

Edition 2.0 2021-01

# INTERNATIONAL **STANDARD**

Electrical installations in ships -

DF of IEC 60092:360:2021 Part 360: Insulating and sheathing materials for shipboard and offshore units, power, control, instrumentation and telecommunication cables

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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

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**INTERNATIONAL ELECTROTECHNICAL** COMMISSION

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#### INTERNATIONAL ELECTROTECHNICAL COMMISSION

#### **ELECTRICAL INSTALLATIONS IN SHIPS -**

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

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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 second edition cancels and replaces the first 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) updates of normatives references;
- b) replacement of linear swelling with volume swelling;
- c) correction of a calculation mistake in Table 3;

- d) change in Table 4 and Table 6 (treatment conditions) of time under load (from 15 min to 10 min);
- e) addition of mechanical properties after aging in oil based test fluid in Table 10 (CAS number 64742-46-7; EC number: 934-956-3).

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

FDIS	Report on voting
18A/437/FDIS	18A/440/RVD

Full information on the voting for the approval of this International Standard 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

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.

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- withdrawn,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

#### **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 Table 1.

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

Table 1 - Categories and types of materials

#### 2 Normative references

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

IEC 60684-2:2011, 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 60811-201:2012, Electric and optical fibre cables – Test methods for non-metallic materials – Part 201: General tests – Measurement of insulation thickness IEC 60811-201:2012/AMD1:2017

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 60811-202:2012/AMD1:2017

IEC 60811-401:2012, Electric and optical fibre cables – Test methods for non-metallic materials – Part 401: Miscellaneous tests – Thermal ageing methods – Ageing in an air oven IEC 60811-401:2012/AMD1:2017

IEC 60811-403:2012, Electric and optical fibre cables – Test methods for non-metallic materials – Part 403: Miscellaneous tests – Ozone resistance test on cross-linked compounds

IEC 60811-404:2012, Electric and optical fibre cables – Test methods for non-metallic materials – Part 404: Miscellaneous tests – Mineral oil immersion tests for sheaths

IEC 60811-409:2012, 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 60811-501:2012, 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 60811-501:2012/AMD1:2018

IEC 60811-505:2012, Electric and optical fibre cables – Test methods for non-metallic materials – Part 505: Mechanical tests – Elongation at low temperature for insulations and sheaths

IEC 60811-507:2012, Electric and optical fibre cables – Test methods for non-metallic materials – Part 507: Mechanical tests – Hot set test for cross-linked materials

IEC 60811-508:2012, 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 60811-508:2012/AMD1:2017

IEC 60811-509:2012, 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)
IEC 60811-509:2012/AMD1:2017

ISO 48-2:2018, Rubber, vulcanised or thermoplastic – Determination of hardness – Part 2: Hardness between 10 IRHD and 100 IRHD

ISO 1817, Rubber, vulcanised or thermoplastic – Determination of the effect of liquids

#### 3 Terms and definitions

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

ISO and EC 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

#### 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

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

#### 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

#### 3.3.2

#### **HEPR**

#### hard ethylene-propylene rubber

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

#### 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

#### 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 S 95

#### 3.4

#### types of sheathing compounds

#### 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

EXAMPLE Chlorosulphonated polyethylene (CSP) or chlorinated polyethylene (CPE), which is compliant with type SH

#### 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<sub>1</sub>

#### 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 Table 4, Table 6 or Table 8

### 4 Cross-linked insulating compounds

#### 4.1 General

The types of cross-linked insulating compound covered by this document 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		nductor 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
HF 90	90	250	Cross-linked polyolefin halogen-free
S 95	95 <sup>a</sup>	350 <sup>b</sup>	Cross-linked silicone rubber

