RUSSIAN MARITIME REGISTER OF SHIPPING

RULES

FOR TECHNICAL SUPERVISION DURING CONSTRUCTION OF SHIPS AND MANUFACTURE OF MATERIALS AND PRODUCTS FOR SHIPS

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RULE CHANGE NOTICE

ENTERS INTO FORCE:

01.07.2026

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RULES FOR TECHNICAL SUPERVISION DURING CONSTRUCTION OF SHIPS AND MANUFACTURE OF MATERIALS AND PRODUCTS FOR SHIPS

The present Rule Change Notice to Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships (hereinafter — RCN) has been approved in accordance with the established approval procedure and contains information on amendments, except for editorial amendments. RCN amendments come in force on 1 July 2026.

REVISION HISTORY

PART I. GENERAL REGULATIONS FOR TECHNICAL SUPERVISION

Item	Applicability	Description	Remarks
Para 5.2	Technical supervision during manufacture of materials and products Products under the RS technical supervision	Requirements for the extent of products testing at single approval have been specified	
Table 5.2-1	Technical supervision during manufacture of materials and products Products under the RS technical supervision	Additional requirements for approval of technical documentation on products supplied to ships according to group 1 have been introduced	
Table 5.2-2, note 2 (deleted)	Technical supervision during manufacture of materials and products Materials under the RS technical supervision	Requirement for review of technical documentation together with its approval for materials supplied to ships according to groups 1 and 5 has been deleted. Notes 3 and 4 have been renumbered 2 and 3, respectively	
Para 5.3.4 (deleted)	Technical supervision during manufacture of materials and products Documents drawn up by the manufacturer	Requirement for the use of a document M drawn up by the manufacturer according to the standards of the firm, as well as references to it in 5.4 and 5.10 have been deleted	
Para 5.12	Technical supervision during manufacture of materials and products Products under the RS technical supervision	Requirement regarding the approved technical documentation has been specified	

Item	Applicability	Description	Remarks
Para 9.3.1.1.8	Recognition of service suppliers Special requirements	Condition for issuing the Certificate of Vocational Training (СПП) (form 7.1.34) has been introduced for the operator/ supervisor of category I	
Para 9.3.15.4.4	Recognition of service suppliers Special requirements (code 22024000МК)	References to ISO 17025:2017, IEC 60942 and IEC 61672-3 have been introduced	IACS UR Z17 (Rev.21 Jan 2025)
Para 9.3.15.5.2	Recognition of service suppliers Special requirements (code 22024000МК)	Reference to IMO circular MSC.1/Circ.1509 "Unified Interpretations of the Code on Noise Levels on Board Ships (Resolution MSC.337(91))" (the latest version) has been introduced	IACS UR Z17 (Rev.21 Jan 2025)
Appendix 1, code 04400000	Radio equipment Radio equipment not mentioned above	Name of item of technical supervision has been replaced by "Other shipborne radio equipment (satellite communication stations, power supply units, UHF radiotelephones, portable radiotelephones, etc.)". A remark has been introduced	
Appendix 1, code 05140400МК	Navigational equipment Radar reflector — passive type	Name of item of technical supervision has been replaced by "Radar reflector"	
Appendix 1, code 05180000МК (new)	Navigational equipment Bridge central alert management system	New item of the RS technical supervision has been introduced	

Item	Applicability	Description	Remarks
Appendix 1, code 05300000	Navigational equipment Navigational equipment which is not mentioned above	Name of item of technical supervision has been replaced by "Other shipborne navigational equipment". A remark has been introduced	
Appendix 1, code 11020210 (new)	Electrical equipment Static sources of electric power	New item of the RS technical supervision has been introduced	
Appendix 3, para 3	Carrying out of remote surveys Requirements for survey of materials and products	Para has been renamed	
Appendix 3, para 3.1	Carrying out of remote surveys Requirements for survey of materials and products	Requirement for the firm carrying out a remote survey of materials and products has been specified	
Appendix 3, para 4	Carrying out of remote surveys Requirements for survey of firms	Para has been renamed	

PART II. TECHNICAL DOCUMENTATION

Item	Applicability	Description	Remarks
Para 8.1	Ships under construction and in service Preparation of results of technical documentation review	The procedure of the reporting documents registration has been specified for the case of a single approval of technical documentation simultaneously with the survey of products	
Para 12.1.2	Software	The software has been specified, which does not require the Type Approval Certificate for Software (СТОП)	

Item	Applicability	Description	Remarks
Appendix 1, Table 1, Item 46 (new)	Ships under construction and in service Ship operational documentation for the items of RS technical supervision	New documents on the hull monitoring system have been added	Transfer from Chapter 3.2 of Part I "Classification" of the RS Rules/C

PART IV. TECHNICAL SUPERVISION DURING MANUFACTURE OF PRODUCTS

Item	Applicability	Description	Remarks
Section 10	Electrical equipment	Section has been completely revised to eliminate redundant requirements for testing of electrical equipment and bringing the Section structure to the format similar to Section 12.	
Para 12.6.5	Automation Equipment Vibration tests Tests of shock-mounted products	Requirements for fastening products during testing have been brought into line with the requirements of Section 10	
Table 12.6.6-1	Automation Equipment Shock tests Categories of Equipment	Categories of equipment according to shock resistance are given in compliance with the requirements of Section 10	
Table 12.6.6-2	Automation Equipment Shock tests Parameters of shock pulses	Parameters of shock pulses are given in compliance with the requirements of Section 10	

Item	Applicability	Description	Remarks
Section 15, Appendix	Radio Equipment	Standards have been updated: - IEC 61097-7; - IEC 61097-9; - IEC 61097-12; - IEC 62288	
	Radio Equipment	Table has been supplemented by a new line for the radio equipment with nomenclature code 04400000	
Section 16, Appendix	Navigational Equipment Bridge Central Alert Management System; Other shipborne navigational equipment	Requirements for the equipment have been introduced	
	Navigational Equipment Radar reflector	ISO 8729-2:2009 standard for active radar reflectors has been introduced	
	Navigational Equipment Presentation of navigation-related information	New version of IEC 62288, Ed. 3.1 has been introduced	
	Navigational Equipment Magnetic compass; Gyrocompass; Ship's trajectory control system	New versions of ISO 25862:2019/Amd 1:2024, ISO 8728:2024 and IEC 62065 Ed. 3.0 (2025-10) have been introduced accordingly	

PART I. GENERAL REGULATIONS FOR TECHNICAL SUPERVISION

5 TECHNICAL SUPERVISION DURING MANUFACTURE OF MATERIALS AND PRODUCTS

Para 5.2 is supplemented by the following paragraph:

"On agreement with the Register, when a single approval is issued to single products, the extent of testing may be reduced based on the technical background submitted by the manufacturer, taking into account products operating conditions for a particular ship.".

Table 5.2-1 is amended as follows:

"Table 5.2-1

Stage of technical supervision	Type of survey/ Issued document	Product groups							
		Group 1	Group 2	Group 3			Group 4		Group 5
		1.1	2.1	3.1	3.2	3.3	4.1	4.2	5.1
Type approval	Approval of technical documentation	×	×	×	×	×	×	×	×
	Type testing of a prototype	—	×	×	×	×	×	×	×[1]
	Type of a type approval certificate issued by RS	—	СТО/ СТПК	СТО			СТО		—
Survey of serial products	Survey of the manufacturer's quality control system	—	—	—	СКК 1	СКК 2	—	СКК 2	—
	Type of the Quality Control System Certificate, issued by RS	—	—	—	СКК 1 Cert.	СКК 2 Cert.	—	СКК 2 Cert.	—
	Survey of products by RS	—×[2]	—	×	—	—	×	—	×
	Certificate issued by RS	—×[2]	—	С	С3	—	С	С3	С
	Document issued by manufacturer	МС	МС	—МС	—МС	МС	—МС	—МС	—МС

[1] Tests are performed to the extent prescribed by the RS rules. A part of tests can be rescheduled for the mooring trials, sea trials or operation tests if it is provided by the RS rules and/or documentation approved by RS.

[2]- Refer to 5.12.

Notes: 1. "×" — means "Required".

2. СКК 1 — refer to 7.3.

3. СКК 2 — refer to 7.4.

4. In case of a single approval given for the equipment of groups 2 — 4, the materials or products are surveyed to the extent of group 5.

5. "—" means "Not applicable" or "Not required".

6. Products of 1, 2 and 3 safety classes in accordance with the Rules for the Classification and Construction of Nuclear Ships and Floating Facilities shall be surveyed to the extent of group 5 regardless of the code. In this regard, the product shall be supplied with the Quality Assurance Plan.

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Table 5.2-2 is amended as follows:

"Table 5.2-2

Stage of technical supervision	Type of survey/ Issued document	Material groups									
		Group 1M	Group 2M[1]			Group 3M			Group 4M		Group 5M
		1.1	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2	5.1
Manufacturer recognition/ type approval	Approval of technical documentation on material	×[2]	×	×	×	×	×	×	×	×	×[2]
	Tests at initial survey	—	×	×	×	×	×	×	×	×	—
	Type of a recognition certificate for manufacturer or a type approval certificate on material issued by RS	—	—	СОСМ	СТО	—	СТО		СПИ		—

Stage of technical supervision	Type of survey/ Issued document	Material groups									
		Group 1M	Group 2M[1]			Group 3M			Group 4M		Group 5M
		1.1	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2	5.1
Survey of serial materials	Survey of the firm's quality control system/periodical confirmation of СПИ/СОСМ	—	—	×	—	—	СКК 1	СКК 2	×	×	—
	Type of the Quality Control System Certificate issued by RS	—	—	—	—	—	СКК 1 Cert.	СКК 2 Cert.	—	СКК 1 Cert.	—
	Survey of material by RS	—	×	—	—	×	×	—	×	—	×[32]
	Certificate issued by RS	—	C	—	—	C	C3	—	C	C3[43]	C
	Document issued by the manufacturer	MC	MC	MC	MC	MC	MC	MC	MC	MC	MC

[1] For welding materials, stages of technical supervision as for groups 2.1 and 2.2 shall apply, for other materials — as for groups 2.1 and 2.3.

[2] ~~Review of technical documentation on material is carried out simultaneously with approval of technical documentation on the item of technical supervision where the material is applied (item of application).~~

[32] Survey is carried out in the scope prescribed by technical documentation, as specified in the documentation on the item of application to be approved by the Register.

[43] The validation of inspection certificates of type 3.2 according to EN 10204:2004 is allowed.

".

Para 5.3.4 is deleted. References to the document M in **5.4** (penultimate paragraph) and **5.10** (last paragraph) are deleted.".

Para 5.12 is amended as follows:

"**5.12** Materials and products included in group 1 may be surveyed by the Register to confirm their compliance with the ~~specified characteristics or~~ approved technical documentation. The document confirming compliance is the Statement of Compliance (form 6.3.27).".

9 RECOGNITION OF SERVICE SUPPLIERS

9.3 SPECIAL REQUIREMENTS

Para 9.3.1.1.8 is supplemented by the following paragraph:

"The Register shall issue the Certificate of Vocational Training (СПП) (form 7.1.34) to the operator/supervisor, who has carried out thickness measurements, confirming his/her training in compliance with the RS normative documents for carrying out thickness measurements on ships and offshore installations.".

Para 9.3.15.4.4 is amended as follows:

"**9.3.15.4.4** Calibration.

The edition of the calibration standard shall correspond with the edition of the manufacturing standard for the instruments. Sound calibrator and sound level meter shall be verified at least every two years by a national standard laboratory or a competent laboratory accredited according to ISO 17025 ~~(2005)~~:2017, as amended. The calibration of sound calibrators shall be carried out in accordance with IEC 60942 Appendix B, whilst the calibration of sound level meters shall be in accordance with IEC 61672-3. A record with a complete description of the equipment used shall be kept, including a calibration log.".

Para 9.3.15.5.2 is amended as follows:

"**9.3.15.5.2** The supplier shall have access to the following documents:

.1 SOLAS 1988, as amended (regulation II-1/3-12);

.2 IMO resolution A.468(XII) and IMO resolution MSC.337(91) "Code on Noise Levels on Board Ships";

.3 IMO resolution A.343(IX) "Recommendation on Methods of Measuring Noise Levels at Listening Posts";

.4 IMO circular MSC.1/Circ.1509 "Unified Interpretations of the Code on Noise Levels on Board Ships (Resolution MSC.337(91))" (the latest version);

.45 the Register rules and guidelines.".

APPENDIX 1

NOMENCLATURE OF ITEMS OF THE REGISTER TECHNICAL SUPERVISION

Appendix 1. Codes 04400000, 05140400MK and 05300000 are amended; new codes 05180000MK and 11020210 are introduced reading as follows:

"

Code of item of technical supervision	Item of technical supervision	Technical supervision of the Register			Remarks
		Group of item of technical supervision (1 — 5)	Other documents issued by RS	Branding	
1	2	3	4	5	6
04400000MK	**RADIO EQUIPMENT**				
04400000	Other shipborne radio equipment (satellite communication stations, power supply units, UHF radiotelephones, portable radiotelephones, etc.)	2			May by approved on request of the manufacturer
05000000MK	**NAVIGATIONAL EQUIPMENT**				
05140400MK	Radar reflector ~~— passive type~~	2			
05180000MK	Bridge central alert management system	3			
05300000	Other shipborne navigational equipment	2			May by approved on request of the manufacturer
11000000	**ELECTRICAL EQUIPMENT**	3			
11020210	Static sources of electric power	5			

".

APPENDIX 3

CARRYING OUT OF REMOTE SURVEYS

Para 3 is amended as follows:

"**3 ~~Additional r~~Requirements for survey of materials and products.**".

Para 3.1 is amended as follows:

"**3.1** Remote survey may be applied to the firms ~~complying with the following criteria~~ that can ensure continuous compliance with the type approval conditions for serial materials and products, and have:

~~availability of the~~ valid Type Approval Certificate (CTO) (form 6.8.3) on the item of technical supervision; ~~or~~

approved technical documentation in case the technical supervision only on the basis of the approved technical documentation is allowed by the Rules~~;~~.

~~compliance of the Quality Management System (QMS) with ISO 9001;~~

~~absence of negative experience in technical supervision.~~".

Para 4 is amended as follows:

"**4 ~~Additional r~~Requirements for survey of firms.**".

PART II. TECHNICAL DOCUMENTATION

8 PREPARATION OF RESULTS OF TECHNICAL DOCUMENTATION REVIEW

Para 8.1. The third paragraph is amended as follows:

"In case of a single approval of technical documentation simultaneously with the survey of products without compiling a conclusion letter, it is allowed to put the surveyor's stamp on the front page of the approved documentation or to have the stamping done by software tools with indication of the date of review~~, an application number pursuant to which the documentation was reviewed,~~ and a serial number of the survey report containing information on approval of technical documentation and the review result ("Approved", "For information", etc.).".

12 SOFTWARE

12.1 TYPE APPROVAL OF SOFTWARE

Para 12.1.2. **The second paragraph** is replaced by the following text:

"Software intended to perform strength calculations and hydrodynamic calculations using numerical calculation methods (including Finite Element Method, Boundary Element Method, and Finite Volume Method) does not require the RS approval. Where software features the functionality of automating specific requirements of the RS rules, such software shall be approved only in the part of this functionality.".

Footnote 1 is deleted.

APPENDIX 1

SHIP OPERATIONAL DOCUMENTATION FOR THE ITEMS OF RS TECHNICAL SUPERVISION

Table 1 is supplemented by the following item:

"

46 — For HMS					
46.1	Technical description of software, including procedure for calculation o parameters used fo monitoring, based on results of measurements	+	–	Agreed	Sect. 17 of Part XVII "Distinguishing Marks and Descriptive Notations in the Class Notation Specifying Structural and Operational Particulars of hips" of the Rules for the Classification and Construction of Sea-Going Ships
46.2	Monitoring system operating manual	+	–	Agreed	Sect. 17 of Part XVII "Distinguishing Marks and Descriptive Notations in the Class Notation Specifying Structural and Operational Particulars of hips" of the Rules for the Classification and Construction of Sea-Going Ships
46.3	Maintenance instruction manual, including calibration procedure	+	–	Agreed	Sect. 17 of Part XVII "Distinguishing Marks and Descriptive Notations in the Class Notation Specifying Structural and Operational Particulars of hips" of the Rules for the Classification and Construction of Sea-Going Ships
46.4	Installation, commissioning and adjustment instruction	+	–	Agreed	Sect. 17 of Part XVII "Distinguishing Marks and Descriptive Notations in the Class Notation Specifying Structural and Operational Particulars of hips" of the Rules for the Classification and Construction of Sea-Going Ships
46.5	Programme of periodical surveys of the system in service	+	–	Approved	Sect. 17 of Part XVII "Distinguishing Marks and Descriptive Notations in the Class Notation Specifying Structural and Operational Particulars of hips" of the Rules for the Classification and Construction of Sea-Going Ships

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PART IV. TECHNICAL SUPERVISION DURING MANUFACTURE OF PRODUCTS

10 ELECTRICAL EQUIPMENT

Section 10 is replaced by the following text:

"10 ELECTRICAL EQUIPMENT

10.1 GENERAL

10.1.1 The provisions of this Section apply during technical supervision of electrical equipment listed in the RS Nomenclature.

10.1.2 The Section contains the basic provisions on surveying and testing at the firm (manufacturer) of product prototypes and products at steady production.

10.1.3 General regulations for organization of the technical supervision of the manufacture of technical supervision objects are given in Part I "General Regulations for Technical Supervision", for technical documentation — in Part II "Technical Documentation".

10.1.4 If specific test descriptions of this Section refer to international standards, later versions (including revisions) of such standards are acceptable provided that their requirements are equivalent to the technical specifications of this Section.

10.1.5 For the on-board computer based systems (CBS) with the RS Nomenclature codes 11100000 — 11120000, in addition to the provisions of this Section, the provisions of Section 12 are applied regarding the provision of technical documentation and testing for cyber resilience.

10.1.6 The accessories provided by the RS Nomenclature and being part of the electric drive and electrical equipment of a mechanism (an arrangement), prior to the beginning of tests as part of such circuits, shall pass post-manufacturing tests in the appropriate scope specified in these paras.

10.1.7 During survey of distribution and control switchboards assembled of components that have documents confirming technical supervision in accordance with the RS Nomenclature, tests can be carried out to an extent of a serial specimen. If the components have the ACS Type Approval Certificate, then it is necessary to be guided by 2.16, Part I "General Regulations for Technical Supervision".

10.2 TERMS AND DEFINITIONS

The following definitions are used for the purpose of this Chapter:

Aperiodic voltage pulse (aperiodic pulse) is a pulse the shape of which can be described by the sum of two exponential functions.

Vibration testing means checking of components, equipment and products to perform their functions in case of mechanical vibrations.

Vibration strength of equipment means a capability of equipment to withstand the effect of vibration without damage retaining all parameters within the set limits after the vibration effect.

Vibration resistance of equipment means a capability of equipment to function under conditions of vibration with its parameters remaining within the set limits.

Humidity resistance of equipment means a capability of equipment to retain its parameters within the set limits on prolonged exposure to increased humidity.

Fungus resistance (mould resistance) means equipment capability to withstand the growth of fungus mould in the environment infected with fungus spores.

Duration of impact momentum is the time while an acceleration of the same sign determined with regard to the impact momentum is acting.

Protection of equipment means a degree of protection of the equipment integrated in the enclosure against the penetration of solid foreign objects, and also a degree of protection of the electrical equipment inside the enclosure against the ingress of water.

Shock tests means checking of components, equipment and products to perform their functions in case of mechanical shock loads.

Test short-term alternating voltage of the mains frequency means sinusoidal voltage at a frequency of 50 Hz or (when testing power transformers and reactors with voltage induced in the transformer or reactor under test) of increased frequency, but not exceeding 400 Hz.

Test alternating one-minute voltage (one-minute test voltage) means test alternating voltage applied to the insulation for 1 minute or, in certain cases, a different time, but not exceeding 5 minutes.

Switching voltage pulse (switching pulse) is a pulse characterized by a voltage rise to its maximum value within a period of 20 μs to several thousand microseconds and a subsequent decrease of the voltage value.

Corrosion resistance means a capability of metal products of the equipment to withstand corrosion in the atmosphere saturated with aqueous salt (identical to sea salt) solutions.

Highest internal frequency is the highest frequency generated or used in the equipment under test or the highest frequency at which the equipment under test is adjusted or operates.

Rated discharge current (OVL Ir) is the maximum (amplitude) value of 8/20 μs lightning current pulse used for OVL classification.

Discharge voltage (OVL Udis) is the maximum voltage value at the limiter when a pulse current with a given amplitude and pulse shape is flowing through it.

Variable voltage at smooth rise means variable voltage applied rising at a defined speed from zero to the overlap or to a defined value followed by a rapid fall to zero without delay.

Steady temperature of a product means the temperature of the product or its part of which the change within 30 minutes does not exceed 1 °C provided the product loading and environmental temperature remain unchanged.

Cold state of a product means the state of the product wherein the temperature of any part of it differs from that of a cooling medium not more than by 3 °C.

Up state is a state of item in which it is able to perform a required function with parameters specified by the requirements in the technical documentation.

Resonance is a phenomenon of increasing the amplitude of vibrations of the product or its units and parts two and more times as compared with that of fastening points vibrations, which is brought about at the coincidence of the disturbing force frequency with the resonance frequency of the product.

Resonance frequency is a frequency of natural vibrations of a product or its units wherein the resonance phenomenon with the product at large or its single units and parts develops.

Standard climatic conditions are characterized by the following values of climatic factors:

temperature 25 ± 10 °C;

relative humidity 60 ± 30 %;

atmospheric pressure 96 ± 10 kPa.

Wet spaces are spaces with high-humidity (above 60%), for example: washrooms, toilets, galleys, bathhouses, showers, bathrooms, laundries, dishwashing areas, preparation rooms, holds, refrigerated spaces, steering gear and thruster rooms, spaces under lower plates in machinery spaces, etc.

Thermal equilibrium of a product means the equilibrium that is considered as reached when the temperature of all parts of the product differs from the environmental temperature by not more than 3 °C.

Note. For non-heat generating products — state of product at which the temperature of all its parts does not differ from their final temperature (average within the time of chamber temperature) by more than 3 %. For heat-generating products — state at which the ratio between two successive intervals of time required to change the temperature of the section(s) under monitoring of product by 3 °C, exceeds 1,7.

Heat stability of equipment means a capability of equipment to function at the highest ambient air temperature, which is likely to occur in operational conditions, sustaining no damages and with its parameters remaining within the set limits.

Shock strength of equipment means a capability of equipment to withstand exposure to impacts without damage and with its parameters remaining within the set limits following the impacts.

Shock resistance of equipment means a capability of equipment to perform its functions, while being impacted, with its parameters remaining within the set limits.

Steady production is a production of products according to the final developed design and technological documentation based on the test results of prototype and pilot specimens confirming compliance of products with the RS requirements.

Cold endurance of equipment means a capability of equipment to function at the lowest ambient air temperature, which is likely to occur in operational conditions, sustaining no damages and corrosion, with its parameters remaining within the set limits.

Cycle of frequency sweeping means the variation of frequency from the lowest to the highest.

Functional tests are tests carried out to check the capability of product to perform its functions and comply with the declared characteristics.

Functioning of equipment is a demonstration of product properties in accordance with its designation.

10.3 TECHNICAL DOCUMENTATION

10.3.1 The extent of documentation subject to review by the Register shall be determined by type and designation of product. The list of documentation for products given in the list of items of the technical supervision and codification used in this Section, are specified in Table 10.3.1-1.

Note. For the review of documentation, the manufacturer may refer to a checklist the form of which is specified in Appendix 2.

Table 10.3.1-1

Code	Title	Description
C1	Set of cyber resilience documentation	documentation for computer based systems (CBS) in accordance with Section 3, Part XXI "Cyber Resilience" of the RS Rules/C.
D1	assembly drawing	document containing an assembly unit and other data necessary for its assembly (manufacture) and control
D2	general arrangement plan	document specifying the product structure, interaction of its components and describing the product operation principle
D3	functional block diagram	document specifying the basic functional components of the product, their purpose and interconnections
D4	circuit diagram	document specifying the complete set of components and their interconnections and, as a rule, providing full (detailed) indication of the operation principles of the product (installation)
T1	specification	document specifying the structure of assembly component, complex or set, as well as describing permissible operating conditions of the equipment
T2	explanatory note	document containing a description of device and operation principle of the product being developed, as well as a substantiation of technical solutions accepted for its development
T3	technical specifications	document containing the product requirements (combination of criteria, standards, rules and provisions), its manufacture, control, acceptance and delivery
T4	test program and test procedure	document containing technical data to be checked during the product testing, as well as the sequence and procedure of their control
T5	failure mode and effects analysis (FMEA)	failure mode and effect analysis representing structured approach to potential failures that may occur during the operation of the product (installation)

Code	Title	Description
T6	calculation of electrodynamic and thermal short circuit strength	calculation shall confirm the capability of equipment to withstand without damage thermal and dynamic forces of external short circuits. The external short circuits are not limited by three-phase short circuits; they include interphase, double fault and short circuits between phase and earth
T7	calculation of immunity to static or dynamic interference	calculation shall contain data concerning immunity to dynamic and/or static interference or method of electromagnetic compatibility testing
T8	Interference suppression measures	indication of specific measures to be taken for interference suppression
T9	documentation showing the transient behavior of alternating current generator upon a sudden short-circuit occurring when excited, and running at nominal speed	documentation shall contain the information sufficient for determining the discrimination settings in the distribution system where the generator is going to be used. The influence of the automatic voltage regulator shall be taken into account, and the setting parameters for the voltage regulator shall be noted together with the decrement curve. Such a decrement curve shall be available when the setting of the distribution system's short-circuit protection is calculated. The decrement curve need not be based on physical testing. The manufacturer's simulation model for the generator and the voltage regulator may be used where this has been validated through the previous type test on the same model
T10	calculation of mechanical vibration and shock loads	calculation shall confirm the capability of equipment to withstand without damage vibrations and shocks, which parameters are given in the RS Rules at maintaining all the parameters within the limits set
T11	rotor shaft (armature) calculation for electric machines	document containing calculation results that determines shaft parameters taking into account loads occurred at machine operation
I1	explosion-proof certificate	document verifying that this type of equipment complies with the particular standard for explosion protection and is specially intended for the use in the explosive environment

N o t e. The documentation need not be mandatory submitted in separate documents corresponding to codes given in the Table. The documents may be consolidated in one or separate sets provided they contain full information required in accordance with Appendix 1 for products with specified codes of the RS Nomenclature.

RS may require to submit additional technical documentation.

10.3.2 When reviewing the technical documentation for electrical equipment, it is necessary to identify the compliance of the design and performance characteristics of the products with the requirements of the relevant parts of the RS Rules.

10.4 PROCEDURE OF ELECTRICAL EQUIPMENT SURVEYING

10.4.1 Prior to tests of electrical equipment, the following shall be available at the firm (manufacturer):

.1 the Register approved technical documentation on the electrical equipment testing;

.2 documents for parts confirming the Register technical supervision during their manufacture if such supervision is required by the RS Nomenclature;

.3 the Register approved test programs and procedures;

.4 documents of competent bodies, which confirm satisfactory results of special types of tests if provided by the test program (for flameproofness, etc.);

.5 testing equipment specified in the test program with documents confirming equipment parameters or certificates of testing laboratory;

.6 instruments having the accuracy rating of at least 1,5 %;

.7 documents confirming compliance of the instruments with the declared accuracy rating.

10.4.2 In surveying, the surveyor shall satisfy himself that tests are carried out in consistency with the Register approved program following the test procedures set forth in this Section or other equivalent procedures.

10.4.3 Breaks are allowed during the performance of single types of tests or between them if these do not affect testing.

10.4.4 The surveyor can reject survey or tests performance if an item is inadequately prepared for tests, and also when defects effecting the safety of survey or test performance are revealed.

10.4.5 If damages to single parts are identified or product operability is effected during testing, the product shall be inspected in the presence of the surveyor with a view to detect defects, whereupon the surveyor takes decision on the further test performance.

10.4.6 If a product has failed to pass a certain kind of tests and, as the result, its design has been changed or improved, the tests shall be repeated in accordance with the test program. The scope of those tests is established by the surveyor.

10.4.7 For single large-sized or heavy products which are impractical for testing on standard test benches and in standard test chambers instead of maritime full scale tests, calculation data regarding mechanical, and environmental effects according to the procedures approved by the Register, or in compliance with national or international standards may be introduced.

10.4.8 The scope and types of tests of the electrical equipment during the manufacture thereof are given in Appendix 1.

10.4.9 With the satisfactory results of tests, a certificate of relevant form shall be drawn up according to Part I "General Regulations for Technical Supervision".

10.4.10 When the term of validity is expired, the Type Approval Certificate (CTO) is renewed on request of the manufacturer in accordance with 6.8, Part I "General Regulations for Technical Supervision".

10.4.11 When the conditions of 6.8.1 are not met and the provisions of 6.8.2, Part I "General Regulations for Technical Supervision" are complied with, for renewal of CTO for the product manufactured under the established production conditions, the firm (manufacturer) shall perform tests according to the RS-approved program at least in the scope of serial products of steady production.

10.4.12 In case of changes to the design of automation equipment resulting in the changes of working process, load to the product components, service life or other essential parameters of the product, or changes in earlier declared technical parameters of material or product, for endorsement of renewal of CTO the products shall be tested according to the RS-approved program taking into consideration the changes made.

10.4.13 If single types of tests of specimens cannot be carried out on a bench, the Register can allow the performance of such tests (checks) onboard a ship during mooring and sea trials (e.g. tests of electric drives of the propulsion plant) what shall be specially agreed by the developer (manufacturer) in the technical documentation for taking into account in the programs and procedures of ship's mooring and sea trials.

10.5 INSTRUCTIONS ON TESTS AND CHECKS PERFORMANCE

10.5.1 The tests and checks shall be carried out on common specimens in a sequence to be specified in test programs and methods.

10.5.2 Irrespective of the sequence specified in the test program, and need not be on the specimens being subjected to other types of tests, the following tests may be performed:

.1 for exposure to salt mist;
.2 for exposure to solar radiation;
.3 for fungus resistance (mould resistance);
.4 fire tests.

It is permitted to combine tests for immunity to temperature changes and for heat stability and cold endurance if test methods specified are followed.

10.5.3 For testing cables or wires of a particular brand, the specimens of each structure and each number of cores with the minimal and maximum cross-sectional area, as well as with intermediate values, if needed, shall be selected. The number of specimens having the same number of cores of different cross-sections is established separately for each test.

10.5.4 Prior to the tests, accumulators shall be subjected to the necessary number of charging-discharging cycles in order that their capacity may reach the values guaranteed in technical documentation, and the results of their rated capacity check shall be submitted.

10.5.5 The accessories specified in the Nomenclature of items of the technical supervision and being part of the electrical equipment of electrically-started internal combustion engines, prior to the beginning of tests as part of the electrical equipment circuits of such engines, shall pass post-manufacturing tests in the appropriate scope specified for such products.

The tests of the electrical equipment set for internal combustion engines shall be carried out when the equipment is mounted in its standard positions on the engine which it is intended for.

During test of electrical equipment at the firm (manufacturer), simulators (if an internal combustion engine is unavailable) may be used separately for a charging generator drive, loading of a starter and starting relay, etc.

Bench tests with use of simulators shall be fully equivalent to tests on an internal combustion engine.

10.5.6 Control gear for lighting fixtures with gas-discharge lamps, if intended for installing separately from the lighting fixture, shall be tested in combination with the lighting fixtures excepting:

heat stability tests;

heat tests.

10.5.7 Efficiency for radio interference suppression shall be checked by a competent organization by a method adopted in the approved technical documentation and at frequencies for which the filter is designed for.

10.5.8 Protection means against pulse interference, power filters, safety transformers, uninterruptible power supply units (UPS) are subject to additional tests to check interference resistance and measurement of induced attenuation or limitation of pulse interferences. Relevant characteristics shall be included in the technical documentation.

10.5.9 Permissible deviations of parameters in mechanical and environmental tests:

Parameter	Permissible deviation
Vibration frequency:	
≤ 50	±2 Hz
> 50	±3 %
Amplitude	±20 %
Acceleration under vibration	±20 %
Acceleration under shocks	±20 %
Temperature	±2 °C
Relative humidity	±3 %

10.6 DESCRIPTION OF TESTS AND CHECKS

The list of tests and checks is given in Table 10.6.

