IEC 60092-379

Edition 1.0 2024-07

INTERNATIONAL STANDARD

Electrical installations in ships – Part 379: Symmetrical category cables with transmission characteristics up to 1 000 MHz

IEC 60092-379:2024-07(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 29.060.20; 47.020.60

ISBN 978-2-8322-9456-7

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ELECTRICAL INSTALLATIONS IN SHIPS –

Part 379: Symmetrical category cables with transmission characteristics up to 1 000 MHz

FOREWORD

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IEC 60092-379 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. It is an International Standard.

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

Draft	Report on voting
18A/487/FDIS	18A/489/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 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 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- withdrawn, or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.

ELECTRICAL INSTALLATIONS IN SHIPS –

Part 379: Symmetrical category cables with transmission characteristics up to 1 000 MHz

1 Scope

This part of IEC 60092 is applicable to shipboard and offshore units Ethernet (category) cables with extruded solid or foamed insulation, intended for fixed installations. Cables designed to maintain functional integrity during fire as specified in 6.1 and to be installed in explosive atmospheres as specified in 6.2 are included.

The various types of Ethernet (category) cables are given in Clause 4. 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 60092-401;

– to allow solid conductor category cables against the recommendations of IEC 60092-352;

– 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; and

– to add requirements and recommendations for the cable installation in accordance with Annex A.

All cables described in this document are halogen-free.

Cables within this document can be installed in many different environments that would call for extra protection where steel wire or tape armouring is required. Examples of areas, such as outdoor, on the ship, where other moveable objects are within the same space, will require extra protection. These areas of concern are found in extreme conditions, like offshore drilling and oil 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 60079-14:2013, *Explosive atmospheres – Part 14: Electrical installations design, selection and erection*

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

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

IEC 60331-1, *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, *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 60331-23, *Tests for electric cables under fire conditions – Circuit integrity – Part 23: Procedures and requirements – Electric data cables*

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 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 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 60811-506, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 506: Mechanical tests – Impact test at low temperature for insulations and sheaths*

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

IEC 61156-1:2023, *Multicore and symmetrical pair/quad cables for digital communications – Part 1: Generic specification*

IEC 61156-5:2020, *Multicore and symmetrical pair/quad cables for digital communications – Part 5: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz – Horizontal floor wiring – Sectional specification*

IEC 61156-6:2020, *Multicore and symmetrical pair/quad cables for digital communications – Part 6: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz – Work area wiring – Sectional specification*

ISO/IEC TS 29125, *Information technology – Telecommunications cabling requirements for remote powering of terminal equipment*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60092-350 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

4 General requirements

4.1 Temperature range of the cables

The category cables, specified in this document, are decided for an operating temperature range from −25 °C up to +80 °C.

NOTE The specified temperature range is extended compared to the range specified in the IEC 61156 series.

Another temperature range can be agreed between manufacturer and customer. In this case ensure that the temperature coefficient of the attenuation should be specified in order to provide this information for network-planning purposes.

4.2 Rated voltage

The rated voltages for category cables are

- 30 V AC for cables with Ethernet data transmission only;
- 57 V AC for cables with Ethernet data transmission and additional Power over Ethernet (PoE) characteristics.

All voltages are given as RMS values.

If cables are used including Power over Ethernet the production and installation shall be in accordance with ISO/IEC TS 29125.

NOTE 1 For Power over Ethernet characteristics and application see the following standards:

- 2-pair PoE (ISO/IEC/IEEE 802.3cq-2020)
- 2-pair PoE+ (ISO/IEC/IEEE 802.3cv-2021)
- 4-pair PoE++ (ISO/IEC/IEEE 802-3:2021/AMD2:2021)

NOTE 2 PoE+ and PoE++ are not official terms.

NOTE 3 The detailed voltage range of a PoE cable is:

- PoE Type1: 44 V - 57 V, DC
- PoE Type2: 50 V- 57 V, DC
- PoE Type3&4: 52 V- 57 V, DC

4.3 Transmission (category) parameters

4.3.1 General

The transmission (category) class shall be defined in accordance with IEC 61156-5 (horizontal wiring) or IEC 61156-6 (work area wiring).

