

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Electrical installations in Ships –
Part 360: Insulating and sheathing materials for shipboard and offshore units,
power, control, instrumentation and telecommunication cables

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



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ELECTRICAL INSTALLATIONS IN SHIPS –**Part 360: Insulating and sheathing materials for shipboard and offshore units, power, control, instrumentation and telecommunication cables**

FOREWORD

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International Standard IEC 60092-360 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 first edition cancels and replaces IEC 60092-351 Ed. 3 published in 2004 and IEC 60092-359 Ed. 1 published in 1987, Amendment 1:1994 and Amendment 2:1992. This edition constitutes a technical revision.

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

- a) rationalization of the number of insulating and sheathing materials. In particular polyvinyl chloride based insulation (PVC) and sheath (ST 1) have been removed. PVC sheath ST 2 is permitted even though it releases harmful fumes under fire conditions. SE and SH also release harmful fumes under fire conditions;

- b) updated temperature limit for thermoplastic sheath in line with the operating temperature on the conductor;
- c) new optional categories of sheathing materials with enhanced oil resistance, and resistance to drilling fluids;
- d) removal of the air bomb test for EPR and HEPR insulating types;
- e) there has been some redistribution of test methods between IEC 60092-350 and this new standard to remove all tests carried out on complete cables.

The text of this standard is based on the following documents:

FDIS	Report on voting
18A/360/FDIS	18A/361/RVD

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

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

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

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

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ELECTRICAL INSTALLATIONS IN SHIPS –

Part 360: Insulating and sheathing materials for shipboard and offshore units, power, control, instrumentation and telecommunication cables

1 Scope

This part of IEC 60092 specifies the requirements for electrical, mechanical and particular characteristics of insulating and sheathing materials intended for use in shipboard and fixed and mobile offshore unit power, control, instrumentation and telecommunication cables.

The different insulating and sheathing materials have been divided into three categories as listed in the following Table 1.

Table 1 – Categories and types of materials

Title	Compounds included
Cross-linked insulating compounds	EPR; HEPR; XLPE; S 95; HF 90
Cross-linked sheathing compounds	SE; SH; SHF 2
Thermoplastic sheathing compounds	SHF 1; ST 2

(standards.iteh.ai)

2 Normative references

[IEC 60092-360:2014](https://standards.iteh.ai/catalog/standards/sist/a6066d0b-4077-4cfl-8419-1e39700a1c/iec-60092-360-2014)

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The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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 60684-2:2011, *Flexible insulating sleeving – Part 2: Methods of test*

IEC 60811-201, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 201: General tests – Measurement of insulation thickness*

IEC 60811-202:2012, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 202: General tests – Measurement of thickness of non-metallic sheath*

IEC 60811-401, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 401: Miscellaneous tests – Thermal ageing methods – Ageing in an air oven*

¹ To be published.

IEC 60811-403, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 403: Miscellaneous tests – Ozone resistance test on cross-linked compounds*

IEC 60811-404, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 404: Miscellaneous tests – Mineral oil immersion tests for sheaths*

IEC 60811-409, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 409: Miscellaneous tests – Loss of mass test for thermoplastic insulations and sheaths*

IEC 60811-501, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 501: Mechanical tests – Tests for determining the mechanical properties of insulating and sheathing compounds*

IEC 60811-505, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 505: Mechanical tests – Elongation at low temperature for insulations and sheaths*

IEC 60811-507, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 507: Mechanical tests – Hot set test for cross-linked materials*

IEC 60811-508, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 508: Mechanical tests – Pressure test at high temperature for insulation and sheaths*

IEC 60811-509, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 509: Mechanical tests – Test for resistance of insulations and sheaths to cracking (heat shock test)*

ISO 1817, *Rubber vulcanised – Determination of the effect of liquids*

ISO 48:2007, *Rubber, vulcanised or thermoplastic – Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

<https://standards.iteh.ai/catalog/standards/sist/a6066d0b-4077-4cfl-8419-5c3e990059b6/iec-60092-360-2014>

3 Terms and definitions

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

3.1

variation

difference between the median value after ageing and the median value without ageing

Note 1 to entry: Variation is expressed as a percentage between the median value before and after ageing.

