shall comply with 4.1.3 of IEC 60092-350:~~2014~~2019 with respect to:

a) indication of origin;
b) rated voltage and cable construction (number of cores and cross-sectional area of the construction);
c) continuity of marking;
d) durability/legibility.

4.2.2 Continuity of marking

The marking is deemed to be continuous if the distance between the end of any marking and the beginning of the next does not exceed:

a) 550 mm if the marking is on the outer surface of the cable;
b) 275 mm in all other cases.

4.2.3 Core identification for three-cores

Cores of cables shall be provided with a suitable method of identification. Each core shall be easily distinguishable from the other cores in the cable.

5 Constructional requirements

5.1 General cable description

5.1.1 Overview

Shipboard and offshore cables for fixed installations shall be single or multicore cables generally constructed as ~~follows~~ indicated in 5.1.2 to 5.1.5.

5.1.2 Armoured single-sheathed cable with outer sheath only

The armoured single-sheathed cables having only an outer sheath are constructed as follows:

- copper conductor, see 5.2;
- conductor semi-conducting screen, see 5.4.2;
- insulation, see 5.3;
- insulation screening, see 5.4~~.3~~;
- cabling (for three-core cables), see 5.6;
- inner covering, see 5.7;
- braid armour, see 5.9;
- outer sheath applied as either one or two layer systems, see 5.10.

5.1.3 Armoured double-sheathed cable with inner and outer sheath

The armoured double-sheathed cables having both an inner and an outer sheath are constructed as follows:

- copper conductor, see 5.2;
- conductor semi-conducting screen, see 5.4.2;
- insulation, see 5.3;
- insulation screening, see 5.4~~.3~~;
- cabling (for three-core cables), see 5.6;
- inner sheath, see 5.8;
- braid armour, see 5.9;
- outer sheath applied as either one or two layer systems, see 5.10.

The use of a thermoplastic inner sheath (ST2 or SHF1) is not recommended if the outer sheath consists of an elastomeric cross-linked material.

5.1.4 Armoured single-sheathed cable with inner sheath only

The armoured single-sheathed cables having only an inner sheath are constructed as follows:

- copper conductor, see 5.2;
- conductor semi-conducting screen, see 5.4.2;
- insulation, see 5.3;
- insulation screening, see 5.4~~.3~~;
- inner sheath, see 5.8;
- braid armour, see 5.9.

The cables for installation in spaces where corrosion ~~can~~ may occur, for example weather decks, wet locations, battery compartments, refrigeration rooms, etc., should have an outer sheath over the braid, if any, unless the braid itself is corrosion-resistant

5.1.5 Unarmoured single-sheathed cable

The unarmoured single-sheathed cables are constructed as follows:

- copper conductor, see 5.2;
- conductor semi-conducting screen, see 5.4.2;
- insulation, see 5.3;
- insulation screening, see 5.4~~.3~~;
- cabling (for three-core cables), see 5.6;
- inner covering (optional), see 5.7;
- outer sheath applied as either one or two layer systems, see 5.10.

5.2 Conductors

Material, metal coating, class and form of the conductors shall be in accordance with IEC 60092-350. The form of the conductor shall be round circular stranded, non-compacted or compacted, in accordance with Class 2 of IEC 60228. To aid installation, a conductor of Class 5 may be used. Cables with such Class 5 conductors should not be regarded as suitable for repeated flexing in service.

The minimum cross-sectional area shall be 10 mm^2 for 3,6/6 (7,2) kV cables, 16 mm^2 for 6/10 (12) kV cables, 25 mm^2 for 8,7/15 (17,5) kV cables, 35 mm^2 for 12/20 (24) kV cables and 50 mm^2 for 18/30 (36) kV cables.

5.3 Insulation

5.3.1 Material

The insulation system shall be EPR, HEPR or XLPE compounds as defined in IEC 60092-360.

5.3.2 Application

The application shall be as detailed in 4.3.2 of IEC 60092-350:~~2014~~2019.

5.3.3 Thickness of insulation

The thickness of the insulation shall be as specified in Table 1 and meet the requirements of 4.3.3 of IEC 60092-350:~~2014~~2019 so that the following applies:

a) the thickness at any point may be less than the specified value provided the difference does not exceed 0,1 mm + 10 % of the specified value;

b) the thickness of the semi-conducting screen on the conductor, or over the insulation, shall not be included in the thickness of insulation.

Table 1 – Insulation thickness

Nominal cross sectional area of conductor	Nominal thickness of insulation at rated voltage U_0/U (U_m)				
	3,6/6 (7,2) kV	6/10 (12) kV	8,7/15 (17,5) kV	12/20 (24) kV	18/30 (36) kV
mm^2	mm	mm	mm	mm	mm
10	2,5	-	-	-	-
16	2,5	3,4	-	-	-
25	2,5	3,4	4,5	-	-
35	2,5	3,4	4,5	5,5	-
50 to 185	2,5	3,4	4,5	5,5	8,0
240	2,6	3,4	4,5	5,5	8,0
300	2,8	3,4	4,5	5,5	8,0
400	3,0	3,4	4,5	5,5	8,0
500 to 630	3,2	3,4	4,5	5,5	8,0

Any smaller conductor cross-section than those given in this table is not recommended. However, if a smaller cross-section is needed, either the diameter of the conductor shall be increased by a conductor screen (see 5.4.2), or the insulation thickness shall be increased in order to limit, at the values calculated with the smallest conductor size given in this table, the maximum electrical stresses applied to the insulation under test voltage.

5.4 Screening of cores

5.4.1 General

Screening of individual cores in single- or three-core cables shall consist of a conductor screen and an insulation screen.