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

#### 4.2 Electrical characteristics

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

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

Table 3 - Electrical requirements of insulation compounds

	EPR	HEPR	XLPE	HF 90	S 95
nsulation resistance constant $K_i$ (M $\Omega$ ·km) (see 7.2 of IEC 60092-350:2020)					
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 $\rho(\Omega \cdot cm)$ (see 7.2 of IEC 60092-350:2020)					
at 20 °C, minimum,	1,0 × 10 <sup>15</sup>	1,0 × 10 <sup>15</sup>	1,0 × 10 <sup>15</sup>	1,5 × 10 <sup>14</sup>	5,0 × 10 <sup>14</sup>
at maximum operating temperature, minimum.	1,0 × 10 <sup>12</sup>	1,0 × 10 <sup>12</sup>	1,0 × 10 <sup>12</sup>	1,5 × 10 <sup>11</sup>	5,0 × 10 <sup>11</sup>
ncrease in AC capacity after immersion in water at 50 °C, (see 7.3 of IEC 60092-350:2020)				٠. ن	50
<ul> <li>between the end of the 1<sup>st</sup> and the end of the 14<sup>th</sup> day, maximum (%),</li> </ul>	15	15	-	(1) (1) (1) (1) (1) (1) (1) (1)	15
between the end of the $7^{th}$ and the end of the $14^{th}$ day, maximum (%).	5	5	- 00	5	5
isted in Table 4.	N.				
ji da karangan karan	entheri				
The test requirements for mechanical charisted in Table 4.	entheri				

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

Test description	Unit	Test method described in		Type of insulating compound				
		Std	Reference	EPR	HEPR	XLPE	HF 90	S 95
Mechanical properties in the state as delivered		IEC 60811-501						
Values to be obtained for the:								
<ul><li>tensile strength, min.</li></ul>	N/mm <sup>2</sup>			4,2	8,5	12,5	9,0	7,0
<ul> <li>elongation at break, min.</li> </ul>	%			200	200	200	120	150
Mechanical properties after ageing in air oven without conductor		IEC 60811-401					360.50	
Ageing conditions:						201		
<ul><li>temperature/ tolerance</li></ul>	°C			135 ± 3	135 ± 3	135 ± 3	135 ± 3	200 ± 3
<ul><li>duration of treatment</li></ul>	h			168	168	168	168	240
Value to be obtained for the tensile strength					ON.			
<ul> <li>minimum value</li> </ul>	N/mm <sup>2</sup>			" \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	-	-	-	5,5
<ul> <li>variation max.</li> </ul>	%		ķ	)±30	±30	±25	±30	-
Value to be obtained for the elongation at break			enthe					
– minimum value	%		6,	-	-	-	100	120
<ul><li>variation max.</li></ul>	%	×O		±30	±30	±25	±30	-
Mechanical properties after ageing in air oven with copper conductor		IEC 608 17-401						
Ageing conditions:	ري.							
<ul><li>temperature/ tolerance</li></ul>	10.C			135 ± 3	150 ± 3			
<ul><li>duration of treatment</li></ul>	h			168	168			
Value to be obtained for the tensile strength								
<ul> <li>variation max.</li> </ul>	%			±30	±30	-		-
Value to be obtained for the elongation at break								
<ul><li>variation max.</li></ul>	%			±30	±30	_		_
Hot set test		IEC 60811-507						
Treatment conditions:								
<ul><li>temperature/ tolerance</li></ul>	°C			250 ± 3	250 ± 3	200 ± 3	200 ± 3	250 ± 3
<ul> <li>time under load min.</li> </ul>	min			10	10	10	10	10
<ul> <li>mechanical stress</li> </ul>	N/cm <sup>2</sup>			20	20	20	20	20