3.2

median value

when several test results have been obtained and ordered in an increasing or decreasing succession, the median is the middle value if the number of available values is odd and is the mean of the two middle values if the number is even

3.3

types of insulating compounds

3.3.1

EPR

ethylene-propylene rubber

cross-linked compound in which the elastomer is an ethylene-propylene, EPDM or an equivalent synthetic elastomer providing a compound compliant with type EPR

Note 1 to entry: This note applies to the French language only.

3.3.2**HEPR****hard ethylene-propylene rubber**

cross-linked high modulus or hard grade compound in which the elastomer is an ethylene-propylene, EPDM or an equivalent synthetic elastomer providing a compound compliant with type HEPR

Note 1 to entry: This note applies to the French language only.

3.3.3**XLPE****cross-linked polyethylene**

cross-linked compound in which the polymer is a low density polyethylene or equivalent synthetic polymer providing a compound compliant with type XLPE

Note 1 to entry: This note applies to the French language only.

3.3.4**HF 90****cross-linked polyolefin halogen-free**

cross-linked compound in which the polymer is a polyolefin or equivalent synthetic polymer not containing halogens providing a compound which is compliant with type HF 90

3.3.5**S 95****cross-linked silicone rubber**

compound based on a polysiloxane elastomer which, when cross-linked, is compliant with type S95.

3.4**types of sheathing compounds**

[IEC 60092-360:2014](https://standards.iteh.ai/catalog/standards/sist/a6066d0b-4077-4cfl-8419-5c3e990059b6/iec-60092-360-2014)

3.4.1**SE****polychloroprene rubber**

cross-linked compound in which the elastomer is a polychloroprene (PCP) or equivalent synthetic elastomer providing a compound which is compliant with type SE

3.4.2**SH****chlorosulphonated polyethylene rubber****chlorinated polyethylene rubber**

cross-linked compound in which the characteristic constituent is a synthetic chlorinated rubber, e.g., chlorosulphonated polyethylene (CSP) or chlorinated polyethylene (CPE), which is compliant with type SH

Note 1 to entry: This note applies to the French language only.

3.4.3**SHF 2****halogen-free rubber**

cross-linked compound in which the polymer is a polyolefin or equivalent synthetic polymer, not containing halogens, providing a compound which is compliant with type SHF 2

3.4.4**SHF 1****halogen-free thermoplastic**

thermoplastic compound in which the polymer is a polyolefin or equivalent synthetic polymer not containing halogens providing a compound which is compliant with type SHF 1

3.4.5**ST 2****polyvinyl chloride thermoplastic**

thermoplastic compound based on plasticised polyvinyl chloride which is compliant with type ST 2

3.5**halogen-free**

compound that complies with the assessment of halogen requirements in Tables 4, 6 or 8

4 Cross-linked insulating compounds**4.1 General**

The types of cross-linked insulating compound covered by this standard are listed in Table 2 together with their abbreviated designations and maximum rated conductor temperatures during normal operation and short-circuit.

Table 2 – Types of cross-linked insulating compounds

Abbreviated designation	Maximum rated conductor temperature °C		Type of insulating material
	Normal operation	Short-circuit	
EPR	90	250	Ethylene propylene rubber
HEPR	90	250	Hard grade ethylene propylene rubber
XLPE	90	250	Cross-linked polyethylene
HF90	90	250	Cross-linked polyolefin halogen-free
S95	95 ^a	350 ^b	Cross-linked silicone rubber

^a The normal maximum rated conductor temperature for silicone is 180°C but it is limited in view of the type of sheathing material used.

^b This temperature is applicable only to power cables and is not appropriate for tinned conductors.