Table 10.6

Para of the present Chapter	Name of tests and checks
10.6.1	**Inspection and checks**
10.6.2	**Functional tests**
10.6.3	**Measurement of insulation resistance**
10.6.4	**Tests of insulation strength**
10.6.4.1	Tests for insulation strength of electrical machines and electromagnetic couplings
10.6.4.2	Tests for insulation strength of transformers
10.6.4.3	Tests for insulation strength of accumulators
10.6.4.4	Tests for insulation strength of electric switchgears, busducts and apparatus
10.6.4.5	Tests for insulation strength of ship's control and monitoring, electrical internal communication and alarm devices
10.6.4.6	Tests for insulation strength of cable products
10.6.4.7	Tests for insulation strength of electrical heating and cooking appliances
10.6.4.8	Tests for insulation strength of electrical measuring instruments
10.6.4.9	Tests for insulation strength of integrated switchgears (IS) 15—35 kV and shielded current leads
10.6.4.10	Tests for insulation strength of integrated gas-insulated switchgears (GIS) 110 — 220 kV
10.6.4.11	Tests for insulation strength of cast (solid) insulated current leads for voltage above 15 kV
10.6.4.12	Tests for insulation strength of gas-insulated current leads 110—220 kV
10.6.4.13	Tests for insulation strength of insulators to be tested separately (collecting busbars, rigid busbar)
10.6.4.14	Tests for insulation strength of dry current-limiting reactors
10.6.4.15	Tests for insulation strength of valve-type arresters, overvoltage limiters
10.6.4.16	Tests for insulation strength of entries, bushing insulators 110 — 220 kV
10.6.4.17	Tests for insulation strength of high-voltage fuses, disconnecting fuses
10.6.5	**Test of interturn insulation strength**
10.6.6	**Vibration tests**
10.6.7	**Shock tests**
10.6.8	**Tests for resistance to motions and prolonged inclinations**
10.6.9	**Tests for heat stability**
10.6.10	**Tests for cold endurance**
10.6.11	**Test for exposure to temperature changes**
10.6.12	**Tests for humidity resistance**
10.6.13	**Tests for exposure to hoarfrost and dew**
10.6.14	**Tests for exposure to salt mist (corrosion resistance)**
10.6.15	**Fungus resistance tests**
10.6.16	**Tests for exposure to solar radiation**
10.6.17	**Protective enclosure testing**
10.6.18	**Heat test**
10.6.19	**Measurement of insulation distances of switchgears**
10.6.20	**Tests for the level of radiated electromagnetic emission**
10.6.21	**Tests for the level of radiated conductive interference**
10.6.22	**Tests for resistance to external electromagnetic interference**
10.6.22.1	**Tests for resistance to conductive low frequency interference**
10.6.22.2	**Tests for resistance to conductive radio frequency interference**
10.6.22.3	**Test for resistance to nanosecond pulse interference in the circuits of the a.c. supply sources, signal and control circuits**
10.6.22.4	**Tests for resistance to microsecond pulse interference**
10.6.22.5	**Tests for electrostatic discharge resistance**
10.6.22.6	**Tests for resistance to electromagnetic field**
10.6.23	**Tests of electrical machines**
10.6.23.1	Overcurrent test
10.6.23.2	Check of voltage regulation systems

Para of the present Chapter	Name of tests and checks
10.6.23.3	Check of commutator machines switching
10.6.23.4	Stalling test
10.6.23.5	Overspeed test
10.6.23.6	Test for electric and thermal strength at short-circuit current
10.6.23.7	Measurement of insulation resistance of electrical machines
10.6.23.8	Heat test
10.6.24	**Tests of transformers**
10.6.24.1	Check of measurement of a secondary voltage value
10.6.24.2	Heat test
10.6.24.3	Test for electrodynamical and thermal strength at short-circuit current
10.6.24.4	Test of a tank for tightness and strength at a higher internal pressure
10.6.25	**Testing of power transformers of the voltage of 15 — 220 kV**
10.6.25.1	Chromatographic analysis of gases dissolved in oil
10.6.25.2	Evaluating the moisture content of entry solid insulation
10.6.25.3	Measurement of insulation resistance of power transformers of the voltage of 15 — 220 kV
10.6.25.4	Measurement of dissipation factor (tgδ) of winding insulation
10.6.25.5	Evaluation of paper winding insulation conditions
10.6.25.6	Testing of insulation with overvoltage at 50 Hz
10.6.25.7	Measurement of d.c. winding resistance
10.6.25.8	Checking current transformer ratio
10.6.25.9	Checking winding group of three-phase transformers and polarity of single-phase transformer leads
10.6.25.10	Paralleling of transformers
10.6.25.11	Measurement of idling losses
10.6.25.12	Measuring the short-circuit resistance (ZK) of the transformer
10.6.25.13	Evaluation of switching device status
10.6.25.14	Tank tightness test
10.6.25.15	Check of cooling devices, safety devices, gas relay, pressure switch, jet switch, oil protection against ambient air
10.6.25.16	Thermovision inspection of transformer status
10.6.25.17	Measurement of partial discharge characteristics
10.6.26	**Tests of static converters and uninterruptible power supplies (UPS)**
10.6.26.1	Overload test
10.6.26.2	Test for electrodynamical and thermal strength at short-circuit current
10.6.26.3	Check of operation at load loss and increase
10.6.26.4	Test for immunity to switching overvoltage
10.6.27	**Tests of accumulators and accumulator batteries**
10.6.27.1	Tests by vibratory and shock loads
10.6.27.2	Tests for resistance to motions and prolonged inclinations
10.6.27.3	Test for heat stability of acid accumulators mastic
10.6.27.4	Check of tightness of acid accumulator monoblock units
10.6.27.5	Check for self-discharge
10.6.28	**Tests of lithium-ion accumulator batteries (LIAB)**
10.6.28.1	Tests for external short-circuit
10.6.28.2	Dynamic shock/ Drop test
10.6.28.3	Heat treatment/Thermal abuse test
10.6.28.4	Forced discharge test
10.6.28.5	Fire/ignition propagation test
10.6.28.6	Test for overcharge control system of voltage
10.6.28.7	Test for overcharge control system of current
10.6.28.8	Check of overheat control system
10.6.28.9	Capacity check
10.6.29	**Tests of supervapacitors (SC) and supercapacitor systems (SCS)**
10.6.29.1	Termination test
10.6.29.2	Short circuit test at 55 °C
10.6.29.3	Abnormal charge test
10.6.29.4	Heat test
10.6.29.5	Dielectric voltage-withstand test

Para of the present Chapter	Name of tests and checks
10.6.29.6	Crush test
10.6.29.7	Impact test
10.6.29.8	Temperature rise test
10.6.30	**Tests of heating units (HU)**
10.6.31	**Tests of solar batteries (SB)**
10.6.32	**Tests of switchgears**
10.6.32.1	Heat test
10.6.32.2	Test for electrodynamical and thermal strength at short-circuit current
10.6.33	**Tests of integrated switchgear (IS) of indoor installation, high-voltage sections of transformer substations (TS) of 15–35 kV**
10.6.33.1	Measurement of insulation resistance
10.6.33.2	Testing with overvoltage at 50 Hz
10.6.33.3	Check of alignment and degree of engagement of the movable contacts in the fixed one
10.6.33.4	D.c. resistance measurement of IS elements
10.6.33.5	Busbar monitoring
10.6.33.6	Mechanical tests
10.6.34	**Tests of electrical (switch, protection, control) apparatus**
10.6.34.1	Check of operate and reset value
10.6.34.2	Test for limiting switching capacity
10.6.34.3	Test for electrodynamical and/or thermal strength
10.6.34.4	Check of functioning of manual and motor
10.6.34.5	Test for the maximum nonfusing current and the minimum fusing current
10.6.35	**Tests of capacitors and capacitor sets for raising a power factor**
10.6.35.1	Test for compliance with operational conditions of equipment onboard a ship
10.6.35.2	Check for tightness
10.6.35.3	Test for discharge
10.6.35.4	Check of protection functioning of capacitors
10.6.36	**Tests of busbars**
10.6.36.1	Mechanical test
10.6.36.2	Heat test
10.6.36.3	Test for electrodynamical and thermal strength at short-circuit current
10.6.37	**Tests of electrical measuring instruments**
10.6.38	**Tests of electric drives and electrical equipment of machinery and arrangements (as a set)**
10.6.39	**Tests of electrical equipment of electrically-started internal combustion engines**
10.6.39.1	Test of starting circuit functioning
10.6.39.2	Test for functioning of the accumulator battery charging circuit
10.6.40	**Tests of lighting fixtures, search lights and control gear of gas-discharge lamps**
10.6.40.1	Heat test
10.6.40.2	Test for constancy of material characteristics
10.6.40.3	Thermal stability test
10.6.41	**Tests of ship's apparatus and devices for intercommunication, alarm, monitoring and control**
10.6.41.1	Heat test
10.6.41.2	Special checks
10.6.42	**Tests of cable products**
10.6.42.1	Mechanical tests
10.6.42.2	Test for cold endurance
10.6.42.3	Test for exposure to solar radiation and seawater
10.6.42.4	Tests of cables for connecting mobile and portable electrical equipment
10.6.42.5	Test for flame resistance (flame retardance)
10.6.42.6	Tests for fire resistance
10.6.42.7	Test of cable products for resistance to drill mud
10.6.43	**Tests of the busbars arranged outside of switchboards instead of cables for supplying section and/or distribution boards of consumers**
10.6.44	**Tests of electrical heating appliances**

Para of the present Chapter	Name of tests and checks
10.6.45	**Tests of items and devices for installation, spicing and connection of cables and wires**
10.6.45.1	Tests of cable ladders, trays and ties for safe working load (SWL)
10.6.45.2	Impact resistance test of plastic cable ladders, protective trays and cable ties
10.6.45.3	Safe Working Load (SWL) test of plastic cable ladders, protective trays and cable ties
10.6.45.4	Flame retardant test
10.6.45.5	Smoke and toxicity test
10.6.45.6	Resistivity test
10.6.45.7	Tensile strength test of cable ties (metallic and plastic)
10.6.46	**Testing of integrated metal sheathed gas-insulated switchgears (GIS)**
10.6.46.1	Resistance measurement of the main current-carrying circuit
10.6.46.2	Insulation resistance measurement of the main current-carrying circuit
10.6.46.3	Testing of main circuit insulation strength
10.6.46.4	Tightness tests
10.6.46.5	Check of the moisture content in electronegative gas
10.6.46.6	Check of the actuation of the electrical contact device of density monitoring instruments of electronegative gas (gas mixture)
10.6.46.7	Check of the pressure of filling GIS gas-insulated compartments with electronegative gas or gas mixture using a test gauge
10.6.46.8	Check of the electromagnetic interlock operation
10.6.46.9	Mechanical integrity monitoring and testing
10.6.47	**Testing of integrated shielded current leads 15 – 35 kV**
10.6.47.1	Measurement of insulation resistance
10.6.47.2	Testing of current lead insulation with overvoltage at 50 Hz
10.6.47.3	Check of the quality of the busbar and screen connections
10.6.47.4	Check of the artificial ventilation devices of the current lead
10.6.47.5	Check for short circuits in the generator voltage current leads
10.6.47.6	Check gas analysis for hydrogen content from a current lead
10.6.47.7	Thermovision inspection
10.6.48	**Testing of gas-insulated current leads (GICL) 35–220 kV**
10.6.48.1	Measurement of main circuit insulation resistance
10.6.48.2	Measurement of main circuit resistance
10.6.48.3	Tests of electrical insulating strength at 50 Hz
10.6.48.4	Check for the tightness of enclosures
10.6.48.5	Check for the moisture content in electronegative gas
10.6.48.6	Check of the pressure of filling GICL gas-insulated compartments with a gas or gas mixture using a test gauge
10.6.49	**Testing of current leads with cast (solid) insulation for the voltage of 15– 35 kV**
10.6.50	**Testing of collecting busbars and connecting bars, rigid busbars**
10.6.50.1	Measurement of insulation resistance of suspended and supported porcelain insulators
10.6.50.2	Testing of busbar insulation with overvoltage at 50 Hz
10.6.50.3	Checking of condition of entries, supporting and bushing insulators
10.6.51	**Testing of current-limiting dry reactors**
10.6.51.1	Measurements of winding insulation resistance relative to hold-down bolts
10.6.51.2	Testing of reactor support insulators with overvoltage at 50 Hz
10.6.52	**Testing of valve-type arresters and overvoltage limiters (OVL)**
10.6.52.1	Resistance measurement of arresters and overvoltage limiters
10.6.52.2	Measurement of the conductive current of valve arresters at the rectified voltage
10.6.52.3	Measurement of the conductive current of the overvoltage limiters
10.6.52.4	Thermovision inspection of valve-type arresters and surge arresters
10.6.52.5	Checking of arrester tightness
10.6.53	**Testing of entries and bushing insulators**
10.6.53.1	Measurement of insulation resistance
10.6.53.2	Measurement of tgδ and insulation capacity
10.6.53.3	Testing with overvoltage at 50 Hz
10.6.53.4	Overpressure test
10.6.53.5	Testing of oil from the entries
10.6.53.6	Monitoring of insulation under operating voltage
10.6.53.7	Check of the insulation integrity

Para of the present Chapter	Name of tests and checks
10.6.54	**Testing of fuses, fuse disconnectors with voltage of 15 – 35 kV**
10.6.54.1	Testing of reference insulation with overvoltage at 50 Hz
10.6.54.2	Check of the integrity of the fuse insert
10.6.54.3	Measurement of the d.c. resistance of the fuse-disconnector cartridge
10.6.54.4	Measurement of contact pressure in the fuse disconnector receptacle contacts
10.6.54.5	Check of the condition of the arc-suppression part of the fuse disconnector cartridge
10.6.54.6	Check of the operation of the fuse disconnector
10.6.55	**Testing of power cable lines with voltages from 15 to 220 kV**
10.6.55.1	Testing of cable insulation by excessive rectified voltage
10.6.55.2	Determination of cable core resistance
10.6.55.3	Determination of the electrical operating capacity of cables
10.6.55.4	Measurement of current distribution over single-core cables
10.6.55.5	Check of the earthing device
10.6.55.6	Testing of 110–220 kV CLP insulated cables with increased a.c. voltage
10.6.56	**Monitoring the condition of couplings by means of measurement and localization of partial discharges**
10.6.57	**Tests of cryogenic cables**
10.6.57.1	Resistance measurement of conductor
10.6.57.2	Insulation resistance measurement
10.6.57.3	Insulation strength testing
10.6.57.4	Bend tests
10.6.58	**Cyber resilience tests**
10.6.59	**Testing of a cargo hold water level alarm system of bulk carriers, ore carriers, combination carriers, passenger ships with 36 people or more on board, cargo ships with one or more holds other than bulk carriers, ore carriers, combination carriers and tankers**
16.6.60	**Test of slip rings**
10.6.60.1	Measurement of insulation distances of low-voltage slip rings
10.6.60.2	Measurement of insulation distances of high-voltage slip rings
10.6.60.3	Measurement of contact resistance
10.6.60.4	Resistance test
10.6.60.5	Short circuit test
10.6.60.6	Tests for resistance to pulse voltage
10.6.61	**Bench functional tests of composite (hybrid) propulsive systems**
10.6.62	**Test for rated power supply deviation**

10.6.1 Inspection and checks.

An inspection and checks are carried out with a view to establish:

compliance of products with approved technical documentation;

compliance of products with the RS rules requirements, which observance is not specified in the approved technical documentation;

availability of the product submitted for testing.

The following shall be checked during the inspection of electrical equipment (including openings-up and single disassemblies if needed):

accessories being part of the equipment inspected;

quality of electrical wiring;

structural design;

strength of connecting and fastening units, current-carrying parts, welded, screwed and other structural and contact joints;

availability of anticorrosion coatings at places subject to corrosion formation;

availability of necessary markings and information inscriptions;

contact and protective terminations of cables and wires;

arrangements ensuring electrical safety (protective earthing, interlocks, etc.).

For electrical machines, the following shall be checked additionally:

results of the test of a water air cooler, as well as of the systems of direct water cooling of the machine, for tightness and strength;

results of measuring the resistance of insulation between a bearing base and a foundation;

results of measuring the ohmic resistance of windings.

For switchgear, the following shall be checked additionally:

arrangement of controls, instruments and pilot lamps;

colour of pilot lamps and control buttons;

availability and workmanship of the earthing of fixed and slide-out elements and the elements fitted on opening structures to the console board frame, as well as availability and workmanship of the units for earthing each section of the console board to the ship's hull;

implementation of arrangements on protecting current carrying parts against ingress of liquid if hydraulic or liquid-cooled devices and apparatus are available;

holding of opening and slide-out doors, boards, panels, etc. in open position.

For electrical (switch, protection, control) apparatus, the following shall be additionally tested:

for apparatus intended for integration in electrical switchboards and other products, the fastenings, convenience of mounting and disassembly in operational conditions are checked;

in products incorporating other apparatus (in controllers, rheostats, etc.), the adjustment of these apparatus for set parameters is checked;

correct earthing and a contact pressure, a contact gap and follow-up are checked.

10.6.2 Functional tests.

Functional tests apply to each product specimen at the firm (manufacturer) prior to performance of single types of tests. Tests shall be carried out at standard environmental conditions. Prior to functional tests performance, it shall be ascertained that product completeness, spare parts and insulation resistance are consistent with technical documentation.

The functional tests of electrical equipment shall be carried out at the design conditions specified in technical documentation.

Characteristics of electrical equipment operating under load are taken after reaching a steady working temperature.

The following shall be checked during functional tests:

all characteristics for compliance with the requirements of the technical documentation;

monitoring of the system state of health (if provided) by simulation of individual faults (within the system, in sensors and test machinery by means of breaks, short-circuits, etc.).

For electrical machines, other tests and checks depending on a particular machine may include:

check in operation of interlocks, protection and alarms (e.g. overspeed protection);

check of the reserve of a.c. generators excitation (refer to 10.6.23);

check of the voltage setting range for a.c. generators with a static field system;

test of functioning of the electric heating of the machine;

measurement of electric voltage between shaft ends, as well as between a bearing base insulated from a foundation and the latter (both measurements are conducted with use of a voltameter having small inner resistance when the machine runs at rated voltage and frequency in the same mode). In measuring the voltage between the bearing base and foundation, oil films between shaft necks and both bearings shall be shunted.

For static converters and uninterruptible power supplies (UPS), the following may be checked:

functioning of the control gear;

functioning of alarms, ventilation;

functioning of filter;

battery capacity;

other checks specified in the approved technical documentation depending on the type of the converter.

For switchgear depending on the type of equipment, the following may be carried out:

run-up of apparatus and drives thereof. It applies to the apparatus and drives jointed in assembly of a switchboard, to the apparatus consisting of separate parts (e.g. bladed-type apparatus), to generator and section switches, as well as to the other apparatus (e.g. contactors and relays) if these are not subject to the operational test;

check of interlocks functioning. The reliability of interlocks operation shall be repeatedly checked during testing for vibration and shock resistance, heat stability and cold endurance, and after the completion of these tests. Electrical interlocks shall be checked at the maximum permissible deviations of voltage and frequency from the rated values;

test of the switchboard structure for mechanical strength at repeated switching operations. Such a test applies to apparatus of which switching on and off need significant forces. The test is carried out by means of repeated switching operations (at least 100 cycles) using each apparatus. After testing, the switchboard structure shall be thoroughly examined in the area of apparatus and their drives fastening;

operational test. Such a test applies to control, monitioring and alarm circuits of all switchboards and consoles, where available, in testing for resistance to mechanical and environmental effects what is of the particular importance for circuits with relay-contact elements;

the check of the voltage drop at navigation light switchboard alarm elements connected into the circuits of these navigation lights confirms its tolerable level.

The operational test of ship's apparatus and devices for intercommunication, alarm, monitoring and control products, excepting manual detectors and contactors, shall be performed during tests for vibration resistance, shock resistance, heat stability and cold endurance at the simultaneous limiting deviations of voltages and frequency from the rated values, in so doing:

with engine telegraphs, the precision of commands and responses transmission, and the alarm functioning are checked; with monitioring devices of ship's control, the accuracy of readings;

no wrong actuations of automatic detectors of a fire detection system or instant breaks of the pilot circuit connected to them shall be recorded. Simulating the action which is to activate detectors, activations shall occur within the set limits of parameters and time period;

with fire alarm stations, all monitoring and alarm circuits shall function properly. No wrong activations are allowed, but the precise one with any signal coming.

10.6.3 Measurement of insulation resistance.

The measurement of insulation resistance is compulsory at the following stages of tests performance:

prior to functional tests;

prior to, and after testing of electrical insulation strength;

prior to, and after heat stability tests;

prior to, and after cold endurance tests;

prior to, and after humidity resistance tests;

prior to, and after tests for exposure to salt mist;

prior to, and after product tests for short-circuit under standard environmental conditions.

Insulation resistance to case, as well as between phases (poles) of electrical equipment shall not be less than that specified in Table 10.6.3. For equipment not stated in Table 10.6.3, it is required to be guided by the norms adopted in the national or international standards, or in technical specifications for specific types of equipment.

Minimum insulation resistance for electrical equipment above 500 V rating as well as for electrical machines with an electric power above 1000 kW shall be determined in compliance with national or international standards.

Table 10.6.3

Electrical equipment	Minimum insulation resistance at an environment temperature 20±5 °C and normal humidity, MOhm	
	in cold state	in hot state
Electrical machines	1	0,5
Transformers	5	2
Switchboards	1	–
Switch, protection and control gear	5	–
Ship's devices for intercommunication, alarm, monitioring and control	20	–
Cooking and heating appliances[1]	1	0,5
Static converters	10	5
Power and lighting feeders, cabling for group telephones, telegraphs, bells and other types of direct-current alarm systems	1[2]	--
[1] For voltages above 5000 V, the insulation resistance is assumed on the basis of 2 kOhm per 1 V of rated voltage. [2] For voltage less than 24 V the insulation resistance shall not be less than 0,3 MOhm, for alternating-current voltage insulation resistance shall be 1,4 times higher than that for direct-current voltage.		

The d.c. voltage produced by a megohmmeter during measurements of insulation resistance shall be at least as specified:

Rated voltage of a product or circuit U_R, in V	Measuring voltage of a megohmmeter, in V
Up to 50	100
51 – 100	250
101 – 500	500
501 – 1000	1000
over 1000	2500

N o t e s : 1. Except for electrical machines.

2. The measuring voltage for transformers at U_R< 100 V shall be at least 500 V.

3. The measuring voltage for capacitors of sets for raising power factor (cos φ) for a voltage U_R≥ 380 V shall be equal to 2500 V.

Measurement of insulation resistance of cables (leads).

The insulation resistance of cables (volume resistivity determination) shall be measured in accordance with IEC 60092-350 or other standards applicable to the specific kinds and types of cables.

The measurements shall be effected at ambient air temperature 20±2°C. The test d.c. voltage of 80 V to 500 V shall be applied to the test specimen within 1-5 min.

If the measurement has been carried out at temperature other than 20°C, and the value of insulation resistance required by standards or technical specifications for specific cable products is set at temperature 20°C, then the measured value of insulation resistance shall be recalculated for temperature 20 °C according to the formula

$$R_{20} = KR_t$$

where R_{20} is an insulation resistance at temperature 20°C, in MOhms;

R_t is an insulation resistance at measurement temperature, in MOhms;

K is a coefficient to bring the insulation resistance to temperature 20°C, determined by the manufacturer.

The volume resistivity shall be calculated by the formula:

$$\rho = \frac{2\pi L R_{20}}{\ln(\frac{D}{d})}$$

where ρ is the volume resistivity, in Ohm·cm;

L if the length of the cable, in cm;

D if the outer diameter of the insulation, in mm;

d in the inner diameter of the insulation, in mm.

The calculated value of volume resistivity shall be not less than the value specified for the applicable insulating material in IEC 60092-360 or other standards applicable depending on the type of insulation materials.

Places (points) for application of voltage (measurements) shall be chosen depending on the kind and type of product with application of international and national standards at the stage of test method and procedure development.

Insulation resistance shall be measured between:

all product parts intended for operation at the same voltage and connected together during measurements and any metallic product part within reach that can be touched (enclosure, handle, etc.);

product parts being alive in operation and electrically not interconnected, between various windings;

each insulated core of cable products and the other cores in any sequence and the metallic cable sheath (armor, screen), and in the absence of these latter, with an electrode in water wherein the cable product is being immersed.

Megohmmeter indications of insulation resistance values shall be taken once the voltage applied becomes steady.

10.6.4 Tests of insulation strength.

The insulation strength of products, excepting single types specified in 10.6.4.1 — 10.6.4.17 where the time, voltage and frequency are specially stipulated, shall be tested during 1 min by the application of alternating voltage of the practically sinusoidal form with a frequency of 50 Hz at standard environmental conditions according to the following:

Voltage, in V

Rated U_R	Test
Up to 65	$2U_R$ + 500
66 – 250	1500
251 – 500	2000
501 – 1000	$2U_R$ + 1000
1001 – 3600	10000
3601 – 7200	20000
7201 – 11000	28000
11001 – 15000	45000
15001 – 20000	55000
20001 – 24000	65000
24001 – 27000	70000
27001 – 35000	85000
35001 – 110000	200000
110001 – 150000	230000
150001– 220000	325000

N o t e . The semiconductor elements of electrical devices that may be damaged during the tests may be disconnected under tests. During shutoff of the specified components the test voltage value shall be defined by the manufacturer with due regard to specifications of such elements.

General instructions on the performance of insulation strength tests and the explanations thereto are given in Table 10.6.4.

T a b l e 10.6.4

Nos.	Stages of tests performance	Test voltage	Comments
1	Immediately after the completion of tests for heat stability (heating) at a temperature of single parts equal to, or near, the maximum one reached during the above tests under normal environmental conditions	Full normalized	
2	After product short-circuit tests (if any) under standard environmental conditions [1]	0,8 normalized	For products with windings and products with elements inaccessible for inspection of which the insulation was exposed to short-circuit currents
3	Upon completion of vibration and shock exposure of the product in its practically cold state under standard environmental conditions of tests	0,7 normalized	
4	At the end of product tests for humidity resistance under the conditions specified for tests in a humidity chamber	0,5 normalized, but at least 1,25 times the rated voltage of the product	
[1] This test also covers the apparatus tested for the limiting switching capacity by the current equal to the rated short-circuit current (or near short-circuit currents).			

The test voltage shall be alternately applied between windings or other current-carrying parts of a product, as well as between windings and other current-carrying parts and the metal case of the product. In general case (except for as stipulated in 10.6.4.1 — 10.6.4.17) points for application of test voltage are those as given in 10.6.3.

The test results are considered satisfactory if no insulation breakdown or damage, tracking across its surface are detected, being visually checked by the sudden decrease of readings of the voltmeter, which is part of the test circuit, or by the noticeable heating of insulation.

In testing insulation strength, d.c. current may be used (from a rectified voltage installation). Cable products and some others depending on their design features may be exposed to d.c. tests. The distinction between those tests is in the values of the testing voltage which are specified for each particular product.

10.6.4.1 Test of insulation strength of electrical machines and electromagnetic couplings.

The insulation of electrical machine windings in compliance with standard IEC 60034-1:2017 shall withstand without breakdown or damage the test voltage of which the root-mean square values are specified in Table 10.6.4.1.

Table 10.6.4.1

Nos	Electrical machine or its part	Test voltage (root-mean square value), in V
1	Insulated windings of rotating machines of rated output less than 1 kW (or kVA) and of rated voltage less than 100 V with the exception of those in items 4 to 8	500 V + twice the rated voltage
2	Insulated windings of rotating machines of rated output less than 10000 kW (or kVA) with the exception of those in item 1 and items 4 to 8 (Note 1)	1 000 V + twice the rated voltage with a minimum of 1500 V (Note 1)
3	Insulated windings of rotating machines of output of 10000 kW (or kVA) or more with the exception of those in items 4 to 8	1 000 V + twice the rated voltage
4	Separately excited field windings of d.c. machines	1 000 V + twice the rated voltage with a minimum of 1500 V
5	Field windings of synchronous generators, synchronous motors and synchronous condensers	
5a)	Rated field voltage: up to, and including 500 V	Ten times the rated field voltage with a minimum of 1500 V
	above 500 V	4000 V + twice the rated field voltage
5b)	When a machine is intended to be started with the field winding short-circulated or connected across a resistance of value less than ten times the resistance of the winding	Ten times the rated field voltage with a minimum of 1500 V and maximum of 3500 V
5c)	When a machine is intended to be started either with the field winding connected across a resistance of value equal to, or more than, ten times the resistance of the winding, or with the field windings on open circuit with or without a field-dividing switch	1000 V + twice the maximum value of the r.m.s. voltage, which can occur under the specific starting conditions, between the terminals or the field winding or in the case of a sectionalized field winding between the terminals of any section, with a minimum of 1500 v (Note 2)
6	Secondary (usually rotor) windings of induction motors or synchronous induction motors of not permanently short-circulated (e.g. if intended rheostatic starting)	
6a)	For non-reversing motors or motors reversible from standstill only	1000 V + twice the open-circuit standstill voltage as a measured between ship-rings or secondary terminals with rated voltage applied to the primary windings
6b)	For motors to be reversed or braked by reversing	1000 V + four times the open-circuit standstill secondary voltage as defined in item 6a)
7	Exciters (except as below)	As for the windings to which they are connected
	Exception 1: exciters of synchronous motors if connected to earth or disconnected from the field windings during starting	1 000 V + twice the rated exciter voltage, with a minimum of1 500 V
	Exception 2: separately excited field windings of exciters (refer to item 4)	
8	Electrically interconnected machines and apparatus	A repetition of the tests in items 1 to 7 above should be avoided if possible, but if a test is performed on a group of machines and apparatus, each having previously passed its withstand voltage test, the test voltage to be applied to such an electrically connected arrangement shall be 80 % of the lowest test voltage appropriate for any individual piece of the arrangement (Note 3)

Nos	Electrical machine or its part	Test voltage (root-mean square value), in V
9	Devices that are in physical contact with windings, for example, temperature detectors, shall be tested to the machine frame. During the withstand test on the machine, all devices in physical contact with the winding shall be connected to the machine frame	1500 V
Notes: 1. For two-phase windings having one terminal in common, the voltage in the formula shall be the highest r.m.s. voltage arising between any two terminals during operation. 2. The voltage occurring between the terminals of the field windings, or sections thereof, under the specified starting conditions, may be measured at any convenient reduced supply voltage, and the voltage so measured shall be increased in the ratio of the specified starting supply voltage to the test supply voltage. 3. For windings of one or more machines connected together electrically, the voltage to be considered is the maximum voltage that occurs in relation to earth.		

10.6.4.2 Test of insulation strength of transformers.

In testing of winding insulation for transformers rated at up to 1000 V at the firm (manufacturer), the windings shall withstand the test voltage of rms values given in Table 10.6.4.2-1.

Table 10.6.4.2-1

Transformers	Rated voltage of windings, in V	Test voltage, in kV
Power ones:		
three-phase rated at up to 6,3 kVA	Up to 50	1,0
single-phase rated at up to 4,0 kVA	51 – 250	1,5
	251 – 400	2,0
	401 – 660	2,5
	661 – 1000	3,0
three-phase rated over 6,3 kVA	127 – 1000	3,0
single-phase rated over 4,0 kVA	127 – 1000	3,0

In testing of winding insulation for transformers for 15 — 220 kV voltage at the firm (manufacturer), the windings shall withstand the test voltage of full and chopped lightning pulse, the actual values of which are given in Table 10.6.4.2-2.

Testing voltages of full and chopped lightning pulses shall represent standard voltage full and chopped lightning pulses, accordingly.

Full voltage lightning pulse (full lightning pulse) is the pulse characterized by the voltage rising to its maximum value in a time range of microsecond fractions to 20 μs followed by a less rapid voltage drop to zero.

Chopped voltage lightning pulse (chopped lightning pulse) is the pulse having a voltage decrease rate significantly greater than the voltage change rate at the time point immediately preceding the fall point.

Table 10.6.4.2-2

Electrical equipment voltage class, in kV	Insulation level[1]	Test voltage of internal and external insulation			
		lightning pulse		short-term (one minute) alternating voltage	
		full	chopped	dry	in the rain
		Power transformers, shunting reactors relative to ground and between phases (poles)[2]	Power transformers, shunting reactors relative to ground and between phases (poles)[2]	Power transformers, shunting reactors relative to ground and between phases (poles)[2]	Power transformers, shunting reactors relative to ground and between phases (poles)[2]
1	2	3	4	5	6
15-19	a	95	115	38	-
	b			45	
20-23	a	125	150	50	-
	b			55	
24-26	a	150	175	60	-
	b			65	
27-34	a	170	200	65	-
	b			70	
35-109	a	190	220	80	-
	b			85	
110-149	-	480	550	200	-
150-219	-	550	600	230/275[3]	-
220	-	750	835	325/395[3]	-

[1] Insulation level:

a – for electrical equipment with paper-oil and cast insulation, designed with the requirement of checking the insulation for the absence of partial discharges according to 4.10, for other electrical equipment – to be determined by agreement between the manufacturer and the user.

b – for electrical equipment designed without the requirement of checking the insulation for the absence of partial discharges.

[2] For electrical equipment of three-phase (three-pole) version.

[3] The denominator indicates values for the dry state test of transformers and shunt reactors between phases, the numerator indicates values relative to the ground.

The standardized test voltages of the high voltage (HV) winding insulation of power transformers of 110, 150 and 220 kV classes with incomplete neutral insulation allowing operation with neutral un-grounding are given in Table 10.6.4.2-3.

Table 10.6.4.2-3

Transformer voltage class, in kV	Short-time test voltage of mains frequency; actual value, in kV				Test voltage of full lightning pulse of internal and external neutral insulation and neutral entry; maximum value, in kV
	One-minute voltage of internal insulation		Voltage (at smooth rise) of external insulation		
	of neutral	neutral entry, tested separately	in dry state	in the rain	
			of neutral and neutral entry	neutral entry location category 1	
1	2	3	4	5	6
110-149	100	130	135	110	200
150-219	130	180	195	155	275
220	200	265	280	215	400

The following pulses shall be applied during testing: for the internal insulation of power transformers, reactors – negative polarity pulses; for the external insulation of power transformers and shunting reactors – positive polarity pulses; for external insulation between phases of power transformers – opposite polarity pulses with values on each of the two tested phases equal to half the standardized test voltage; the third phase shall be earthed.

The methods for insulation testing by lightning pulses and the test endurance criteria shall comply with the standards for the individual types of electrical equipment and shall be in accordance with IEC 60060-1:2025.

The following test procedures shall be used:

for the internal insulation of electrical equipment (except for gas-filled equipment) – three-impact method;

for the external insulation of electrical equipment and internal insulation of gas-filled electrical equipment – 15-impact method.

During the test (three-impact or 15-impact method) the standardized number of pulses of test voltage of each polarity (positive and negative) or only one polarity shall be applied in accordance with the instructions in the standard documentation for insulation resistance requirements (in accordance with IEC 60060-1:2025).

For the external insulation of power transformers, it is permissible to use the 50 % discharge voltage method instead of the 15-impact method, whereby the withstand voltage with a 90 % probability shall not be less than the appropriate test voltage.

Testing of the internal and external insulation of power transformers and reactors with lightning pulse voltages may be carried out simultaneously; the requirements for both internal and external insulation with respect to polarity, number of pulses and their maximum value, which shall be the highest of the two values standardized for internal and external insulation, with correction for atmospheric conditions during testing for the latter, shall be met.

In testing of winding insulation of transformers for the voltage of 15—220 kV at the firm (manufacturer), the windings shall withstand the test short-term alternating voltages of the mains frequency. The rms values of the standardized test voltages for the air gaps of electrical equipment of the voltage classes 15 — 220 kV are given in Table 10.6.4.2-4.

Table 10.6.4.2-4

Electrical equipment voltage class, in kV	Insulation level[1]	Test voltage	
		variable at smooth rise	
		relative to ground	between phases
1	2	3	4
15-19	a, b	60	-
20-23	a, b	70	-
24-26	a, b	80	-
27-34	a, b	90	-
35-109	a, b	105	-
110-149	a, b	280	-
150-219	a, b	320	415
220	a, b	465	600
[1] The conditions for the application of the insulation levels are shown in Table 10.6.4.2-2.			