5.4.2 Conductor screening

The conductor screen shall be non-metallic and shall consist of an extruded semi-conducting compound, which may be applied on top of a semi-conducting tape. Where tape is not applied, the extruded semi-conducting compound shall be firmly bonded to the insulation.

5.4.3 Insulation screening

The insulation screening is designed as follows.

a) The insulation screen shall consist of a non-metallic semi-conducting layer in combination with a metallic layer.

b) The non-metallic layer shall be extruded directly upon the insulation of each core and consist of either a bonded or strippable semi-conducting compound.

NOTE A layer of semi-conducting tape can then be applied over the individual cores.

c) The metallic layer shall be applied over the individual cores and shall comply with the requirements of 5.5.

5.5 Metallic screen

5.5.1 Construction

The metallic screen shall consist of one or more tapes, or a braid, or a concentric layer of wires, or a combination of tape(s) and wires.

If a metallic braid screen is applied, the fictitious diameter over the screen is given by:

~~$D_c + 5\,dw$, in mm~~

$D_c + 5d_w$, in mm

where

D_c is the fictitious diameter of core;

d_w is the nominal diameter of the braid wire.

5.5.2 Requirements

The dimensional, physical and electrical requirements of the metallic screen shall be determined taking into account any other requirements (e.g. national or approval authority regulations and standards), including the value of the current to be carried in case of fault.

5.6 Assembly of three-core cables, inner coverings and fillers

Cores of a three core cable shall be laid up, and the interstices filled if necessary with fillers, inner covering or inner sheath (outer sheath in the case of unarmoured cables) according to 4.~~5~~6 of IEC 60092-350:~~2014~~2019.

5.7 Inner covering

5.7.1 General

The inner covering shall be extruded. The relevant material and characteristics shall be in accordance with extruded inner coverings in 4.6 of IEC 60092-350:~~2014~~2019.

5.7.2 Thickness of inner covering

The values of the (approximate) thickness of extruded inner covering for the calculation of fictitious diameters are given in Table 2.

Table 2 – Thickness of extruded inner covering for calculation of fictious diameters

Fictitious diameter over laid up cores		Thickness of extruded inner covering
Above mm	Up to and including mm	(approximate value) mm
–	25	1,0
25	35	1,2
35	45	1,4
45	60	1,6
60	80	1,8
80	–	2,0
NOTE For the calculation of fictitious diameter, see Annexes A and C of IEC 60092-350:~~2014~~2019.		

5.8 Inner sheath

5.8.1 Material

The inner sheath shall be selected from one listed in IEC 60092-360. The compound selected shall be compatible with the cable components with which it is in contact and compatible with the operating temperature of the cable.

5.8.2 Application

The application shall be as detailed in 4.7.2 of IEC 60092-350:~~2014~~2019.

5.8.3 Thickness of inner sheath

The thickness of the inner sheath is given as a function of the internal diameter of the sheath under consideration, the fictitious diameter being calculated by the method in Annexes A and C of IEC 60092-350:~~2014~~2019.

For armoured cable as per 5.1, the formula is:

$$t_1 = (0{,}04\ D + 0{,}8)$$ mm, with a minimum thickness of 1,0 mm for construction 5.1.3 and 1,4 mm for construction 5.1.4,

where

D is the fictitious diameter under the inner sheath.

The thickness at any point shall satisfy the prescriptions given in 4.7.3 of IEC 60092-350:~~2014~~2019.

5.9 Braid armour

5.9.1 General

The armour type covered by this document is braid armour (see 5.9.2).

The materials and the constructional requirements of the armours shall be those given in 4.8 of IEC 60092-350:~~2014~~2019. When choosing the material of the armour, special consideration shall be given to the possibility of corrosion.

The armour of single-core cables for use on AC circuits shall consist of non-magnetic material. In special cases, for instance when the cables are used on DC circuits, magnetic materials can also be used.

The armour shall be applied in such a way that it shall not adhere to the inner sheath, nor to the outer sheath, nor the inner covering.

The nominal diameters of round armour wires shall be not less than the values given in ~~the following subclauses~~ 5.9.2 and 5.9.3.

5.9.2 Braid wire armour

The braid wire armours are defined as follows.

a) The coverage density of the braid shall be in accordance with IEC 60092-350.

b) The fictitious diameter under the braid is calculated by the method given in Annexes A and C of IEC 60092-350:~~2014~~2019.

5.9.3 Braid wire diameter

Irrespective of the metal used, the nominal diameter of the braid wire shall be:

– ~~0,3~~ 0,30 mm, as a minimum, for cables having fictitious diameter under the braid less than or equal to 30 mm;

– ~~0,4~~ 0,40 mm, as a minimum, for cables having fictitious cable diameter under the braid larger than 30 mm.

5.10 Outer sheath

5.10.1 Material

The outer sheath shall be selected from one listed in IEC 60092-360. The compound selected shall be compatible with the cable components with which it is in contact and compatible with the operating temperature of the cable.

5.10.2 Application

The application shall be as detailed in 4.9.2 IEC 60092-350:~~2014~~2019.

5.10.3 Thickness of outer sheath

The thickness of outer sheath is given as a function of the internal diameter of the sheath under consideration, the fictitious diameter being calculated by the method in Annexes A and C of IEC 60092-350:~~2014~~2019.

The formula is as follows.

a) For armoured single-sheathed cables as per 5.1.2 or unarmoured single-sheathed cables as per 5.1.5:

$$t_1 = (0{,}04\ D + 0{,}8)$$ mm, with a minimum thickness of 1,0 mm

where

D is the fictitious diameter under the sheath.

b) For armoured double-sheathed cables as 5.1.3:

$$t_2 = (0{,}025\ D + 0{,}6)$$ mm, with a minimum thickness of 0,8 mm.