4.3.2 Categories

For shipboard and offshore units application the following cables shall be used:

- Category 5e
- Category 6
- Category 6A
- Category 7
- Category 7A

4.4 Markings

4.4.1 Indication of origin and core identification

Cables shall comply with IEC 60092-350:2020, 4.1.3, with respect to

a) indication of origin,
b) cable construction (number of cores and cross-sectional area of the construction),
c) transmission category,
d) continuity of marking, and
e) durability/legibility.

NOTE The cross sectional area can be given either in metric dimensions or in AWG size.

4.4.2 Continuity of marking

The marking is deemed to be continuous if the distance between the beginning of any marking and the beginning of the next does not exceed 1 000 mm if the marking is on the outer surface of the cable.

5 Construction requirements

5.1 Overview

Ethernet (category) cables for shipboard and offshore application for fixed installations shall be multicore (multipair) cables generally constructed as follows.

The sequence of the bullet points indicates the sequence of the construction elements in the cable.

5.2 Unarmoured single or double-sheathed cable

- copper conductor, see 5.4;
- insulation, see 5.5;
- cabling (for multicore cables), see 5.7;
- inner covering (optional), see 5.8;
- electrostatic screening, see 5.9;
- inner sheath (optional), see 5.10;
- outer sheath applied as either one or two layer systems, see 5.12.

5.3 Armoured cables

a) Armoured single-sheathed cable with outer sheath only

- copper conductor, see 5.4;
- insulation, see 5.5;
- cabling (for multicore cables), see 5.7;
- inner covering below electrostatic screening (optional), see 5.8;
- electrostatic screening, see 5.9;
- inner covering (only extruded for SWA), see 5.8;
- armour, see 5.11;
- outer sheath applied as either one- or two-layer systems, see 5.12.

b) Armoured double-sheathed cable with inner and outer sheath

- copper conductor, see 5.4;
- insulation, see 5.5;
- cabling (for multicore cables), see 5.7;
- inner covering (optional), see 5.8;
- electrostatic screening, see 5.9;
- inner sheath, see 5.10;
- armour, see 5.11;
- outer sheath applied as either one or two layer systems, see 5.12.

5.4 Copper conductors

The material, metal coating, class and form of the conductors shall be in accordance with IEC 61156-1.

NOTE Typical cross sections for wires are AWG 22, AWG 23, AWG 24, AWG 26.

5.5 Insulation

The conductor shall be insulated with a suitable solid, foamed, foam-skin, skin-foam-skin or hybrid material.

The insulation shall be of any insulation system that meets high frequency transmission, environmental and mechanical requirements.

5.6 Core identification

5.6.1 General

Cores shall be clearly identified by colours.

5.6.2 Colours of cores

The core colours shall be in accordance with IEC 61156-1.

5.7 Cabling

Cabling (lay-up of the cable elements) shall be in accordance with IEC 60092-350:2020, 4.5, and IEC 61156-1.

NOTE Cabling (lay-up of the cable elements) in this document is 'cable make-up' in the IEC 61156 series.

5.8 Inner covering

5.8.1 General

The inner covering, if any, can be extruded or lapped. The relevant material and characteristics shall be in accordance with IEC 60092-350:2020, 4.6, and IEC 61156-1.

5.8.2 Cables with helically applied steel wire armour

Inner covering for cables with helically applied steel wire armoured cable, commonly abbreviated as SWA, shall be extruded.

5.9 Electrostatic screen

The design, material, metal coating, class and form of the electrostatic screen shall be in accordance with IEC 61156-1. IEC 60092-350 states that in multi-unit cables, the individual electrostatic screens shall be electrically isolated both from each other and the collective screen, if any.

5.10 Inner sheath

5.10.1 General

Inner sheath is optional for unarmoured cables and mandatory for armoured cables with braid armour.

5.10.2 Material

The inner sheathing compound and its designation shall be one of those halogen-free types given in IEC 60092-360.

5.10.3 Application

The application shall be as detailed in IEC 60092-350:2020, 4.7.2.

5.10.4 Thickness of inner sheath

The nominal sheath thickness (t) is defined as follows:

Sheath thickness t = 0,04 D + 0,5 mm with a minimum thickness of 0,7 mm.

D is the diameter under the sheath.

The mean value of the thickness and the thickness at any point, shall satisfy the descriptions given in IEC 60092-350:2020, 4.7.3.