The test voltages for short-term mains frequency are given in Table 10.6.4.2-4:

a – the one-minute voltage applied to the insulation at the rated value for 1 minute or another time (5 minutes or less than 1 minute);

b – the smooth-rise voltage applied to the insulation without delay at the standardized value.

The methods for insulation testing by the short-time voltage of the mains frequency and the test endurance criteria shall comply with the standards for the individual types of electrical equipment and shall be in accordance with IEC 60060-1:2025.

The following test procedures shall be used:

for internal and external insulation in relation to the ground – a single application of a one-minute test voltage;

for the external insulation of power transformers and shunt reactors, the electrical strength of which is determined by the strength of the purely air gap, in relation to the ground and between the phases – three times application of the test voltage with a smooth rise.

It is permissible to use the full discharge method instead of the triple voltage method with a smooth rise; in this case the voltage withstand with 90 % probability shall not be less than the corresponding test voltage.

For the neutral winding insulation of power transformers and shunting reactors which do not allow neutral unearthed operation, a one-minute mains voltage test according to the method specified for the internal insulation is at the same time a test of their external insulation.

10.6.4.3 Test of insulation strength of accumulators.

Insulation of accumulator batteries, solar batteries and heating units regardless of battery rated voltage shall be tested by 2000 V (rms value).

Test pressure for lithium-ion accumulator batteries, lithium-ion battery systems shall comply with the value given in Table 10.6.4.3.

Table 10.6.4.3

Voltage between casing and any lead of accumulator (battery), in V	Test voltage (root mean square value), in V	
	In standard climate conditions	At increased air humidity
Up to 12 act.	100	50
12 to 27	250	125
27 to 60	500	250
60 to 115	700	350
115 to 220	1000	500
Above 220	1000 + twice the value of voltage at terminals but not less than 1500	500 + twice the value of voltage at terminals but not less than 750

10.6.4.4 Test of insulation strength of electrical switchgear, busducts and apparatus.

The insulation of electrical (switching, protective, control) apparatus, switchboards and consoles, busducts, lighting fixtures for a voltage of up to 1000 V shall withstand without breakdown and tracking the test voltage applied of which rms values are as follows:

Voltage, in V

Rated voltage of apparatus by insulation, U_R	Test voltage (rms value)
60	1000
60 – 250	2000
251 – 660	2500
661 – 800	3000
801 – 1000	3500
1001 – 3000	$3U_н$

Notes: 1. In testing switchboards, consoles, busducts, their accessories previously tested independently for insulation strength may be disconnected.

Instead of disconnecting such elements, the test voltage may be reduced by 20 % as compared with the above.

2. The test voltage for apparatus rated over 3 kV is specified in a separate table of this Chapter.

3. The insulation of electromagnetic releasing machinery windings is tested at a rms value of 2000 V.

The test voltage for fuses insulation up to 500 V rating shall be 3000 V.

Capacitors shall withstand the test voltage applied between connected armatures and the body, of which rms values are given below:

Voltage, in V

Rated voltage of a capacitor, U_R	Test voltage (rms value)
220	3000
380	3000
500	3000
660	6000
1000	6000
3150	16000
6300	22000

Capacitor sets to raise a power factor (cos φ) shall withstand the test voltage of an a.c. sinusoidal current of 50 Hz between armatures applied to their terminals during 10 s and equal to 2,15 times the rated voltage, or the d.c. voltage equal to 4,3 times the rated one.

10.6.4.5 Test of insulation strength of ship's control and monitoring, electrical internal communication and alarm devices.

Insulation strength of ship's control and monitoring, electrical internal communication and alarm devices shall withstand the test voltage of the following rms values:

Voltage, in V

Rated voltage of a capacitor, U_R	Test voltage (rms value)
Up to 60	$500 + 2U_R$
61 – 250	1500
251 – 380	2000

The above test voltages do not apply to tachometer sensors for which the voltages specified in 10.6.4.1 and 10.6.4.4 (for secondary devices of meters) shall be applied.

10.6.4.6 Test of insulation strength of cable products.

Each insulated core of a finished cable shall withstand during 5 min without breakdown the application of an a.c. single-phase sinusoidal voltage having a frequency of 50 (60) Hz or the d.c. voltage specified in Table 10.6.4.6. These test voltages for the finished cable apply both following the exposure of the products to water and without such exposure, both with and without immersion in water.

Table 10.6.4.6

Cables	Test voltage, in V	
	A.c. 50 (60) Hz current	D.c. current
Power cables for rated voltage, in V:		
250	1500	3000
750	2500	5000
1000	3000	-
3000	7000	-
6000	21000	-
8700	30500	-
12000	42000	-
18000	63000	-
45000-47000	65000	-
60000-69000	90000	-
110000-115000	160000	-
132000-138000	190000	-
150000-161000	218000	-
Alarm and communication cables for rated voltage 250 V	1500	3000
Notes: 1. The Table refers to cables having rubber, PVC and polyethylene insulation in a rubber or PVC sheath. 2. The test voltage for the cables of which the rated is ignored in the Table is stipulated by technical documentation in compliance with national and international standards. 3. The test voltage may be reduced by 25 % as compared with the one in the Table for cables with screened cores if these latter account for more than 50 % of all the cores.		

10.6.4.7 Test of insulation strength of electrical heating and cooking appliances.

Electrical heating and cooking appliances with tubular electric heaters, excepting fuel oil and lubricating oil heaters, shall withstand the test voltage of which rms values are specified in Table 10.6.4.7.

Table 10.6.4.7

Rated voltage of a heating device, in V B	Test voltage (rms value), in V		
	In practically cold state		heated up to a working temperature irrespective to the tubular electric heater diameter
	tubular electric heater diameter up to 10 mm	tubular electric heater diameter over 10 mm	
12 – 60	800	1000	600
110 – 127	1300	1500	1200
220	1500	1700	1200
380	1800	2000	1200
Note. The above voltages may be reduced by 20 % in tests of heating and cooking appliances with tubular electric heaters being tested at the firm (manufacturer).			

Fuel oil and lubricating oil heaters for rated voltages 220 V and 380 V shall be tested at a voltage of 2000 V in a cold state and 1500 V in the state heated up to a working temperature.

10.6.4.8 Test of insulation strength of electrical measuring instruments.

Analog and digital devices for measuring electrical quantities, transducers, as well as components of devices for measuring nonelectric quantities, if an electric quantity is fed to the input of these components, are classed with the electrical quantity measuring devices covered by the requirements.

The insulation of measuring instruments designed for various operating voltages shall withstand the test voltage of which rms values are given below:

Operating voltage, in V	Test voltage (rms value), in V
Up to 130	500
131 – 250	1500
251 – 660	2000
661 – 1000	3000
over 1001	in compliance with national or international standards

N o t e s : 1. The above voltages are taken for testing insulation between current-carrying parts and a device case.

2. D.c. current may be used for tests. In this case, the above voltages shall be increased by 1,41 times.

10.6.4.9 Test of insulation strength of integrated switchgear (IS) 15–35 kV and shielded current leads.

During testing at the firm (manufacturer) the external insulation, as well as insulation inside the IS enclosure, circuits of the IS primary connections shall withstand the voltages of full lightning pulses given in Table 10.6.4.9.

T a b l e 10.6.4.9

Electrical equipment voltage class, in kV	Insulation level[1]	Test voltage of internal and external insulation				
		lightning pulse		short-term (one minute) alternating voltage		
		full		dry		In the rain
		IS with one pole break in relation to ground and between phases (poles)[2]	IS with two pole breaks in relation to ground and between phases (poles)[2]	IS with one pole break in relation to ground and between phases (poles)[2]	IS with two pole breaks in relation to ground and between phases (poles)[2]	IS in relation to the ground and between phases (poles)[2]
1	2	3	4	5	6	7
15-19	a	95	110	38	45	38
	b			55	63	
20-23	a	125	145	50	60	50
	b			65	75	
24-26	a	150	165	60	70	60
	b			75	90	
27-34	a	170	190	65	85	65
	b			80	95	

Electrical equipment voltage class, in kV	Insulation level[1]	Test voltage of internal and external insulation				
		lightning pulse		short-term (one minute) alternating voltage		
		full		dry		In the rain
		IS with one pole break in relation to ground and between phases (poles)[2]	IS with two pole breaks in relation to ground and between phases (poles)[2]	IS with one pole break in relation to ground and between phases (poles)[2]	IS with two pole breaks in relation to ground and between phases (poles)[2]	IS in relation to the ground and between phases (poles)[2]
1	2	3	4	5	6	7
35	a	190	220	80	95	80
	b			95	120	

[1] Insulation level:
a – for electrical equipment with paper-oil and cast insulation, designed with the requirement of checking the insulation for the absence of partial discharges, for other electrical equipment – to be determined by agreement between the manufacturer and the user.
b – for electrical equipment designed without the requirement of checking the insulation for the absence of partial discharges.
[2] For electrical equipment of three-phase (three-pole) version.

Test voltage shall be applied to:

insulation in relation to the ground and between the poles in the operating and disconnected (control) positions of the withdrawable element;

insulation between live and earthed parts when the withdrawable part is in repair position;

insulation in relation to the ground and between the poles when disconnectors are switched on and off, connected to the primary circuits for the IS without withdrawable elements.

N o t e . Electrical equipment normally connected to the primary circuits of IS for which lightning pulse test voltages are lower than those specified in Table 10.6.4.9 shall be disconnected from the primary connection circuits during the testing according to this para. The test shall be repeated with all connected electrical equipment at the voltage permitted for all electrical equipment.

External insulation inside the IS enclosure between the current-carrying parts of the same pole of the IS primary circuits in the disconnected (check) position of the withdrawable component with two discontinuities per pole shall withstand the full lightning pulse voltages specified in Table 10.6.4.9 (column 4).

IS without withdrawable elements shall withstand external insulation tests between the contacts of the same disconnector pole of the primary circuit breakers in the disconnector tripped position.

The primary circuit insulation of IS shall be able to withstand the one minute voltages specified in Table 10.6.4 (columns 5, 6 and 7).

Test voltage shall be applied to insulation in accordance with Table 10.6.4.9.

The external insulation inside the IS enclosure between the current-carrying parts of the same pole of the IS primary circuits in the disconnected (check) position of the withdrawable component with two discontinuities per pole shall withstand in dry state the voltages specified in Table 10.6.4.9 (column 6).

The external insulation (outside the OPSG/outdoor packaged switchgear enclosure) of the OPSG primary circuits in relation to the ground shall withstand in the rain the voltages given in Table 10.6.4.9 (column 7);

Insulation of shielded current leads shall withstand:

voltages of full lightning pulses given in Table 10.6.4.9 (column 3);

one minute alternating voltages given in Table 10.6.4.9 (column 5).

10.6.4.10 Test of insulation strength of integrated gas-insulated switchgears (GIS) 110 — 220 kV.

When tested at the firm (manufacturer), the insulation relative to GIS ground, as well as the insulation between the poles of the three-pole GIS, shall withstand the full lightning pulse test voltages in accordance with Table 10.6.4.10 (column 2);

Insulation of electromagnetic voltage transformers shall also be tested with the voltage of a chopped lightning pulse. Thus, the values of the test voltages of the chopped lightning pulse shall be equal to the values of the test voltages of full lightning pulse given in Table 10.6.4.10;

Insulation between the contacts of the same pole of switches and disconnectors shall withstand the test voltages of a full lightning pulse when the apparatus is switched off, according to Table 10.6.4.10 (columns 3 and 4);

When tested at the firm (manufacturer), the insulation relative to GIS ground, as well as the insulation between the poles of the three-pole GIS, shall withstand test short-time (one minute) alternating voltages specified in Table 10.6.4.10 (column 5);

Insulation of the air – electronegative gas entry in GIS of voltage classes 72,5 to 220 kV in dry state, and for entries of location category 1, as well as in the rain, shall withstand test short-term (one-minute) alternating voltages according to Table 10.6.4.10 (column 5).

Table 10.6.4.10

Voltage class	Test voltage, in kV					
	full lightning pulse			short-term (one minute) alternating voltage		
		between the contacts			between the contacts	
	in relation to the ground and between the poles	breakers	disconnectors	in relation to the ground and between the poles	breakers	disconnectors
1	2	3	4	5	6	7
72,5-99	325		375	140		160
100-122	450		520	185		210
123-149	550		630	230		265
150-219	750		860	325		375
220	950		1050	395		460

Insulation between the contacts of the same pole of switches and disconnectors shall withstand the test short-time (one minute) alternating voltages according to Table 10.6.4.10 (columns 6 and 7);

Insulation of GIS main circuits shall withstand testing by alternating voltage with partial discharge measurement. Partial discharge test shall be carried out by applying an alternating voltage to the insulation to be tested, the preliminary value of which for a duration of 10 s shall be equal to 1.05 $U_{v.o}$[1]. – for the equipment of 110 kV and over.

Then the voltage shall be reduced to a value of 1,1 $U_{v.o}/\sqrt{3}$ without switching off and maintained for at least 1 minute. The insulation is considered to have passed the test if the intensity of partial discharges at the voltage of 1,1 $U_{v.o}/\sqrt{3}$ does not exceed the value of 10^{-1} Kl.

[1] *Uv.o* – the maximum operating voltage of electrical equipment – the maximum voltage of 50 Hz frequency, the application of which to the terminals of the different phases (poles) of the electrical equipment for an unlimited time period is permissible under its insulation operating conditions.

GIS bushing insulation shall comply with the requirements for thermal breakdown resistance and, for "air – electronegative gas" bushings in GIS of location category 1 – also with the leakage path length of the external insulation (for the bushing insulation requirements refer to 10.6.4.16).

Insulation of the secondary windings of GIS voltage transformers shall withstand for 1 minute the test voltage of 3 kV at 50 Hz applied from an external source.

The insulation of the secondary windings of current transformers shall withstand for 1 minute the test voltage of 3 kV at 50 Hz applied from an external source.

The inter-sectional insulation of the primary and secondary winding sections intended for changing the ratio of current transformers shall withstand for 1 minute the test voltage of 3 kV at 50 Hz.

Insulation of the GIS control and auxiliary circuits with respect to earth shall withstand a short-term (one-minute) alternating voltage test for the electrical equipment of 220 kV and below, equal to 2 kV and applied alternately between:

live and earthed parts;

live parts of different circuits;

open contacts of the same circuit elements.

The test voltage exposure time shall be equal to 1 min.

N o t e . Testing of live parts of different circuits and open contacts of the same circuit elements may be omitted, provided that the electrical equipment manufacturer guarantees the required insulation quality.

Interturn insulation of solenoid windings in GIS control circuits (except those included in the secondary circuit of current transformers) shall withstand for 1 minute a short-term alternating voltage applied between the winding leads equal to 3,5 U_v – for a.c. windings and 2,5 U_v – for d.c. windings, where U_v is the rated voltage of auxiliary circuits and control circuits.

General instructions on testing GIS insulation resistance:

.1 GIS insulation shall be subjected to the above tests. Each GIS or each GIS cell, pole, separate module or transport unit consisting of one or more modules shall be tested;

.2 testing of the GIS insulation shall be carried out at the rated minimum operating density of electronegative gas. The rated value for the minimum operating density of electronegative gas is given in the type-specific electrical equipment standards (IEC 62271-203:2011) as well as in the operating manual of the equipment;

.3 test voltages shall be adjusted to atmospheric conditions during the test only when testing the dielectric strength of the "air – electronegative gas" bushings;

.4 when testing the insulation of main circuits of GIS with full lightning pulse voltage, the 15-pulse method with positive and negative polarity pulses shall be applied;

.5 when testing the voltage transformers with the voltage of chopped lightning pulse, the three-pulse method shall be used, with pulses of positive and negative polarity applied.

.6 when testing the insulation of main circuits of GIS with switching pulse voltage, the 15 pulse method shall be applied with pulses of positive and negative polarity, except for the "air – electronegative gas" entry in the GIS of location category 1, which shall be tested in dry state with pulses of positive polarity, and in the rain with pulses of positive and negative polarity;

.7 when testing the insulation of main circuits, control circuits and auxiliary circuits of GIS and secondary windings of measuring transformers with short-term alternating voltages, the one-minute voltage method shall apply. Testing by the alternating voltage test with partial discharge measurement shall be carried out following the electrical strength test of the insulation by the lightning pulse, switching pulse and short-time alternating voltage.

10.6.4.11 Test of insulation strength of cast (solid) insulated current leads for the voltage above 15 kV.

When tested by the firm (manufacturer), electrical equipment or parts thereof with cast or compound-filled insulation shall withstand the test for the absence of partial discharges in gas inclusions in the insulation by application of alternating voltage.

The above test may be carried out by measuring the dissipation factor of the voltage varied to 120 % of the highest operating voltage for the electrical equipment of voltage classes 3 to 110 kV or 120 % of the highest operating voltage divided by √3 for the equipment of voltage classes 110 kV and over.

Partial discharge test shall be carried out by applying an alternating voltage to the insulation to be tested, the pretest value of which during 10 s to be equal to 1,3 $U_{o.v}$[1] for the equipment of voltage classes from 3 to 35 kV, 1,05 $U_{o.v.}$[1] – for the electrical equipment of 110 kV and over.

Then the voltage shall be reduced to a value of 1,1 $U_{v.o}/\sqrt{3}$ without switching off and held for at least 1 minute; the PD intensity, the permissible value of which is specified in the sections containing the requirements for specific types of electrical equipment, shall be measured;

The method of testing in parts, as well as the voltage to be applied to those parts, shall be chosen by the manufacturer in accordance with the national standards for electrical equipment.

10.6.4.12 Test of insulation strength of gas-insulated current leads 110–220 kV.

When tested at the firm (manufacturer), the standardized test voltages of the main circuits of the gas-insulated current leads shall comply with the data specified in Table 10.6.4.12.

Table 10.6.4.12

Voltage class	Test voltage, in kV			
	full lightning pulse		short-term (one minute) alternating voltage	
	in relation to the ground	between phases for GICL 3P	in relation to the ground	between phases for GICL 3P
110	450	450	230	230
150	650	650	300	300
220	900	900	440	440

Notes:
GICL – gas-insulated current lead;
GICL 3P – gas-insulated current lead with all three phases housed in the same enclosure.

For current leads with a common enclosure for all three phases, the test voltage is applied to each phase of the current lead or to two phases when the third phase is connected to the earthed enclosure in turn.

Insulation of GICL control and auxiliary circuits in relation to the ground shall withstand a test short-term (one-minute) alternating voltage of 2,0 kV applied alternately between live and earthed parts, as well as between live parts of different circuits.

Partial discharge intensity in the GICL insulation shall not exceed the value of 10 – 11 KI when an alternating voltage equal to $1{,}1U_{o.v}/\sqrt{3}$ is applied.

When an alternating voltage equal to $1{,}1U_{o.v}/\sqrt{3}$, is applied to the external insulation of GISL terminations in the form of "air – electronegative gas" entries, the absence of a visible corona shall be recorded.

[1] *Uv.o* – the maximum operating voltage of electrical equipment – the maximum voltage of 50 Hz frequency, the application of which to the terminals of the different phases (poles) of the electrical equipment for an unlimited time period is permissible under its insulation operating conditions.

Electrical strength of the internal insulation of GICL "air – electronegative gas", "oil – electronegative gas", "cable – electronegative gas" and "electronegative gas – electronegative gas" entries shall comply with the values of the rated test voltage in relation to the ground in accordance with Table 10.6.4.12.

10.6.4.13 Test of insulation strength of insulators to be tested separately (collecting busbars, rigid busbar).

The external insulation of insulators shall withstand the full lightning pulse voltages specified for insulators and busbar supports in Table 10.6.4.13.

Table 10.6.4.13

Electrical equipment voltage class, in kV	Insulation level[1]	Test voltage of internal and external insulation		
		lightning pulse	short-term (one minute) alternating voltage	
		full	dry	in the rain
		Insulator in relation to the ground and between phases (poles)[2]	Insulator in relation to the ground and between phases (poles)[2]	Insulator in relation to the ground and between phases (poles)[2]
1	2	3	4	5
15-19	a	95	38	38
	b		*55*	
20-23	a	125	50	50
	b		65	
24-26	a	150	60	60
	b		75	
27-34	a	170	65	65
	b		80	
35-109	a	190	80	80
	b		95	
110-149	-	450/550[3]	230	200
150-219	-	650	275	275
220	-	950	395	395

[1] Insulation level:
a – for electrical equipment with paper-oil and cast insulation, designed with the requirement of checking the insulation for the absence of partial discharges, for other electrical equipment – to be determined by agreement between the manufacturer and the user.
b – for electrical equipment designed without the requirement of checking the insulation for the absence of partial discharges.
[2] For electrical equipment of three-phase (three-pole) version.
[3] The denominator indicates values for dry testing of non-oil insulators without checking the quality of insulation performance for the absence of partial discharges or by other additional methods, as well as busbar supports, the numerator indicates values for the remaining electrical equipment.

The internal insulation of insulators, including the insulation of apparatus bushings, shall withstand the one-minute voltages given in Table 10.6.4.10 (columns 4 and 5).

The external insulation of insulators shall withstand in dry state, and for category 1 insulators also in the rain, the one-minute voltages specified for the insulators in Table 10.6.4.12 (columns 4 and 5).

10.6.4.14 Test of insulation strength of dry current-limiting reactors.

When testing winding insulation of dry current limiting reactors for 15–220 kV voltage at the firm (manufacturer), the windings shall withstand the test voltage of full and chopped lightning pulse, the actual values of which are given in Table 10.6.4.2-2.

Each specimen of electrical equipment shall be subjected to an insulation test when leaving the manufacturer's premises:

for internal insulation by one-minute alternating test voltage in relation to the ground equal to 2 kV with the test voltage exposure time equal to 1 min.

for internal insulation filled with liquid or gaseous dielectric material with molded insulation elements of voltage classes 110 kV and above – by alternating voltage with the measurement of partial discharge characteristics.

Notes: 1. It is permitted not to separately test the products at steady production of insulation installed on reactors of voltage classes 15 to 35 kV, reinforced by the reactor manufacturer, but limit to the application of a test one-minute alternating voltage to the bushing of the reactor or apparatus during the testing.

2. It is permitted not to test products at steady production of the insulation of the assembled current-limiting dry-type reactors, but limit to testing of their insulators.

Internal insulation of the current-limiting reactor windings shall withstand, relative to ground and other windings, the one-minute test voltage applied from an external source as specified in Table 10.6.4.2-2. Parts of a split winding shall be considered as a separate winding each.

10.6.4.15 Test of insulation strength of valve-type arresters, overvoltage limiters.

Insulation of valve-type arresters and overvoltage limiters (hereinafter, overvoltage limiters or OVL) made of organic (polymer) materials shall be tracking-erosion-resistant.

When tested by the firm (manufacturer), the insulation of the overvoltage limiter enclosure shall withstand lightning pulse, switching pulse, one-minute power frequency voltage in accordance with Table 10.6.4.15-1.

Table 10.6.4.15-1

Electrical equipment voltage class, in kV	Insulation level[1]	Test voltage of internal and external insulation		
		грозового импульса	short-term (one minute) alternating voltage	
		full	dry	in the rain
		Surge arrester, OVL in relation to the ground and between phases (poles)[2]	Surge arrester, OVL in relation to the ground and between phases (poles)[2]	Insulator in relation to the ground and between phases (poles)[2]
1	2	3	4	5
15 – 19	a	95	38	38
	b		55	
20 – 23	a	125	50	50
	b		65	
24 – 26	a	150	60	60
	b		75	
27 – 34	a	170	65	65
	b		80	
35 – 109	a	190	80	80
	b		95	

Electrical equipment voltage class, in kV	Insulation level[1]	Test voltage of internal and external insulation		
		грозового импульса	short-term (one minute) alternating voltage	
		full	dry	in the rain
		Surge arrester, OVL in relation to the ground and between phases (poles)[2]	Surge arrester, OVL in relation to the ground and between phases (poles)[2]	Insulator in relation to the ground and between phases (poles)[2]
1	2	3	4	5
110 ─ 149	-	450	230	200
150 ─ 219	-	650	300	275
220	-	900	440	395

[1] Insulation level
a – for electrical equipment with paper-oil and cast insulation, designed with the requirement of checking the insulation for the absence of partial discharges, for other electrical equipment – to be determined by agreement between the manufacturer and the user.
b – for electrical equipment designed without the requirement of checking the insulation for the absence of partial discharges.
[2] For electrical equipment of three-phase (three-pole) version.

Lightning pulse voltage test shall be carried out for all types of limiters. The maximum value of the test pulse voltage shall not be less than the residual voltage at the limiter at rated discharge current multiplied by 1,3.

Switching pulse test shall be carried out on the external insulation of limiters with the rated discharge currents of 10000 and 20000 A and the maximum long-term permitted operating voltage of 210 kV or higher. The test voltage shall be equal to the residual voltage at the highest value of switching current given in Table 10.6.4.15-2, multiplied by 1,25. The residual voltages of the limiter shall be specified by the manufacturer in the technical documents for the particular types of limiter at 30/60 μs, 8/20 μs and 1/10 μs current pulses with the maximum pulse values given in Table 10.6.4.15-2.

Table 10.6.4.15-2

Arrester class by capacity	Rated discharge current, in A	Maximum current values, A, at pulses, μs		
		30/60	8/20	1/10
ю	5000	125, 250, 500	2500, 5000, 10000	5000
	10000	125, 250, 500	5000, 10000, 20000	10000
2	10000	250, 500, 1000	5000, 10000, 20000	10000
3	10000	500, 1000, 2000	5000, 10000, 20000	10000
4	10000	500, 1000, 2000	5000, 10000, 20000	10000
	20000	500, 1000, 2000	10000, 20000, 40000	20000
5	20000	500, 1000, 2000	10000, 20000, 40000	20000

Limiters with a rated discharge current of 5000 A as well as limiters with a rated discharge current of 10000 A and 20000 A, with a continuous permissible operating voltage of less than 210 kV, shall be subjected to the power frequency test (1 min).

The amplitude of the one-minute test voltage shall not be less than the value of:

the remaining voltage at the rated discharge current, multiplied by 0,88;

for limiters with a rated discharge current of 5000 A;

the residual voltage at the highest switching current according to Table 10.6.4.15-2 (depending on the capacity class and rated discharge current) multiplied by 1.06 – for limiters with the rated discharge current 10000 and 20000 A.

Testing of the OVL insulation enclosure shall be carried out by the 15-impact method. Under normal atmospheric conditions, the test voltage shall not be less than the residual voltage of the OVL at the rated discharge current multiplied by 1,3.

10.6.4.16 Test of insulation strength of entries, bushing insulators 110–220 kV. Requirements to the insulation of entries and bushing insulators at lightning pulse voltage. During the testing at the firm (manufacturer) the external insulation of entries and bushing insulators with the voltage from 15 to 110 kV shall withstand the voltages of full lightning pulses given in Table 10.6.4.13.

The external insulation of entries and bushing insulators 110–220 kV shall withstand the full lightning pulse voltages specified in Table 10.6.4.16.

Table 10.6.4.16

Electrical equipment voltage class, in kV	Insulation level[1]	Test voltage of internal and external insulation		
		lightning pulse	short-term (one minute) alternating voltage	
		full	dry	in the rain
		Entry, bushing insulator in relation to the ground and between the phases (poles)[1]	Entry, bushing insulator in relation to the ground and between the phases (poles)[1]	Entry, bushing insulator in relation to the ground and between the phases (poles)[1]
1	2	3	4	5
110	-	450/550[2]	230	200
150	-	650	275	275
220	-	950	395	395
[1] For electrical equipment of three-phase (three-pole) version – also between the poles. [2] Values for bushings are given in the denominator; values for other insulators – in the numerator.				

It is permitted not to carry out testing under rain of the external insulation of electrical equipment with main active parts located in a metal enclosure and connected via separate bushings when the test of the external insulation of the bushings in the rain was performed separately.

Each specimen of electrical equipment shall be subjected to an insulation test when leaving the manufacturer's premises:

for internal insulation of bushings of voltage classes 110 kV and above – by alternating voltage with the measurement of partial discharge characteristics.

Notes: 1. It is permitted not to separately test the insulation of bushings installed on transformers, reactors and apparatus of voltage classes 3 to 35 kV, reinforced by the transformer, reactor or apparatus manufacturer, as well as bushings assembled from parts on the electrical equipment tank, but limit to the application of a test one-minute alternating voltage to the bushing of the transformer, reactor or apparatus during the testing of products at steady production of the latter.

2. The scope of testing of porcelain bushing insulators specified in the standards for these insulators may omit the one-minute alternating voltage test, provided that another method of checking the manufacturing quality of the insulators is specified, as a substitute for the one-minute voltage test.

External insulation of bushings intended for winding neutral terminals of HV power transformers of 110, 150 and 220 kV voltage classes with incomplete neutral insulation allowing operation with neutral un-grounding shall be tested with full lightning impulse voltages specified in Table 10.6.4.2-3 (column 6).

The internal insulation of insulators, including the insulation of apparatus entries, shall withstand the one-minute voltages given in Table 10.6.4.13 (columns 4 and 5).

The internal insulation of entries in power transformers and shunting reactors of voltage classes 110 kV and over shall withstand testing with continuous alternating voltage equal to $1{,}5\ U_{H.P}/\sqrt{3}$.

The voltage shall be smoothly raised to the rated value and then maintained for 0,5 h regardless of its frequency; the intensity of the partial discharges shall be measured.

The insulation is considered to have passed the test if the intensity of the partial discharges during the voltage exposure does not exceed the value of 10^{-11} Kl.

10.6.4.17 Test of insulation strength of high-voltage fuses, disconnecting fuses.

When tested by the firm (manufacturer), the external insulation of fuses, fuses-disconnectors (hereinafter, the fuses) shall withstand full lightning pulse voltages given in Table 10.6.4.17.

The methods for insulation testing by lightning pulses and the test endurance criteria shall comply with IEC 60060-1:2025 for the individual types of electrical equipment and are specified in Table 10.6.4.17.

The following test procedures shall be used:

for the internal insulation of electrical equipment – 3-impact method;

for the external insulation of electrical equipment – 15-impact method.

For external insulation between the contacts of the same poles of disconnectors and fuses with the cartridge removed, it is permissible to use the full discharge method instead of the 15-impact method, whereby the withstand voltage with a 90 % probability shall not be less than the appropriate test voltage.

Table 10.6.4.17

Electrical equipment voltage class, in kV	Insulation level[1]	Test voltage of internal and external insulation					
		lightning pulse		short-term (one minute) alternating voltage			
		full		dry		in the rain	
		Fuse in relation to the ground	Fuse between the contacts[2]	Fuse in relation to the ground	Fuse between the contacts[2, 3]	Fuse in relation to the ground	Fuse between the contacts[2]
1	2	3	4	5	6	7	8
15 ─ 19	a	95	110	38	45	38	45
	b			55	63		
20 ─ 23	a	125	145	50	60	50	60
	b			65	75		
24 ─ 26	a	150	165	60	70	60	70
	b			75	90		
27 ─ 34	a	170	190	65	85	65	75
	b			80	95		
35 ─ 109	a	190	220	80	95	80	95
	b			95	120		
110 ─ 149	-	450	570	230		230	

Electrical equipment voltage class, in kV	Insulation level[1]	Test voltage of internal and external insulation					
		lightning pulse		short-term (one minute) alternating voltage			
		full		dry		in the rain	
		Fuse in relation to the ground	Fuse between the contacts[2]	Fuse in relation to the ground	Fuse between the contacts[2, 3]	Fuse in relation to the ground	Fuse between the contacts[2]
1	2	3	4	5	6	7	8
150 ─ 219	-	650	790	300	315	300	315
220	-	900	1100	440	460	440	460

[1] Insulation level:
a – for electrical equipment with paper-oil and cast insulation, designed with the requirement of checking the insulation for the absence of partial discharges, for other electrical equipment – to be determined by agreement between the manufacturer and the user;
b – for electrical equipment designed without the requirement of checking the insulation for the absence of partial discharges.
[2] The insulation level between the contacts of the same fuse pole with cartridge but without fuse insert between the electrodes.
[3] The insulation level between the contacts of the same pole, fuses with the cartridge removed.

.1 testing of insulators, disconnectors, lightning pulse test voltages according to the method specified for external insulation is at the same time a test of the electrical strength of their internal insulation;

.2 external insulation of the fuses (fuse with a fuse holder with an undamaged fuse link) in relation to the ground and, for three-pole fuses, between adjacent poles, shall withstand full lightning pulse voltages specified in Table 10.6.4.17 (column 3). The external insulation of the fuses between the contacts of the same pole of the fuse with the cartridge removed shall withstand the voltages of full lightning pulses specified in Table 10.6.4.17 (column 4);

.3 requirements for insulation at one minute alternating voltage. Internal insulation of the fuses (fuse with a fuse holder with an undamaged fuse link) in relation to the ground and, for three-pole fuses ─ between adjacent poles, shall withstand the one minute voltage specified in Table 10.6.4.17 (column 5);

.4 external insulation of fuses in relation to the ground shall withstand in the dry state and, for category 1 fuses, also in the rain, the one-minute voltages specified in Table 10.6.4.17 (columns 5 and 7);

.5 **external** insulation of fuses between contacts of the same pole of the fuse with the cartridge removed shall withstand in dry state the one-minute voltage specified in Table 10.6.4.17 (column 6), and the insulation between contacts of the same pole of the fuse with the cartridge but without the fusible link between the electrodes in dry state and in the rain – the values specified in Table 10.6.4.17 (columns 6 and 8).

10.6.5 Testing interturn insulation strength.

Windings of electrical machines, transformers, electromagnetic couplings, etc. are subject to interturn tests.

The interturn insulation of electrical machine (electromagnetic coupling) windings is tested when the one runs idle. The tests are carried out in the heated machine (coupling) at a temperature near the maximum reached during the heat test. The test voltage shall be equal to 1,3 times the rated voltage. The test duration is 3 min (5 min for turbogenerators) unless otherwise specified.

At that, the following shall be taken into account:

.1 machines operating within a certain range of voltage shall withstand the interturn insulation test for a voltage equal to at least 1,3 times the highest level of voltage;

.2 if the off-load voltage of synchronous machines (excepting turbogenerators) at the rated exciting current exceeds 1,3 times the rated voltage, the test shall be carried out at that higher off-load voltage corresponding to the rated exciting current;

.3 if a field system of synchronous machines includes a power transformer, the interturn insulation of the latter is tested along with the machine winding insulation at the same voltage;

.4 the interturn insulation of three-phase multispeed motors shall be tested for each speed;

.5 if the test voltage increased up to 1,3 U_r results in the impermissible rise of voltage between the bars of d.c. motors with more than four poles, tests may be carried out at the lesser value of the test voltage than that specified in the approved technical documentation for the machine;

.6 if the voltage of a field-forced exciter exceeds 1,3 times the rated voltage, the test shall be carried out at the maximum forced voltage during 1 min.