Test description	Unit	Test method described in		Type of insulating compound				
root doornphion	· · · · ·	Std	Reference	EPR	HEPR	XLPE	HF 90	S 95
Test requirements:  – elongation max. under load	%			175	175	175	175	175
<ul> <li>elongation max.</li> <li>after unloading</li> </ul>	%			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					<u> </u>
Modulus at 150 % elongation (minimum)	N/mm <sup>2</sup>				4,5		60:50	
Ozone resistance test (method A or B)		IEC 60811-403				3	3	
Test conditions of method A				_	_	6000	-	_
<ul><li>temperature</li></ul>	°C			25 ± 2	25 ± 2	_	25 ± 2	_
<ul><li>duration</li></ul>	h			30	30	_	30	_
<ul><li>ozone concentration</li></ul>	ppm			275 ± 25	275 ± 25	-	275 ± 25	-
Result to be obtained				No cracks	No cracks	_	No cracks	_
Test conditions of method B				$O_{I_{i_{i_{i_{i_{i_{i_{i_{i_{i_{i_{i_{i_{i_$		_		_
<ul><li>temperature</li></ul>	°C		1//	40 ± 2	40 ± 2	_	40 ± 2	_
– duration	h		87	72	72	_	72	_
<ul> <li>ozone concentration, (by volume)</li> </ul>	%	, XY		(200 ± 50) x 10 <sup>-6</sup>	(200 ± 50) x 10 <sup>-6</sup>	<del></del>	(200 ± 50) x 10 <sup>-6</sup>	<del>-</del>
<ul> <li>relative humidity</li> </ul>	%	Cili		55 ± 10	55 ± 10	_	55 ± 10	_
<ul> <li>minimum air speed at the level of the test piece</li> </ul>	mm/s	<b>.</b>		500	500	-	500	_
Result to be obtained	W.			No cracks	No cracks		No cracks	
Assessment of halogens <sup>a</sup>	*							
рН ДО		IEC 60754-2		≥4,3	≥4,3	≥4,3	≥4,3	≥4,3
Conductivity	μS⋅mm <sup>-1</sup>			≤10	≤10	≤10	≤10	≤10
Amount of halogen acid gas:								
<ul><li>HCl and HBr (max.)</li></ul>	%	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	n materials	are used in halo	ogen-free ca	bles or id	entified as a	a halogen-f	ree compou	nd.

### 5 Cross-linked sheathing compounds

#### 5.1 General

The types of cross-linked sheathing compound covered by this document 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 except for XLPE. Types SE and SH are permitted even though it releases harmful fumes under fire conditions. SE and SH materials should be avoided for installation in passenger vessels and in evacuation areas.

#### 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. 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 de	escribed	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 <sup>2</sup> %			10 250	10 300	9 120	
Mechanical properties after ageing in air oven		IEC 60811-401				-0^	
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		OK O			
Ageing conditions:  - temperature of oil  - duration of treatment	°C h		ce full	100 ± 2 24	100 ± 2 24	100 ± 2 24	
Values to be obtained for:  – tensile strength, variation max.	%	ionien		±40	±40	±40	
<ul><li>elongation at break, variation max.</li></ul>	%	10		±40	±40	±40	
Hot set test		1EC 60811-507					
Treatment conditions:  - temperature/tolerance  - time under load min.  - mechanical stress	) min N/cm <sup>2</sup>			200 ± 3 10 20	200 ± 3 10 20	- 200 ± 3 10 20	
Test requirements:  - elongation max. under load	%			175	175	175	
<ul> <li>elongation max. after unloading</li> </ul>	%			15	15	15	

Test description	Unit Test method described in			Type of cross-linked sheathing compound			
•		Std	Clause	SH	SE	SHF 2	
Ozone resistance test (method A or B)		IEC 60811-403					
Test conditions of method A							
<ul><li>temperature</li></ul>	°C			25 ± 2	25 ± 2	25 ±2	
<ul><li>duration</li></ul>	h			24	24	24	
<ul><li>ozone concentration (by volume)</li></ul>	%			(275 ± 25) x 10 <sup>-4</sup>	(275 ± 25) x 10 <sup>-4</sup>	(275 ± 25) x 10 <sup>-4</sup>	
Result to be obtained				No cracks	No cracks	No cracks	
Test conditions of method B						9V)	
<ul><li>temperature</li></ul>	°C			40 ± 2	40 ± 2	40 ± 2	
<ul><li>duration</li></ul>	h			72	720	72	
<ul><li>ozone concentration, (by volume)</li></ul>	%			$(200 \pm 50) \text{ x}$ $10^{-6}$	(200 <u>+</u> 50) x	$(200 \pm 50) \text{ x}$ $10^{-6}$	
<ul> <li>relative humidity</li> </ul>	%			55 ± 10	55 ± 10	55 ± 10	
<ul> <li>minimum air speed at the level of the test piece</li> </ul>	mm/s			500	500	500	
Result to be obtained				No cracks	No cracks	No cracks	
Behaviour at low temperature				OK			
Elongation test (for cables not subject to bending test)		IEC 60811-505	الراع				
Test conditions:		×					
– temperature:	°C	W.S.		-15 ± 2	–15 ± 2	-15 ± 2	
- duration	h	Jie		16	16	16	
Result to be obtained:  - elongation at break, min.	%	iick to		30	30	30	
Assessment of halogens <sup>a</sup>	. (	7					
рН	Th.	IEC 60754-2				≥4,3	
Conductivity	μS·mm <sup>−1</sup>	IEC 60754-2				≤10	
Amount of halogen acid					<b>1</b>		
- HCl and HBr (maximum)	%	IEC 60754-1				0,5	
– HF (maximum)	%	IEC 60684- 2:2011	45			0,1	
a Test required when mat	erials use	ed in halogen free	cables or i	dentified as halo	gen free compou	ınds.	