The thickness at any point shall satisfy the prescriptions given in 4.9.3 of IEC 60092-350:~~2014~~2019.

5.10.4 Colour of outer sheath

The outer sheath shall be coloured red, unless otherwise specified by the purchaser at the time of ordering.

6 Tests – Methods and requirements

The tests shall be carried out according to Table 3 to Table 6 where applicable. For the purposes of this document, the definitions given in IEC 60092-350 for routine test, sample test and type test apply.

Table 3 –Tests applicable to all cables

Test	Applicability – All types of cable unless otherwise stated	Status	Method according to IEC 60092-350:~~2014~~2019	Requirement – As in IEC 60092-350 unless otherwise stated
Measurement of electrical resistance of conductors		Routine	5.2.2	IEC 60228
Voltage test		Routine	5.2.3	-
Voltage test on sheath	Armoured cables	Routine	5.2.3	-
Insulation resistance test		Type	7.2.1	-
Partial discharge test		Routine	7.7.3	~~IEC 60885-2~~ IEC 60885-3
High voltage sequence test		Type	7.7	
Conductor examination		Sample and type	6.4	-
Check of cable dimensions		Sample and type		
Thickness of insulation			6.5 and 8.~~1~~2	-
Thickness of non metallic sheaths			6.6 and 8.~~2~~3	-
Dimensions of braid armour				~~IEC 60092-354,~~ 5.9.2 and 5.9.3
External diameter			6.7	-
Hot set test	EPR, HEPR, XLPE, insulation and SE, SH and SHF2 sheath	Sample	6.8	IEC 60092-360
Coverage density of braid	Braid armoured cables	Type	4.8.2	
Insulation resistance measurement at maximum rated temperature		Type	7.2.2	IEC 60092-360
Increase in AC ~~capacitance~~ capacity after immersion in water		Type	7.3	IEC 60092-360
High-voltage test for 4 h		Type	7.7.9	

Test	Applicability – All types of cable unless otherwise stated	Status	Method according to IEC 60092-350:~~2014~~2019	Requirement – As in IEC 60092-350 unless otherwise stated
Mechanical properties of insulation before and after ageing		Type	8.4	IEC 60092-360
Mechanical properties of sheath before and after ageing		Type	8.5	IEC 60092-360
Additional ageing compatibility test		Type	8.6	IEC 60092-360
Loss of mass test	PVC ST2 sheath	Type	8.7	IEC 60092-360
Behaviour at high temperature	PVC ST2 and SHF1 sheaths	Type	8.8	IEC 60092-360
Behaviour at low temperatures	PVC ST2, SHF1 and SHF2 sheaths	Type	8.9	IEC 60092-360
Test for coating of copper wires		Type	8.11	
Galvanizing test		Type	8.12	
Resistance to cracking heat shock	PVC ST2 and SHF1 sheaths	Type	8.13	IEC 60092-360
Ozone resistance	Insulations and sheaths	Type	8.14	IEC 60092-360
Hot oil immersion	SE1, SH and SHF2 sheaths	Type	8.15.1	IEC 60092-360
Flame-spread tests: IEC 60332-1-2 and IEC 60332-3-22		Type	8.17.1 8.17.2	IEC 60332-1-2 and IEC 60332-3-22 in which case cables shall be installed in touching configuration on the front of the ladder.
Determination of hardness	HEPR insulation	Type	8.18	IEC 60092-360
Determination of modulus of elasticity	HEPR insulation	Type	8.19	IEC 60092-360
Durability of marking		Type	8.20	The marking shall remain legible following the test as given in 8.20 of IEC 60092-350:~~2014~~2019

Table 4 – Additional tests for halogen-free cables

Test	Applicability – All types of cable unless otherwise stated	Status	Method according to IEC 60092-350:~~2014~~2019	Requirement – As in IEC 60092-350 unless otherwise stated
Acid gas emission	Halogen free cables	Type	8.17.4	IEC 60754-1
pH and conductivity	Halogen free cables	Type	8.17.5	IEC 60754-2
Fluorine content test	Halogen free cables	Type	8.17.6	IEC 60684-2

Table 5 – Additional test for low smoke cables

Test	Applicability – All types of cable unless otherwise stated	Status	Method according to IEC 60092-350:~~2014~~2019	Requirement – As in IEC 60092-350 unless otherwise stated
Smoke density test for cables insulated and sheathed with halogen-free materials. When tested according to IEC 61034-1 and IEC 61034-2		Type	8.17.3	The test is satisfactory for the finished cables if the levels of light transmittance exceeds 60 % throughout the test
NOTE The smoke density test is in general applicable to halogen free cables. See also Table 4.				

Table 6 – Additional tests when required

Test	Applicability – All types of cable unless otherwise stated	Status	Method according to IEC 60092-350:~~2014~~2019	Requirement – As in IEC 60092-350 unless otherwise stated
Special test for low temperature behaviour	When required	Type	8.~~10~~9	
Enhanced hot oil immersion	When required	Type	8.15.2	IEC 60092-360
Drilling fluid test	When required	Type	8.16	IEC 60092-360

Annex A
(~~informative~~ normative)

Electrical tests after installation

By agreement between the purchaser and the contractor, an AC voltage test in accordance with IEC 60060-3 and with item a) or b) or c) below may be used:

a) test for 15 min with the phase-to-phase voltage U at a frequency between 20 Hz to 300 Hz shall be applied between the conductor and the metal screen/sheath;

b) test for 24 h with the normal rated voltage U_0 of the system;

c) test for 15 min with 3 U_0 rated voltage at a frequency of 0,1 Hz shall be applied between the conductor and the metal screen/sheath.