For asynchronous motors powered by semi-conducting frequency convertors the insulation voltage impulse tests of winding shall be carried out in accordance with standard IEC 60034-15:2009.

The interturn insulation of voltage transformer windings is tested by the two-fold rated voltage (of higher frequency), which value is specified in 10.6.4.2.

Interturn winding insulation of transformers is tested by applying twice the nominal high frequency voltage to the leads of one of the windings with the other windings open.

Test duration *t,* in min, shall be at least as determined by the formula:

$$t = 2f_{\mathrm{R}}/f \qquad (10.6.5.6)$$

where f_R = rated frequency, in Hz;
f = increased frequency of test voltage equal to $2f_R - 2f_R$ (any value within these limits).

In all cases, the test duration shall be at least 15 s.

The results of interturn insulation tests are considered satisfactory if no insulation breakdown or damage has happened.

10.6.6 Vibration tests.

The tests are carried out in compliance with standard IEC 60068-2-6:2007 (test F_c).

The tests shall carried out for checking the capability of products to perform their functions and maintain the parameter values within the limits specified in documentation for the products and test programs in case of sinusoidal vibration in the specified test conditions.

The test shall be carried out under mechanical and (or) electrical loads, the type, parameters and control methods of which shall be specified in the documentation for the products and test programme.

For the check it is recommended to select parameters, the changing of which allows to consider the stability of the product in general (e.g., vibronoise level, distortion of output signal or changing its value, circuit continuity, instability of contact resistance, etc.).

The method of fastening of the equipment for tests shall be indicated in the technical documentation with due account of the possible positions of the equipment in service. If the technical documentation specifies different methods of fastening in service of equipment, the latter shall be tested using each method of fastening. If the technical documentation specifies different methods of fastening during operation of the equipment, it shall be tested using the method of fastening which is the most dangerous.

The tests shall be conducted in three mutually perpendicular directions in relation to the equipment within two cycles (the cycle means the continuous variation of frequency within the required range from the lowest to the highest and vice versa $f_1 \rightarrow f_2 \rightarrow f_1$,where f_1 and f_2 are the lowest and highest frequency range accordingly) in each direction. The speed variation rate shall be sufficient to check and record of the necessary parameters but not more than two octave per minute.

If the technical documentation specifies different methods of fastening during operation of the equipment, it shall be tested using the method of fastening which is the most dangerous.

The tests shall be carried out on regular shock-mounts, if any.

Categories of equipment according to vibration resistance depending on the operating conditions are given in Table 10.6.6.

Table 10.6.6

Category of equipment	Description
V1	Equipment operated under normal service conditions
V2	Equipment operating under the conditions of increased vibration (e.g. the equipment to be installed directly on the internal combustion engines, air compressors, etc.)
V3	Equipment intended for operation under the conditions of increased vibration, e.g. in exhaust-gas receivers or diesel engine injection systems, etc.

For the equipment of category V1 the tests shall be carried out at the following vibration conditions:

within the frequency range of 2^{+3}_{-0} Hz — 13,2 Hz - amplitude ± 1 mm;

within the frequency range of 13,2 Hz — 100 Hz – acceleration ± 0,7*g*.

For the equipment of category V2 the tests shall be carried out at the following vibration conditions:

within the frequency range of 2^{+3}_{-0} Hz — 25 Hz - amplitude ± 1,6 mm;

within the frequency range of 25 Hz — 100 Hz – acceleration ± 4,0*g*.

For the equipment of V3 category the tests shall be carried out at the following vibration conditions:

within the frequency range of 40 Hz — 2000 Hz, acceleration ± 10,0*g* at the temperature of 600 °C, duration 90 min.

During the test, resonance frequencies, at which the performance characteristics of the equipment are impaired, are determined. The time of search shall be sufficient to reveal resonance.

When resonance frequencies are detected, the amplitude of which exceeds the normal one by two and more times, the tests shall be conducted on each resonance frequency during at least 90 min.

Where a number of resonant frequencies are detected close to each other, the test may be conducted during 120 min with smooth frequency variation within the detected range.

The test duration in case of no resonance condition is 90 min at 30 Hz.

The frequency standards refer to product having mass up to 200 Kg. The equipment over 200 Kg by mass, if it is made up of separate structurally-split blocks, sections, etc., may be subjected to test by the block (section).

The documentation confirming the compliance of the equipment with the operating conditions specified in Part XI "Electrical Equipment" of the RS Rules/C shall be submitted for unsplit equipment.

For single large-sized or heavy products which are impractical for testing on standard test benches instead of maritime full scale tests, calculation data according to the procedures approved by RS, or in compliance with national or international standards may be introduced.

The equipment shall be considered to have passed the tests, if in the process of vibration effect it retains its parameters within the prescribed limits and remains undamaged.

10.6.7 Shock tests.

The tests are carried out in compliance with standard IEC 60068-2-27 (test E_a).

The tests are carried out for checking the capability of products to perform their functions and maintain the parameter values within the limits specified in documentation for the products and test programs in case of multiple mechanical impacts in the specified test conditions.

The test shall be carried out under mechanical and (or) electrical load, the type, parameters and control methods of which shall be specified in the documentation for the products and test program.

For the check it is recommended to select parameters, the changing of which allows to consider the stability of the product in general (e.g., vibronoise level, distortion of output signal or changing its value, circuit continuity, instability of contact resistance, etc.).

The method of fastening the items for testing shall be indicated in the technical documentation with due account of the possible positions of the items in service.

The tests shall be carried out in operating condition under effect of shock load in each of the three mutually perpendicular directions in relation to the item, in turn. The items having axis of symmetry shall be tested in two mutually perpendicular directions (along and perpendicularly to the axis of symmetry). If the technical documentation on the items specifies different methods of fastening in service, the item shall be tested using the most dangerous method of fastening.

The tests shall be carried out on regular shock-mounts, if any.

Categories of equipment according to shock resistance depending on the operating condition are given in Table 10.6.7-1.

Table 10.6.7-1

Category of equipment	Description
G0	Equipment intended for installation on berth-connected ships, ships without ice class, ships with ice classes **Ice1**, **Ice2**, **Ice3**, fixed offshore platforms, and floating offshore oil and gas production units
G3	Equipment not falling under Category G0, intended for installation on ships with ice classes **Arc4** — **Arc6** and on icebreakers **Icebreaker6**
G5	Equipment intended for installation on ships with ice classes **Arc7** — **Arc9**, and icebreakers **Icebreaker7** — **Icebreaker9**

Form of the shock pulse, the acceleration value, shock duration, number of shocks in each position of the item for various categories of equipment are given in Table 10.6.7-2.

Table 10.6.7-2

Category of equipment	Form of the shock pulse	Acceleration, g	Shock duration, ms	Number of shocks in each position	Number of shocks per minute
G0	no tests required				
G3	half-sinusoid	3,0	6 or 30	100 ± 5	40 to 80
G5	half-sinusoid	5,0	6 or 30	100 ± 5	40 to 80

For single large-sized or heavy products which are impractical for testing on standard test benches instead of maritime full scale tests, calculation data according to the procedures approved by RS, or in compliance with national or international standards may be introduced.

The equipment shall be considered to have passed the tests, if during and after the shock effect it retains its parameters within the prescribed limits and remains undamaged.

10.6.8 Tests for resistance to motions and prolonged inclinations.

During testing, the product shall be in an operating condition under standard environmental conditions.

The tests are not required for products without movable parts.

In tests for resistance to motions, the equipment is held in a motions condition sequentially in two mutually perpendicular positions with measurements of parameters in each position. A limiting angle of inclination in each position is 30° with the vertical to each side with a period of 7 s to 9 s.

The duration of tests in each position shall be sufficient for product monitoring and parameters measuring, but not less than 15 min.

In tests for resistance to prolonged inclinations, the product is held in an inclined position sequentially in two mutually perpendicular planes alternately to each of four sides by an angle of 22,5°, and emergency equipment, by an angle of 30° with the horizontal.

The duration of inclined product tests in an operating condition shall be sufficient for monitoring product operation and measuring parameters in each position, but not less than 5 min to each side.

The products of which the technical documentation contains the restrictions on their location onboard a ship due to prolonged inclinations are tested taking into account such restrictions approved by the Register.

The product is considered to have passed the test if it functioned properly, maintained the set parameters and had no jammings, seizures or overheats of movable parts during testing.

10.6.9 Tests for heat stability.

Lighting fixtures that are subjected to thermal tests with a higher degree of severity, as well as products that are subjected to heat tests, which, due to their dimensions, cannot be tested in a heating chamber, or which heat test temperature is higher than the thermal resistance test temperature are exempted from the tests specified in the Chapter.

The tests shall be carried out in compliance with standard IEC 60068-2-2:2007 (test B).

For the equipment where heat dissipation is not provided by its structure, the tests shall be carried out according to test B_b. For the equipment where heat dissipation is provided by its structure (availability of heating units and/or cooling system), the tests shall be carried out according to test B_e.

Categories of equipment according to heat stability depending on the operating conditions are given in Table 10.6.9.

Table 10.6.9

Category of equipment	Description
TH1	Equipment not related to categories TH2 and TH3
TH2	Components and devices intended for installation in switchboards, consoles or housing together with other heat-generating equipment
TH3	Equipment for which higher operating temperatures are possible, for example, directly fitted to internal combustion engines, boilers, etc.

Test timing starts when the product to be tested reaches practically steady-state temperature at test temperature held in the heat chamber.

Prior to the tests commencement and after their end the insulation resistance measurement of equipment shall be carried out under standard environmental conditions.

For the equipment of category TH1 the tests shall be carried out at the following conditions:
temperature: +55 °C ±2 °C;
test duration: 16 h.
For the equipment of category TH2 the tests shall be carried out at the following conditions:
temperature: +70 °C ± 2 °C;
test duration: 16 h.
For the equipment of category TH3 the tests shall be carried out at the following conditions:
temperature: 10 °C exceeding the working temperature or at +85 °C ± 2 °C, whichever is higher;
test duration: 16 h.

The equipment shall be operating during the complete test period and shall be tested together with cooling system in service, where provided. The functional test shall be carried out during the last hour at the test temperature.

When testing accumulator batteries, they shall be charged and discharged at a test temperature. The charge and discharge modes may be normal or accelerated, being selected in each particular case. However, the obtained values of voltage, current and capacity shall be consistent with those specified in the technical documentation for the battery.

Starter batteries shall be discharged in a starter mode.

Only control gear for lighting fixtures with gas-discharge lamps, if intended for installing separately from the lighting fixture, shall be subject to heat stability tests.

In heat stability testing, cable products shall be in a heat chamber at the maximum ambient air temperature and under the maximum load which are permissible for a cable (wire) of a given brand in a long run.

The equipment shall be considered to have passed the tests, if during and after the tests it retains its parameters within the prescribed limits and remains undamaged.

10.6.10 Tests for cold endurance.

The tests shall be carried out in compliance with standard IEC 60068-2-1:2007 (test A).

For the equipment where heat dissipation is not provided by its structure, the tests shall be carried out according to test Ab. For the equipment where heat dissipation is provided by its structure (availability of heating units and/or cooling system), the tests shall be carried out according to test Ad.

Test timing starts when the product to be tested reaches practically steady-state temperature at test temperature held in a cooling chamber.

Prior to the tests commencement and after their end the insulation resistance measurement of equipment shall be carried out under standard environmental conditions.

Categories of equipment according to cold endurance depending on the operating conditions are given in Table 10.6.10.

Table 10.6.10

Category of equipment	Description
TL1	The equipment intended for installation in heated spaces
TL2	The equipment installed on the open deck or in unheated spaces
TL3(DAT)[1]	The equipment installed on the open deck or in unheated spaces of ships with the distinguishing mark **WINTERIZATION (DAT)** in the class notation
[1] Instead of **DAT**, the value of design ambient temperature shall be indicated in brackets	

For the equipment of category TL1 the tests shall be carried out at the following conditions:
temperature: +5 °C ± 3 °C;
test duration: 2 h.

For the equipment of category TL2 the tests shall be carried out at the following conditions:
temperature: - 25 °C ± 3 °C;
test duration: 2 h.

For the equipment of category TL3 (**DAT**) the tests shall be carried out at an operating temperature in the chamber equal to the design external temperature.
test duration: 2 h.

The equipment shall be in inoperative condition during the complete testing period, expect for the devices that ensure the performance of products in low temperatures (for example: electrical heating devices) and functional test shall be carried out during the last hour at the test temperature.

When testing accumulator batteries, they shall be charged and discharged at a test temperature. The charge and discharge modes may be normal or accelerated, being selected in each particular case. However, the obtained values of voltage, current and capacity shall be consistent with those specified in the technical documentation for the battery.

Starter batteries shall be discharged in a starter mode.

Upon the completion of the trials, the functional tests shall be carried out under standard environmental conditions.

The equipment shall be considered to have passed the tests, if during and after the tests it retains its parameters within the prescribed limits and remains undamaged.

10.6.11 Tests for exposure to temperature changes.

To be tested are the products intended for installation on open decks.

The test procedure is as follows:

.1 a product is held in a humidity chamber during 5 days under conditions of stabilization time of the test for humidity resistance (95 — 100 % at a temperature of 25 °C);

.2 after the holding in the chamber during 2 — 3 h under normal environmental conditions, the product is subjected in succession to at least two cycles of the following tests:

gradual cooling in the chamber down to the temperature of − 25 °C or DAT (for the equipment supplied on board the ships with distinguishing mark **Winterization (DAT)** in the class notation);

switching-on under the rated load with a temperature at the end of tests elevated up to +55 °C). On reaching the thermal equilibrium, the cycle is completed;

.3 after completing the last cycle, the product is placed in the humidity chamber and the test for humidity resistance is carried out in a full scope according to 10.6.12.

The test for exposure to temperature changes is recommended to combine with tests for heat stability and cold endurance.

The product is considered to have passed the tests if it had passed the test for humidity resistance performed immediately after the completion of the last cycle of the tests.

10.6.12 Tests for humidity resistance.

The tests shall be carried out in compliance with standard IEC 60068- 2- 30:2005 (test D_b).

Before and after the tests the insulation resistance measurement of equipment shall be carried out under standard environmental conditions.

Before the commencement of testing, the equipment shall be held at temperature +25 °C ± 3 °C and not less than 95 % humidity within the time required for the equipment to reach practically steady-set temperature.

The tests shall be carried out with +55 °C ±2 °C and at least 95 % humidity. The duration of the tests shall include two cycles 2 x (12 h + 12 h).

The equipment shall be operating during the complete first cycle and switched off during the second cycle except for the functional test.

The functional tests shall be carried out during the first two hours of the first cycle at the test temperature and during the last two hours of the second cycle at the test temperature. Duration of the second cycle can be extended due to more convenient handling of the functional test.

Insulation resistance measurements and performance test during 1 — 3 hours shall be carried out following removal from the cold chamber and recovery at standard atmosphere conditions.

The equipment of any design shall be tested in regular enclosures, except for the equipment having degree of protection against penetration of water being 6 (IPX6) and over, the covers of which during the tests in the chamber shall be open. The tests shall be conducted with the equipment being put periodically into operation.

If large-dimension assembled machines are impractical to test for humidity resistance, these may be tested in knock-down form (e.g. separate tests of armatures, rotors and parts of split stators). In such cases, the values of insulation resistance received in measurements after testing shall be referred (converted) to the machine as a set.

Prior to humidity resistance testing, the specimen leads shall be brought out from a humidity chamber, fanned out and prepared for measuring insulation resistance and testing insulation strength. Cores insulation and lead sheaths shall be sealed. Cable products shall be tested in deenergized state.

The equipment shall be considered to have passed the tests, if during and after the tests it retains its parameters within the prescribed limits and remains undamaged.

10.6.13 Tests for exposure to hoarfrost and dew.

The products installed on open decks and in other places potential for hoarfrost formation on the product shall be tested for exposure to hoarfrost and dew.

The tests are carried out according to the following procedure:

.1 the switched-off product is placed in a cold chamber and held there during 2 h at a temperature of – 20±5 °C;

.2 the product is removed from the chamber and the voltage specified in a test program (the maximum permissible value of the operating voltage is considered as adequate) is applied to its terminals. The product is held at such voltage (no load) under standard environmental conditions till hoarfrost thawing and drying, but at least for 2 h.

The product is considered to have passed the test if no breakdown of, or damage to, the product insulation has occurred.

10.6.14 Tests for exposure to salt mist (corrosion resistance).

The tests shall be carried out in compliance with IEC 60068-2-52:2017, test K_b.

Categories of equipment according to corrosion resistance depending on the operating condition are given in Table 10.6.14-1.

Table 10.6.14

Category of equipment	Description
C0	The equipment intended for installation indoors
C1	The equipment intended for installation on the open deck or in open spaces

Before and after the tests the insulation resistance measurement of equipment shall be carried out under standard environmental conditions.

Before the test, the initial functional test shall be performed. The equipment shall be inoperative condition during the testing period.

For the equipment of category C0 the tests for resistance to sea mist (corrosion resistance) are not required.

For the equipment of category C1 the tests shall be carried out in 4 cycles. Each cycle consists of the following stages:

salt solution atomization during 2 h;

storage of the equipment in the chamber during 7 days.

Functional tests of the equipment shall be carried out on the seventh day of each storage period.

Upon completion of the fourth test cycle after reinstatement (washing and drying of the sample) the insulation resistance shall be measured and the functional tests shall be carried out during 4 — 6 h.

For products in metal casings with special coatings as well as metal components (glands, cable trays and ladders, cable ties etc.) it is allowed to perform accelerated cyclic tests for salt mist exposure by means of the cyclic spraying of aqueous salt solution (sea mist) at +27±2 °C.

Upon finalization of tests it is necessary to make sure that there is no evidence of corrosion or it is exclusively superficial.

The test for exposure to salt mist applies to cable products having outer metallic braids, sheaths and armor.

The equipment shall be considered to have passed the tests, if during and after the tests it retains its parameters within the prescribed limits and remains undamaged.

10.6.15 Fungus resistance tests.

The tests shall be carried out in compliance with standard IEC 60068-2-10 (test J), test variant 2.

The products installed in wet spaces, except for those in the insulated enclosure, where fungus-proof coatings were applied, shall be subject to fungus resistance.

Electrical parameters and functioning of the product shall be checked prior to tests.

The equipment is considered to have passed the test if, resulting the inspection by the unaided eye, no noticeable growth of mold is revealed or single germinating spores only are seen on them with a 50X magnifying glass, and no changes in physical and mechanical properties of the specimen were detected, and the equipment is in operable condition.

The tests for fungus resistance are performed at a microbiological laboratory by competent personnel.

The surveyor may ignore the technical supervision of the tests, but their results shall be submitted in the form of a record and to be consistent with the above procedure.

10.6.16 Tests for exposure to solar radiation.

To be tested are the products designed for operation on the open deck and which will fully or partially be exposed to continuous solar radiation while in service.

The tests are carried out in a special chamber at an air temperature of 55±2 °C in the chamber shade. The product or its part is subjected to irradiation from infra-red and ultra-violet radiation sources during 120 h. It is allowed to expose nto the radiation not the whole product, but its separate parts provided the product is made of homogeneous material. The radiation plant intensity shall provide the total heat-flux density not less than 1125 W/m^2, the flux density of the ultra-violet part of the spectrum with a wave length of 280 to 400 nm shall be at least 42 W/m^2.

The product is considered to have passed the test if:

.1 no deformation, cracking, delamination, buckling, ungluing of parts made of plastic and other materials have occurred;

.2 parameters and insulation resistance have remained normal;

.3 visibility and distinguishability of inscriptions and symbols on scales or other parts of the product have not deteriorated.

10.6.17 Tests of enclosure protection.

Protection against penetration of hard objects.

These tests apply to products with voltage up to 1000 V.

Testing the degree of protection for voltage over 1000 V shall be in compliance with IEC standard 60529:2013.

Testing the protection degree of rotation electrical machines shall be in compliance with IEC standard 60034-5:2000+AMD:2006.

The protection degree against penetration inside the product of foreign hard objects is checked during the tests.

The test procedure for product enclosures for the conformity of the protective enclosure regarding the penetration inside the product of foreign hard objects and criteria for tests assessment are given in Table 10.6.17-1.

Table 10.6.17-1

Degree of protection (first numeral after IP)	Test procedure and assessment criteria
1	A rigid sphere 50 mm in diameter is applied to any holes in the product enclosure with a force of 50 N ± 10 %. The results are considered satisfactory if the sphere does not pass through and touch current-carrying parts inside the product.
2	A test probe (refer to Appendix 10) connected to a safety voltage (not below 40 V) source is applied in any possible position with a force of 10 N ±10%, as well as a rigid sphere 12,5 mm in diameter is applied to any holes with the 30 N ±10%. The results are considered satisfactory if the pilot lamp of the probe does not illuminate, and the probe does not get through any of the holes and touch current-carrying or moving parts inside the product enclosure.
3	A rigid steel wire of 2,5 mm in diameter is applied to any hole in the enclosure with a force of 3 N ±10 %. The results are considered satisfactory if the wire does not get through any of the holes in the enclosure.
4	Similar, the wire diameter is 1 mm and force applied 1N ±10 %
5	Enclosures are of necessity in one of two categories: – Category 1: Enclosures where the normal working cycle of the equipment causes reductions in air pressure within the enclosure below that of the surrounding air, for example, due to thermal cycling effects. – Category 2: Enclosures where no pressure difference relative to the surrounding air is present. The enclosure shall be deemed category 1 unless the relevant product standard for the equipment specifies that the enclosure is category 2. **Test of Category 1 enclosures.** The enclosure is supported inside the test chamber and the pressure inside the enclosure is maintained below the surrounding atmospheric pressure by a vacuum pump. The suction connection shall be made to a hole specially provided for this test. If not otherwise specified in the relevant product standard, this hole shall be in the vicinity of the vulnerable parts. If it is impracticable to make a special hole, the suction connection shall be made to the cable inlet hole. If there are other holes (for example, more cable inlet holes or drain holes) these shall be treated as intended for normal use on site. The product is blown over with talc screened through a mesh with a clear opening of 75 μm and wire thickness of 50 μm on the basis of 2 kg of talc per 1 m^3 of the chamber volume. The talc applied during the test shall not be use more than 20 tests. The object of the test is to draw into the enclosure, by means of depression, a volume of air 80 times the volume of the sample enclosure tested without exceeding the extraction rate of 60 volumes per hour. In no event shall the depression exceed 2 kPa (20 mbar) on the manometer. If an extraction rate of 40 to 60 volumes per hour is obtained the duration of the test is 2 h. If, with a maximum depression of 2 kPa (20 mbar), the extraction rate is less than 40 volumes per hour, the test is continued until 80 volumes have been drawn through, or a period of 8 h has elapsed. **Tests of Category 2 enclosures.** The enclosure under test is supported in its normal operating position inside the test chamber, but is not connected to a vacuum pump. Any drain-hole normally open shall be left open for the duration of the test. The test shall be continued for a period of 8 h. If it is impracticable to test the complete enclosure in the test chamber, one of the following procedures shall be applied: – testing of individually enclosed sections of the enclosure; – testing of representative parts of the enclosure, comprising components such as doors, ventilation openings, joints, shaft seals, etc., in position during test; – testing of a smaller enclosure having the same full-scale design details. In the last two cases, the volume of air to be drawn through the enclosure under test shall be the same as for the whole enclosure in full scale.

Degree of protection (first numeral after IP)	Test procedure and assessment criteria
	The protection is satisfactory if, on inspection, talcum powder has not accumulated in a quantity or location such that, as with any other kind of dust, it could interfere with the correct operation of the equipment or impair safety. No dust shall deposit where it could lead to tracking along the creepage distances.
6	The enclosure shall be deemed category 1, whether reductions in pressure below the atmospheric pressure are present or not. The test shall be carried out as for the enclosure of Category 1 (degree 5X). The protection is satisfactory if no deposit of dust is observable inside the enclosure at the end of the test (complete protection against penetration of dust).

If complete equipment is impractical to test, main parts of the equipment or smaller equipment but having full-scale structural parts subject to testing shall be tested.

Water protection.

The test procedure and the provisions on the assessment of testing the protective product enclosure against the ingress of water are given in Table 10.6.17-2. Testing the degree of protection shall be in compliance with IEC standard 60529:2013.

Table 10.6.17-2

Degree of protection (second numeral after IP)	Test procedure and assessment criteria
1	Protection against vertically-falling water drops. The product in a normal working position is placed on a turntable. The turntable on which the enclosure is placed has a rotation speed of 1 r/min and the eccentricity (distance between turntable axis and specimen axis) is approximately 100 mm. The enclosure under test is placed in its normal operating position under the drip box, the base of which is larger than that of the enclosure. Except for enclosures designed for wall or ceiling mounting, the support for the enclosure under test shall be smaller than the base of the enclosure. The enclosure is exposed to vertically-falling water drops from a tank with water through holes in its bottom arranged at nodes of an imaginary net with a mesh dimensioned 20 mm. The area of the bottom shall be larger than that of the product under test. An enclosure normally fixed to a wall or ceiling is fixed in its normal position of use to a wooden board having dimensions which are equal to those of that surface of the enclosure which is in contact with the wall or ceiling when the enclosure is mounted as in normal use. Water temperature shall not differ from the temperature of tested item by more than 5 °C. Delivery rate shall be 1 mm/min. The duration of test is at least10 min. The test results are considered satisfactory if water drops penetrating the product do not break its normal functioning and water does not accumulate in single places and close to cable entries.
2	Protection against water drops. Tests are conducted in the same way as for degree of protection 1 herewith table on which the enclosure is placed does not turn as in the case of the test for the second characteristic numeral 1. Tilt angle for each position is 15° on either side of the vertical in two mutually perpendicular planes. The enclosure is tested for 2,5 min in each of four fixed positions of tilt. Delivery rate shall be 3 mm/min. The total duration of the test is 10 min. The assessment of test results is also as for the protection degree 1.
3	Protection against rain drops. Tests with oscillating tube or spray nozzle in accordance with the standard for a specified product. **Tests with oscillating tube.** The product in a normal working position is sluiced with fine water jets from holes in a pipe bent in the shape of a semicircle. The support for enclosure shall not be perforated. The enclosure to be tested is placed at the centre point of the semicircle. The tube is caused to oscillate through an angle of 120°, 60° on either side of the vertical, the time for one complete oscillation (2 × 120°) being about 4 s and the test duration being 5 min.

Degree of protection (second numeral after IP)	Test procedure and assessment criteria
	The enclosure is then turned through a horizontal angle of 90° and the test is continued for a further 5 min. An average rain intensity per one hole is 0,07±5 % l/min. The number of holes is defined depending on the tube radius. The maximum acceptable radius of the oscillating tube is 1 600 mm. **Tests with spray nozzle.** The product in a normal working position is sprayed at an angle of ±60° vertically to the spray nozzle on the maximum distance of 200 mm. For this test the counterbalanced shield is installed at 30°. Average delivery rate is 10±5 % l/min. The water pressure is adjusted to give the specified delivery rate in the range of 50 –150 kPa. The pressure shall be kept constant during the test. The test duration is 1 min/m^2 of the calculated surface area of the enclosure (excluding any mounting surface), with a minimum duration of 5 min. The test results are assessed as for the protection degree 1.
4	Similar to the protection degree 3 but with specifications. **Tests with oscillating tube.** The oscillating tube has spray holes over the whole 180° of the semicircle. The tube is caused to oscillate through an angle of almost 360°, 180° on either side of the vertical, the time for one complete oscillation (2× 360°) being about 12 s. The duration of the test is 10 min. If not specified otherwise in the relevant product standard, the support for the enclosure under test is perforated so as to avoid acting as a baffle and the enclosure is sprayed from every direction by oscillating the tube to the limit of its travel in each direction. **Tests with spray nozzle.** The counterbalanced shield is removed from the spray nozzle and the enclosure is sprayed from all practicable directions. The test results are assessed as for the protection degree 1.

Degree of protection (second numeral after IP)	Test procedure and assessment criteria
5	Protection against water jets. The test is made by spraying the enclosure from all practicable directions with a stream of water from a test nozzle. The conditions to be observed are as follows: – internal diameter of the nozzle: 6,3 mm; – delivery rate: 12,5 l/min ±5 %; – water pressure: to be adjusted to achieve the specified delivery rate; – core of the substantial stream: circle of approximately 40 mm diameter at 2,5 m distance from nozzle; – test duration per square metre of enclosure surface area likely to be sprayed: 1 min; – minimum test duration: 3 min; – distance from nozzle to enclosure surface: between 2,5 m and 3 m. The test results are assessed as for the protection degree 1.
6	Protection against ship's deck conditions (protection against high pressure water jet). The test is made by spraying the enclosure from all practicable directions with a stream of water from a test nozzle. The conditions to be observed are as follows: – internal diameter of the nozzle: 12,5 mm; – delivery rate: 100 l/min ±5 %; – water pressure: to be adjusted to achieve the specified delivery rate; – core of the substantial stream: circle of approximately 120 mm diameter at 2,5 m distance from nozzle; – test duration per square metre of enclosure surface area likely to be sprayed: 1 min; – minimum test duration: 3 min; – distance from nozzle to enclosure surface: between 2,5 m and 3 m. The test results are assessed as for the protection degree 1.

Degree of protection (second numeral after IP)	Test procedure and assessment criteria
7	Protection against immersion in water. The test is made by completely immersing the enclosure in water in its service position as specified by the manufacturer so that the following conditions are satisfied: **.1** the lowest point of enclosures with a height less than 850 mm is located 1 000 mm below the surface of the water; **.2** the highest point of enclosures with a height equal to or greater than 850 mm is located 150 mm below the surface of the water; **.3** the duration of the test is 30 min; **.4** the water temperature shall not differ from that of the equipment by more than 5 °C. The water shall not penetrate the enclosure at specified pressure and time. For electrical machines the test shall be replaced by the following: – the machine shall be tested with an inside air pressure of about 10 kPa (0,1 bar); – the duration of the test is 1 min. The test is deemed satisfactory if no air leaks are found during the test. Air leakage may be detected either by submersion, the water just covering the machine, or by the application onto it of a solution of soap in water.
8	Unless there is a relevant product standard, the test conditions are subject to agreement between manufacturer and user, but they shall be more severe than those for degree of protection 7 and they shall take account of the condition that the enclosure will be continuously immersed in actual use.
N o t e s : 1. Electrical machines having degrees of protection 1, 2, 3 and 7 are tested in a nonoperating condition, while those with degrees of protection 4, 5 and 6, in both an operating and a non-operating conditions. The duration of each test is at least 10 min. 2. Following product enclosure tests against water penetration, electrical machines are immediately subjected to tests for insulation strength. If tests are carried out on non-rotating machines, prior to insulation strength testing, these latter shall be operational under idling conditions for 15 min. The test voltage therewith shall make up 50 % of the normal test voltage, but at least 125 % of the rated voltage. Electrical equipment designed for underwater operation regarding its structure and insulation is considered equivalent to the degree of protection 8. An enclosure designed with the second characteristic numeral 0 to 6 means simultaneous compliance with all requirements for smaller numerals.	

10.6.18 Heat test.

In testing, a product shall operate in a nominal mode.

Products intended for operation in a short-time mode shall be tested being from the start in a practically cold state. The test duration shall be not less than that of the mode specified for product operation.

The other products may be tested starting both with the practically cold state and hot state. The test continues until practically steady-state temperature.

The test of products designed for supply by three-phase current (e.g. of switching devices of which the poles therewith are connected in series) may be carried out by single-phase current at currents up to 400 A.

The product shall be tested in an operational position.

During tests, the opening parts of enclosures (doors, covers, detachable casings, etc.), as well as holes for cable entries shall be in a regular operational position. The parts to be monitored in heating shall be specified in the product test program and procedure.

Permissible temperatures of heating insulating materials of different classes for long-term operation are as follows:

Insulation class	Permissible temperature, in °C
A	105
E	120
B	130
F	155
H	180
C	above 180

If insulation consists of different materials, the temperature of potential heating for each of these materials shall not exceed the one permissible for a given material.

If insulation consists of several layers of different materials and it is impractical to measure the temperature of single layers heating, the permissible temperature for use of the lowest class material is considered as the permissible one of such insulation heating.

The material used for mechanical protection and spacers only may be of a lower insulation class.

The permissible excesses of temperature for different parts of breakers relative to an environmental temperature +45 °C shall not exceed values specified in Table 10.6.18.

Table 10.6.18

Nos.	Parts of a breaker			Permissible temperature excess, in °C
1	Solid spring contacts	Of copper	In continuous duty	35
			In 8 h continuous running duty, intermittent and short-time duties	55
		Of silver or with silver inserts		Refer to footnote 1
		Of other materials or metal-ceramic agglomerates		Depending on the type of metal or metal-ceramic agglomerate[1]
2	Brush contacts			25
3	Busbar joints	Unprotected against oxidization in the point of contact		45
		Protected against oxidization in the point of contact	By a tinning or cadmium coating	55
			By silver coating	75
		Soldered or welded		75

Nos.	Parts of a breaker		Permissible temperature excess, in °C
4	Magnets, cores and the like		Like the insulation in contact with these parts
5	Manual controls	Of metal	10
		Of insulating material	20
6	Cases, shields or parts unprotected against an inadvertent touch		35
7	Rheostat cases protected against an inadvertent touch		200
8	Air-cooled rheostats in measurements at a distance of 25 mm		175
[1] The temperature may be exceeded up to such a value when a heated part does not cause the increase of an adjacent parts temperature above the temperatures permissible for them.			

10.6.19 Measurement of switchgear insulation distances.

Both the air and insulation material surface distances between alive parts of different potentials, or between alive parts and earthed metallic parts or an equipment frame shall be consistent with working voltages and operational conditions of equipment with due regard for the insulating materials used. Such distances shall comply with the requirements of standards for ship's electrical equipment approved by the Register.

Where instructions on insulation distances are lacking in technical documentation, the data in Table 10.6.19 are recommended.

The insulation distances for equipment rated over 7500 V shall be determined in compliance with national and international standards.