# 6 Thermoplastic sheathing compounds

#### 6.1 General

The types of thermoplastic sheathing compounds covered by this document are listed in Table 7 together with their abbreviated designations.

Table 7 – Types of thermoplastic sheathing compound

Abbreviated designation	Type of thermoplastic sheathing material
ST 2	Polyvinyl chloride thermoplastic is permitted even though it releases harmful fumes under fire conditions
SHF 1	Halogen-free thermoplastic for use over all types of insulation in Table 2

Type ST 2 is permitted even though it releases harmful fumes under fire conditions. ST 2 material should be avoided for installation in passenger vessels and in evacuation areas.

#### 6.2 Mechanical characteristics

The test requirements for mechanical characteristics of thermoplastic sheathing compounds are listed in Table 8.

Table 8 - Test requirements for thermoplastic sheathing compounds

Took docominstics	II m i 4	Test method des	cribed in	Type of sheathing compound					
Test description	Unit	Std	Clause	ST 2	SHF 1				
Mechanical properties in the state as delivered		IEC 60811-501	SIF						
Values to be obtained for: – tensile strength, min. – elongation at break, min.	N/mm² %	N.P.	5	12,5 150	9,0 120				
Mechanical properties after ageing in air oven without conductor		IEC 60811-401							
Ageing conditions: – temperature – duration of treatment	°C h	New EL		100 ± 2 168	100 ± 2 168				
Value to be obtained for the tensile strength  – minimum value  – variation max.	N/mm <sup>2</sup>			12,5 ±25	7,0 ±30				
Value to be obtained for the elongation at break  - minimum value  - variation max.	% %			150 ±25	110 ±30				
Pressure test at high temperature		IEC 60811-508							
Test conditions.  - temperature  - duration for cables having an outer diameter <12,5 mm  - duration for cables having an outer diameter >12,5 mm	°C h			80 ± 2 4 6	80 ± 2 4 6				
Value to be obtained:  – maximum permissible deformation	%			50	50				

	1114	Test method described in		Type of sheathing compound		
Test description	Unit	Std	Clause	ST 2	SHF 1	
Heat shock		IEC 60811-509				
Test conditions:						
<ul><li>temperature</li></ul>	°C			150 ± 3	150 ± 3	
<ul><li>duration</li></ul>	h			1	1	
Result to be obtained:				No cracks	No cracks	
Loss of mass		IEC 60811-409			Not applicable	
Test conditions						
– temperature	°C			100 ± 2		
<ul><li>duration</li></ul>	h			168	0	
Result to be obtained: Maximum loss of mass	mg/cm <sup>2</sup>			1,5	.201	
Behaviour at low temperature				20	9	
Elongation test (for cables not subject to bending test)		IEC 60811-505		69/		
Test conditions:				CO.		
– temperature:	°C			-15 ± 2	-15 ± 2	
<ul><li>duration</li></ul>	h		<b></b>	4	4	
Result to be obtained:			4,			
<ul> <li>elongation at break, min.</li> </ul>	%		< °	30	30	
Assessment of halogens <sup>a</sup>		Q	<b>)</b> •	Not applicable		
рН		IEC 60754-2			≥4,3	
Conductivity	$\mu S \cdot mm^{-1}$	IEC 60754-2			≤10	
Amount of halogen acid gas:		ill				
<ul> <li>HCl and HBr (maximum)</li> </ul>	%	EC 60754-1			0,5	
– HF (maximum)	%	1€C 60684-2:2011	45		0,1	