4.2 Electrical characteristics

The test requirements for electrical characteristics of insulating compounds are listed in the following Table 3.

Table 3 – Electrical requirements of insulation compounds

Designation of the insulating compound	EPR	HEPR	XLPE	HF90	S 95
Insulation resistance constant K_i (M Ω .km) (see 7.2 of IEC 60092-350:—)					
– at 20 °C, minimum,	3 670	3 670	3 670	550	1 850
– at maximum operating temperature, minimum.	3,67	3,67	3,67	0,55	1,85
Volume resistivity ρ (Ω .cm) (see 7.2 of IEC 60092-350:—)					
– at 20 °C, minimum,	$1,0 \times 10^{15}$	$1,0 \times 10^{15}$	$1,0 \times 10^{15}$	$1,5 \times 10^{14}$	$5,0 \times 10^{13}$
– at maximum operating temperature, minimum.	$1,0 \times 10^{12}$	$1,0 \times 10^{12}$	$1,0 \times 10^{12}$	$1,5 \times 10^{11}$	$5,0 \times 10^{10}$

Designation of the insulating compound	EPR	HEPR	XLPE	HF90	S 95
Increase in a.c. capacity after immersion in water at 50 °C, (see 7.3 of IEC 60092-350:—)					
– between the end of the 1 st and the end of the 14 th day, maximum (%),	15	15	–	15	15
– between the end of the 7 th and the end of the 14 th day, maximum (%).	5	5	–	5	5

4.3 Mechanical characteristics

The test requirements for mechanical characteristics of cross-linked insulating compounds are listed in the following Table 4.

Table 4 – Test requirements for cross-linked elastomeric insulating compounds

Test description	Unit	Test method described in		Type of insulating compound				
		Std	Clause	EPR	HEPR	XLPE	HF90	S 95
Mechanical properties in the state as delivered		IEC 60811-501						
Values to be obtained for the:		iTeh STANDARD PREVIEW (standards.iteh.ai)						
– tensile strength, min	N/mm ²			4,2	8,5	12,5	9,0	7,0
– elongation at break, min	%			200	200	200	120	150
Mechanical properties after ageing in air oven without conductor		IEC 60811-401						
Ageing conditions:		https://standards.iteh.ai/catalog/standards/sist/a6066d0b-4077-4c11-8419-5c3e990059b6/iec-60092-360-2014						
– temperature / tolerance	°C			135±3	135±3	135±3	135±3	200±3
– duration of treatment	h			168	168	168	168	240
Value to be obtained for the tensile strength								
– minimum value	N/mm ²			-	-	-	-	5,5
– variation max	%			±30	±30	±25	±30	-
Value to be obtained for the elongation at break								
– minimum value	%			-	-	-	100	120
– variation max	%			±30	±30	±25	±30	-
Mechanical properties after ageing in air oven with copper conductor		IEC 60811-401						
Ageing conditions:								
– temperature / tolerance	°C			135±3	150±3			
– duration of treatment	h			168	168			

Test description	Unit	Test method described in		Type of insulating compound				
		Std	Clause	EPR	HEPR	XLPE	HF90	S 95
Value to be obtained for the tensile strength – variation max	%			±30	±30	-		-
Value to be obtained for the elongation at break – variation max	%			±30	±30	-		-
Hot set test		IEC 60811-507						
Treatment conditions: – temperature/ tolerance	°C			250±3	250±3	200±3	200±3	250±3
– time under load min	min			15	15	15	15	15
– mechanical stress	N/cm ²			20	20	20	20	20
Test requirements: – elongation max under load	%			175	175	175	175	175
– elongation max after unloading	%			15	15	15	15	25
Determination of hardness IRHD minimum		IEC 60092-360	Annex A	80				
Determination of elastic modulus		IEC 60092-360	Annex B					
Modulus at 150 % elongation (minimum)	N/mm ²				4,5			
Ozone resistance test (method A or B)		IEC 60811-403						
Test conditions of method A – temperature	°C			25±2	25±2	-	25±2	-
– duration	h			30	30	-	30	-
– ozone concentration	ppm			250-300	250-300	-	250-300	-
Result to be obtained				No cracks	No cracks	-	No cracks	-
Test conditions of method B – temperature	°C			40±2	40±2	-	40±2	-
– duration	h			72	72	-	72	-
– ozone concentration, (by volume)	%			(200±50) x10 ⁻⁶	(200±50) x10 ⁻⁶	-	(200±50) x10 ⁻⁶	-
– relative humidity	%			55±10	55±10	-	55±10	-
– minimum air speed at the level of the test piece	mm/s			500	500	-	500	-
Result to be obtained				No cracks	No cracks		No cracks	