Table 10.6.19

Electrical equipment	Insulation distances	Insulation distances, in mm, for voltage, in V																			
		≤ 60		61 – 250		251 – 500		501 – 750		751 – 1000		1001 – 1500		1501 – 2000		2001 – 3000		3001 – 5500		5501 – 7500	
		a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
Switchgear, electrical machines, transformers	Between noninsulated busbars and earthed metallic parts, or between noninsulated busbars related to different poles or phases	6	8	8	14	14	20	30	–	30		40	–	50	–	60		90	–	105	–
	Between live parts other than busbar joints (not related to commutators)	3	5	5	7	8	10	10	14	14	20	20	28	28	36	36	50	55	80	75	105
Electrical apparatus: wiring accessories of intercommunication, ship's control and monitoring devices	Between noninsulated busbars and earthed metallic parts, or between noninsulated busbars related to different poles or phases	6	8	8	14	14	20	30	–	30	–	40	–	50	–	60	–	90	90	–	105
	Between live parts (other than busbar joints)	–	–	–	–	–	–	10	14	14	20	20	28	28	36	36	50	50	75	75	105
Electrical cooking appliances, lighting fixtures, wiring accessories	Between live parts and earthed metallic parts	3	4	5	7	8	10	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Note. a – air distance; b – insulation material surface distance. Distances in column "b" are related to the materials tolerant to surface-leakage currents.																					

10.6.20 Tests for the level of radiated electromagnetic emission.

The tests shall be carried in accordance with standards CISPR 16-2-3:2016 and IEC 60945:2002 for the frequency range of 156 — 165 MHz.

During tests, the equipment shall operate under normal test conditions, and the setting of controls affecting the level of emissions shall be varied in order to ascertain the maximum emission level. If the equipment has more than one energized state, the state which produces the maximum emission level shall be ascertained, and full measurements for that state shall be made.

Categories of equipment according to electromagnetic compatibility depending on the operating conditions are given in Table 10.6.20.

Table 10.6.20

Category of equipment	Description
E1	Equipment installed on the open deck and navigation bridge
E2	Equipment installed in enclosed machinery and other enclosed spaces of the ship

For the equipment of category E1, the levels of radiated electromagnetic emission at a distance of 3 m shall not exceed the following values within the frequency ranges stated below:

0,15 — 0,3 MHz - 80 — 52 dBμV/m;
0,3 — 30 MHz - 52 — 34 dBμV/m;
30 — 1000 MHz - 54 dBμV/m;
1000 — 6000 MHz - 54 dBμV/m;
except for the range 156 — 165 MHz where 24 dBμV/m shall be established.

Note. For the equipment with the highest internal frequency of less than 2000 MHz, the upper limit of frequency range is allowed to be set at 2000 MHz.

Alternatively, the radiation limit at a distance of 3 m from the enclosure port over the frequency in the range from 156 to 165 MHz shall be 30 dBμV/m peak.

For the equipment of category E2, the levels of radiated electromagnetic emission at a distance of 3 m shall not exceed the following values within the frequency ranges stated below:

0,15 — 30 MHz - 80 — 50 dBμV/m;
30 — 100 MHz - 60 — 54 dBμV/m;
100 — 1000 MHz - 54 dBμV/m;
1000 — 6000 MHz - 54 dBμV/m;
except for the range from 156 to 165 MHz where 24 dBμV/m shall be established.

Note. For the equipment with the highest internal frequency of less than 2000 MHz, the upper limit of frequency range is allowed to be set at 2000 MHz.

The transmission bandwidth of the receiver for the frequency range from 0,15 to 30 MHz and from 156 to 165 MHz shall be 9 kHz and in the frequency range from 30 to 156 MHz and from 165 MHz to 1 GHz – 120 kHz.

The equipment to be tested shall be presented in full set with all the cables connecting devices and installed in the normal working position.

If the equipment to be tested consists of several units, the connecting cables between the basic and all other units shall have a maximum length stated in the firm's (manufacturer's)

specification. The existing inlets and outlets of the equipment to be tested shall be connected to the equivalents of usually used auxiliary equipment with the use of cables of maximum length specified by the firm (manufacturer).

The surplus length of the cables shall be coiled and located at 30 – 40 cm (horizontally) from the connectors to which they are hooked up. If this is impracticable, the positioning of the surplus length of the cables shall meet the stated requirements as close as possible.

The measuring antenna shall be located at a distance of 3 m from the equipment to be tested. To determine the maximum interference level the antenna which measures the electric field strength shall be adjusted in the vertical extent only and be capable of rotating to obtain horizontal and vertical polarization or for rotation of the equipment itself located in the orthogonal plane of the antenna at its middle point level.

10.6.21 Test for the level of emitted conducted interference.

The tests shall be carried out in compliance with standard CISPR 16-2-1:2017.

For the equipment of category E1 (refer to Table 10.6.20), the levels of the caused interference in the supply circuits and input-output circuits shall not exceed the following values within the frequency ranges stated below:

10 — 150 kHz – 96 — 50 dBμV;

150 — 350 kHz – 60 — 50 dBμV;

350 kHz — 30 MHz – 50 dBμV.

For the equipment of category E2 (refer to Table 10.6.20), the levels of caused interference in the supply circuits and input-output circuits shall not exceed the following values within the frequency ranges stated below:

10 — 150 kHz – 120 — 69 dBμV;

150 — 500 kHz – 79 dBμV;

500 kHz — 30 MHz – 73 dBμV.

The transmission bandwidth of the receiver when measurements are made in the frequency range from 10 kHz to 150 kHz shall be 200 Hz and in the frequency range from 150 kHz to 30 MHz – 9 kHz.

The connecting cables between the electric power supply terminals of the tested equipment and the artificial mains network shall be screened. The distance between the equipment to be tested and the artificial mains networks shall not exceed 0,8 m in length. In cases when the current in the supply line of the product under testing exceeds the permissible current of artificial mains networks, interference voltage may be measured by means of artificial mains networks as a voltage probe or a voltage probe according to CISPR 16-2-1:2017. If the tested equipment consists of several units with separate terminals for alternating and direct current, the power supply terminals with similar voltage rating may be connected in parallel.

When making measurements, all the measuring instruments and the equipment being tested shall be installed on an earthed plane and connected thereto. Where the use of an earthed plane is impossible, an artificial earthing shall be carried out by connecting to a metal frame or casing of the equipment being tested.

10.6.22 Test for resistance to external electromagnetic interference.

When conducting these tests, the equipment shall be presented in its normal working set and operate under normal conditions.

During the tests for the resistance to external electromagnetic interference the results shall be assessed against the functioning (performance) criteria related to the working

conditions and functional purpose of the equipment being tested. These criteria shall be defined as follows:

functioning criterion A: the equipment being tested shall continue to operate for its designed purpose during and after the tests. No degradation of performance or loss of functions specified in the appropriate standard for equipment and technical documentation of the manufacturer shall be allowed;

functioning criterion B: the equipment being tested shall continue to operate for its designed purpose during and after the tests. No degradation of performance or loss of functions specified in the appropriate standard for equipment and technical documentation of the manufacturer shall be allowed. Nevertheless, degradation or loss of functions or performance which can be self-restored may be allowed during the tests, but no change in the mode set or operational data shall be allowed;

functioning criterion C: temporary degradation or loss of function or performance shall be allowed during the tests. Along with that, the self-restoring function is ensured or restoration of the disturbed function or performance may be provided in the end of the tests through the use of adjustments in accordance with the standard for equipment and technical documentation of the firm (manufacturer).

10.6.22.1 Tests for resistance to conductive low frequency interference.

These tests simulate effect of the interference generated, for example, by electronic consumers (thyristors, etc.) and introduced in the power supply circuits in the form of higher harmonic voltage. These tests shall not be applied to the equipment supplied solely by accumulators.

The equipment shall remain operable (functioning criterion A) when additional test voltages are imposed on its supply voltage:

for the electrical equipment supplied by direct current:

frequency range: from 50 Hz to 10 kHz;

test voltage (effective value): 10 % of the nominal supply voltage;

test signal maximum power – 2 W;

for the electrical equipment supplied by alternating current:

the frequency range from the rated supply voltage frequency to the 200-th harmonic voltage;

test voltage (effective value): 10 % from the rated supply voltage frequency to the 15-th harmonic; reducing from 10 % to 1 % in the range from the 15-th to 100-th harmonic; 1 % in the range from the 100-th harmonic to 200-th harmonic;

test signal maximum power – 2 W, minimum value of test voltage effective value – 3 V. The specified value of test voltage may be reduced in case the maximum power exceeds.

10.6.22.2 Tests for resistance to conducted radio frequency interference.

The tests shall be carried out in compliance with standard IEC 61000- 4- 6:2013.

During the tests, the radio frequency voltages are generated, which arise in the power supply, control and signalling circuits due to operation of the electric power converters, echo sounders, shipboard radio transmitters on frequencies below 80 MHz.

The tests shall be carried out with the use of a generator connected sequentially to each coupler and decoupler. The unused input terminals of the couplers and decouplers used for connection of the test generator shall be loaded by an equivalent with noninductive impedance equal to the characteristic impedance of the cable. The test generator shall be tuned for each circuit design of the coupler and decoupler; whilst so doing, the additional and tested equipment shall be disconnected and replaced by a noninductive resistors of suitable ratings (when the cable impedance is 50 Ohm additional resistances shall be 150 Ohm). The test generator shall be tuned in such a way as to provide a non-modulated voltage of the required level at the input terminals of the equipment being tested.

The equipment shall remain operable (functioning criterion A) at the following levels of the test signal:

for the equipment of E2 category (refer to Table 10.6.20) the effective voltage value: 3 V at the frequency varying in the range from 150 kHz to 80 MHz. For the equipment of E1 category (refer to Table 10.6.20), the effective voltage value shall be increased up to 10V at points with frequencies: 2 MHz, 3 MHz, 4 MHz, 6,2 MHz, 8,2 MHz, 12,6 MHz, 16,5 MHz,18,8 MHz, 22 MHz and 25 MHz;

the frequency variation rate: ≤1,5 x 10^{-3} decade/s (or 1 % / 3 s);

modulation depth: 80 %;

modulation frequency: 1000 Hz.

N o t e . At the modulation frequency of the input signal being 1000 Hz the modulation frequency of the interference signal may be chosen to be 400 Hz.

10.6.22.3 Test for resistance to nanosecond pulse interference due to burst electrical fast transient in the AC and DC supply lines, signal, data and control circuits.

The tests shall be carried out in compliance with standard IEC 61000-4-4:2012.

During these tests, the fast low-energy transient processes generated by the equipment the switching on of which is accompanied by sparking at contacts shall be simulated.

The equipment shall remain operable (operability criterion B) if pulse voltage with the following parameters is applied to the inlets of the supply sources:

pulse rise time: 5 ns (between 10 % and 90 % amplitude level);

duration of unit pulse: 50 ns (at 50 % value);

amplitude: 2kV – when applied to the supply circuits relative to the casing;

amplitude: 1 kV – when applied to the signal, control and communication supply circuits;

unit pulse recurrence frequency: 5 kHz or 100 kHz (pulse recurrence frequency 5 kHz is more applicable during the tests, nevertheless, frequency 100 kHz is more realistic. The equipment manufacturer shall define the recurrence frequency for the particular product);

pulse burst duration: 15 ms;

burst recurrence period: 300 ms;

duration: 5 min for each positive and negative pulse polarity.

For a.c. and d.c. power supply circuits, the tests using a capacitive coupling clamp are permitted if the coupling isolation method in accordance with 6.3 of IEC 61000-4-4:2012 is not possible (refer to 6.4.1 of IEC 61000 -4-4:2012).

10.6.22.4 Tests for resistance to microsecond pulse interference (Surge).

The tests shall be carried out in compliance with standard IEC 61000-4-5:2017.

These tests simulate effects of the pulse voltages induced by switching "ON" or "OFF" high power inductive consumers.

The equipment shall retain its performance (performance criterion B), when pulses of the following characteristics are applied to its power lines:

pulse rise time: 1,2 μs (front time);

pulse duration: 50 μs (time to half value);

amplitude (peak): 1 kV line/earth;

amplitude: 0,5 kV line/line;

recurrence frequency: ≥ 1 pulse/min;

Short circuit current:

pulse rise time: 8 μs (front time);

pulse width: 20 μs (time to half value);

repetition rate: ≥ 1 pulse/min;

pulse number: 5 pulses for each positive and negative pulse polarity.

10.6.22.5 Tests for electrostatic discharge resistance.

The tests shall be carried out in compliance with standard IEC 61000-4-2:2008.

During these tests the discharges of the static electricity are simulated which can arise when persons touch the appliance.

The discharges from the generator shall be applied to those points and surfaces that could normally be reached by the operator. In testing the preferable method is the contact discharge. If use of the contact method is impossible (where painted surfaces are available) air discharge shall be used.

The equipment shall continue to operate as intended after the tests (performance criterion B), at the following parameters of electrostatic discharges:

amplitude: 6 kV — for contact discharge,

amplitude: 2 kV, 4 kV and 8 kV — for air discharge;

number of pulses: 10 pulses for each positive and negative pulse polarity.

If voltage test is satisfactory of 8 kV for air discharge, air discharge voltage tests of 2 kV and 4 kV may not be carried out.

10.6.22.6 Tests for resistance to electromagnetic field.

The tests shall be carried out in compliance with standard IEC 61000-4-3:2020 or IEC 61000-4-3:2006+AMD1:2007+AMD2:2010.

During these tests electromagnetic fields radiated by different transmitters are simulated as may occur when persons touch the appliance, e.g. shipboard fixed and portable VHF radio sets adjacent to the equipment operate on frequencies over 80 MHz.

The equipment shall remain operable (performance criterion A) at the following parameters of the electromagnetic field:

frequency range: 80 MHz to 6 GHz;

frequency sweep rate: $\leq 1{,}5 \times 10^{-3}$ decade/s (or 1 % / 3 s);

field strength: 10 V/m;

modulation depth: 80 %;

modulation frequency: 1000 Hz.

N o t e . When the modulation frequency of the input signal of the equipment being tested is 1000 Hz, the modulation frequency of the interference signal may be chosen to be 400 Hz.

10.6.23 Tests of electrical machines.

10.6.23.1 Overcurrent test.

Generators after heating up to the steady-state temperature corresponding to the rated load shall withstand overcurrent loads specified in Table 10.6.23.1-1.

T a b l e 10.6.23.1-1

Generator	Overcurrent, %/I_{rated}	Overcurrent duration, in s
AC generators having rated output not exceeding 1200 kVA	50	30
AC generators having rated outputs above 1200 kVA	50	15
Direct current	50	15

In testing a.c. generators for a short-time overcurrent, it is recommended to simultaneously check the sufficiency of their excitation reserve. The check is carried out at a power factor of 0,6 (cos φ).

The excitation reserve is considered sufficient if the generator voltage is not lowered by more than 10 % during 2 min of testing by a current 150 % of the rated one at the above power factor.

Electric motors shall withstand torque overloads specified in Table 10.6.23.1-2 without a stop or sudden speed change.

Table 10.6.23.1-2

Electric motors	Torque overload, in %	Overload duration, in s	Comments
Polyphase synchronous, as well as squirrel-cage motors with a starting current less than a 4,5-fold rated current	50	15	Frequency, voltage and excitation shall be maintained at the level of rated values
Polyphase squirrel-cage and slip-ring induction motots for continuous and intermittent operation	60	15	Frequency and voltage shall be maintained at the level of rated values
As above, but for short-time operation and for continuous operation under variable load	100	15	Ditto
D.c. motors	50	15	Voltage shall be maintained at the level of a rated value

The test shall be performed at the maximum values of the temperature of product parts reached in the heat test and at the same temperature of a cooling medium.

The tests of the electric propulsion motors of propulsion plants for a short-time torque overload given in specification for the electric propulsion plants may be replaced by the tests for a corresponding overcurrent. In addition to the above tests, the mechanical strength analysis for the components of the electric propulsion motor (output shaft, pole attachment points, etc.) at the design torque overload shall be submitted.

The product is considered to have passed the test if, after its inspection following the test, no deformations, damages, noticeable changes of an insulation colour have been detected, and product parameters have remained within the set limits.

10.6.23.2 Tests of voltage regulation systems.

Testing a.c. generators with their voltage regulation systems, the following shall be checked:

.1 voltage variation up to the rated voltage at the rated power factor with the change of loading starting from the idling. In this case, the voltage shall not change by more than 2,5 % of the rated voltage for main generators and 3,5 % for emergency ones;

.2 voltage variation with the sudden change of the symmetrical load of a generator operating at the rated speed and voltage, and at the current and power factor available. In this case, the voltage drop shall not be below 85 % and its increase above 120 % of the rated voltage. After that change of loading, the generator voltage shall be restored within ±3 % of the rated one during not more than 1,5 s. For emergency generators, these values may be increased up to 5 s in time and up to ±4 % in voltage.

If precise data on the maximum sudden load are lacking, a load valued 60 % of the rated current with an inductive power factor of 0,4 and less, being put during idling and switched-off later, may be used. Such voltage regulation during transient conditions may be calculated values based on the previous type test records, and need not to be tested during factory testing of a generator.

10.6.23.3 Tests of commutation of commutator machines.

Checking the commutation of commutator machines, the following shall be taken into account:

.1 the check shall be carried out both in a rated mode and during short-time overcurrent;

.2 the check at a rated load shall be carried out following the time period required for a machine to reach a practically steady-state temperature;

.3 the check of commutation at a rated load is expediently to combine with the heat test, the overcurrent check, with the test for short-time overcurrent;

.4 a degree of machine sparking in the rated mode of operation shall not exceed 1,5 unless otherwise specified in the technical documentation for the machine in exceptional justified cases.

The sparking degree during overcurrent in all cases shall be specified in the technical documentation for the machine;

.5 the degree of sparking at electrical machine commutators is evaluated by the most sparkling brushes. The degrees are given in Table 10.6.23.3.5.

Table 10.6.23.3.5

Sparking degree	Characteric of sparking degree	Condition of a commutator and brushes
1	No sparking (sparkless commutation)	Blackening on the commutator and traces of carbon deposit on brushes are lacking
1,25	Light sparking under the small part of a brush edge	Ditto
1,5	Light sparking under the large part of a brush edge	Blackening traces emerge on the commutator surface, which are readily wiped out with petrol, as well as carbon deposit traces on brushes
2	Sparking under the entire brush edge. Allowed in short-time load and overload kicks only	Blackening traces emerge on the commutator surface, which cannot be wiped out with petrol, as well as carbon deposit traces on brushes
3	Essential sparking under the entire brush edge with large-sized escaping sparks. Allowed only for the moment of direct (without rheostat steps) switch-on or reverse of machines if a commutator and brushes therewith remain in the condition suitable for further operation	Essential blackening on the commutator surface, which cannot be wiped out with petrol, as well as burning and failure of brushes
Note. The key indicator of commutation evaluation is the condition of a commutator and brushes.		

10.6.23.4 Stalling test.

The stalling test is applied only to propulsion motors, motors for a direct drive of the rudder and steering gear, and also to motors driving anchor and mooring machinery.

The stalling test shall be carried out under the following conditions:

.1 the rated mode of motor operation, a temperature of motor heating is the maximum during operation in that mode;

.2 the motor under test shall be mechanically locked, a stalling time shall be counted off since the rotor (armature) stop;

.3 the stalling duration for motors of the steering gear for directly-driven rudders is 60 s, the stalling duration and modes for motors of anchor and mooring machinery shall be consistent with the provisions in 5.6.2, Part XI "Electrical Equipment" of the RS Rules/C;

.4 following the test, the machines shall be thoroughly examined for any damages, deformations, the noticeable change of an insulation colour.

10.6.23.5 Overspeed test.

The overspeed test shall follow the short-time overcurrent test, and as to the machines subjected to the stalling test, after the latter at a temperature of machine parts close to a steady-state temperature reached at the end of the heat test, with the following conditions to be met:

.1 the test duration for all machines excepting starters is 2 min (20 s for starters);

.2 series-wound motors shall be tested at a speed exceeding by 20 % the maximum specified in their rating plate, but exceeding by not less than 50 % the rated speed (at 120 % of an idle speed for starters in all cases);

.3 adjustable speed motors, as well as those having several rated speeds shall be tested at a speed exceeding by 20 % the maximum specified in their rating plate; all the others – at a speed exceeding the rated one by 20 %;

.4 machines may be tested in the mode of both a generator and motor; the mode corresponding to the machine purpose is preferred;

.5 the test duration is counted off since the moment when the machine has reached its test speed;

.6 following the test, the machine shall be thoroughly examined for any damages and deformations.

10.6.23.6 Test for electric and thermal strength at short-circuit current.

The test for immunity to shock short-circuit current shall be carried out in compliance with standard IEC 60034-1:2017 (para 9.9) under the following conditions:

.1 the short-circuit mode shall be produced by a sudden simultaneous closing of all the three phases (poles) when a machine runs idle at a voltage of 105 % of the rated voltage with an automatic voltage regulation device switched on;

.2 the motor output in test shall be not less than the service one;

.3 the length of conductors from the machine to a closing device shall be the least, a cross-sectional area, the largest among specified in the technical documentation for a generator, the conductors material is copper;

.4 parameters of the short-circuit mode shall be recorded using an oscillograph;

.5 the assessment of test results (mechanical strength of the machine) is performed by means of the thorough examination of the machine, particularly of the condition and securing of frontal parts of the stator winding, welds and other mechanical joints, with due regard for the results of an insulation strength test carried out after the test for immunity to short-circuit current.

The evaluation of the results of testing machines rated over 1000 kW is additionally carried out also for indications obtained from the strain measurement of stresses in the fastenings of an active steel and insulation of frontal parts, as well as from the measurements of vibrations (with vibration transducers) of the same parts, and also of the machine case and bearings.

A capability of maintaining a current of at least three times the rated current of the generator within 2 s at a short-circuit or, where precise data is available, for a duration of any time delay which will be fitted in the tripping device for discrimination purposes.

In order to provide sufficient information for determining the discrimination settings in the distribution system where the generator is going to be used, the generator manufacturer shall provide documentation showing the transient behavior of the short circuit current upon a sudden short-circuit occurring when excited, and running at nominal speed. The influence of the automatic voltage regulator shall be taken into account, and the setting parameters for the voltage regulator shall be noted together with the decrement curve. Such a decrement curve shall be available when the setting of the distribution system's short-circuit protection is

calculated. The decrement curve need not be based on physical testing. The manufacturer's simulation model for the generator and the voltage regulator may be used where this has been validated through the previous type test on the same model.

10.6.23.7 Measurement of insulation resistance of electrical machines.

D.c. voltage developed by megger when measuring the insulation resistance of electrical machines shall comply with the values specified in Table 10.6.23.7.

Table 10.6.23.7

Rated voltage Un, in V	Minimum Test Voltage, in V	Test Minimum Insulation Resistance, in MΩ
Un ≤ 250	2xUn	1
250<Un ≤ 1000	500	1
1000<Un ≤ 7200	1000	(Un/100)+1
7200<Un ≤ 15000	5000	(Un/100)+1

10.6.23.8 Heat test.

The test of electrical machines for heating shall be carried out under the normal environmental conditions at an air temperature of 25±10 °C up to a steady-state temperature.

The test for heating may be combined with the test for heat stability.

In testing, a product shall operate in a nominal mode.

The permissible excesses of temperature for electrical machines are given in Table 10.6.23.8. They are determined for a cooling air temperature of 45 °C.

Table 10.6.23.8

Permissible temperature excesses for electrical machines at a cooling air temperature of 45 °C

Nos.	Parts of electrical machines	Class of insulating material														
		A			E			B			F			H		
		Measurement method (instrument)														
		Thermometer	Resistance method	Thermal detectors placed in a slot between coils	Thermometer	Resistance method	Thermal detectors placed in a slot between coils	Thermometer	Resistance method	Thermal detectors placed in a slot between coils	Thermometer	Resistance method	Thermal detectors placed in a slot between coils	Thermometer	Resistance method	Thermal detectors placed in a slot between coils
1	Windings of ac synchronous machines rated 5000 kVA and over or having a core length of 1 m and more	–	55	55	–	65	65	–	75	75	–	95	95	–	120	120
2	Windings of ac machines rated under 5000 kVA and having a core length under 1 m	45	55	–	60	70	–	65	75	–	80	95	–	100	120	–
3	Field windings of d.c.-excited d.c. and a.c. machines excepting those in items 5 to 8 of the Table	45	55	–	60	70	–	65	75	–	80	95	–	100	120	–
4	Armature windings connected to a commutator	–	–	–	–	–	–	–	85	–	–	105	–	–	–	–

Nos.	Parts of electrical machines	Class of insulating material														
		A			E			B			F			H		
		Measurement method (instrument)														
		Thermometer	Resistance method	Thermal detectors placed in a slot between coils	Thermometer	Resistance method	Thermal detectors placed in a slot between coils	Thermometer	Resistance method	Thermal detectors placed in a slot between coils	Thermometer	Resistance method	Thermal detectors placed in a slot between coils	Thermometer	Resistance method	Thermal detectors placed in a slot between coils
5	Field windings of d.c.-excited nonsalient pole machines	–	–	–	–	–	–	–	85	–	–	105	–	–	–	–
6	Single-row field windings with bare surfaces	60	60	–	75	75	–	85	85	–	105	105	–	130	130	–
7	Bar windings of asynchronous machine rotors	60	60	–	75	75	–	85	85	–	105	105	–	130	130	–
8	Field windings of low resistance with several layers and compensation windings	55	55	–	70	70	–	75	75	–	95	95	–	120	120	–
9	Insulated windings continuously closed on itself	55	–		70	–	–	75	–	–	95	–	–	120	120	–
10	Noninsulated windings continuously closed on itself	The excess of a temperature of these parts shall not reach the values, which would cause a risk of damaging insulating and other adjacent materials														
11	Steel cores and other parts having no contact with windings															
12	Cores and other steel parts in contact with windings	55	–	70	–	–	–	75	–	–	95	–	–	120	120	–
13	Unprotected and protected commutators and slip rings	55	–	60	–	–	–	75	–	–	85	–	–	95	95	–

N o t e s : 1. For windings of a.c. machines for rated voltage over 11000 V, the limiting permissible excesses of temperature shall be reduced by 1,5 °C for each complete and incomplete 1000 V above 11000 V in measurements with a thermometer or by 1 °C when a thermal detector is used.

2. The limiting permissible excesses of a windings temperature specified in the Table, measured by the resistance method, may be increased by 5 °C for enclosed machines for voltage not more than 1500 V.

3. The specified class of insulating material as per item 13 of the Table applies to the commutator or slip ring insulation, or else to the insulation of windings connected thereto if the insulation class of these latter is below that of the commutator or slip rings.

4. The resistance method is generally used for measuring the excess of a winding temperature. The use of a thermometer is allowed only in those cases when the above method cannot be applied due to certain reasons; the limiting permissible excesses of temperatures for these cases are specified in the Table.

5. If a thermometer indication is desirable additionally to the data received by the resistance method, the temperature excess measured in the most heated accessible point shall not exceed 60 °C for insulation class A, 75 °C for insulation class E, 85 °C for class B, 105 °C for class F and 130 °C for class H.

6. The permissible temperature excesses for commutators and slip rings may exceed the values specified in item 13 of Table if the following conditions are met:

the temperature excess for insulating materials of commutators and slip rings and their related windings does not exceed the values specified in items 4 and 7 of the Table for materials of the relevant classes;

the temperature does not reach the values dangerous for solder joints.

If a cooling medium temperature is below the specified values, temperature excesses may be increased accordingly, but not more than by 10 °C.

If a cooling medium temperature is above the specified values, the temperature excess shall be accordingly reduced.

10.6.24 Tests of transformers.

10.6.24.1 Check of measurement of a secondary voltage value.

To check the variation of secondary voltage on a percentage basis (ΔU, in %), the measurements of voltages at secondary winding terminals in idling U_o and at the active rated load U_r are compared. The check is combined with the heat test. The value to be checked is calculated from the formula

$$\Delta U = \frac{U_0 - U_{\text{r}}}{U_{\text{r}}} 100\cdot \qquad (10.6.24.1)$$

A value of ΔU shall be less or equal to 5 % for transformers rated below 6,3 kVA, less or equal to 2,5 % for those rated 6,3 kVA and over.

10.6.24.2 Heat test.

In heat testing, the following shall be taken into account:

.1 the test shall be carried out by direct loading of transformers at rated voltages across terminals and rated currents in windings;

.2 in testing transformers with a non-combustible liquid dielectric, a temperature rise for upper layers of the latter over the temperature of a cooling medium is also determined.

The temperature excess for transformers operating at rated loads and an environmental temperature +45 °C shall not exceed values specified in Table 10.6.24.2.

Table 10.6.24.2

Parts of a transformer	Method for measuring	Permissible temperature excesses, in °C, for insulation classes				
		A	E	B	F	H
Windings	Resistance	55	65	75	95	120
Cores and other parts of a transformer	Temperature	The temperature excess shall not exceed the temperatures permissible for adjacent materials				

10.6.24.3 Test for electrodynamical and thermal strength at short-circuit current.

The test for electrodynamical and thermal strength at short-circuit current is performed at an external short-circuit for compliance with the maximum values specified in the technical documentation for a transformer.

For three-phase rated 6,3 kVA and over, and single-phase rated over 4 kVA transformers, the test shall be performed under the following conditions:

.1 a test set shall provide the required value of a shock short-circuit current via the transformer with an accuracy of ±5 % of the rated one and the duration of short-circuit conditions therewith at least 0,5 s;

.2 the test set shall provide the flow of a steady-state short-circuit current via the transformer with an accuracy of ±10 % of the rated value and the duration of short- circuit conditions corresponding to the time of thermal short-circuit strength of the transformer (at least 3 s);

.3 the voltage (of frequency 50 Hz) shall ensure the above conditions;

.4 prior to the beginning of the test, the transformer shall be thoroughly examined with a view to compare its condition prior to, and after, the test. Moreover, prior to the beginning of these tests, open circuit and short-circuit tests of the transformer shall be carried out. The data of insulation resistance measurements and insulation strength tests, also necessary for the following comparison, may be taken from the previous tests;

.5 the test may be performed both by using a special appararus for producing a short-circuit at terminals of the second winding of the transformer pre-connected in a circuit and by connecting in the circuit the transformer with the preliminary closed-coil secondary winding;

.6 the test shall be performed for each secondary winding, but if these have taps, then both with all the turns connected and with their minimal number.

The results of adjusting short-circuits are ignored as the test ones;

.7 the test shall be performed with the heated transformer at a temperature close to the maximum reached in the heat test;

.8 during the tests, the voltage and current at input, and the current in a short-circuited winding shall be recorded using an oscillograph.

It is recommended to measure forces in support structures;

.9 following the tests, the check open-circuit and short-circuit tests shall be carried out, insulation resistance shall be measured and the thorough examination of the transformer shall be performed. If all checks are satisfactory, insulation strength (at voltage equal to 0,8 time the full test voltage) and interturn insulation shall be tested, whereupon the transformer shall be disassembled if necessary;

.10 the transformer is considered to have passed the test if no deformations, turns sliding, essential change of colour were revealed in examination, and comparison tests were satisfactory. Insignificant residual axial shiftings of windings and insignificant residual deformations of yoke beams, if these are within the standard limits, may be ignored in evaluating the test results.

The test for electrodynamical and thermal strength at short-circuit current of other transformers shall be carried out in accordance with standards or, if these latter are lacking, with the other approved technical documentation for transformers.

10.6.24.4 Tank test for tightness and strength at a surplus pressure.

Transformer tanks for non-combustible liquid dielectric shall be tested for tightness and strength at a surplus pressure. The test technique, surplus pressure and criteria for evaluating the results shall be specified in the technical documentation for such transformers. Additionally, the records shall be submitted on testing the liquid dielectric taken from the tank of such a transformer, and on determining the conformity of breakdown voltage and the dielectric loss tangent with technical documentation.

10.6.25 Testing of power transformers of the voltage of 15 – 220 kV.

10.6.25.1 Chromatographic analysis of gases dissolved in oil.

The condition of transformer equipment shall be assessed by comparing the measured data with the limit values of gas concentration in oil, the rate of growth of gas concentration in oil, the ratios of diagnostic gas concentrations (gas pairs) and the graphical criterion taking into account operational factors and other applicable normative documents on the power transformer diagnosis.

The following shall be monitored:

for voltage class 35 kV – unit transformers, auxiliary transformers and transformers with an average annual load of at least 50 % of the rated load (subject to an appropriate sampling method for the analysis of gases dissolved in oil);

for voltage classes 110 kV and over – all transformers.

For shunting reactors, evaluation of the condition based on the analysis results of gases dissolved in the oil, according to the manufacturers' instructions.

10.6.25.2 Determination of the moisture content in solid insulation.

Tests are carried out for transformers with a voltage level of 110 kV and over. The permissible moisture content of solid insulation shall not exceed 1 %

The moisture content of solid insulation in transformers is determined by analyzing the moisture content of insulation samples in the tank.

10.6.25.3 Measurement of insulation resistance of power transformers of the voltage of 15 – 220 kV.

Winding insulation resistance is measured with a megohmmeter for 2500 V.

Insulation resistance of each winding of newly commissioned and overhauled transformers, adjusted to the test temperature at which the initial values were determined, shall be at least 50 % of the values specified by the manufacturer. Where no manufacturer's values are available, with respect to the originally measured values. In any case, insulation resistance above 3000 MOhm at 20 °C is considered satisfactory and no comparison with initial data is necessary.

For transformers of 15 to 35 kV inclusive and up to 10 MVA and arc suppression reactors, winding insulation resistance shall not be lower than the values shown in Table 10.6.25.3.

Table 10.6.25.3

Insulation resistance value

Winding temperature, in °C	10	20	30	40	50	60	70
$R_{60''}$, in MOhm	450	300	200	130	90	60	40

Insulation resistance of dry-type transformers with rated voltage of more than 15 kV at a winding temperature of 20 – 30 °C shall not be less than 500 MOhm.

Winding insulation resistance shall be measured at an insulation temperature not lower than:

10 °C – for transformers up to 150 kV inclusive;

20 °C – for 220 kV transformers.

Measurement of insulation resistance of available tension pins, bandages, yoke half-bandages and pressing rings relative to active steel and yoke beams, as well as yoke beams relative to active steel and electrostatic shields relative to the windings and magnetic conductor:

the measurements shall be taken in case of examination of the active part of the transformer or via a special bushing on the transformer tank (if available). Megohmmeters for 1000 V are used;

the measured values of insulation resistance of tension pins, bandages, yoke half-bandages and pressing rings relative to active steel and yoke beams, as well as yoke beams relative to active steel shall be at least 2 MOhm and the insulation resistance of the yoke beams at least 0,5 MOhm.