# 7 Additional optional properties of sheathing compounds

#### 7.1 General

Additional optional requirements for enhanced oil resistance and drilling fluid resistance are included in Clause 7.

#### 7.2 Test requirements

Enhanced oil resistant sheathing compounds shall comply with the tests according to Table 9.

Drilling fluid resistant sheathing compounds shall comply with the enhanced oil resistance tests according to Table 9 and to all the tests according to Table 10.

Table 9 – Test requirements for sheathing compounds with enhanced oil resistance properties

Test description for enhanced oil resistant types	Unit	Test method d	Require- ment	
		Standard	Reference	
Mechanical properties after ageing in IRM 902		IEC 60092-360	Annex C	
Test conditions:  – temperature/tolerance of oil  – duration of treatment	°C h			100 ± 2 168
Result to be obtained:  - tensile strength, variation max.  - elongation at break, variation max.  - volume swell, variation max.	%		~.D	±40 ±40 ±30

Table 10 – Test requirements for sheathing compounds with drilling fluids resistance properties (test for mud lesistance)

Test description for drilling fluid resistant types	pes Unit	Test method	Require- ment	
		Standard	Reference	
Mechanical properties after ageing in IRM 903		(JEC 60092-360	Annex C	
Test conditions:		)		
<ul> <li>temperature/tolerance of oil</li> </ul>	°C			100 ± 2
<ul> <li>duration of treatment</li> </ul>	<b>KU</b> h			168
Result to be obtained:  - tensile strength, variation max.  - elongation at break, variation max.  - volume swelling, variation max.	Ø			
- tensile strength, variation max.	%			±30
– elongation at break, variation max.	%			±30
<ul> <li>volume swelling, variation max.</li> </ul>	%			±30
– weight change, variation max.	%			±30
Mechanical properties after ageing in calcium bromide brine		IEC 60092-360	Annex D	
Test conditions:				
<ul> <li>temperature/tolerance of fluid</li> </ul>	°C			70 ± 2
– duration of treatment	days			56
Result to be obtained:				
<ul> <li>tensile strength, variation max.</li> </ul>	%			±25
<ul> <li>elongation at break, variation max.</li> </ul>	%			±25
<ul> <li>volume swelling, variation max.</li> </ul>	%			±20
– weight change, variation max.	%			±15
Mechanical properties after aging in oil based test fluid (CAS number: 64742-46-7; EC number: 934-956-3) a		IEC 60092-360	Annex D	
Test conditions:				
<ul> <li>temperature/tolerance of fluid</li> </ul>	°C			70 ± 2
<ul> <li>duration of treatment</li> </ul>	days			56
Result to be obtained:				
<ul> <li>tensile strength, variation max.</li> </ul>	%			±30
<ul> <li>elongation at break, variation max.</li> </ul>	%			±30
<ul> <li>volume swelling, variation max.</li> </ul>	%			±25
<ul> <li>weight change, variation max.</li> </ul>	%			±25

The test fluid properties shall be according to CAS and EC numbers.

NOTE CAS (Chemical Abstracts Service) is a chemical substance category system.; EC number is a European Community unique identification of a chemical material.

# Annex A

(normative)

#### Determination of hardness of HEPR insulation

### A.1 Test piece

The test piece shall be a sample of completed cable with all the coverings external to the rubber surface to be measured carefully removed. Alternatively, a sample of insulated core may be used.

#### A.2 Test procedure

#### A.2.1 General

Tests shall be made in accordance with ISO 48-2 with exceptions as indicated in A.2.2 to A.2.5.