NOTE During the AC test, a dissipation factor and/or partial discharge can be monitored.

For installations which have been in use, lower voltages and/or shorter durations may be used. Values should be negotiated, taking into account the age, environment, history of breakdowns and the purpose of carrying out the test.

Bibliography

IEC 60092-352, *Electrical installations in ships - Part 352: Choice and installation of electrical cables*

IEC 61892-4, *Mobile and fixed offshore units - Electrical installations - Part 4: Cables*

IEC 60060-3, *High-voltage test techniques - Part 3: Definitions and requirements for on-site testing*

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IEC 60092-354

Edition 4.0 2020-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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)

Installations électriques à bord des navires – Partie 354: Câbles d'énergie unipolaires et tripolaires à isolement massif extrudé pour des tensions assignées allant de 6 kV (U_m = 7,2 kV) jusqu'à 30 kV (U_m = 36 kV)

IEC 60092-354:2020-02(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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)

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60092-354 has been prepared by subcommittee 18A: Electric cables for ships and mobile and fixed offshore units, of 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 2014. This edition constitutes a technical revision.

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

a) Editorial adaptations have been made.

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

CDV	Report on voting
18A/419/CDV	18A/424/RVC

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

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

The list of all the parts of the IEC 60092 series, 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 "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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

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)

1 Scope

This part of IEC 60092 is applicable to shipboard and offshore power cables with extruded solid insulation, conductor and core screening, having a voltage rating of one of the following: 3,6/6 (7,2) kV,6/10 (12) kV, 8,7/15 (17,5) kV, 12/20 (24) kV, 18/30 (36) kV.

NOTE 1 Subclause 4.1 gives more details.

The cables are intended for fixed installations.

The various types of power cables are given in 5.1. The constructional requirements and test methods are aligned with those indicated in IEC 60092-350, unless otherwise specified in this document.

The object of this document is:

– to standardize cables whose safety and reliability is ensured when they are installed in accordance with the requirements of IEC 60092-352 or IEC 61892-4;
– to lay down standard manufacturing requirements and characteristics of such cables directly or indirectly bearing on safety;
– to specify test methods for checking conformity with those requirements.

NOTE 2 Only radial field cables are covered.

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 60038, *IEC standard voltages*

IEC 60228, *Conductors of insulated cables*

IEC 60092-350:—, *Electrical installations in ships – Part 350: General construction and test methods of power, control and instrumentation cables for shipboard and offshore applications*[1]

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

[1] Under preparation. Stage at the time of publication: IEC/BPUB 60092-350:2019.

IEC 60332-1-2, *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 cables under fire conditions – Part 3-22: Test for vertical flame spread of vertically-mounted bunched wires or cables – Category A*

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 60885-2, *Electrical test methods for electric cables. Part 2: Partial discharge tests*

IEC 61034-1, *Measurement of smoke density of cables burning under defined conditions – Part 1: Test apparatus*

IEC 61034-2, *Measurement of smoke density of cables burning under defined conditions – Part 2: Test procedure and requirements*

3 Terms and definitions

For the purpose of this document, the definitions given in IEC 60092-350 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

4 General requirements

4.1 Rated voltage

The standard method of designating the rated voltages of cables covered by this document shall take the form

$$U_0/U\ (U_m)$$

where

U_0 is the rated power-frequency voltage between phase conductor and earth or metallic screen, for which the cable is designed;

U is the rated power-frequency voltage between phase conductors for which the cable is designed;

U_m is the maximum value of the “highest system voltage” for which the equipment (including cable) may be used (see IEC 60038).

All voltages are given as RMS values.

The standard rated voltages $U_0/U\ (U_m)$ of the cables considered in this document are:

U_0/U (U_m) = 3,6/6 (7,2) − 6/10 (12) − 8,7/15 (17,5) − 12/20 (24) − 18/30 (36) kV

4.2 Markings

4.2.1 Indication of origin and voltage identification

Cables shall comply with 4.1.3 of IEC 60092-350:2019 with respect to:

b) indication of origin;

c) rated voltage and cable construction (number of cores and cross-sectional area of the construction);

d) continuity of marking;

e) durability/legibility.

4.2.2 Continuity of marking

The marking is deemed to be continuous if the distance between the end of any marking and the beginning of the next does not exceed:

a) 550 mm if the marking is on the outer surface of the cable;

b) 275 mm in all other cases.

4.2.3 Core identification for three-cores

Cores of cables shall be provided with a suitable method of identification. Each core shall be easily distinguishable from the other cores in the cable.

5 Constructional requirements

5.1 General cable description

5.1.1 Overview

Shipboard and offshore cables for fixed installations shall be single or multicore cables generally constructed as indicated in 5.1.2 to 5.1.5.

5.1.2 Armoured single-sheathed cable with outer sheath only

The armoured single-sheathed cables having only an outer sheath are constructed as follows:

- copper conductor, see 5.2;
- conductor semi-conducting screen, see 5.4.2;
- insulation, see 5.3;
- insulation screening, see 5.4;
- cabling (for three-core cables), see 5.6;
- inner covering, see 5.7;
- braid armour, see 5.9;
- outer sheath applied as either one or two layer systems, see 5.10.

5.1.3 Armoured double-sheathed cable with inner and outer sheath

The armoured double-sheathed cables having both an inner and an outer sheath are constructed as follows:

- copper conductor, see 5.2;
- conductor semi-conducting screen, see 5.4.2;

- insulation, see 5.3;
- insulation screening, see 5.4;
- cabling (for three-core cables), see 5.6;
- inner sheath, see 5.8;
- braid armour, see 5.9;
- outer sheath applied as either one or two layer systems, see 5.10.