Test description	Unit	Test method described in		Type of insulating compound				
		Std	Clause	EPR	HEPR	XLPE	HF90	S 95
Assessment of halogens ^a								
pH		IEC 60754-2		≥4,3	≥4,3	≥4,3	≥4,3	≥4,3
Conductivity	μS.mm ⁻¹			≤10	≤10	≤10	≤10	≤10
Amount of halogen acid gas:								
– HCl and HBr (max)	%	IEC 60754-1		0,5	0,5	0,5	0,5	0,5
– HF (max)	%	IEC 60684-2:2011	45	0,1	0,1	0,1	0,1	0,1

^a Test required when materials are used in halogen-free cables or identified as a halogen-free compound.

5 Cross-linked sheathing compounds

5.1 General

The types of cross-linked sheathing compound covered by this standard are listed in Table 5 together with their abbreviated designations.

Table 5 – Types of cross-linked sheathing compound

Abbreviated designation	Type of material and general application
SE	Polychloroprene rubber
SH	Chlorosulphonated polyethylene or chlorinated polyethylene rubber
SHF 2	Halogen-free rubber
SE and SH materials are suitable for use over the types of insulation given in Table 2 of this specification with the exception of XLPE. Types SE and SH may release harmful fumes under fire conditions.	

5.2 Mechanical characteristics

The test requirements for mechanical characteristics of cross-linked sheathing compounds are given in Table 6. Additional requirements for enhanced types are given in Clause 7. In order to claim enhanced performance, compounds shall comply with the relevant table or tables of Clause 7 in addition to the basic requirements in Table 6.

Table 6 – Test requirements for cross-linked sheathing compounds

Test description	Unit	Test method described in		Type of cross-linked sheathing compound		
		Std	Clause	SH	SE	SHF 2
Mechanical properties in the state as delivered		IEC 60811-501				
Values to be obtained for: – tensile strength, min – elongation at break, min	N/mm ² %			10 250	10 300	9 120
Mechanical properties after ageing in air oven		IEC 60811-401				
Ageing conditions: – temperature/tolerance – duration of treatment	°C h			100±2 168	100±2 168	120±3 168
Tensile strength – variation max	%			±30	±30	±30
Elongation at break – value min – variation max	% %			±30	250 ±40	– ±30
Mechanical properties after immersion in mineral oil IRM 902		IEC 60811-404				
Ageing conditions: – temperature of oil – duration of treatment	°C h			100±2 24	100±2 24	100±2 24
Values to be obtained for: – tensile strength, variation max – elongation at break, variation max	% %	IEC 60092-360:2014 https://standards.iteh.ai/catalog/standards/sist/a6066d0b-4077-4cfl-8419-5c3e990059b6/iec-60092-360-2014		±40 ±40	±40 ±40	±40 ±40
Hot set test		IEC 60811-507				
Treatment conditions: – temperature/tolerance – time under load min – mechanical stress	°C min N/cm ²			200±3 15 20	200±3 15 20	– 200±3 15 20
Test requirements: – elongation max under load – elongation max after unloading				175 15	175 15	175 15