10.6.25.4 Measurement of the winding insulation dissipation factor (tgδ).

tgδ values of winding insulation of newly commissioned and overhauled transformers, adjusted to the test temperature at which the initial values were determined, taking into account the influence of oil tgδ shall not deviate from the values specified by the manufacturer in the negative direction by more than 50 %;.

The measured (at the insulation temperature 20 °C and over) tgδ values of winding insulation of transformers not exceeding 1 % are considered satisfactory.

tgδ of insulation shall be measured both according to the manufacturer's diagrams and in addition as per the insulation areas (e.g., HV - housing, LV – housing, HV – LV) by connecting the "screen" lead of the measuring bridge to free windings or tank.

Measurement of winding tgδ shall be carried out at an insulation temperature not lower than:

10 °C – for transformers up to and including 150 kV;

20 °C – for 220 kV transformers;

60 °C – for all transformers when evaluating the moisture content of the solid insulation by calculation.

10.6.25.5 Evaluation of paper insulation winding.

The content of furan derivatives in transformer oil, which limits the area of normal equipment condition, shall not exceed 0,0006 % by mass.

When the CO_2/CO ratio exceeds 30 in conjunction with an oil moisture content of more than 30 g/t, this indicates that the lifetime of the paper winding insulation is completely expired (indicator of the limit state). If the content of furan derivatives and/or the CO_2/CO ratio reaches the above values, the paper insulation tests shall be carried out.

Oil sampling for furan compounds shall be carried out prior to changing the silica gel in the adsorption and thermosyphon filters and oil treatment (degassing, regeneration, etc.), but not earlier than 6 months after changing.

Evaluation by the degree of polymerization:

.1 the degree of polymerisation of cellulose degradation, which affects the mechanical strength of the paper insulation, is assessed for transformers of 110 kV and over;

.2 solid insulation sampling is carried out when, according to indirect evaluation methods, there are reasonable grounds to expect significant deterioration of the solid insulation. An indirect evaluation of the solid insulation condition is carried out according to the following indicators:

the presence of furan derivatives, including furfural, in transformer oil;

the results of chromatographic analysis of furanic compounds dissolved in oil, CO and CO_2 gases as recommended in 10.6.25.1;

the results of oil physical-chemical analysis;

the results of insulation dielectric measurements (R60, tgδ);

.3 the resource of paper winding insulation is considered expired when the degree of polymerization of the paper drops to 250 units (limit value) or less. For essential 35 kV transformers, which have served their time as specified in the technical documentation (unit transformers, auxiliary transformers), evaluation of the paper insulation condition of windings by the degree of polymerization and determination of furan compounds is carried out during comprehensive diagnostic examinations.

10.6.25.6 Testing of insulation with overvoltage at 50 Hz.

The overvoltage test together with the bushings is mandatory for all transformer types and classes. The value of the test voltage shall be taken equal to the voltage used by the manufacturer.

Test voltage values are specified in Tables 10.6.25.6-1 and 10.6.25.6-2. Test duration – 60 s.

Imported transformers may only be tested with the voltages given in Tables 10.6.25.6-1 and 10.6.25.6-2 if they do not exceed the voltage values with which the transformer was tested by the manufacturer.

The insulation test of the protective and instrumentation circuits installed on the transformer is performed on the fully assembled transformers. The insulation (relative to earthed parts and structures) of circuits with connected current transformers, gas and safety relays, oil detectors, shut-off valve and temperature sensors shall be tested with the disengaged connectors of the pressure gauge thermometers, the circuits of which are tested separately. Test voltage value – 1 kV. Test duration ─ 1 min. Test voltage value for testing manometer thermometers ─ 750 V. Test duration ─ 1 min.

Table 10.6.25.6-1

Test voltages of industrial frequency of electrical equipment of voltage classes up to 35 kV with normal and light insulation

Transformer voltage class, in kV	Test voltage					
	power transformers, shunting reactors and arc-suppression coils			apparatus, current and voltage transformers, current-limiting reactors, insulators, entries, communication condensers, shielded current leads, collecting busbars, IS		
	prototype at the manufacturer	prototype at the manufacture	at steady production	prototype at the manufacturer	prototype at manufacture and at steady production	
					porcelain insulation	other types of insulation
15-19	45,0/37,0	40,5/33,3	38,3/31,5	55,0 (63,0)	55,0 (63,0)	49,5 (56,7)
20-34	55,0/50,0	49,5/45,0	46,8/42,5	65,0 (75,0)	65,0 (75,0)	58,5 (64,5)
35	85,0	76,5	72,3	95,0 (120,0)	95,0 (120,0)	85,5 (108,0)

Notes: 1. Test voltages indicated as a fraction apply to electrical equipment: numerator for normal insulated equipment, denominator for lightly insulated equipment (including dry-type transformers).

2. The test voltages for apparatus and IS apply both to their insulation against the ground and between the poles and to the gap between the contacts with one or two (figure in brackets) discontinuities per pole. Where the test equipment cannot provide a test voltage higher than 100 kV, it is permissible to carry out the test at the highest possible test voltage, but at least 100 kV.

3. When the prototype at the manufacturer was tested by the voltage different from that specified, the test voltages of the prototype at manufacture and at steady production shall be adjusted accordingly.

Table 10.6.25.6-2

Test voltages of industrial frequency of pressure-tight power transformers

Transformer voltage class, in kV	Test voltage, in kV		
	prototype at the manufacturer	prototype at production	at steady production
15	38	34,2	32,3
20	50	45,0	42,5

10.6.25.7 Measurement of d.c. winding resistance.

Resistance of transformer windings to direct current shall be measured on all taps, unless otherwise specified in the transformer's certificate.

At least three complete switching cycles shall be performed prior to measuring the winding resistance of transformers equipped with load tap changers and a change-over switchgear without excitation.

The winding resistance of three-phase transformers measured on the same taps of different phases at the same temperature shall not differ by more than 2 %.

The winding resistance values of single-phase transformers after temperature recalculation shall not differ by more than 5 % from the initial values.

10.6.25.8 Checking current transformer ratio.

The test is carried out at all positions of the tap changers.

The transformation ratio measured at commissioning of the transformer shall not differ by more than 2 % (unless otherwise stated in the manufacturer's documentation) from the values measured on the corresponding taps of other phases and from the initial values.

10.6.25.9 Checking winding group of three-phase transformers and polarity of single-phase transformer leads.

The connection group shall comply with the specifications in the transformer documentation and the polarity of the terminals shall comply with the markings on the transformer cover.

10.6.25.10 Paralleling of transformers.

Prior to the first start-up of new equipment it shall be phased.

10.6.25.11 Measurement of idling losses.

Measurements are made on prototype transformers of 1000 kVA or over at the voltage applied to the LV winding equal to that specified in the factory test report (certificate). For three-phase transformers, the idling losses are measured with single-phase excitation according to the manufacturer's schemes.

At the production for prototype three-phase transformers, the ratio of losses in the different phases shall not deviate by more than 5 % from the ratios indicated in the factory test report (certificate). For single-phase transformers, the measured losses shall not exceed the initial (certified) values by more than 10 %.

10.6.25.12 Measurement of short-circuit resistance (ZK) of the transformer.

The short-circuit resistance is measured for transformers of 125 MVA and over.

For transformers with on-load changer ZK shall be measured on the main and both outermost branches.

ZK values of the transformer at steady production shall not exceed the values determined from the transformer fault voltage (Uf) on the main branch by more than 5 %.

ZK values during the measurements at steady production shall not exceed the initial values by more than 3 %. For three-phase transformers, the difference in ZK values per phase on the main and outermost branches is additionally rated and shall not exceed 3 %.

10.6.25.13 Evaluation of switchgear status.

In NLTC switchgear (no-load tap changer) the condition of the following shall be checked:

contact element and gear;

spring contacts.

For drum-type NLTCs, the force developed by the spring contacts shall be checked, and the value thereof shall be between 20 — 50 N (2 — 5 kgf).

For OLTC switchgear (on-load changing) the following shall be performed:

.1 the condition of the switchgear is assessed in accordance with the manufacturer's instructions and the operating manual of the particular switchgear;

.2 oil in the OLTC contactor tank shall be tested for breakdown voltage. Oil from the OLTC switchgear is tested for moisture content in case of unsatisfactory breakdown voltage results;

.3 if the values exceed the standard limits, oil shall be drained, cleaned or replaced. Oil sampling from the OLTC contactor tank for the analysis of oil-dissolved gases shall be carried out in case of unsatisfactory results of AVC of oil sampled from the transformer tank. The results are evaluated according to the OLTC manufacturer recommendations.

10.6.25.14 Tank tightness test.

Prototypes of all transformer types, except for pressurized transformers and transformers without a surge tank, are subjected to testing.

Testing shall be carried out as follows:

for transformers up to and including 35 kV – by the hydraulic pressure of the oil column, the height of which above the level of the filled surge tank is 0,6 m, except for transformers with corrugated tanks and plate-type radiators, for which the height of the oil column is taken as 0,3 m;

for transformers with oil film protection – by creating an overpressure of 10 kPa inside the flexible enclosure;

for other transformers – by creating an overpressure of 10 kPa of nitrogen or dry air in the above-oil space of expansion tank.

In all cases, the test duration shall be at least 3 h.

During the test the oil temperature in the tank shall be:

at least 10 °C — for transformers up to and including 150 kV;

at least 20 °C — for 220 kV transformers.

The transformer tank is considered to have passed the leakage test if no oil leakage or rated overpressure is detected outside the tank within the rated period of time.

10.6.25.15 Check of cooling devices, safety devices, gas relay, pressure switch, jet switch, oil protection against ambient air.

The cooling devices are checked in accordance with the operating instructions for the cooling system included in the technical documentation of the manufacturer of the given transformer.

The safety and shut-off valve as well as the safety (exhaust) pipe are checked in accordance with the manufacturer's instructions.

Check and test of the gas, pressure and jet relays are carried out in accordance with the operating instructions of the respective relays. It is prohibited to check the functionality of the gas relay installed on transformers with film protection by air blowing into it. The setting value of the gas relay shall be in accordance with the transformer's operating documentation. If there is no indication in the operating instructions, a setpoint corresponding to the maximum sensitivity that prevents the relay from tripping during start-up and shut-down of the electric cooling system pumps shall be accepted.

The air dryer, the nitrogen and film oil protection systems, the thermosiphon filter and the adsorption filter shall be checked in accordance with the manufacturer's documentation and national standards. The adsorbent to be loaded into the air dryer and transformer filters shall have a residual moisture content not exceeding 0,5 % by mass.

10.6.25.16 Thermovision inspection of transformer status.

Thermovision inspection shall be carried out for transformers of 15 kV and over.

It is advisable to carry out the IR test with the transformer under maximum load and additionally at no-load.

10.6.25.17 Measurement of partial discharge characteristics.

Winding insulation monitoring according to partial discharge (PD) characteristics applies to transformers of 110 and 220 kV voltage classes.

For transformers of voltage classes 35 kV, inspection of winding insulation according to partial discharge characteristics is carried out when electrical defects are detected on the basis of analysis of gases dissolved in oil.

10.6.26 Tests of static converters and uninterruptible power supplies (UPS).

10.6.26.1 Overload test.

In testing for overload, having completed a duty at the maximum temperature reached by the converter in overload, the functioning of overload protection, if provided, shall be checked. The current and the time of protection activation, as well as other pertinent parameters shall be checked for conformity with technical documentation.

10.6.26.2 Test for electrodynamical and thermal strength at short-circuit current.

The test for electrodynamical and thermal strength at short-circuit current shall be carried out under the following conditions:

.1 the short-circuit test shall be performed at the maximum short-circuit current withstood by the converter;

.2 the test at the maximum permissible short-circuit current shall be performed with the converter in practically cold state, under the normal environmental conditions and at the maximum continuously permissible value of voltage at the input of the converter which picks up the rated load, by producing the short-circuit close to output terminals, and for inverters – close to output and input terminals with amplitude and the duration of input short-circuit current entered in data sheets;

.3 the test may be performed at the minimum short-circuit current and the maximum permissible duration of its flow. This test shall be carried out with the converter in a hot state. The temperatures of the converter and the environment by the beginning of the test shall be the same as in the test for heat stability (heat test), i.e. this test shall be performed immediately after the completion of the test in a heat chamber;

.4 oscillographs shall be used in short-circuit processes.

10.6.26.3 The check of converter functioning at load loss and increase.

The check of converter functioning at load loss and increase is effected at rated parameters at the converter input by means of sudden switching the load on and off according to the scheme: 0 – 50 % – 0, 0 – 100 % – 0, 0 – permissible load – 0. Oscillographs shall be used in the processes.

10.6.26.4 Tests for immunity to switching overvoltages.

Tests for immunity to switching overvoltages are carried out by means of connecting the no-load converter to, and disconnecting it from, a supply source, and after that, of connecting the on-load converter carrying the maximum permissible load. An oscillogram shall evidence that the peak voltage at rectifiers therewith does not exceed their rated reverse voltage.

10.6.27 Tests of accumulators and accumulator batteries.

Each type of an accumulator battery shall be tested.

Accumulators are tested if delivered individually (not as a battery).

Prior to the tests, batteries (accumulators) shall be subjected to the necessary number of charging-discharging cycles in order that their capacity may reach the values guaranteed in technical documentation, and the results of their rated capacity check shall be submitted.

In the test for heat stability and cold endurance, the battery shall be charged and discharged at a test temperature. The charge and discharge modes may be normal or accelerated, being selected in each particular case. However, the obtained values of voltage, current and capacity shall be consistent with those specified in the technical documentation for the battery.

Starter batteries shall be discharged in a starter mode.

10.6.27.1 Tests for vibratory and shock loads.

Tests by vibratory and shock loads shall be carried out as follows:

.1 fully charged batteries (accumulators) prepared shall be exposed to vibratory and impact effects in three mutually perpendicular directions; in this case, any plugs preventing an outflow of electrolyte may be used;

.2 in tests for vibration resistance and shock resistance, the batteries shall be connected to a monitoring circuit. The current and voltage therewith shall be stable.

Having completed all the tests by vibratory and shock loads, the batteries shall be subjected to discharging to check the rated capacity which shall not be less than that specified in technical documentation (minus the energy consumed in the monitoring circuit).

10.6.27.2 Tests for resistance to motions and prolonged inclinations.

The batteries are tested for resistance to motions and prolonged inclinations only for the purpose of checking the absence of electrolyte leakage. Herewith, it is not required to check functioning of the batteries.

The batteries with the maximum permissible level of electrolyte shall be exposed to motions according to 10.6.8 followed by alternate inclinations at 40° to the vertical for 10 min to both sides lying in two mutually perpendicular planes. In motions and inclinations, no electrolyte traces shall appear on the accumulators surface (plugs may be closed, but no sealing parts are allowed).

10.6.27.3 Test for heat stability of acid batteries mastic.

The test for heat stability of acid batteries mastic may be carried out with specimens not used in other types of tests. At first, the batteries are tested without electrolyte during 6 h at a temperature of +60 °C inclined at 45° to a normal position, and then, after cooling down to the normal test temperature, during 6 h at a temperature of +40 °C in a normal position. No mastic runs are allowed after heating, and no mastic breaks, cracks and breaks-away from monoblock unit covers after cooling.

10.6.27.4 Check of tightness of an acid battery monoblock unit.

The check of tightness of an acid battery monoblock unit shall be carried out after the battery exposure to all mechanical and temperature effects with due regard for the following conditions:

.1 if the batteries other than those which had passed the mechanical tests, were tested for mastic heat stability, the check of tightness shall be performed both with the batteries which have passed the mechanical and environmental tests and with the batteries tested for heat stability only;

.2 the battery tightness is checked by applying inside it an increased or lowered pressure differing from the atmospheric one by 133 ± 9 N/m^2 during 4 to 5 s.

The battery is considered to have passed the check if the manometer or vacuum gauge reading does not change.

The positive result of the check confirms the mastic stability to mechanical and thermal effects;

.3 the tightness of battery without topping-up necks is checked by applying inside it an overpressure until safety valves activation.

10.6.27.5 Check for self-discharge.

The check for self-discharge consists in checking the residual capacity of the previously fully-charged battery, which has passed the tests for compliance with operational conditions, after 28 days out of operation at a temperature of 25±5 °C. The loss of capacity due to self-discharge shall not exceed 30 % of the rated capacity for acid accumulators and 25 % for alkaline ones.

10.6.28 Tests of lithium-ion accumulator batteries (LIAB) and lithium-ion battery systems (LIBS).

10.6.28.1 External short-circuit test.

The test shall be carried out in compliance with standard IEC 62619:2017 (para 7.2.1).

10.6.28.2 Dynamic shock/drop test.

The test shall be carried out in compliance with standard IEC 62619:2017 (para 7.2.2).

10.6.28.3 Heat treatment/thermal abuse test.

The test shall be carried out in compliance with standard IEC 62619:2017 (para 7.2.4).

10.6.28.4 Forced discharge test.

The test shall be carried out in compliance with standard IEC 62619:2017 (para 7.2.6).

10.6.28.5 Fire/ignition propagation test.

The test shall be carried out in compliance with standard IEC 62619:2017 (para 7.3.3).

10.6.28.6 Test for overcharge control system of voltage.

The test shall be carried out in compliance with standard IEC 62619:2017 (para 8.2.2).

10.6.28.7 Test for overcharge control system of current.

The test shall be carried out in compliance with standard IEC 62619:2017 (para 8.2.3).

10.6.28.8 Overheat control test.

The test shall be carried out in compliance with standard IEC 62619:2017 (para 8.2.4).

10.6.28.9 Capacity check.

The test shall be carried out in compliance with standard IEC 62620:2014 (para 6.3.1).

10.6.29 Tests of supercapacitors (SC) and supercapacitor systems (SCS).

10.6.29.1 Termination test.

The test shall be carried out in compliance with standard UL 810A (para 11.1 or 11.2).

10.6.29.2 Short circuit test at 55 °C.

The test shall be carried out in compliance with standard UL 810A (para 13).

10.6.29.3 Abnormal charge test.

The test shall be carried out in compliance with standard UL 810A (para 14).

10.6.29.4 Heating test.

The test shall be carried out in compliance with standard UL 810A (para 16).

10.6.29.5 Dielectric voltage-withstand test.

The test shall be carried out in compliance with standard UL 810A (para 17).

10.6.29.6 Crush test.

The test shall be carried out in compliance with standard UL 810A (para 18.2).

10.6.29.7 Impact test.

The test shall be carried out in compliance with standard UL 810A (para 18.3).

10.6.29.8 Temperature rise test.

The test shall be carried out in compliance with standard UL 810A (para 15).

10.6.30 Tests of heating units (HU).

Tests of heating units (HU) shall be carried out in compliance with the requirements of IEC standards (IEC) – IEC 62282.

10.6.31 Tests of solar batteries (SB).

Tests of solar batteries (SB) shall be carried out in compliance with the requirements of IEC standards (IEC) – IEC 61646, IEC 61215, IEC 61730, IEC 61853 and IEC 62548.

10.6.32 Tests of switchgear.

10.6.32.1 Heat test.

In addition to the provisions of 10.6.18, the heat test shall be carried out with due regard for the following:

.1 cables shall be terminated at products with a bottom entry in the same way as onboard a ship in order to take into account the additional heating of cables;

.2 the number of cables shall correspond to the number of product power circuits which may function simultaneously in operational conditions;

.3 cables cross-section area shall correspond to that specified in a connection diagram;

.4 cables heat release, that is potential in operation, may be simulated in any other equivalent way;

.5 in testing, the temperature of heating current-carrying and insulating parts, the air inside an enclosure, the product enclosure and an ambient air shall be measured.

10.6.32.2 Test of switchgear for electrodynamical and thermal strength at a short-circuit current.

The test of switchgear for electrodynamical and thermal strength at a short-circuit current shall be carried out with due regard for the following conditions:

three-phase current switchboards may be tested by a single-phase short-circuit current provided it is alternately conducted in each two adjacent phases of a power circuit. In such cases, the maximum value of a shock short-circuit current is reduced by 7 % as compared with the amplitude value of the limiting short-circuit current specified in the switchboard technical documentation;

switchgear power circuits are subject to testing. The scheme of tests shall be approved by the Register as part of the test program and procedure;

prior to the beginning of tests for electrodynamical strength, distances between current-carrying parts in a number of cross-sections mostly potential for deformations shall be measured. These distances shall be checked each time after switching on a shock current;

if the electrodynamical strength of apparatus is below the rated strength of switchboard busbars, such apparatus may be shunted or replaced by jumpers of which the locations shall be specified in the test scheme;

the test of switchgear for electrodynamical and thermal strength at a short-circuit current can be carried out according to the national and international standards.

The DC (direct current) distribution board tests of functioning short circuit protection and strength shall be performed, provided the following conditions are complied with:

direct current switchboards mounted on a tailored test bench and fitted to the electrical power source, are connected with the power consumers, the composition of which is defined in accordance with the agreed program and test procedure. The consumers are selected by the highest predicted current contribution to the short-circuit point;

direct current switchboards shall be tested by connecting through automatic circuit breaker of interpolar non-inductive jumper. The jumper direct-current resistance and switching circuit breaker are calculated and selected on the basis of the predicted severe conditions of short circuit occurrence;

the maximum value of shock short-circuit current shall be reduced by 7 % as compared to the amplitude value of the limiting short-circuit current specified in the switchboard technical documentation.

A switchboard is considered to have passed the thermal short-circuit test if:

no deformation or break-down of current-carrying parts and their fastenings has occurred;

no actuation of disconnector blades, contacts disconnection or freezing have occurred;

a temperature of current-carrying parts has not exceeded the permissible one;

no other damages interfering with the normal switchboard functioning are detected;

no deterioration of the switchboard insulation has been detected in testing the insulation strength following the thermal short-circuit test;

the switchboard and installed equipment protection gear has been activated in accordance with the algorithm preset in the test program;

no failures and malfunctions have occurred in the operation of circuit-breakers, protected equipment and other distribution switchboard operating systems.

The short-circuit test of navigation light switchboards provides for the check of protection actuation at a short-circuit in the line to a navigation light, and the check of the switchboard in the process. The test shall be performed alternately for two lines with two short-circuits in each line.

The results of short-circuit tests are considered satisfactory if:

protection has switched off an emergency line;

an alarm on the switching-off of the emergency line has been activated;

the other lantern lines have continued operation what is evidenced by functioning of the alarm of the circuit under test;

switchboard elements have remained operational with no replacements excepting fuse links of fuses;

the test of insulation strength has confirmed a satisfactory condition of insulation;

the examination result is positive;

the check of the voltage drop at navigation light switchboard alarm elements connected into the circuits of these navigation lights confirms its tolerable level.

10.6.33 Testing of integrated switchgear (IS) of indoor installation, high-voltage sections of transformer substations (TS).

Testing of integrated switchgear (IS) of indoor installation, high-voltage sections of transformer substations (TS) of 15–35 kV in addition to 10.6.32.

10.6.33.1 Measurement of insulation resistance.

The insulation resistance of elements made of organic materials is measured with a megohmmeter at 2500 V. The insulation resistance shall not be lower than the values given in Table 10.6.33.1.

Table 10.6.33.1

The lowest permissible insulation resistance values for moving parts made of organic materials

Insulation resistance, in MOhm	
for rated voltage of 15 ─ 150 kV	for rated voltage of 220 kV
3000	5000

Measurement of the insulation resistance of the secondary circuits is carried out with a megohmmeter for voltage 500 ─ 1000 V.

10.6.33.2 Testing with overvoltage at 50 Hz.

Overvoltage testing of primary cell circuits with the frequency of 50 Hz shall be carried out on the equipment up to 35 kV inclusive. Test voltage value is assumed in accordance with Table 10.6.4.16.

Duration of test voltage application ─ 1 min.

All withdrawable elements with breakers are placed in the operating position, the breakers are switched on; withdrawable elements with surge arresters, power and measuring transformers are rolled out to the check position. The overvoltage test is carried out before the power cables are connected.

10.6.33.3 Checking the alignment and degree of engagement of the movable contacts in the fixed ones.

Contact misalignment shall not exceed 4 ─ 5 mm. The vertical play of slats of the disconnecting contacts of the withdrawable trolley shall be within 8 ─ 14 mm.

The contact opening of the movable contacts shall be at least 15 mm, the stroke margin – at least 2 mm.

10.6.33.4 Measurement of d.c. resistance values of IS elements.

Plug contact resistance shall not exceed the values specified in Table 10.6.33.4.

Table 10.6.33.4

Permissible d.c. resistance values of IS elements

Element to be measured[1]	Permissible resistance values
1. Primary circuit plug contacts	The permissible contact resistance values are given in the manufacturer's instructions.

Element to be measured[1]	Permissible resistance values
	Where contact resistance values are not given in the manufacturer's instructions, they shall not exceed: for 400 A contacts – 75 microohm; for 630 A contacts – 60 microohm; for 1000 A contacts – 50 microohm; for 1600 A contacts – 40 microohm; for 2000 A contacts and over – 33 microohm
2. Ground connection of the withdrawable element to the body	Not more than 0,1 Ohm

N o t e . 1. Measurement is carried out when the IS design allows for it.

10.6.33.5 Busbar monitoring.

The inspection of the busbar connections shall be carried out in accordance with the instructions of 10.6.50.

10.6.33.6 Mechanical tests.

Tests include 5 times rolling in and out of the withdrawable elements, checking the alignment of the main circuit disconnecting contacts, operation of the shutter mechanism, interlocks, locks.

10.6.34 Tests of electrical (switch, protection, control) apparatus.

10.6.34.1 Check of operate and reset values for apparatus.

The check of operate and reset values for apparatus shall be carried out when the following conditions are met:

.1 it is essential to make sure that the apparatus operation and reset at the limiting permissible deviations from the rated values of voltage, current and frequency occur (do not occur if are not supposed to);

.2 in checks of electromagnetic apparatus, a power source (a supply circuit) shall provide an opportunity to receive steady parameters of electric power.

The travel of the electromagnet armature shall not essentially impact the set voltage and current;

.3 checks shall be carried out in the hot and cold state of the apparatus when its parts have reached the thermal equilibrium during tests for heat stability and cold endurance. In the apparatus with voltage coils in a hot state, sufficiency of the force developed by an electromagnet to activate the apparatus at the minimum permissible values of voltage and frequency is also checked; in the apparatus with voltage coils in a cold state, the check concerns the mechanical strength of the apparatus activated at the maximum permissible voltage across the electromagnet coil;

.4 at least three measurements of parameters shall be made in activation; for d.c. coils, at least six measurements (by threes of each polarity);

.5 the measurements shall be evaluated in terms of the worst result;

.6 for apparatus with d.c. voltage coils, an operate voltage U_{op} may be determined indirectly, i.e. by measuring an operate current I_{op} with the following recalculation of the result by the formula

$$U_{\text{op}} = I_{\text{op}} R_t \qquad (10.7.6.34.1.6)$$

where R_t = active resistance of a coil at a test temperature, in Ohm;

.7 protective characteristics, if a time delay depends on the apparatus temperature, are determined in heating with constant current beginning with the cold state of the apparatus.

10.6.34.2 Tests for limiting switching capacity.

The purpose of the test for limiting switching capacity is to make sure that this capacity corresponds to the one specified in technical documentation. The test shall be carried out when the following conditions are met:

.1 depending on the apparatus type and the requirements of the technical documentation for the apparatus, all or some of the following parameters are checked:

maximum breaking capacity;

maximum making capacity;

the apparatus capability to withstand one or more cycles consisting of the following one after the other operations of the switching-on and automatic switching-off of the maximum current which defines the maximum switching capacity of the apparatus;

the apparatus capability to switch off the currents which are lesser than those defining the maximum breaking capacity of the apparatus; it is also checked the apparatus capability to switch off its critical currents if the zone of such currents is not specified in the technical documentation for the apparatus;

.2 potentials of the test installation shall be consistent with the requirements of the Register approved technical documentation;

.3 the apparatus under test shall be installed and tested in a normal working position;

.4 all the apparatus parts to be earthed in operation, as well as all its current-carrying parts having no electrical links with the circuit under test, in order to ascertain that no arc overthrow to them occurs in testing for breaking capacity (including the switching-off of critical currents), shall be electrically- interconnected and terminated at the neutral of a power source or an artificial neutral point;

.5 if the ionized zone created by an arc is not limited by the apparatus enclosure, the boundaries of the ionized zone of the apparatus discharge shall be checked for compliance with the boundaries specified in technical documentation. For this purpose, steel gratings or perforated plates (recommended: plate thickness – 3 mm, hole diameter – 7 mm, distance between hole centres – 10 mm) electrically- interconnected and terminated shall be arranged on the zone boundaries;

.6 the boundaries of a flameout in switching the maximum current off shall be checked (for this purpose, it is recommended to arrange flammable material on the flameout zone boundaries specified in the technical documentation for the apparatus);

.7 tests shall be carried out at the limiting value of the time constant (power factor) of the circuit, as well as at the values for which the most severe conditions of commutation are expected (to be specified in the test program and procedure). In each three-phase circuit, a power factor shall not depart from an arithmetic mean of the power factor of three phases by more than ±15 %;

.8 to avoid the improvement of test conditions for apparatus for which an opening time essentially depends on the setting value of releases, such apparatus shall be tested being adjusted for the maximum and minimum values of the opening time;

.9 to avoid the improvement of test conditions for single-pole apparatus designed for operation in three-phase circuits (e.g. fuses), such apparatus shall be tested being simultaneously connected in all the phases in accordance with the conditions of their application (because during testing in a single-phase circuit, the opening may occur at a favourable current phase);

.10 during tests, oscillography shall be used for currents at apparatus poles and the voltage across input terminals;

.11 the test for maximum breaking capacity shall be carried out with fuses with fuse links for rated current;

.12 the test of switching capacity of controllers, starter and starting-regulating rheostats shall be carried out with controllers (rheostats) connected in the circuit of an electric drive.

The output of the motor used in the test and test conditions (starts, reverses, overloads, current commutation for a braked motor, etc.) shall be stipulated by the manufacturer's technical documentation.

The apparatus is considered to have passed the test for switching capacity if during the test:

no damage interfering with the normal operation of the apparatus has occurred (a need of insignificant repair is allowed, e.g. contacts cleaning or replacement);

no enclosure failure, insulation degradation or other defects interfering with the further operation of the apparatus, but potentially hazardous for the service personnel have occurred;

no arc overthrow between poles, to the metallic enclosure and the other earthed and current-carrying parts has been observed;

the arcing time did not exceed the values specified in the technical documentation for the apparatus;

no contacts weld has occurred.

10.6.34.3 Test for electrodynamical and/or thermal strength.

The test purpose is to check the apparatus capability to withstand a mechanical and/or thermal action of limiting short-circuit currents specified in the technical documentation for the apparatus. The output of the motor used in the test and test conditions (starts, reverses, overloads, current commutation for a braked motor, etc.) shall be stipulated by the manufacturer's technical documentation.

The test shall be conducted when the following conditions are met:

.1 the test circuit voltage shall be sufficient to prevent the current break in the circuit when contacts are opened by electrodynamic forces;

.2 if the apparatus design provides for an opportunity to adjust a contact pressure, the test shall be performed at the rated working values of pressure specified in the technical documentation for the apparatus;

.3 the test may be started with the apparatus in a cold state. A shock current shall be switched on at least three times (switchings-on in adjustment are ignored). Intervals between shock current supplies shall be such that the current-carrying parts of the apparatus could cool down to a temperature corresponding to their continuous operation at the full load.

The test for thermal strength is recommended to combine with the last switching-on of shock current. Otherwise, it shall be started by the switching-on of shock current at the above working temperature of the apparatus;

.4 means for measuring a temperature in the test for thermal strength shall provide readings within not more than 2 s;

.5 switching-on and -off of the test circuit shall be carried out by the apparatus of a test installation. The parameters of the short-circuit process shall be monitored by means of an oscillograph.;

The apparatus is considered to have passed the test in the absence of the following:

contacts weld;

spontaneous switching-off;

extreme heating of parts (in excess of the specified in the technical documentation for the apparatus);

arc overthrow between poles, to adjacent electrically-independent current-carrying parts, an enclosure and other earthed metallic parts;

occurrence of external effects hazardous for the service personnel;

damages preventing its further normal operation.

10.6.34.4 Check of the driving gear of a circuit breaker.

The following shall be tested when checking the driving gear of a circuit breaker:

.1 reliability of breaker opening by means of any of releases with an excited closing device;

.2 impossibility to close the breaker if a closing operation begins while an opening device is still active;

.3 absence of hazard for the personnel and of breaker damages in wrong actions (actuation of the closing device with the closed breaker and of the opening device with the opened breaker);

.4 transition to a manual drive and vice versa;

.5 safety of the personnel and the lack of a possibility to damage the apparatus using the manual drive and simultaneously remotely closing (opening) driving gear circuits;

.6 functioning of interlocking against repeated closings of the breaker for short-circuit (recommended to be combined with the test for the limiting switching capacity of the apparatus).

10.6.34.5 Test for the maximum nonfusing current and the minimum fusing current.

The test for the maximum nonfusing current and the minimum fusing current applies to fuses with fuse links taking into account the following:

.1 the test for the maximum nonfusing current shall be performed with fuses with fuse links having the maximum electrical resistance, and for the minimum fusing current, with fuse links having the minimum resistance;

.2 the temperature in testing shall be consistent with the one specified in technical documentation.

If within the time specified in technical documentation, the fuse does not interrupt a circuit in the test for the maximum nonfusihg current, and within the time not exceeding the one specified in technical documentation, interrupts the circuit in the test for the minimum fusing current, the fuse has passed the test.

Time-current and ampere-second characteristics of fuses shall be checked against the oscillograms obtained in testing for breaking capacity.

10.6.35 Tests of capacitors and capacitor sets for raising a power factor.

10.6.35.1 Testing capacitor sets for compliance with operational conditions onboard a ship.

Testing capacitor sets for compliance with operational conditions onboard a ship, instead of the test for heat stability, the test for so-called thermal stability is carried out at a temperature in a thermal chamber by 5 °C exceeding the one specified in 10.6.9 and at the voltage across the terminals at least 120 % of the rated one with a frequency of 50 Hz. After a warm-up to the thermal equilibrium, capacitors are held during 48 h. The results of tests are considered satisfactory if the loss-angle tangent and the change of an enclosure temperature during the last 10 h are within the limits set in technical documentation.

If essential changes are observed, the test is continued until stabilization or breakdown.