The use of a thermoplastic inner sheath (ST2 or SHF1) is not recommended if the outer sheath consists of an elastomeric cross-linked material.

5.1.4 Armoured single-sheathed cable with inner sheath only

The armoured single-sheathed cables having only an inner sheath are constructed as follows:

- copper conductor, see 5.2;
- conductor semi-conducting screen, see 5.4.2;
- insulation, see 5.3;
- insulation screening, see 5.4;
- inner sheath, see 5.8;
- braid armour, see 5.9.

The cables for installation in spaces where corrosion may occur, for example weather decks, wet locations, battery compartments, refrigeration rooms, etc., should have an outer sheath over the braid, if any, unless the braid itself is corrosion-resistant

5.1.5 Unarmoured single-sheathed cable

The unarmoured single-sheathed cables are constructed as follows:

- copper conductor, see 5.2;
- conductor semi-conducting screen, see 5.4.2;
- insulation, see 5.3;
- insulation screening, see 5.4;
- cabling (for three-core cables), see 5.6;
- inner covering (optional), see 5.7;
- outer sheath applied as either one or two layer systems, see 5.10.

5.2 Conductors

Material, metal coating, class and form of the conductors shall be in accordance with IEC 60092-350. The form of the conductor shall be round circular stranded, non-compacted or compacted, in accordance with Class 2 of IEC 60228. To aid installation, a conductor of Class 5 may be used. Cables with such Class 5 conductors should not be regarded as suitable for repeated flexing in service.

The minimum cross-sectional area shall be 10 mm^2 for 3,6/6 (7,2) kV cables, 16 mm^2 for 6/10 (12) kV cables, 25 mm^2 for 8,7/15 (17,5) kV cables, 35 mm^2 for 12/20 (24) kV cables and 50 mm^2 for 18/30 (36) kV cables.

5.3 Insulation

5.3.1 Material

The insulation system shall be EPR, HEPR or XLPE compounds as defined in IEC 60092-360.

5.3.2 Application

The application shall be as detailed in 4.3.2 of IEC 60092-350:2019.

5.3.3 Thickness of insulation

The thickness of the insulation shall be as specified in Table 1 and meet the requirements of 4.3.3 of IEC 60092-350:2019 so that the following applies:

a) the thickness at any point may be less than the specified value provided the difference does not exceed 0,1 mm + 10 % of the specified value;

b) the thickness of the semi-conducting screen on the conductor, or over the insulation, shall not be included in the thickness of insulation.

Table 1 – Insulation thickness

Nominal cross sectional area of conductor	Nominal thickness of insulation at rated voltage U_0/U (U_m)				
	3,6/6 (7,2) kV	6/10 (12) kV	8,7/15 (17,5) kV	12/20 (24) kV	18/30 (36) kV
mm^2	mm	mm	mm	mm	mm
10	2,5	-	-	-	-
16	2,5	3,4	-	-	-
25	2,5	3,4	4,5	-	-
35	2,5	3,4	4,5	5,5	-
50 to 185	2,5	3,4	4,5	5,5	8,0
240	2,6	3,4	4,5	5,5	8,0
300	2,8	3,4	4,5	5,5	8,0
400	3,0	3,4	4,5	5,5	8,0
500 to 630	3,2	3,4	4,5	5,5	8,0

Any smaller conductor cross-section than those given in this table is not recommended. However, if a smaller cross-section is needed, either the diameter of the conductor shall be increased by a conductor screen (see 5.4.2), or the insulation thickness shall be increased in order to limit, at the values calculated with the smallest conductor size given in this table, the maximum electrical stresses applied to the insulation under test voltage.

5.4 Screening of cores

5.4.1 General

Screening of individual cores in single- or three-core cables shall consist of a conductor screen and an insulation screen.

5.4.2 Conductor screening

The conductor screen shall be non-metallic and shall consist of an extruded semi-conducting compound, which may be applied on top of a semi-conducting tape. Where tape is not applied, the extruded semi-conducting compound shall be firmly bonded to the insulation.

5.4.3 Insulation screening

The insulation screening is designed as follows.

a) The insulation screen shall consist of a non-metallic semi-conducting layer in combination with a metallic layer.

b) The non-metallic layer shall be extruded directly upon the insulation of each core and consist of either a bonded or strippable semi-conducting compound.

NOTE A layer of semi-conducting tape can then be applied over the individual cores.

c) The metallic layer shall be applied over the individual cores and shall comply with the requirements of 5.5.

5.5 Metallic screen

5.5.1 Construction

The metallic screen shall consist of one or more tapes, or a braid, or a concentric layer of wires, or a combination of tape(s) and wires.

If a metallic braid screen is applied, the fictitious diameter over the screen is given by:

$$D_c + 5d_w, \text{ in mm}$$

where

D_c is the fictitious diameter of core;

d_w is the nominal diameter of the braid wire.

5.5.2 Requirements

The dimensional, physical and electrical requirements of the metallic screen shall be determined taking into account any other requirements (e.g. national or approval authority regulations and standards), including the value of the current to be carried in case of fault.

5.6 Assembly of three-core cables, inner coverings and fillers

Cores of a three core cable shall be laid up, and the interstices filled if necessary with fillers, inner covering or inner sheath (outer sheath in the case of unarmoured cables) according to 4.6 of IEC 60092-350:2019.

5.7 Inner covering

5.7.1 General

The inner covering shall be extruded. The relevant material and characteristics shall be in accordance with extruded inner coverings in 4.6 of IEC 60092-350:2019.

5.7.2 Thickness of inner covering

The values of the (approximate) thickness of extruded inner covering for the calculation of fictitious diameters are given in Table 2.