5.11 Armour

5.11.1 General

In this document, only metal armours are specified, the wires being of copper, copper alloy, stainless steel or galvanized steel. Joints in the wires shall be soldered, twisted or woven-in, and the complete armour shall not be jointed. The armour shall be evenly applied. The armour can be fabricated as a braid or as stranded helical lay-up. Armour and electrostatic screen shall be separated construction elements.

5.11.2 Braided armour

5.11.2.1 Braid wire diameter

Irrespective of the metal used, the nominal diameter of the braid wire shall be at least 0,2 mm, as a minimum.

5.11.2.2 Coverage density

The coverage density of the armour shall be in accordance with IEC 60092-350:2020, 4.8.2.

5.11.3 Helically applied armour

5.11.3.1 Layed-up stranded wire (SWA) diameter

Irrespective of the metal used, the nominal diameter of the armour wire shall be at least 0,8 mm, as a minimum.

5.11.3.2 Coverage density

The coverage density of the armour shall be in accordance with IEC 60092-350:2020, 4.8.2.

5.11.4 Application of the armour

The armour shall be applied in such a way that it shall not adhere to any other layer inside or outside.

5.12 Outer sheath

5.12.1 Material

The outer sheathing compound and its designation shall be a halogen-free type given in IEC 60092-360. Multi-layers are possible with variations of compound.

5.12.2 Application

The application shall be as detailed in IEC 60092-350:2020, 4.9.2.

5.12.3 Thickness of the sheath

The nominal sheath thickness (t) is defined as follows:

Sheath thickness t = 0,04 D + 0,5 mm with a minimum thickness of 0,7 mm.

D is the diameter under the sheath.

The mean value of the thickness, and the thickness at any point, shall satisfy the descriptions given in IEC 60092-350:2020, 4.9.3.

5.12.4 Colour of outer sheath

The outer sheath shall be colored in black or gray, or for fire resistant cables, in orange, or for cables for hazardous areas, in blue, unless otherwise specified by the purchaser at the time of ordering.

6 Construction for special applications

6.1 Fire resistant cables

Fire resistant cables shall guarantee complete functional integrity during fire including defined data transmission characteristics in accordance with the requirements in Table 4 and Table 5.

6.2 Cables for installation in areas with explosive atmospheres

Cables for installation in areas with explosive atmospheres (zone 1 or zone 2) shall be armoured with a braid for earth detection in accordance with 5.11.2.

Braided armouring of cables installed in areas with explosive atmospheres shall be effectively earthed at least on both ends. Where there is risk of intermittent contact between armour and exposed metalwork, non-metallic sheath has to be applied over the metallic armour of cables.

This design is recommended for all kinds of hazardous areas.

6.3 Cables for installation between areas with and without explosive atmospheres

Cables for installation between areas with and without explosive atmospheres shall fulfil the special technical requirements for cables of IEC 60079-14. The cable's stranding and geometrical construction shall minimize any possible air gaps or spaces. Therefore, any potential spaces shall be packed with solid fillers or other materials.

7 Tests – methods and requirements

7.1 General

The tests shall be carried out in accordance with Table 1 to Table 6 where applicable.

Table 1 – Tests applicable to all cables

Test	Applicability – all types of cable unless otherwise stated	Status	Method – subclause number given in IEC 60092-350:2020	Requirement – as in IEC 60092-350 unless otherwise stated
Check of cable dimensions thickness of non metallic sheaths (excluding inner coverings) external diameter		Sample and type	6.6 and 8.3 6.7	 – – –
Hot set test	SHF2 sheaths only	Sample	6.8	IEC 60092-360
Coverage density of braid	Braid armoured cables	Type	4.8.2	–
Mechanical properties of sheath before and after ageing		Type	8.5	IEC 60092-360
Additional ageing compatibility test		Type	8.6	IEC 60092-360
Behaviour at high temperature	SHF1 sheaths only	Type	8.8	IEC 60092-360
Behaviour at low temperatures	SHF1 and SHF2 sheaths	Type	8.9	IEC 60092-360
Galvanizing test		Type	8.12	IEC 60092-360