10.6.35.2 Tightness test.

The check for tightness is performed with a purpose to make sure that an impregnating dielectric does not leak. Capacitors are held in a thermal chamber at a temperature of 105 to 110 °C until the full heating round the whole volume during 8 to 16 h (depending on overall dimensions), and then are cooled down at a temperature of 5 to 35 °C during the same time, are heated again and cooled down in the same way.

10.6.35.3 Test for discharge.

The test for discharge is carried out by means of five short-circuited discharges after charging by the d.c. double rated voltage. Not later than in 5 min after that, the strength of insulation between armatures shall be tested.

Capacitors are considered to have passed the test if the change of their capacity measured prior to the test for discharge and after the test of insulation strength does not exceed 2 %.

10.6.35.4 Check of capacitors protection functioning.

The check of capacitors protection functioning shall demonstrate that with the capacitor element breakdown its fuse operates and the capacitor does not fail, and to confirm the right choice of protection and the immunity of the capacitor set to short-circuit current effects.

On completion of the check, the set shall be thoroughly examined and insulation parameters shall be checked.

10.6.36 Test of busbars.

10.6.36.1 Mechanical tests.

Mechanical tests apply to all the busbar elements being different from the others in design (straight, angular, tee and other sections, junction boxes) assembled in various combinations in several spans.

If supports are significantly spaced, it is allowed to test several single busbar spans installed and secured to a stand on two supports each.

10.6.36.2 Heat test.

The heat test shall be performed at least with three interconnected and end-closed various elements of the busbar which are most representative for such a test. The same busbar elements shall be used in the overload test.

10.6.36.3 Test for electrodynamical and thermal strength at short-circuit current.

The test for electrodynamical and thermal strength at short-circuit current shall be performed with busbar sections and junction box types which are most representative for a given design. Otherwise, the provisions of 10.6.32.2 shall be followed in the test.

10.6.37 Tests of electrical measuring instruments.

The test for compliance with operational conditions onboard a ship is carried out with due regard to the following:

.1 in tests for vibration resistance and shock strength, the electrical load of an instrument shall be equal to about 65 to 70 % of the rated one, and half the amplitude of indicator oscillations and the change of readings shall not exceed the tolerable basic error of the instrument;

.2 in tests for resistance to motions and prolonged inclinations, the change of instrument readings in the working section of a scale shall not exceed the value of the basic error;

.3 in tests for heat stability and cold endurance, the changes of instrument readings due to the variation of the temperature of an ambient air in a test chamber within the range of the maximum and minimum working temperature shall be checked. The values obtained shall not exceed those permitted by technical documentation.

Heat and overload (long-term and impulse) tests, checks of a basic error, variation and complementary error (i.e. check of the effect of external factors defining the complementary error, like the change of an instrument inclination, of a temperature, voltage, frequency, voltage or current curve form, an external magnetic and electric field, the effect of an adjacent instrument and a ferromagnetic shield whereon the instrument is placed) are carried out according to the technical documentation agreed in accordance with an established procedure.

10.6.38 Tests of electric drives and electrical equipment of machinery and arrangements (as a set).

The accessories provided by the RS Nomenclature and being part of the electric drive or electrical equipment of a mechanism (an arrangement), prior to the beginning of tests as part of such circuits, shall pass post-manufacturing tests in the appropriate scope specified in this Section.

If single types of tests of electric drive specimens cannot be carried out on a stand, the Register can allow the performance of such tests (checks) onboard a ship during mooring and sea trials (e.g. tests of electric drives of the propulsion plant) what shall be specially agreed by the developer (manufacturer) of the electric drive in the technical documentation for its supply for taking into account in the programs and procedures of ship's mooring and sea trials.

Additionally to electric drives, the sets of electrical equipment for lifts also include alarm and lighting circuits (with elements), for watertight doors include alarm circuits, for refrigerating plants in addition to electric drives may include measurement circuits and alarm circuits. Because of this, the functioning of all the other circuits and elements in all potential and rule-required versions of their operation shall be checked during integrated tests of such electrical equipment.

The inspection and checks of electric drives are carried out in the main in order to ascertain the conformity of electrical equipment and its connection diagrams with technical documentation.

The insulation resistance of circuits shall be measured in a practically cold and hot (following the on-load test) states.

The check of functioning of a discharging magnetic field energy is carried out in the circuits of d.c. electric drives (with shunt- and compound-wound motors) both with the switched discharging resistor circuit of a parallel winding and with the permanently closed one. In the first case, the timeliness of circuit closing and the discharging effect are checked – voltage therewith is across the winding, in the second case, the discharging effect only.

If limit switches are impractical, due to design reasons, to arrange under stand conditions similarly to the operational version, they shall be at least connected to appropriate circuits to check the diagram functioning.

The check of a drive for no-load functioning involves repeated starts, stops, reverses and operation of the drive for every speed during the time sufficient for being convinced of the normal operation of the drive and for measuring the necessary parameters.

The test for on-load functioning of a drive being part of the machinery shall be carried out according to the Register approved program and procedure for tests of the mechanism in all the modes of its on-load and overload operation.

The functioning of overload protection shall be checked at long-term and short-time overloads of a driving gear.

The check of electric drives may be carried out with use of special electrical loading devices at the firm (manufacturer).

10.6.39 Tests of electrical equipment of electrically-started internal combustion engines.

The accessories specified in the RS Nomenclature and being part of the electrical equipment of electrically-started internal combustion engines, prior to the beginning of tests as part of the electrical equipment circuits of such engines, shall pass post-manufacturing tests in the appropriate scope specified in this Section.

The tests of the electrical equipment set for internal combustion engines shall be carried out when the equipment is mounted in its standard positions on the engine which it is intended for.

During test of electrical equipment at the firm (manufacturer), simulators (if an internal combustion engine is unavailable) may be used separately for a charging generator drive, loading of a starter and starting relay, etc.

Bench tests with use of simulators shall be fully equivalent to tests on an internal combustion engine.

10.6.39.1 Test of starting circuit functioning.

The test of starting circuit functioning should be carried out by means of at least three series of starter switchings-on beginning with the practically cold state of the starter and the internal combustion engine. Each series comprises ten switchings-on having a duration of 5 to 6 s at the maximum load of the starter. Intervals between working periods shall be within 6 to 10 s, between series, the minimum necessary for starter cooling.

10.6.39.2 Test of the charging circuit of an accumulator battery.

The test of the charging circuit of an accumulator battery shall be carried out in all possible modes of internal combustion engine operation untill the full charge of the discharged battery. The engine speed at which the battery is switched on for charging, the speed (at speed drop) at which the battery is switched off of the charging circuit, the presence and the value of reverse current shall be recorded.

Generator regulators (voltage regulators) with contact and contactless elements shall be checked with standard generators and a corresponding accumulator battery.

10.6.40 Tests of lighting fixtures, search lights and control gear of gas-discharge lamps.

Control gear for lighting fixtures with gas-discharge lamps, if intended for installing separately from the lighting fixture, shall be tested in combination with the lighting fixtures excepting the cases specified in 10.6.40.1.

10.6.40.1 Heat test.

The heat test shall be performed with due regard for the following:

.1 the test voltage shall be equal to 1,1 times the rated one, the lamp power is the largest the lighting fixture is designed for;

.2 in testing, deckhead and bulkhead lighting fixtures shall be secured on a wooden board of at least 15 mm thick coated with a black dull paint.

The lighting fixtures to be integrated in deckheads are installed on a mock-up.

10.6.40.2 Test for constancy of material characteristics.

The test for constancy of material characteristics shall be performed in a heat chamber when the following conditions are met:

.1 temperature in the chamber is +55 °C;

.2 lighting fixtures with incandescent lamps shall be tested at the power by 15 % exceeding the rated power of the largest lamp the lighting fixture is designed for;

.3 lighting fixtures with gas-discharge and LED lamps shall be tested at the voltage by 10 % exceeding the rated one;

.4 control gear intended for installing separately from a lighting fixture are not tested for the constancy of material characteristics;

.5 the test shall continue for at least 300 h;

.6 lighting fixtures are considered to have passed the test for the constancy of material characteristics if the following has not been revealed:

wire insulation drying-up and cracking;

loss of spring properties of lampholder central contacts;

flaking, cracking, fusing, burning or the change of the geometric shape of parts;

not permissible reduction of insulation resistance.

10.6.40.3 Thermal stability test.

The thermal stability test shall be performed with due regard for the following:

.1 the test shall be applied to lighting fixtures having a degree of protection IPX1 and over (control gear intended for installing separately from the lighting fixture are not subject to testing);

.2 lighting fixtures with lamps of the largest power they are designed for, shall be kept switched on until the thermal equilibrium is reached, whereupon the hot lighting fixtures are immediately to be exposed (being switched on) to water effects according to Table 10.6.40.3 (depending on the protective enclosure of lighting fixtures);

.3 a temperature of water in the test of lighting fixtures having enclosures IPX1 to IPX4 shall not exceed 20 °C, enclosures IPX5 to IPX6, 15 °C;

.4 duration of water exposure shall be 15 min for lighting fixtures having enclosures IPX1, 10 min for IPX2 and 5 min for IPX3 to IPX6;

.5 the entire cycle of testing for IPX5 and IPX6 lighting fixtures shall be performed 3 times, i.e. after warming-up and drying-up, the hot lighting fixtures shall again be exposed to a water jet;

.6 the test for thermal stability is recommended to be combined with protective enclosure testing.

Table 10.6.40.3

Second numeral designating a protection degree	Characteric of electrical equipment protection against ingress of water and other liquids
0	Protection is lacking
1	Protection against vertically-falling water condensate drops. Water drops vertically-falling onto the case shall not have an adverse effect upon equipment
2	Protection against water drops. Falling water drops shall not have an adverse effect upon equipment when a case is inclined at an angle of up to 15° to the vertical[1]
3	Protection against raining. Raining at an angle equal to, or lesser than, 60° to the vertical shall not have an adverse effect upon equipment
4	Protection against splashing. Water splashes from any direction shall not have an adverse effect upon equipment
5	Protection against water jets. The water jet produced with a nozzle from any direction at certain conditions shall not have an adverse effect upon equipment
6	Protection under conditions on the ship's deck (including watertight deck equipment). When exposed to sea waves, water shall not penetrate in the hull under certain conditions
7	Protection against immersion in water. Water shall not penetrate into the hull under the pressure and during the time specified
8	Protection during indefinitely extended immersion in water under a certain specified pressure[2]

[1] The designation of a given degree of protection may be supplemented with the index "C" (e.g. IP22C) which specifies stricter requirements for the angle of raindrops falling. The protection degree corresponding to the supplementary index is specified in national standards or specifications effective in the country.

[2] The electrical equipment having the enclosure fit for underwater operation by its design and insulation is considered to be equivalent, as to its protection, to protection degree 8.

10.6.41 Tests of ship's apparatus and devices for intercommunication, alarm, monitoring and control.

10.6.41.1 Heat test.

The heat test shall be carried out at the largest continuously-permissible voltage at the inputs of products power supply. The lamps of scale lighting shall be completely switched on.

The heat test of tachogenerators shall be carried out at the largest working speed and the largest (permissible) number of connected secondary devices.

10.6.41.2 Special checks.

Special checks include:

.1 check of inscriptions and symbols distinguishability;

.2 check of audible signals loudness;

.3 electroacoustical tests, measurements and checks of telephone apparatus shall be performed in accordance with the approved technical documentation for these products following the completion of mechanical and environmental tests;

.4 operational test of fire alarm stations following the completion of mechanical and environmental tests, i.e. check of operation of all types of alarms, monitoring and interlocks in all potential versions;

.5 fire tests to evaluate automatic fire detectors (smoke, heat, flame and others), shall be carried out in accordance with the applicable requirements specified in the fire test TF1-TF9 of ISO/TS 7240-9:2012 "Fire detection and alarm systems - Part 9: Test flame for fire detectors.".

.6 Linear heat detectors shall be tested according to standards EN 54-22:2015 and IEC 60092-504. Alternative testing standards may be used as determined by the Register.

10.6.42 Tests of cable products.

When cable products are manufactured according to the international or national standards in accordance with 16.8.1.1, Part XI "Electrical Equipment" of the RS Rules/C, the scope of tests and test methods may be changed upon agreement with the Register.

Prior to the beginning of tests and checks, the materials containing the results of testing physical, mechanical and other properties of insulation and sheathing of which the specimens were tested using the procedures specified in the approved technical documentation, shall be submitted to the surveyor. For all products, such tests include the determination of strength at the rupture and lengthening of insulation and sheathing, of heat stability and cold endurance, thermal ageing and electrical characteristics.

For products designed for operation in engine rooms and on decks of tankers, the sheathing resistance to oil products shall also be assessed.

For testing cables or wires of a particular brand, the specimens of each structure and each number of cores with the minimal and maximum cross-sectional area, as well as with intermediate values, if needed, shall be selected. The number of specimens having the same number of cores of different cross-sections is established separately for each test.

The inspection and checks of cable products are carried out for the compliance with the Register approved technical documentation.

Prior to the test of insulation and the measurement of its resistance, it shall be convinced of the absence of core breaks, and of the electrical serviceability of metallic braids, sheaths and armor by means of their connection to a pilot circuit.

Irrespective of the tests of electrical insulation strength performed on the specimens subjected to the other types of tests, the electrical insulation strength shall additionally be tested on separate specimens after their holding in water for at least 6 h for products and single cores having polyvinylchloride and polyethylene insulation.

10.6.42.1 Mechanical tests.

The common types of tests for compliance with operational conditions onboard a ship, such as the tests for vibration strength and shock strength of cables and wires, shall be carried out with due regard to the following conditions:

.1 at least six specimens of each largest, least and several intermediate cross-sectional areas of each structure of the given cable (wire) brand shall be prepared for testing.

All the specimens shall be separated into three equal groups regarding specimens number and structure;

.2 each specimen from the first group shall be curved like the sinusoid of the least radius permitted by technical documentation and secured on supports spaced apart according to Table 16.8.5.2 of Part XI "Electrical Equipment" of the RS Rules/C. An opportunity of displacement for those specimens in their secured position shall be prevented. Excepting the securing points, the specimens shall have no contacts over their entire length.

Each specimen from the second group shall be secured without bends on four supports welded to a common vertical foundation. The distances between supports shall exceed by 25 % those specified in Table 16.8.5.2 of Part XI "Electrical Equipment" of the RS Rules/C;

.3 the test for vibration strength of the first groups of specimens may be carried out when exposed to vibration perpendicular to their axes. The second groups of specimens shall be tested by exposures along, and perpendicularly to, axes.

In shock strength testing, the specimens of the first and second groups shall be subjected to mechanical actions initially directed perpendicularly to their axes, and then along the axes; for curved specimens – along sinusoid axes;

.4 the third group specimens shall be secured at one end each and to be freely suspended from a rack fastened on a stand. The length of the free-suspended part of a specimen shall be specified in the technical documentation for the cable (wire) of a given brand, number and cross-section area of cores. The end secured and the free-suspended part of a specimen shall be in straight line with one another. Specimens swinging with mechanical actions shall be limited along the entire length within their several diameters. Where the permissible length of the free-suspended part is too large for testing, the specimens may be shortened, if approved by the Register, compensating the mass of the lacking part with the load of the same mass fastened to the lower end of the suspended specimen;

.5 the test of free-suspended specimens for vibration strength shall be performed with the simultaneous exposure to vibration in two mutually-perpendicular directions of which one shall be lengthwise of their axes. The test for shock strength with shock loads shall be performed lengthwise of specimen axes only;

.6 during tests for vibration and shock strength, all specimens shall be energized at a voltage (excepting the single-core ones) by 20 % exceeding the largest working voltage of a cable (wire);

.7 specimens are considered to have passed the test if no electrical breakdown of cores insulation has occurred, no cracks and other damages to specimens have been found on protective coatings, sheaths and insulation of cores in examination without use of magnifying devices.

The above tests fully apply to tests of cables for connecting mobile and portable electrical equipment. Such cables shall initially be tested in hanks, and thereafter test specimens shall be cut from them.

10.6.42.2 Test for cold endurance.

The test for cold endurance may be omitted for cables and wires specially designed for internal wiring. Usually, tests for cold endurance include tests for bending and impact test after exposure of cables to negative temperature. The standard test temperature –40 °C (cold bending) and –35 °C (cold impact) may be lowered in relation to cable operating conditions. Methodology and results of tests shall comply with requirements of the international standard IEC 60092-350:2020.

Upon agreement with the Register test for cold bending may be carried out according to the methodology set forth below:

.1 test specimens shall be wound in one layer around metallic hollow cylinders having diameters corresponding to the least permissible radii of specimens bending, and held in a cooling chamber at a temperature of –50 °C during the time given below:

Outside diameter of a cable, in mm	Time of holding in a cooling chamber, in h
Under 15	1
15 – 30	2
30 – 50	3
Over 50	5

.2 after holding in a room at the temperature corresponding to normal environmental conditions of the tests, all the specimens shall be removed without unbending from the cylinders and secured in such a condition (for use in tests in such a condition for resistance to solar radiation and seawater);

.3 the results of the given test are considered to be satisfactory if no cracks, ruptures, etc. are found on sheaths.

10.6.42.3 Test for exposure to solar radiation and seawater.

For products designed for operation on open decks of ships, the sheathing resistance to seawater and solar radiation shall additionally be assessed.

The specimens prepared according to 10.6.42.2.2 shall be tested for resistance to solar radiation and seawater in order to test on the same specimens most attacks the cable products may be exposed to, in service.

The test for exposure to solar radiation are carried out according to 10.6.16. Thereupon these unbent specimens shall be tested for resistance to seawater according to method Rc1 of standard IEC 60068-2-18.

The test is made by full immersing unbent specimens at 0,15 m in salt water for 48 h. At that, specimen leads shall be brought out and reliably sealed.

Cable specimens for underwater application for supply circuits and/or control and/or transfer of information to MODU and FOP shall be tested for resistance to seawater taking into account hydrostatic pressure relevant to the limit depth of cable operation.

After exposure to salt water the product shall be brought out and washed with fresh water by immersion or by spraying water with a hose.

The product shall be dried by blowing with dry warm air (temperature 60 °C to 80 °C).

Directly after drying, insulation resistance shall be measured and specimens insulation strength tested.

If these measurements and tests give satisfactory results, the specimens have passed the tests.

10.6.42.4 Tests of cables intended for connecting mobile and portable electrical equipment.

Tests for durability under repeated reverse bends by roller systems, for bend durability, axial twisting durability, for durability to bending with axial twisting, for tension and crushing durability of cables intended for connecting mobile and portable electrical equipment shall be performed on standard test sets using the techniques specified in the approved technical documentation. These tests shall be carried out at normal environmental conditions. The number and details of operations with specimens shall be specified in the test program and procedure.

All the listed types of specimen tests, excepting those for tension and crushing durability, shall be performed at the voltage equal to the maximum working one the specimens are designed for, and in tests at the normal temperature, under load.

The test results are considered to be satisfactory if:

.1 cracks and ruptures of cores insulation and sheaths visible to the unaided eye are lacking;

.2 breaks of core wires are lacking;

.3 no electrical breakdowns of insulation are found and stability of load current during tests is maintained;

.4 the results of testing the electrical strength of insulation on completion of all mechanical actions are satisfactory.

10.6.42.5 Test for flame resistance (flame retardance).

The test for flame resistance (flame retardance) shall be performed on a standard test set according to the approved program and procedure in compliance with standard IEC 60332-1-2 + AMD1:2015 or any test procedure equivalent thereto.

For cable products intended for use on the mobile offshore drilling units (MODU), fixed offshore platforms (FOP), floating offshore oil-and-gas product units (FPU) and requiring resistance against hydrocarbon burning, the flame resistance testing shall be carried out in accordance with standard IEC 61892- 4:2019.

10.6.42.6 Test for fire resistance.

The test if carried out for cables of devices required for operation under fire conditions and running through high fire risk spaces.

Cables shall be tested for fire resistance in accordance with standards IEC 60331-1 — for cables with outside diameter more than 20 mm and IEC 60331-21 or IEC 60331-2 for other cables.

10.6.42.7 Tests of cable products for resistance against drilling mud.

For cable products intended for use on decks of the mobile offshore drilling units (MODU), fixed offshore platforms (FOP), floating offshore oil-and-gas product units (FPU), drilling ships, supply vessels for drilling platforms as well as in those premises of the above ships and structures where drilling mud may spill on these products the tests for resistance of cable against drill mud shall be carried out in addition to tests for resistance to oil products in compliance with IEC standard 61892-4. For hydrocarbon- and ether-based drill mud, such tests shall be performed in compliance with the 2007 edition of the standard (IEC standard 61892-4:2007), or in compliance with the national standards.

In the documents issued by RS for cable products, the specific types (groups) of drill mud shall be indicated, for resistance to which the relevant tests have been performed.

10.6.43 Tests of the busbars arranged outside of switchboards for supplying section and/or distribution boards of consumers.

The scope of tests and checks of the busbars arranged outside of switchboards for supplying section and/or distribution boards of consumers instead of cables is given in Table 10.6.43.

Table 10.6.43

Nos	Test	Requirements for test procedure	Notes
1	Temperature rise test	IEC 61439-6	
2	Short-circuit strength test	IEC 61439-6	
3	Verification of resistance and reactance	IEC 61439-6	
4	Verification of structural strength	IEC 61439-6	The enclosure of the system shall be designed to be sufficiently robust, or alternatively additionally protected, to withstand normal mechanical forces which may be expected on board ships
5	Insulation resistance test for main and auxiliary circuits	12.6.2 of Section 12	

Nos	Test	Requirements for test procedure	Notes
6	High-voltage test for main and auxiliary circuits	12.6.3 of Section 12	
7	Vibration test	IEC 60068-2- 6 Test F_c	
8	Fire test	IEC 60332-1-1:2004+ AMD1:2015 and IEC 60332-1-2 + AMD1:2015	
9	Verification of protection degree	IEC 60529	
10	EMC tests	12.6.14 — 12.6.16 of Section 12	Only if electronic devices form part of the busbar system

10.6.44 Tests of electrical heating appliances.

If the cases of electric heating devices are pressurized in operation with water steam or fuel oil or luboil vapours (or may be pressurized with these resulting a malfuction or personnel's mishandling), and if therewith they are subject to 1.3.2.1, Part X "Boilers, Heat Exchangers and Pressure Vessels" of the RS Rules/C, they and their safety (emergency) valves shall pass tests in accordance with 9.7.3.

10.6.45 Tests of items and devices for installation, spicing and connection of cables and wires.

10.6.45.1 Tests of cable ladders, trays and ties for safe working load (SWL).

The test shall be performed according to IEC 61537:2023.

Tests of cable ladders, trays and ties for safe working load (SWL):

.1 ready-assembled specimens are tested for SWL at minimum and maximum working temperature. In case of mechanical properties of specimens changing not more than by ±5 % in all ranges of temperature, it is allowed to perform test at any temperature within this range;

.2 during test the load applied to the specimen is increased from zero to nominal SWL value. Discrete change of load is allowed with a step of not more than 25 % of the nominal value;

.3 bending is measured in certain places every 5 min after application of the full load. Tests are finished when increment of bending is less than 2 %;

.4 no damage or cracks visible by unaided eye shall be observed on a specimen or its joints after test. The value of bending measured in the middle of the tested specimen shall not be greater than 1 % of the length of span. The value of transverse bending in the middle part of each span shall not exceed 5,0 % of specimen width;

.5 at the final stage the load applied to the specimen is increased up to 170 % SWL. The specimen shall withstand testing without failure, meanwhile deformation and twisting of specimen is allowed;

.6 specimens of cable ties are tested at standard fixing of cables on cable ladders and trays at 100 % and 170 % SWL. Duration of test is the same as for cable ladders and trays. Loosening of cable fixing is not allowed.

10.6.45.2 Impact resistance test of plastic cable ladders, protective trays and cable ties.

The test shall be performed according to IEC 60068-2-75:2014 using the pendulum hammer.

The test shall be carried out on samples of cable tray lengths or cable ladder lengths, of 250 mm ± 5 mm long. Samples of ladder shall consist of two side-members with one rung positioned centrally. Samples of mesh trays shall be prepared in such a way that there will be a wire in the centre.

Before the test, plastics components shall be aged at a temperature of 90 °C ± 2 °C for 240 h continuously.

The samples shall be mounted on wooden fibreboard of thickness 20 mm ± 2 mm.

The samples to be tested shall be placed in a refrigerator, the temperature within which is maintained at the ambient temperature of —25 °C for outdoor use and at the ambient temperature of +5 °C for indoor use in engine rooms and other closed ship spaces with a tolerance of ± 2 °C.

After 2 h, the samples shall, in turn, be removed from the refrigerator and immediately placed in the test apparatus.

At 10 s ±1 s after removal of each sample from the refrigerator the hammer shall be allowed to fall with impact energy of 10 J, the mass of the hammer of 5 kg and the fall height of 200 ± 2 mm.

The impact shall be applied to the base, or the rung, in the first sample, to one of the side members in the second sample, and to the other side member in the third sample.

In each case, the impact shall be applied to the centre of the face being tested.

After the test, the samples shall show no signs of disintegration and/or deformation that will impair the safety.

10.6.45.3 Safe Working Load (SWL) test of plastic cable ladders, protective trays and cable ties.

Cable trays/protective casings and joints shall be assigned a Safe Working Load (SWL) satisfying the following criteria, tested at the declared ambient temperatures of - 25 °C to + 90 °C for installation on open decks, from + 5 °C to 90 °C for installation in engine rooms and other closed ship spaces:

the maximum deflection shall not exceed L/100 where L is the distance between the supports;

no mechanical defects or failure are observed when tested to 1.7 x SWL;

all loads shall be uniformly distributed (UDL) over the length and width of the samples as shown on Fig. 10.6.45.3.

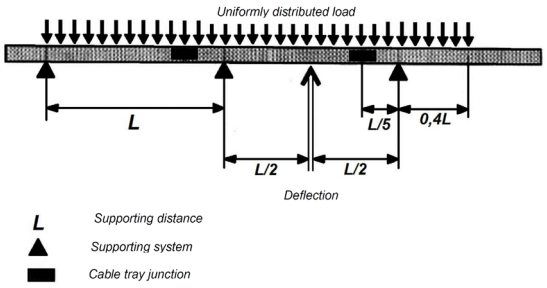

Fig. 10.6.45.3

The loads shall be applied in such a way that a UDL is ensured even in the case of extreme deformation of the samples.

To allow for settlement of the samples, a pre-load of 10 % of the test load unless otherwise specified, shall be applied and held for at least 5 min, after which the measurement apparatus shall be calibrated to zero.

The load shall then be gradually increased evenly longitudinally and transversely up to the test load continuously or when a continuous increase is impractical, the load may be increased by increments.

These increments shall not exceed about a quarter of the safe working load. The load increments shall be distributed through the load plates longitudinally and transversely as evenly as is practical.

After loading, the deflection shall be measured at the points specified to give a practical mid-span deflection.

The samples shall be left and the deflections measured every 5 min until the difference between two consecutive sets of readings is less than 2 % with regard to the first set of the two consecutive sets of readings.

The first set of readings measured at this point is the set of deflections measured at the test load.

When subject to the test load the samples, their joints and internal fixing devices, shall show no damage or crack visible to normal view or corrected vision without magnification.

The load shall then be increased to 1,7 times the test load.

The samples shall be left and the deflections measured every 5 min until the difference between two consecutive sets of readings is less than 2 % with regard to the first set of the two consecutive sets of readings. The samples shall sustain the increased loading without collapsing. Buckling and deformation of the samples is permissible at this loading.

N o t e . Alternatively, tests can be carried out:

at any temperature within the declared range if documentation is available which states that the relevant structural properties of the materials as used within the system do not differ by more than 5 % of the average between the maximum and minimum property values;

only at maximum temperature within the range, if documentation is available, which states that the relevant structural properties of the materials, as used within the system decrease when the temperature is increasing;

at maximum and minimum temperature only. Tests shall be carried out for the smallest and largest sizes of cable trays lengths or cable ladder lengths, having the same material, joint and topological shape.

10.6.45.4 Flame retardant test.

Flame retardant test shall be carried out in accordance with IEC 60695- 11- 5:2016.

The test shall be carried out with flame application of 5 times 15 s each. Interval between each application shall be 15 s or 1 time 30 s. The equipment shall be considered to have passed the tests if burnt out or damaged part is not more than 60 mm long, no flame, no incandescence or - in the event of a flame or incandescence being present, it shall extinguish itself within 30 s of the removal of the test flame. The dripping material shall extinguish itself in such a way as not to ignite a wrapping tissue.

10.6.45.5 Smoke and toxicity test.

Smoke and toxicity test shall be carried out in accordance with 2010 FTP Code adopted by IMO resolution MSC.437(88) as amended by IMO resolution MSC.437(99), or any international or national standard.

10.6.45.6 Resistivity test.

Cable trays/protective casings passing through a hazardous area shall be electrically conductive. The volume resistivity level of the cable trays/protective casings and fittings shall be below 10^5 Ohm m and the surface resistivity shall be below 10^8 Ohm.

The cable tray/protective casings shall be tested in accordance with IEC 62631-3-1:2016 and IEC 62631-3-2:2015.

N o t e 2 . The resistance to earth from any point in these appliances shall not exceed 10^6 Ohm.

10.6.45.7 Tests of cable ties (metallic and plastic) to measure the ultimate tensile strength.

Cable ties (metallic and plastic) are tested to measure the ultimate tensile strength. The specimen is fixed around split-type cylinder of the test machine in a standard position with the

lock of the cable tie located opposite to split line to ensure maximum force applied to lock when parts of cylinder are drawn separately. Ultimate tensile strength shall be not less than the value given in the product specification.

10.6.46 Testing of integrated metal sheathed gas-insulated switchgears (GIS).

10.6.46.1 Resistance measurement of the main current-carrying circuit.

Measurements shall be carried out in accordance with the measurement chart for the main circuit section resistance given by the manufacturer in the operating documentation for GIS.

The measured resistance shall not exceed the values specified in the manufacturer's documentation.

10.6.46.2 Insulation resistance measurement of the main current-carrying circuit.

Measurements are made with a 2500 V megohmmeter.

Insulation resistance shall not be lower than the values given in Table 10.6.33.1-1.

10.6.46.3 Testing of main circuit insulation strength.

Testing shall be carried out at the rated electronegative gas (mixture) pressure. All cells are subject to testing. Tests are carried out with alternating-voltage power-frequency or resonant-type test apparatuses. Tests may be carried out with alternating voltages of up to 400 Hz. The value and procedure of applying the test voltage, the stages and the order of testing the cells are determined by a technical test programme drawn up based on the provisions of IEC 62271-203 and the requirements of GIS manufacturers. Sections not subjected to testing in these cases, separated from the part under test by a breaker or disconnector, shall be earthed.

The tests shall be accompanied by monitoring of the partial discharge level. Level monitoring may be carried out using available electrical, acoustic or high-frequency partial discharge measurement methods. The GIS is considered to have passed the test if no insulation breakdowns and no partial discharges other than the noise level are detected during the test. In case of a breakdown, the repaired GIS volume shall be retested with partial discharge monitoring.

10.6.46.4 Tightness tests.

Tests shall be carried out on GIS filled to rated pressure with the same gas and under the same conditions as those used in operation.

The allowable leakage flow of electronegative gas shall not exceed 0,5 % per year of the total electronegative gas mass.

The leakage test is carried out to ensure that the leakage gas flow rate *F* does not exceed the manufacturer's approved leakage gas flow rate *Fp*.

Table 10.6.46.4

The allowable leakage flow of electronegative gas

Ambient temperature, in °C	Allowable leakage flow, in *Fp*
+40 and +50	*3 Fp*
20 ± 2	*Fp*
-5 /-10 /-15 /-25 /-30/-40	*3 Fp*
-50	*6 Fp*
-60	*10 Fp*

When checking for leaks with a leak detector probe, the seal points of detachable joints and welds and the seals of movable parts of earthing disconnectors and breakers shall be examined. Where appropriate (multiple small defects in welds, adverse weather conditions, etc.), it is permissible to localize the suspected area with an unsatisfactory gas tightness indicator with a covering material.

Monitoring shall be carried out using a leak detector with a sensitivity of at least 102 Pa cm^3/s. The test result is considered satisfactory if the output of the leak detector shows no leakage.

Monitoring can also be carried out with fixed continuous monitoring systems (sensors) or special thermovision cameras.

10.6.46.5 Checking the moisture content in electronegative gas.

The moisture content of commercial electronegative gas and used electronegative gas intended for filling or refilling of GIS isolated compartments is subject to checking when no manufacturer's certificate is available. The mass fraction of water shall not exceed 0,0015 % (corresponding to a dew point of minus 40 °C at the atmospheric pressure) for electronegative gas manufactured in accordance with IEC 60480:2019. When the manufacturer of the gas-insulated switch has higher quality requirements for electronegative gas than those given in the specifications, the moisture content of such gas shall comply with these requirements.

The moisture content of electronegative gas in the GIS compartment shall be measured prior to GIS being put into operation (following the initial filling or refilling of GIS with electronegative gas or gas mixture, where necessary). To prevent condensation, the highest permissible moisture content inside gas-insulated GIS compartments shall be such that the dew point is not higher than minus 5 °C for measurements at plus 20 °C and rated electronegative gas pressure. An appropriate correction shall be made for moisture content measurements made at other temperatures, unless a different moisture content value is provided by the GIS manufacturer.

Should the moisture content in the electronegative gas contained in the gas-insulated GIS compartment exceed the standard, the gas shall be pumped out, the compartment drained and refilled with electronegative gas. The gas discharged from the compartment can be recovered and used in accordance with the guidelines of the GIS manufacturers and the recommendations of IEC 60480:2019.

Moisture content in the electronegative gas intended for reuse shall comply with the requirements of IEC 60480:2019.

10.6.46.6 Checking the actuation of the electrical contact device of density monitoring instruments of electronegative gas (gas mixture).

Checking the actuation of the electrical contact device of density monitoring instruments of electronegative gas (gas mixture) shall be carried out for each contact group of the device when the pressure monitored by the appliance is artificially reduced to warning and alarm values. The specified values shall be determined from the test pressure gauge and further adjusted to a temperature of plus 20 °C. The values obtained this way shall comply with the standard specified in the GIS operating instructions.

10.6.46.7 Checking the pressure of filling GIS gas-insulated compartments with electronegative gas or gas mixture using a test gauge.