Table 2 – Thickness of extruded inner covering for calculation of fictious diameters

Fictitious diameter over laid up cores		Thickness of extruded inner covering
Above mm	Up to and including mm	(approximate value) mm
–	25	1,0
25	35	1,2
35	45	1,4
45	60	1,6
60	80	1,8
80	–	2,0
NOTE For the calculation of fictitious diameter, see Annexes A and C of IEC 60092-350:2019.		

5.8 Inner sheath

5.8.1 Material

The inner sheath shall be selected from one listed in IEC 60092-360. The compound selected shall be compatible with the cable components with which it is in contact and compatible with the operating temperature of the cable.

5.8.2 Application

The application shall be as detailed in 4.7.2 of IEC 60092-350:2019.

5.8.3 Thickness of inner sheath

The thickness of the inner sheath is given as a function of the internal diameter of the sheath under consideration, the fictitious diameter being calculated by the method in Annexes A and C of IEC 60092-350:2019.

For armoured cable as per 5.1, the formula is:

t_1 = 0,04 D + 0,8 mm, with a minimum thickness of 1,0 mm for construction 5.1.3 and 1,4 mm for construction 5.1.4,

where

D is the fictitious diameter under the inner sheath.

The thickness at any point shall satisfy the prescriptions given in 4.7.3 of IEC 60092-350:2019.

5.9 Braid armour

5.9.1 General

The armour type covered by this document is braid armour (see 5.9.2).

The materials and the constructional requirements of the armours shall be those given in 4.8 of IEC 60092-350:2019. When choosing the material of the armour, special consideration shall be given to the possibility of corrosion.

The armour of single-core cables for use on AC circuits shall consist of non-magnetic material. In special cases, for instance when the cables are used on DC circuits, magnetic materials can also be used.

The armour shall be applied in such a way that it shall not adhere to the inner sheath, nor to the outer sheath, nor the inner covering.

The nominal diameters of round armour wires shall be not less than the values given in 5.9.2 and 5.9.3.

5.9.2 Braid wire armour

The braid wire armours are defined as follows.

a) The coverage density of the braid shall be in accordance with IEC 60092-350.

b) The fictitious diameter under the braid is calculated by the method given in Annexes A and C of IEC 60092-350:2019.

5.9.3 Braid wire diameter

Irrespective of the metal used, the nominal diameter of the braid wire shall be:

– 0,30 mm, as a minimum, for cables having fictitious diameter under the braid less than or equal to 30 mm;

– 0,40 mm, as a minimum, for cables having fictitious cable diameter under the braid larger than 30 mm.

5.10 Outer sheath

5.10.1 Material

The outer sheath shall be selected from one listed in IEC 60092-360. The compound selected shall be compatible with the cable components with which it is in contact and compatible with the operating temperature of the cable.

5.10.2 Application

The application shall be as detailed in 4.9.2 IEC 60092-350:2019.

5.10.3 Thickness of outer sheath

The thickness of outer sheath is given as a function of the internal diameter of the sheath under consideration, the fictitious diameter being calculated by the method in Annexes A and C of IEC 60092-350:2019.

The formula is as follows.

a) For armoured single-sheathed cables as per 5.1.2 or unarmoured single-sheathed cables as per 5.1.5:

$$t_1 = 0{,}04\ D + 0{,}8 \text{ mm, with a minimum thickness of } 1{,}0 \text{ mm}$$

where

D is the fictitious diameter under the sheath.

b) For armoured double-sheathed cables as 5.1.3:

$$t_2 = 0{,}025\ D + 0{,}6 \text{ mm, with a minimum thickness of } 0{,}8 \text{ mm.}$$

The thickness at any point shall satisfy the prescriptions given in 4.9.3 of IEC 60092-350:2019.

5.10.4 Colour of outer sheath

The outer sheath shall be coloured red, unless otherwise specified by the purchaser at the time of ordering.

6 Tests – Methods and requirements

The tests shall be carried out according to Table 3 to Table 6 where applicable. For the purposes of this document, the definitions given in IEC 60092-350 for routine test, sample test and type test apply.

Table 3 –Tests applicable to all cables

Test	Applicability – All types of cable unless otherwise stated	Status	Method according to IEC 60092-350:2019	Requirement – As in IEC 60092-350 unless otherwise stated
Measurement of electrical resistance of conductors		Routine	5.2.2	IEC 60228
Voltage test		Routine	5.2.3	-
Voltage test on sheath	Armoured cables	Routine	5.2.3	-
Insulation resistance test		Type	7.2.1	-
Partial discharge test		Routine	7.7.3	IEC 60885-3
High voltage sequence test		Type	7.7	
Conductor examination		Sample and type	6.4	-
Check of cable dimensions Thickness of insulation Thickness of non metallic sheaths Dimensions of braid armour External diameter		Sample and type	 6.5 and 8.2 6.6 and 8.3 6.7	 - - 5.9.2 and 5.9.3 -
Hot set test	EPR, HEPR, XLPE, insulation and SE, SH and SHF2 sheath	Sample	6.8	IEC 60092-360
Coverage density of braid	Braid armoured cables	Type	4.8.2	
Insulation resistance measurement at maximum rated temperature		Type	7.2.2	IEC 60092-360
Increase in AC capacity after immersion in water		Type	7.3	IEC 60092-360
High-voltage test for 4 h		Type	7.7.9	