Test	Applicability – all types of cable unless otherwise stated	Status	Method – subclause number given in IEC 60092-350:2020	Requirement – as in IEC 60092-350 unless otherwise stated
Resistance to cracking heat shock	SHF1 sheaths only	Type	8.13	IEC 60092-360
Ozone resistance	SHF2 sheaths only	Type	8.14	IEC 60092-360
Hot oil immersion	SHF2 sheaths only	Type	8.15.1	IEC 60092-360
Fire-retardant tests: IEC 60332-1-2 and IEC 60332-3-24 or IEC 60332-3-25		Type	8.17.1 8.17.2	IEC 60332-1-2 and IEC 60332-3-24 or IEC 60332-3-25 in which case cables shall be installed in the touching configuration on the front of the ladder.
Durability of marking		Type	8.20	-
Conductor resistance		Sample and type	-	IEC 61156-5:2020, 6.2.1 or IEC 61156-6:2020, 6.2.1
Conductor resistance unbalance within pair		Sample and type	-	IEC 61156-5:2020, 6.2.2.2 or IEC 61156-6:2020, 6.2.2.2
Dielectric strength conductor/conductor and conductor/screen		Sample and type	-	IEC 61156-5:2020, 6.2.3 or IEC 61156-6:2020, 6.2.3
Insulation resistance conductor/conductor and conductor/screen		Sample and type	-	IEC 61156-5:2020, 6.2.4 or IEC 61156-6:2020, 6.2.4
Capacitance unbalance pair to ground		Sample and type	-	IEC 61156-5:2020, 6.2.6 or IEC 61156-6:2020, 6.2.6
Transfer impedance		Type	-	IEC 61156-5:2020, 6.2.7 or IEC 61156-6:2020, 6.2.7
Coupling attenuation		Type	-	IEC 61156-5:2020, 6.2.8 or IEC 61156-6:2020, 6.2.8
Phase and differential delay (delay skew)		Type	-	IEC 61156-5:2020, 6.3.2.1 or IEC 61156-6:2020, 6.3.2.1
Differential delay (delay skew)		Sample and type	-	IEC 61156-5:2020, 6.3.2.2 or IEC 61156-6:2020, 6.3.2.2
Attenuation		Sample and type	-	IEC 61156-5:2020, 6.3.3.1, 6.3.3.2, 6.3.3.3 or IEC 61156-6:2020, 6.3.3.1, 6.3.3.2, 6.3.3.3
Unbalance attenuation		Type	-	IEC 61156-5:2020, 6.3.4 or IEC 61156-6:2020, 6.3.4
Power sum Near-end crosstalk (PS NEXT)		Sample and type	-	IEC 61156-5:2020, 6.3.5 or IEC 61156-6:2020, 6.3.5
Near-end crosstalk (NEXT)		Sample and type	-	IEC 61156-5, 6.3.5 or IEC 61156-6, 6.3.5
Power sum equal level far-end crosstalk (ACR-F)		Sample and type	-	IEC 61156-5:2020, 6.3.6 or IEC 61156-6:2020, 6.3.6
Impedance		Sample and type	-	IEC 61156-5:2020, 6.3.10 or IEC 61156-6:2020, 6.3.10

Test	Applicability – all types of cable unless otherwise stated	Status	Method – subclause number given in IEC 60092-350:2020	Requirement – as in IEC 60092-350 unless otherwise stated
Return loss		Sample and type	-	IEC 61156-5:2020, 6.3.11 or IEC 61156-6:2020, 6.3.11
Crush resistance of the cable		Type	IEC 61156-1	IEC 61156-1:2023, 6.4.8
Impact resistance of the cable		Type	-	IEC 61156-1:2023, 6.4.9, IEC 60811-506
Single bend test U-bend test		Type	IEC 61156-1	IEC 61156-1:2023, 6.4.10.3.2
Simulated installation testing of the cable		Type	IEC 61156-1	IEC 61156-1:2023, 6.4.10.3.2
Tensile performance		Type	IEC 61156-1	IEC 61156-1:2023, 6.4.12
Tensile strength of the insulation		Type	-	IEC 61156-5:2020, 6.4.3 or IEC 61156-6:2020, 6.4.3
Elongation at break of the insulation		Type	-	IEC 61156-5:2020, 6.4.4 or IEC 61156-6:2020, 6.4.4
Acid gas emission		Type	8.17.4	IEC 60754-1
pH and conductivity		Type	8.17.5	IEC 60754-2
Fluorine content test		Type	8.17.6	IEC 60684-2
All cables shall be referenced to IEC 61156-1. Horizontal cables shall be referenced additionally to IEC 61156-5. Work-area cables shall be referenced additionally to IEC 61156-6. NOTE The use of attenuation limits according to IEC 61156-6 leads to lower maximum transmission lengths compared to the attenuation limits according to IEC 61156-5.				