## A.2.2 Surfaces of large radius of curvature

The test instrument, in accordance with ISO 48-2, shall be constructed so as to rest firmly on the rubber surface and permit the presser foot and indentor to make vertical contact with this surface. This is done in one of the following ways:

- a) the instrument is fitted with feet movable in universal joints so that they adjust themselves to the curved surface;
- b) the base of the instrument is fitted with two parallel rods A and A' at a distance apart depending on the curvature of the surface (see Figure A.1).

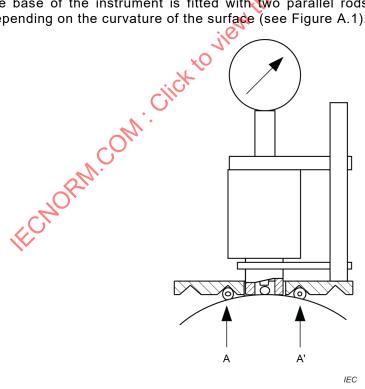


Figure A.1 – Testing surfaces of large radius of curvature

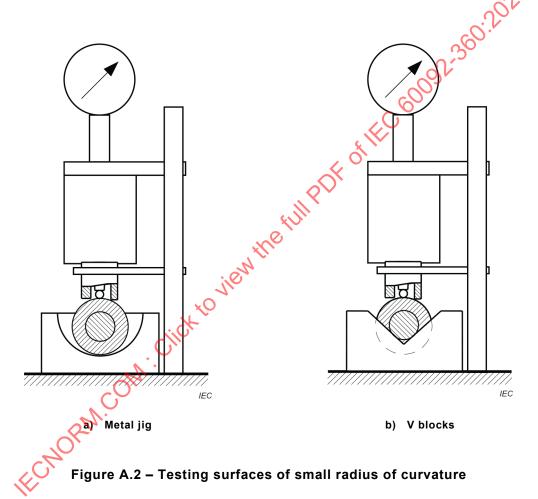
These methods may be used on surfaces with a radius of curvature down to 20 mm.

When the thickness of rubber tested is less than 4 mm, an instrument as described in the method in ISO 48-2 for thin and small test pieces shall be used.

#### A.2.3 Surfaces of small radius of curvature

On surfaces with too small a radius of curvature for the procedures described in A.2.2, the test piece shall be supported on the same rigid base as the test instrument, in such a way as to minimise bodily movement of the rubber surface when the indenting force increment is applied to the indentor and so that the indentor is vertically above the axis of the test piece. Suitable procedures are as follows:

- a) by resting the test piece in a grove or trough in a metal jig see Figure A.2 a);
- b) by resting the ends of the conductor of the test piece in V-blocks see Figure A.21b).



The smallest radius of curvature of the surface to be measured by these methods shall be at least 4 mm.

For smaller radii, an instrument as described in the method in ISO 48-2 for thin and small test pieces shall be used.

#### A.2.4 Conditioning and test temperature

The minimum time between manufacture, i.e. vulcanisation, and testing shall be 16 h.

The test shall be carried out at a temperature of  $(20 \pm 2)$  °C and the test pieces shall be maintained at this temperature for at least 3 h immediately before testing.

#### A.2.5 Number of measurements

One measurement shall be made at each of three or five different points distributed around the test piece. The median of the results shall be taken as the hardness of the test piece, reported to the nearest whole number in International Rubber Hardness Degrees (IRHD).

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## Annex B (normative)

# Determination of the elastic modulus of HEPR insulation

#### B.1 **Procedure**

Sampling, preparation of the test pieces and the test procedure shall be carried out in accordance with IEC 60811-201.

The loads required for 150 % elongation shall be measured. The corresponding stresses shall be calculated by dividing the loads measured by the cross-sectional areas of the unstretched .C0097:360 test pieces. The ratios of the stresses to strains shall be determined to obtain the elastic modulus at 150 % elongation.

The elastic modulus shall be the respective median values.

#### **B.2** Requirements

ents grant Refull Pulls of the Rull Pulls of the The results of the test shall comply with the requirements given in Table 4.