Test	Applicability – All types of cable unless otherwise stated	Status	Method according to IEC 60092-350:2019	Requirement – As in IEC 60092-350 unless otherwise stated
Mechanical properties of insulation before and after ageing		Type	8.4	IEC 60092-360
Mechanical properties of sheath before and after ageing		Type	8.5	IEC 60092-360
Additional ageing compatibility test		Type	8.6	IEC 60092-360
Loss of mass test	PVC ST2 sheath	Type	8.7	IEC 60092-360
Behaviour at high temperature	PVC ST2 and SHF1 sheaths	Type	8.8	IEC 60092-360
Behaviour at low temperatures	PVC ST2, SHF1 and SHF2 sheaths	Type	8.9	IEC 60092-360
Test for coating of copper wires		Type	8.11	
Galvanizing test		Type	8.12	
Resistance to cracking heat shock	PVC ST2 and SHF1 sheaths	Type	8.13	IEC 60092-360
Ozone resistance	Insulations and sheaths	Type	8.14	IEC 60092-360
Hot oil immersion	SE1, SH and SHF2 sheaths	Type	8.15.1	IEC 60092-360
Flame-spread tests: IEC 60332-1-2 and IEC 60332-3-22		Type	8.17.1 8.17.2	IEC 60332-1-2 and IEC 60332-3-22 in which case cables shall be installed in touching configuration on the front of the ladder.
Determination of hardness	HEPR insulation	Type	8.18	IEC 60092-360
Determination of modulus of elasticity	HEPR insulation	Type	8.19	IEC 60092-360
Durability of marking		Type	8.20	The marking shall remain legible following the test as given in 8.20 of IEC 60092-350:2019

Table 4 – Additional tests for halogen-free cables

Test	Applicability – All types of cable unless otherwise stated	Status	Method according to IEC 60092-350:2019	Requirement – As in IEC 60092-350 unless otherwise stated
Acid gas emission	Halogen free cables	Type	8.17.4	IEC 60754-1
pH and conductivity	Halogen free cables	Type	8.17.5	IEC 60754-2
Fluorine content test	Halogen free cables	Type	8.17.6	IEC 60684-2

Table 5 – Additional test for low smoke cables

Test	Applicability – All types of cable unless otherwise stated	Status	Method according to IEC 60092-350:2019	Requirement – As in IEC 60092-350 unless otherwise stated
Smoke density test for cables insulated and sheathed with halogen-free materials. When tested according to IEC 61034-1 and IEC 61034-2		Type	8.17.3	The test is satisfactory for the finished cables if the levels of light transmittance exceeds 60 % throughout the test
NOTE The smoke density test is in general applicable to halogen free cables. See also Table 4.				

Table 6 – Additional tests when required

Test	Applicability – All types of cable unless otherwise stated	Status	Method according to IEC 60092-350:2019	Requirement – As in IEC 60092-350 unless otherwise stated
Special test for low temperature behaviour	When required	Type	8.9	
Enhanced hot oil immersion	When required	Type	8.15.2	IEC 60092-360
Drilling fluid test	When required	Type	8.16	IEC 60092-360

Annex A
(normative)

Electrical tests after installation

By agreement between the purchaser and the contractor, an AC voltage test in accordance with IEC 60060-3 and with item a) or b) or c) below may be used:

a) test for 15 min with the phase-to-phase voltage U at a frequency between 20 Hz to 300 Hz shall be applied between the conductor and the metal screen/sheath;

b) test for 24 h with the normal rated voltage U_0 of the system;

c) test for 15 min with 3 U_0 rated voltage at a frequency of 0,1 Hz shall be applied between the conductor and the metal screen/sheath.

NOTE During the AC test, a dissipation factor and/or partial discharge can be monitored.

For installations which have been in use, lower voltages and/or shorter durations may be used. Values should be negotiated, taking into account the age, environment, history of breakdowns and the purpose of carrying out the test.

Bibliography

IEC 60092-352, *Electrical installations in ships - Part 352: Choice and installation of electrical cables*

IEC 61892-4, *Mobile and fixed offshore units - Electrical installations - Part 4: Cables*

IEC 60060-3, *High-voltage test techniques - Part 3: Definitions and requirements for on-site testing*

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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INSTALLATIONS ÉLECTRIQUES À BORD DES NAVIRES –

Partie 354: Câbles d'énergie unipolaires et tripolaires à isolement massif extrudé pour des tensions assignées allant de 6 kV (U_m = 7,2 kV) jusqu'à 30 kV (U_m = 36 kV)

AVANT-PROPOS

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La Norme internationale IEC 60092-354 a été établie par le sous-comité 18A: Câbles électriques pour navires et unités mobiles et fixes en mer, du comité d'études 18 de l'IEC: Installations électriques des navires et des unités mobiles et fixes en mer.

Cette quatrième édition annule et remplace la troisième édition parue en 2014. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) des adaptations rédactionnelles ont été effectuées.

Le texte de cette Norme internationale est issu des documents suivants:

CDV	Rapport de vote
18A/419/CDV	18A/424/RVC

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation du présent document.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2.

Une liste de toutes les parties de la série IEC 60092, publiées sous le titre général *Installations électriques à bord des navires*, peut être consultée sur le site web de l'IEC.

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "http://webstore.iec.ch" dans les données relatives au document recherché. A cette date, le document sera

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INSTALLATIONS ÉLECTRIQUES À BORD DES NAVIRES –

Partie 354: Câbles d'énergie unipolaires et tripolaires à isolement massif extrudé pour des tensions assignées allant de 6 kV (U_m = 7,2 kV) jusqu'à 30 kV (U_m = 36 kV)

1 Domaine d'application

La présente partie de l'IEC 60092 est applicable aux câbles d'énergie installés à bord des navires et des unités en mer à isolement massif extrudé, avec écran sur âme et blindage des conducteurs, et ayant l'une des tensions assignées suivantes: 3,6/6 (7,2) kV, 6/10 (12) kV, 8,7/15 (17,5) kV, 12/20 (24) kV, 18/30 (36) kV.