Table 2 – Additional test required for low smoke cables

Test	Status	Method – subclause number given in IEC 60092-350:2020	Requirement – as in IEC 60092-350 unless otherwise stated
Smoke emission test for cables insulated and sheathed with halogen-free materials. When tested in accordance with IEC 61034-2	Type	8.17.3	The test is satisfactory for the finished cables if the levels of light transmittance exceed 60 % throughout the test

Table 3 – Additional tests required for specific performances

Test	Status	Method – subclause number given in IEC 60092-350:2020	Requirement – as in IEC 60092-350 unless otherwise stated
Special test for low temperature behaviour	Type	8.10	
Enhanced hot oil immersion	Type	8.15.2	IEC 60092-360
Drilling fluid test	Type	8.16	IEC 60092-360

Table 4 – Additional test required for fire resistant cables

Test	Status	Method –subclause number given in IEC 60092-350:2020	Requirement – as in IEC 60092-350 unless otherwise stated
Test for fire resistance (limited circuit integrity)	Type	8.17.7	The test shall be carried out in accordance with IEC 60331-23 or IEC 60331-1 or IEC 60331-2. During the flaming period the parameters shall be measured – at minimum every 5 min in the first 20 min and later every 10 min in accordance with Table 5. The minimum time of the flaming period shall be 90 min, 120 min or 180 min.
NOTE The test apparatus for the test procedure defined in IEC 60331-23 is detailed in IEC 60331-1.			

Table 5 – Requirements for insulation and functional integrity of Ethernet (category) cables

Maximum Frequency	High-frequency properties	Requirements for functional integrity
< 100 kHz	Dielectric strength	No short circuit between the wires, voltage as defined by manufacturer in accordance with 4.2. The minimum time of the flaming period shall be 90 min, 120 min or 180 min.
	Attenuation	Maximum difference < 30 %
≥ 100 kHz < 100 MHz	Dielectric strength	No short circuit between the wires, voltage as defined by manufacturer in accordance with 4.2 The minimum time of the flaming period shall be 90 min, 120 min or 180 min.
	Attenuation	Maximum difference < 12,5 %
	NEXT	> 26 - 15 log 10(f/10) dB, 1 MHz up to 10 MHz
≥ 100 MHz < 1 000 MHz	Dielectric strength	No short circuit between the wires, voltage as defined by manufacturer in accordance with 4.2 The minimum time of the flaming period shall be 90 min, 120 min or 180 min.
	Attenuation	Maximum difference < 12,5 %
	Return loss	> 8 dB
	NEXT	> 26 - 15 log 10(f/10) dB, 1 MHz up to 10 MHz
NOTE The cable performance between 1 MHz and 4 MHz is achieved by design only and it is therefore not necessary to test for this performance below 4 MHz.		

NOTE 1 In this document the wording "fire resistant cables" and "functional integrity of cables" means the same feature.

NOTE 2 The requirements of Table 5 are similar to the requirements of EN 50289-4-16.

Test sample length for tests in accordance with Table 4 and Table 5 shall be in accordance with IEC 61156-5 or IEC 61156-6 and the burning test place shall be in the middle of the test sample.

7.2 Tests on cables for installation in explosive atmospheres

Tests shall be provided in accordance with Table 1 to Table 3 and Table 5 for braided armoured cables.

7.3 Additional test on cables for installation between areas with and without explosive atmospheres

The test in accordance with Table 6 shall be carried out additionally to the tests described in Table 1 to Table 5 where applicable.

Table 6 – Additional test for cables for installation between areas with and without explosive atmospheres

Test	Status	Method –given in IEC 60079-14:2013	Requirement
Test for limitation of the gas flow through the cable	Type	Annex E	The test shall be carried out in accordance with IEC 60079-14:2013, Annex E Test shall be provided without armour.