NOTE 1 Le 4.1 fournit davantage d'informations à ce sujet.

Les câbles sont destinés à des installations fixes.

Les différents types de câbles d'énergie sont présentés en 5.1. Les exigences de fabrication et les méthodes d'essai sont alignées sur celles qui sont indiquées dans l'IEC 60092-350, sauf spécification contraire dans le présent document.

L'objet du présent document est:

– de normaliser les câbles dont la sécurité et la fiabilité sont assurées lorsqu'ils sont installés conformément aux exigences de l'IEC 60092-352 ou de l'IEC 61892-4;

– d'établir des exigences et caractéristiques de fabrication normalisées pour ces câbles se référant directement ou indirectement à la sécurité;

– de spécifier les méthodes d'essai visant à vérifier la conformité à ces exigences.

NOTE 2 Seuls les câbles à champ radial sont couverts.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60038, *Tensions normales de la CEI*

IEC 60228, *Ames des câbles isolés*

IEC 60092-350:—, *Electrical installations in ships – Part 350: General construction and test methods of power, control and instrumentation cables for shipboard and offshore applications* (disponible en anglais seulement) [1]

IEC 60092-360, *Installations électriques à bord des navires – Partie 360: Matériaux d'isolation et de gainage des câbles d'alimentation, de commande, d'instrumentation et de télécommunication installés à bord des navires et des unités en mer*

[1] En cours de préparation. Stade au moment de la publication: IEC/BPUB 60092-350:2019.

IEC 60332-1-2, *Essais des câbles électriques et à fibres optiques soumis au feu – Partie 1-2: Essai de propagation verticale de la flamme sur conducteur ou câble isolé – Procédure pour flamme à prémélange de 1 kW*

IEC 60332-3-22, *Essais des câbles électriques soumis au feu – Partie 3-22: Essai de propagation verticale de la flamme des fils ou câbles montés en nappes en position verticale – Catégorie A*

IEC 60684-2, *Gaines isolantes souples – Partie 2: Méthodes d'essai*

IEC 60754-1, *Essai sur les gaz émis lors de la combustion des matériaux des câbles – Partie 1: Détermination de la quantité de gaz acide halogéné*

IEC 60754-2, *Essai sur les gaz émis lors de la combustion des matériaux prélevés sur câbles – Partie 2: Détermination de la conductivité et de l'acidité (par mesure du pH)*

IEC 60885-2, *Méthodes d'essais électriques pour les câbles électriques. Deuxième partie: Essais de décharges partielles*

IEC 61034-1, *Mesure de la densité de fumées dégagées par des câbles brûlant dans des conditions définies – Partie 1: Appareillage d'essai*

IEC 61034-2, *Mesure de la densité de fumées dégagées par des câbles brûlant dans des conditions définies – Partie 2: Procédure d'essai et exigences*

3 Termes et définitions

Pour les besoins du présent document, les définitions de l'IEC 60092-350 s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

4 Exigences générales

4.1 Tension assignée

La méthode normalisée de conception des tensions assignées des câbles couverts par le présent document doit prendre la forme suivante:

$$U_0/U\ (U_m)$$

où

U_0 est la tension assignée à fréquence industrielle entre le conducteur de phase et la terre ou l'écran métallique, pour laquelle est conçu le câble;

U est la tension assignée à fréquence industrielle entre les conducteurs de phase, pour laquelle est conçu le câble;

U_m est la valeur maximale de la "tension de réseau la plus élevée" pour laquelle le matériel (y compris le câble) peut être utilisé (voir IEC 60038).

Toutes les tensions sont exprimées en valeurs efficaces.

Les tensions assignées normales U_0/U (U_m) des câbles relevant du présent document sont les suivantes:

U_0/U (U_m) = 3,6/6 (7,2) − 6/10 (12) − 8,7/15 (17,5) − 12/20 (24) − 18/30 (36) kV

4.2 Marquages

4.2.1 Indication de l'origine et de la tension

Les câbles doivent être conformes au 4.1.3 de l'IEC 60092-350:2019 en ce qui concerne:

b) l'indication de l'origine;

c) la tension assignée et la construction du câble (nombre de conducteurs et section de la construction);

d) la continuité du marquage;

e) l'indélébilité/la lisibilité.

4.2.2 Continuité du marquage

Le marquage est considéré comme continu si la distance entre la fin d'un marquage et le début du suivant ne dépasse pas:

a) 550 mm si le marquage se trouve sur la surface extérieure du câble;

b) 275 mm dans tous les autres cas.

4.2.3 Identification des conducteurs pour les câbles tripolaires

Les conducteurs de câbles doivent être fournis avec une méthode d'identification adéquate. Chaque conducteur doit être facilement identifiable par rapport aux autres conducteurs du câble.

5 Exigences de construction

5.1 Description générale des câbles

5.1.1 Vue d'ensemble

Les câbles pour installations fixes à bord des navires et des unités en mer doivent être des câbles unipolaires ou multipolaires, généralement conçus comme indiqué du 5.1.2 au 5.1.5.

5.1.2 Câble armé à une seule gaine, externe uniquement

Les câbles armés à une seule gaine, externe uniquement, sont construits comme suit:

- âme en cuivre, voir 5.2;
- écran semiconducteur sur âme, voir 5.4.2;
- enveloppe isolante, voir 5.3;
- écran sur enveloppe isolante, voir 5.4;
- assemblage (pour les câbles tripolaires), voir 5.6;
- revêtement d'assemblage, voir 5.7;
- armure tressée, voir 5.9;
- gaine externe appliquée comme des systèmes à une ou deux couches, voir 5.10.