Checking the pressure of filling GIS gas-insulated compartments with electronegative gas or gas mixture shall be carried out using a test gauge of the accuracy class 0,6 or higher.

The measured pressure value adjusted to a temperature of plus 20 °C shall be within the range specified by the manufacturer.

10.6.46.8 Checking the electromagnetic interlock operation.

Electromagnetic interlocking includes interlocking between high voltage apparatus within the GIS cubicle, interlocking against connected busbar earthing switches and interlocking against manual operation of high voltage (HV) apparatus. Interlocking circuits are assembled on the secondary contacts of HV apparatus in accordance with the diagrams provided by the GIS manufacturer. The check consists of enabling control by an individual apparatus when the

interlock conditions are met, or denying control if the conditions are not met. The check shall be carried out for all GIS apparatus.

10.6.46.9 Mechanical integrity monitoring and testing.

Checking of characteristics (clearances in actuator assemblies, strokes of actuator components, spring compression, etc.) is performed to the extent and according to the standards specified in the GIS operating documentation.

10.6.47 Testing of integrated shielded current leads 15 – 35 kV.

10.6.47.1 Measurement of insulation resistance.

Measurements are made with a 2500 V megohmmeter.

The insulation resistance measured during commissioning of the current lead is used as a baseline for subsequent monitoring during major repair work on generators or IS.

10.6.47.2 Testing of current lead insulation with overvoltage at 50 Hz.

The test is carried out on equipment up to 35 kV inclusive.

The value of the test voltage with the windings of generators and power transformers disconnected is taken according to Table 10.6.4.9. For conductors with a screen common to all three phases, the test voltage is applied alternately to each phase of the conductor with the other phases connected to the earthed enclosure.

Duration of the test voltage application – 1 min.

10.6.47.3 Checking the quality of the busbar and screen connections.

The quality of the busbar connections shall be checked in accordance with the manufacturer's instructions.

The quality of the welded joints during installation of the conductors shall be checked in accordance with the aluminum welding instructions or, if an appropriate installation is available, by X-ray or gamma-ray inspection, or by the method recommended by the manufacturer.

The welded joints of the busbars and shields shall meet the following requirements:

no cracks, burns, unsealed pits or spotting exceeding 10 % of the weld length and more than 15 % of the welded metal thickness are allowed;

the total value of poor penetration, undercuts, gas pores, oxide and tungsten inclusions in welded aluminum and aluminum alloys bars and shields in each considered section shall not exceed 15 % of the welded metal thickness.

10.6.47.4 Checking the artificial ventilation devices of the current lead.

Check is carried out in accordance with the manufacturer's instructions.

10.6.47.5 Check for short circuits in the generator voltage current leads.

The check of current leads is carried out according to Table 10.6.47.5.

Table 10.6.47.5

Criteria for the absence of short circuits in the current leads

Current lead design	Assembly to be checked	Condition assessment criterion	Notes
With continuous screens	Insulation of shields or current lead ducts from transformer and generator enclosure at: a continuous air gap (slot) between the current lead shields and the generator enclosure;	No metal shorts between the shields and the generator enclosure	At visual examination
	one-side insulation of shield seals or current lead	Integrity of the insulating bushings, no	At visual examination

Current lead design	Assembly to be checked	Condition assessment criterion	Notes
	ducts from transformer and generator enclosure;	contact of the shielding surfaces or ducts (at the insulating points) with the transformer and generator housings	
	double-side insulation of shield seals or current lead ducts connected to transformer and generator enclosure	The insulation resistance of the removable screen or duct against the transformer and generator enclosure with the tie rods and earthing conductors removed shall be at least 10 kOhm	To be measured with a 500 ─ 1000 V megohmmeter
Sectioned	Insulation of rubber compensators of current lead shields from transformer and generator housings	The clearance between the bolts of adjacent rubber compensator pressure rings shall be at least 5 mm	At visual examination
	Insulation of rubber seals for removable and movable screens	The insulation resistance of the screen against the steel structures with the tie rods removed shall be at least 10 kOhm	To be measured with a 500 ─ 1000 V megohmmeter
All types with double-layer screen bed gaskets	Insulating gaskets for screen beds	The insulation resistance of the gaskets against the steel structure shall be at least 10 kOhm	1. To be measured with a 500 ─ 1000 V megohmmeter 2. The condition of bushings of the frame fixing bolts is checked by visual inspection
All types	Interphase rods of disconnectors and earthing switches	The rods shall have insulating bushings or other elements to prevent short-circuiting	At visual examination

10.6.47.6 Check gas analysis for hydrogen content from a current lead.

During the analysis, the hydrogen content of the hydrogen nodes is checked. The hydrogen content of shielded current leads, line and neutral terminal enclosures shall be less than 1 %.

10.6.47.7 Thermovision inspection.

Heating of the contacts and contact connections of the current-carrying circuit is assessed during the inspection. Heat monitoring is carried out where technically possible.

10.6.48 Testing of gas-insulated current leads (GICL) 35 ─ 220 kV.

10.6.48.1 Measurement of main circuit insulation resistance.

Measurements are made with a 2500 V megohmmeter.

Insulation resistance shall not be lower the values given in Table 10.6.33.1

10.6.48.2 Measurement of main circuit resistance.

Measurements shall be carried out in accordance with the measurement chart for the main circuit resistance given by the manufacturer in the operating documentation for the gas-insulated current leads.

The measured resistance shall not exceed the maximum values permissible during the acceptance test.

10.6.48.3 Tests of electrical insulating strength at 50 Hz.

The insulation of the main circuits of gas-insulated current leads shall be subjected to high-voltage testing with alternating voltage. Testing shall be carried out at the rated electronegative gas (mixture) pressure. All GIS cells are subject to testing. Tests are carried out with alternating-voltage power-frequency or resonant-type test apparatuses. Tests may be carried out with alternating voltages of up to 400 Hz. The value and procedure of applying the test voltage, the stages and the order of testing the cells are determined by a technical test programme drawn up based on the requirements of equipment manufacturers. Sections not subjected to testing in these cases, separated from the part under test by a breaker or disconnector, shall be earthed.

The tests shall be accompanied by monitoring of the partial discharge level. Level monitoring may be carried out using available electrical, acoustic or high-frequency partial discharge measurement methods. The current lead is considered to have passed the test if no insulation breakdowns and no partial discharges other than the noise level are detected during the test. In the event of a breakdown, the repaired GICL volume shall be retested with partial discharge monitoring.

10.6.48.4 Checking the tightness of enclosures.

Tests shall be carried out on gas-insulated current leads filled to the rated pressure with the same gas and under the same conditions as those used in operation.

Checking is carried out using a leak detector with a sensitivity of at least 10^2 Pa cm^3/s. The leak detector probe is used to inspect the joint seals and enclosure welds. The test result is considered satisfactory where no leak is indicated by the leak detector.

The allowable leakage flow of electronegative gas shall not exceed 1 % per year of the total electronegative gas mass.

The check can also be carried out with fixed continuous monitoring systems (sensors) or special thermovision cameras.

10.6.48.5 Checking the moisture content in electronegative gas.

The moisture content of commercial electronegative gas and used electronegative gas intended for filling or refilling of GICL isolated compartments is subject to checking when no manufacturer's certificate is available. The mass fraction of water shall not exceed 0,0015 % (corresponding to a dew point of minus 40 °C at the atmospheric pressure) for electronegative gas manufactured in accordance with IEC 60480:2019. When the manufacturer of the gas-insulated switch has higher quality requirements for electronegative gas than those given in the specifications, the moisture content of such gas shall comply with these requirements.

The moisture content of electronegative gas in the GIS compartment shall be measured prior to GIS being put into operation (following the initial filling or refilling of GIS with electronegative gas or gas mixture, where necessary). To prevent condensation, the highest permissible moisture content inside gas-insulated GIS compartments shall be such that the dew point is not higher than minus 5 °C for measurements at plus 20 °C and rated

electronegative gas pressure. An appropriate correction shall be made for moisture content measurements made at other temperatures, unless a different moisture content value is provided by the GIS manufacturer.

Should the moisture content in the electronegative gas contained in the gas-insulated GIS compartment exceed the standard, the gas shall be pumped out, the compartment drained and refilled with electronegative gas. The gas discharged from the compartment can be recovered and used in accordance with the guidelines of the GIS manufacturers and the recommendations of IEC 60480:2019.

Moisture content in the electronegative gas intended for reuse shall comply with the requirements of IEC 60480:2019.

10.6.48.6 Checking the pressure of filling GICL gas-insulated compartments with a gas or gas mixture using a test gauge.

Checking the pressure of filling GICL gas-insulated compartments with a gas or gas mixture shall be carried out using a test gauge of the accuracy class 0,6 or higher.

The measured pressure value, adjusted to a temperature of plus 20 °C, shall be within the range specified by the manufacturer.

10.6.49 Testing of cast (solid) insulation for the voltage of 15 — 35 kV.

Testing shall be carried out within the extent specified in 10.6.47.1 — 10.6.47.3.

10.6.50 Testing of collecting busbars and connecting bars, rigid busbars.

10.6.50.1 Measurement of insulation resistance of suspended and supported porcelain insulators.

Measurement shall be carried out with a megohmmeter for a voltage of 2500 V only when the ambient air temperature is positive.

When installing insulators, the insulation resistance is measured immediately before installing the insulators.

The resistance of each insulator or each element of a multiple-element insulator shall be at least 300 MOhm.

10.6.50.2 Testing of busbar insulation with overvoltage at 50 Hz.

The test is carried out on equipment up to 35 kV inclusive.

Test voltage value is assumed in accordance with Table 10.6.4.2-2.

Newly installed multi-element or suspended insulators shall be tested with increased voltage of 50 kV at 50 Hz applied to each insulator element.

Duration of test voltage application ─ 1 min.

10.6.50.3 Checking of condition of entries, supporting and bushing insulators.

Checking is carried out in accordance with the provisions of 10.6.53.

10.6.51 Testing of current-limiting dry reactors.

10.6.51.1 Measurements of winding insulation resistance relative to hold-down bolts.

Measurement is carried out with a megohmmeter for voltages of 1000 ─ 2500 V. The value of the insulation resistance of reactors shall be at least 0,5 MOhm.

10.6.51.2 Testing of reactor support insulators with overvoltage at 50 Hz.

The test is carried out on equipment up to 35 kV inclusive.

Test voltage value is assumed in accordance with Table 10.6.4.2-2.

Testing of reactor support insulators with 50 Hz overvoltage can be carried out together with bus arrangement insulators.

Duration of test voltage application ─ 1 min.

10.6.52 Testing of valve-type arresters and overvoltage limiters (OVL).

Overvoltage limiters not listed in this Section shall be tested in accordance with the manufacturer’s operating instructions.

10.6.52.1 Resistance measurement of arresters and overvoltage limiters.

The measurement shall be carried out:

for arresters and OVL with the rated voltage below 3 kV – by a 1000 V megohmmeter;

for arresters and OVL with the rated voltage of 3 kV and over – by a 2500 V megohmmeter.

The resistance is measured before commissioning of the equipment to which the protective devices are connecte.

The resistance of the RVP, RVO, GZ arrester types shall not be less than 1000 MOhm, and for RVN shall comply with the manufacturer's requirements.

The resistance of the RVS-type arrester elements shall comply with the requirements of the manufacturer's instructions. The resistance of the RVM, RVRD, RVMG, RVMK type arrester elements shall comply with the values given in Table 10.6.52.1.

The resistance of the capacity simulator shall be measured with a 1000 V megohmmeter. The value of the measured resistance shall not differ by more than 50 % from the manufacturer's measurement results.

Table 10.6.52.1

Resistance values of valve-type arresters

Type of arrester or element	Resistance, in MOhm		Permissible operating variations from the manufacturer's data or initial measurement data
	not less	not more	
RVM-15 RVM-20 RVM-35 (2-element)	600 1000 600	2000 10000 2000	± 30 %
RVMG arrester element 110M 150M 220M	 400 400 400	 2500 2500 2500	± 60 %

The insulation resistance of the insulating bases of arresters with trip recorders shall be measured with a 1000 — 2500 V megohmmeter. The value of the measured insulation resistance shall not be less than 1 MOhm.

The resistance of overvoltage limiters with the rated voltage of 3 – 35 kV shall comply with the manufacturer's instructions.

The resistance of overvoltage limiters with the rated voltage of 110 kV or over shall not be less than 3000 MOhm (unless another value is specified in the manufacturer's instructions) and shall not differ by more than ±30 % from that given in the data sheet or obtained from previous measurements in operation.

10.6.52.2 Measurement of the conductive current of valve arresters at the rectified voltage.

Measurement shall be carried out for arresters with shunt resistors before commissioning, and in addition for arrester with magnetic arc quenching at least every 6 years. An unscheduled measurement of the conductivity current is carried out for a final assessment of the arrester condition where the megohmmeter measurement detects a change in resistance exceeding the value specified in Table 10.6.52.2.

The permissible conductivity currents of the valve arresters are given in Table 10.6.52.2.

Table 10.6.52.2

Permissible values of conductive current of valve arresters at the rectified voltage

Type of arrester or element	Test rectified voltage, in kV	Conductive current at arrester temperature 20 °C, in μA	
		not less	not less
РВС-15 РВС-20 РВС-33 РВС-35	16 20 32 32	200 200 450 200	340 340 620 340
РВМ-15 РВМ-20	18 28	500 500	70 700
РВЭ-25М РВМЭ-25	28 32	400 450	650 600
РВМГ-110М, 150М, 220М arrester element	30	1000	1350

Note. To adjust the conductive currents of the arresters to a temperature of plus 20 °C, a correction equal to 3 % for every 10 degrees of deviation shall be made (at the temperature above 20 °C the correction shall be negative).

10.6.52.3 Measurement of the conductive current of the overvoltage limiters.

Measurement of the conductive current of the overvoltage limiters shall be carried out:

for limiters of voltage classes 15 — 110 kV at the highest continuous permissible phase voltage;

for limiters of voltage class 150, 220* kV at 100 kV of 50 Hz frequency.

The method of conductive current measurement, as well as the limiting values at which the limiter is taken out of service, are specified in the manufacturer's instructions.

10.6.52.4 Thermovision inspection of valve-type arresters and surge arresters.

The inspection is carried out on valve-type arresters with shunt resistance and overvoltage limiters, where technically possible.

10.6.52.5 Checking of arrester tightness.

Checking shall be carried out at vacuum of 300─400 mmHg. The pressure change with the valve closed shall not exceed 0,5 mmHg within 1 ─ 2 hours.

10.6.53 Testing of entries and bushing insulators.

Testing of 35 ─ 750 kV bushings with RIP, RBP, RIN insulation is carried out according to the manufacturer's procedure. The rated parameters and test periods are as specified in the manufacturer's certificates and instructions.

10.6.53.1 Measurement of insulation resistance.

The measurement of the insulation resistance of the measuring capacitor PIN (C_2) with a 2500 V megohmmeter, and of the last insulation layers (C_3) with a 2500 V megohmmeter shall be carried out, unless otherwise instructed by the manufacturer.

The insulation resistance values shall be at least 1000 MOhm during commissioning.

For entries with solid insulation, measurements of insulation resistance shall be made in accordance with the manufacturer's instructions.

Measurement of the insulation resistance of transformer entries shall be carried out in accordance with 10.6.25.6.

* For overvoltage limiters of 220 kV the conductive current may be measured at 75 kV of 50 Hz frequency.

10.6.53.2 Measurement of tgδ and insulation capacity.

The following measurement of tgδ and capacity shall be carried out:

of the base insulation of entries at 10 kV;

insulation of the measuring capacitor PIN (C_2) or (and) the terminal layers of the insulation (C_3) at 5 kV, unless the measurement of C_3 is prohibited by the manufacturer;

the measurement of C_3 and $tg\delta_3$ for RIP insulation is not performed to prevent damage to the entry.

Limit values of tgδ are given in Table 10.6.53.2.

Table 10.6.53.2

Limiting tgδ values of entries

Entry type and insulation area	Limit values of tgδ, in %, for entries with the rated voltage, in kV		
	35	110 ─ 150	220
Paper-oil insulation of entry: - base insulation (C1) and PIN capacitor insulation (C2); - terminal layers of insulation (C3).	-─ -	0,7 1,2	0,6 1,0
Solid entry insulation with oil filling*: - base insulation (C1).	1,0	1,0	─
Paper-bakelite mastic-filled input insulation: - base insulation (C1)	3,0	─	─
RIP – entry insulation[1] - base insulation (C1)	1	0,7	

* In accordance with the manufacturer's documentation.

1. The tgδ values adjusted to a temperature of 20 °C are standardized. The adjustment shall be made in accordance with the instructions for the entry operation.
2. "-" sign indicates no limit value.

10.6.53.3 Testing with overvoltage at 50 Hz.

The test is carried out on equipment up to 35 kV inclusive.

The test voltage value for bushing insulators and entries tested separately or upon installation on equipment, is assumed according to Table 10.6.4.13.

Testing of entries installed on power transformers is carried out together with testing of the windings of these transformers. Test voltage value is assumed in accordance with Table 10.6.4.13.

Duration of test voltage application – 1 min.

10.6.53.4 Overpressure test.

The overpressure test is carried out on untight oil-filled entries of 110 kV and over, with an overpressure of 0,1 MPa for the purpose of checking the seals.

The test duration is 30 min. A pressure drop of max. 5 kPa during the test period is permissible.

10.6.53.5 Testing of oil from the entries.

Oil shall be tested in accordance with the relevant requirements.

Determination of the physical and chemical characteristics of oil from unsealed entries is performed for 110 ─ 220 kV entries.

10.6.53.6 Monitoring of insulation under operating voltage.

It is advisable to monitor the insulation of entries under operating voltage at all capacitor-type entries of 110 ─ 220 kV with paper-oil insulation, installed on transformers with the rated voltage of 110 kV and higher, installed on the essential facilities.

Parameters to be monitored: change of dissipation factor ($\Delta tg\delta$) and capacitance ($\Delta C/C$) of the base insulation. The change in the values of the parameters to be monitored is defined as the difference between the results of regular measurements and those taken at the manufacturer's release.

where the $tg\delta$ value differs from the manufacturer's data by 0,3 % and more, perform measurements at Utrest = 10 kV. Should the difference be observed, perform DGA. The limit value of the increase in insulation capacitance is 5 % of the value measured when the live monitoring system is put into operation. Periodicity of inspection of live entries is 2 times a year. One of the measurements can also be taken at sub-zero temperatures.

Table 10.6.53.6

Limiting values of $|\Delta tg\delta|$ and $\Delta Y/Y$

Voltage class, in kV	Limiting values of parameters, in, %, $\lvert \Delta tg\delta \rvert$ and $\Delta Y/Y$	
	at periodical monitoring	at continuous monitoring
110 ─ 220	2,0	3,0

Note. A decrease of $\Delta tg\delta$ (%) ≥ 0,3 in $tg\delta$ of the base insulation of the sealed entry in comparison with the previous measurement is an indication for additional tests to determine the cause of the decrease in $tg\delta$.

10.6.53.7 Checking the insulation integrity.

If chipping and cracking of porcelain, cracks in reinforcement joints are detected, vibroacoustic examination of the damaged entries and bushings shall be carried out.

10.6.54 Testing of fuses, fuse disconnectors with voltage of 15 ─ 35 kV.

10.6.54.1 Testing of reference insulation with overvoltage at 50 Hz.

The test is carried out on equipment up to 35 kV inclusive.

The value of the test voltage of the fuse, fuse disconnector base insulation is taken according to Table 10.6.4.17.

Duration of test voltage application ─ 1 min.

10.6.54.2 Checking the integrity of the fuse insert.

To be checked:

using an ohmmeter ─ the integrity of the fusible link;

visually ─ the calibration on the cartridge.

10.6.54.3 Measurement of the d.c. resistance of the fuse-disconnector cartridge.

The measured resistance value shall correspond to the nominal current value of the cartridge calibration.

10.6.54.4 Measurement of contact pressure in the fuse disconnector receptacle contacts.

The measured value of the contact pressure shall correspond to the manufacturer's specifications.

10.6.54.5 Check the condition of the arc-suppression part of the fuse disconnector cartridge.

Check the internal diameter of the arc-suppression part of the fuse disconnector cartridge. The measured value of the internal diameter of the arc-suppression section of the cartridge shall be in accordance with the manufacturer's specifications.

10.6.54.6 Checking the operation of the fuse disconnector.

5 cycles of fuse disconnector on and off operations are performed.

Each operation shall be successful at a single attempt.

10.6.55 Testing of power cable lines with voltages from 15 to 220 kV.

For power cable lines (CL) of 15 to 220 kV, the following tests shall be carried out to confirm the quality and proper installation of CL and to determine the technical characteristics of CLs:

a.c. voltage, sinusoidal waveform and frequency ─ in the range of 20 ─ 300 Hz, test voltage level according to Table 10.6.55.1, or rated operating line voltage for 24 hours without load;

determination of cable core integrity and phasing of cable cores and cable shields is carried out in operation after assembly, installation of sleeves or disconnection of cable cores has been completed;

determination of cable core resistance;

determination of the electrical operating capacity of cables;

measurement of current distribution over single-core cables and shields;

checking the earthing device (measuring the earthing resistance);

testing of cable sheaths with d.c. voltage;

measurement of partial discharge characteristics;

thermovision inspection of terminations and cable entries in GIS (for 35 ─ 220 kV cable lines);

measurement of the dissipation factor;

checking the integrity of the fibre optic cables (at the customer's request, this check can also be carried out immediately after laying the construction cable lengths, before installation of the couplings and termination sleeves).

Electrical tests of cable lines after laying are carried out upon completion of the cable installation.

10.6.55.1 Testing of cable insulation by excessive rectified voltage.

For plastic-insulated cables up to 3 ─ 35 kV the duration of the full test voltage application is 10 min.

For cables of 35 ─ 220 kV the duration of the full test voltage is 15 min.

The permissible leakage currents depending on the test voltage and the permissible values of the asymmetry coefficient for measuring the fault current are given in Table 10.6.55.1.

The absolute value of the leakage current is not a rejection indicator.

Cables with satisfactory insulation must have stable fault currents. The fault current shall decrease when the test is carried out. If the fault current does not decrease, or when it increases or the current is unstable, carry out the test until the defect is detected, but not longer than 15 minutes.

Table 10.6.55.1

Fault currents and asymmetry coefficients for power cables

Cable of voltage, in kV	Test voltage, in kV	Permissible fault current values, in mA	Permissible values of asymmetry coefficients (I_{MAX}/I_{MIN})
20 — 34	100	1,5	10
35 — 109	175	2,5	10
110 — 149	285	not standardized	not standardized
150 — 219	347	not standardized	not standardized
220	510	not standardized	not standardized

It is permissible, in agreement with the cable manufacturer, to carry out an a.c. voltage test at 50 Hz instead of a rectified voltage test for cables of 110 – 220 kV voltage level. In this case the tests shall be carried out with the voltage (1,00 – 1,73)·Unom, and test duration time shall be agreed with the manufacturer.

10.6.55.2 Determination of cable core resistance.

Tests are carried out for lines of 20 kV and over. Resistance of cable cores to direct current, corrected to a specific value (per 1 mm^2 of cross-section, 1 m of length, at 20 °C), shall not exceed 0,01793 Ohm for copper core and 0,0294 Ohm for aluminum core. The measured resistance (corrected to specific value) may deviate from the specified values by no more than 5 %.

10.6.55.3 Determination of the electrical operating capacity of cables.

Determination is carried out for lines of 20 kV and over. Cross-linked polyethylene (CLP) cables are not subject to this test. The measured capacity corrected to a specific value (per 1 m of length) shall not differ from the factory test values by more than 5 %.

10.6.55.4 Measurement of current distribution over single-core cables.

Current distribution irregularity in the conductive cores and sheaths (shields) of the cables shall not exceed 10 %. Monitoring is performed when 2 or more cables are connected in parallel in the same phase.

10.6.55.5 Checking the earthing device.

For 15─ 220 kV lines, the transient earthing resistance of cable terminals and terminations are measured in relation to the armour (shield) of the CL and the earth connection of the electrical installation to which the cable line is connected. Transient resistance is measured (if the contact connection is in good condition, resistance does not exceed 0,05 Ohm).

The integrity of the metal bonding between the earthing switches of cable lines of voltage 110 kV and over and the transformer neutral is measured by tapping the joints with a hammer and examination for breaks and other defects.

10.6.55.6 Testing of 110–220 kV CLP insulated cables with increased a.c. voltage.

Testing shall be carried out in accordance with IEC 60840:2017 and IEC 62067:2011.

20 ─ 300 Hz overvoltage tests are carried out with a resonant high-voltage test equipment. Duration of test voltage application ─ 60 min.

Table 10.6.55.6

Value of test alterating voltage for 35 ─ 220 kV CLs with CLP insulation

Voltage class, in kV	Test voltage level, in kV
35 ─ 47 (IEC 60840:2017)	52 kV
47,1-69(IEC 60840:2017)	72 kV
69,1-115 (IEC 60840:2017)	128 kV
115,1-138 (IEC 60840:2017)	152 kV
138,1-161 (IEC 60840:2017)	174 kV
161,1-220 (IEC 62067:2011)	180 kV

10.6.56 Monitoring the condition of couplings by means of measurement and localization of partial discharges.

The examination is carried out on plastic-insulated CLs of 110 kV and over.

10.6.57 Tests of cryogenic cables.

10.6.57.1 Conductor resistance measurement.

Wheatstone bridge or other appropriate means of measurement may be used to measure the conductor resistance. The measurement results shall be brought to temperature 20 °C for the cable length of 1 km according to the formula:

$$R_{20} = R_t \times K_t \times \frac{1000}{l}$$

where

R_{20} = conductor resistance, in Ohm/km, converted to the value per kilometer at 20 °C;

R_t = measured conductor resistance, in Ohm, at ambient temperature t;

l = conductor length, in m;

K_t = coefficient for a copper conductor determined by the formula:

$$K_t = 1 + 0{,}004041 \times (20 - t)$$

where t = ambient temperature when performing measurements.

The value of conductor resistance shall not exceed the value indicated in the manufacturer's technical documentation.

10.6.57.2 Measurement of insulation resistance.

Insulation resistance shall be measured prior to and after insulation strength test.

One of the following methods may apply at measurement of insulation resistance:

.1 in water. When testing, the cable shall be immersed in clear water. Prior to measurement, the cable shall be held in water not less than 1 h. Test d.c. voltage not less than 100 V shall be applied between the conductor and water for single-core cables, and between the conductors and between the conductors and water for multi-core cables. The insulation resistance shall be measured not less than 1 min. and no longer than 5 min. When measuring, metallic sheath of cables shall be earthed.

.2 in air. Test d.c. voltage not less than 100 V shall be applied between the conductors, for cable with metallic sheath the test voltage shall be applied between the conductors and between the conductors and earthed metallic sheath.

Measurement results shall be brought to temperature of 20 °C for the cable length of 1 km according to the formula:

$$R_{20} = R_t \times K \times \frac{l}{1000}$$

where

R_{20} = insulation resistance, in MOhm·km, converted to the value per kilometer at temperature 20 °C;

R_t = measured conductor resistance, in Ohm, at ambient temperature t;

l = conductor length, in m;

K = coefficient to bring the insulation resistance to temperature of 20 °C determined based on experimental results received for the relevant insulation material.

The value of insulation resistance shall not be less than the value specified in the manufacturer's technical documentation.

10.6.57.3 Test of insulation strength.

One of the following methods may apply when testing the electrical insulation strength:

.1 in water. When testing, the cable shall be immersed in clear water. Prior to measurement, the cable shall be held in water not less than 1 h. Test a.c. voltage of practically sinusoidal form with a frequency of 50 Hz or 60 Hz shall be applied between the conductor and water for single-core cables, and between the conductors and between the conductors and water for multi-core cables. Test voltage and test duration shall comply with the values specified in the manufacturer's technical documentation.

.2 in air. Test a.c. voltage of practically sinusoidal form of frequency 50 Hz or 60 Hz shall be applied between the conductors, for cable with metallic sheath the test voltage shall be applied between the conductors and between the conductors and grounded metallic sheath. Test voltage and test duration shall comply with the values specified in the manufacturer's technical documentation.

The test results are considered satisfactory if no insulation breakdown or damage are detected.

10.6.57.4 Bend tests.

Prior to bend tests, the specimen of cryogenic cable to be tested shall be cooled down to the temperature relevant to the operating temperature of cryogenic cable. Time of exposure at temperature relevant to the operating temperature shall be indicated in the test procedure, but shall not be less than 10 min. After cooling, the specimen shall be immediately subjected to ten bend cycles (one cycle corresponds to two bends in opposite directions) with an angle of 90° and radius relevant to the minimum permissible bending radius specified in the technical documentation. Upon test completion, the specimen shall be held at ambient temperature within the time sufficient to reach the steady-state temperature and then the specimen shall be subjected to testing of insulation strength in accordance with 10.6.57.3.

The test results are considered satisfactory if no cable damage, insulation breakdown or damage, are detected at visual examination.

10.6.58 Cyber resilience tests.

The tests shall apply to computer based systems (CBS) of ships with the **CYBER** and **CYBER-A** class symbols.

Tests of the safety functionality of CBS shall confirm compliance with the requirements of Section 3, Part XXI "Cyber Resilience" of the RS Rules/C.

The tests of the equipment in the assembled form shall be carried at standard environmental conditions.

10.6.59 Testing of a cargo hold water level alarm system of bulk carriers, ore carriers, combination carriers, passenger ship with 36 people or more on board, cargo ships with one or more holds other than bulk carriers, ore carriers, combination carriers and tankers.

A protective enclosure of bodies of detectors and other elements fitted in cargo holds, ballast tanks and dry spaces shall meet the IP68 requirements in accordance with IEC 60529:2011.

Protection of the enclosures of electrical equipment located on the deck above ballast and cargo spaces shall satisfy the requirements of IP56 in accordance with IEC 60529:2011. Electrical equipment which shall be used in refrigerated cargo spaces shall satisfy the requirements of a national/international standard covering the relevant service temperatures.

The testing of detector/cable box bodies by water pressure shall be based on a pressure head. For detectors/cable boxes to be fitted in holds intended for the carriage of water ballast or in ballast tanks, the application head shall be the hold or tank depth and the hold period shall be 20 days. For detectors/cable boxes to be fitted in spaces intended to be dry, the application head shall be the depth of the space and the hold period shall be 24 h.

Where a detector/cable box is fitted in a space adjacent to a cargo hold (e.g. lower stool, etc.) and the space is considered to be flooded under damage stability calculations, the detector/cable box shall meet the IP68 requirements for a water head equal to the hold depth for a period of 20 days or 24 h whether or not the cargo hold is intended to be used as a ballast tank as specified above.

The functioning of the detector assembly with filtration arrangements shall be verified in the cargo/water mixture with immersion repeated 10 times without cleaning any filtration arrangements.

For test purposes, an agitated suspension of representative fine materials in seawater with a concentration of 50 % by weight shall be used.

The test container for the cargo/water mixture shall be dimensioned so that its height and volume are such that the sensor and filtration arrangements can be totally submerged repeated 10 times and tested by static and dynamic inclinations.

The sensor and filtration arrangements fitted, that shall be submerged, and arranged in the container as they would be installed in accordance with the installation instructions.

The pressure in the container for testing the complete detector shall be not more than 0,2 bar at the sensor and filtration arrangement. The pressure may be realised by pressurization or by using a container of sufficient height.

10.6.59.1 The cargo/water mixture is pumped into the test container and suitable agitation of the mixture is provided to keep the solids in suspension:

.1 the pumping of the cargo/water mixture into the test container shall not affect the functioning of the sensor and filter arrangements;

.2 the cargo/water mixture is pumped into the test container to a predetermined level that submerges the detector and the operation of the alarm is observed;

.3 the test container is then drained and the de-activation of the alarm condition is observed;

.4 the test container and sensor with the filter arrangement shall be allowed to dry without physical intervention.

The satisfactory alarm activation and de-activation at each of the ten consecutive tests demonstrate satisfactory testing.

10.6.59.2 The cargo/water mixture used for type testing shall be representative of the range of cargoes within the following groups and shall include the cargo with the smallest particles expected to be found from a typical representative sample:

.1 iron ore particles and seawater;

.2 coal particles and seawater;

.3 grain particles and seawater;

.4 aggregate (sand) particles and seawater.

The smallest and largest particle size together with the density of the dry mixture shall be ascertained and recorded. The particles shall be evenly distributed throughout the mixture. In general, testing with representative particles qualify all types of cargoes within the four groupings shown above.

10.6.59.3 Guidance on the selection of test particles is provided below:

.1 Iron ore fines shall consist primarily of fine, free-flowing fractions of iron ore, rather than lumps of ore (dust particle size <0,1 mm);

.2 Coal fines shall consist primarily of fine, free-flowing fractions of coal, rather than lumps of coal (dust particle size <0,1 mm);

.3 Grain particles shall consist primarily of fine, free-flowing grains that are easily poured (grain size >3 mm, e.g., wheat);

.4 Aggregate particles shall consist primarily of fine, free-flowing granules of sand, without lumps (dust particle size <0.1 mm).

10.6.60 Test of slip rings.

10.6.60.1 Measurement of insulation distances of low-voltage slip rings.

Minimum clearances and creepage distances between non-insulated parts of contact low-voltage rings are given in Table 10.6.60.1. Clearances and creepage distances apply between phases, between phase and neutral, between phase and earth and between neutral and earth.

Table 10.6.60.1

Clearances and creepage distances for low-voltage slip rings

Rated insulation voltage a.c. r.m.s. or d.c., in V	Minimum clearance, in mm	Minimum creepage distance, in mm
< 250	15	20
250 - 690	20	25
> 690	25	35

For slip rings passed the type tests, it is allowed to apply reduced values specified in standard IEC 60092-302.

Creepage distances between current-carrying parts and between current-carrying parts and earthed metal parts shall comply with standard IEC 60092-503 for the rated voltage of the system, type of insulation material and transient overvoltage created at shut-off and failures.

10.6.60.2 Measurement of insulation distances of high-voltage slip rings.

Interphase air clearances and air clearances between the phase and the earth, between the non-insulated parts shall be not less than those given in Table 10.6.60.2.

It is allowed to apply intermediate values for rated voltage provided the nearest maximum air clearance is met.

In case of lesser clearances, high-voltage impulse tests are required.

Table 10.6.60.2

Minimum clearances

Rated value, in kV	The highest voltage value for equipment, in kV	Minimum air clearance, in mm
3 - 3.3	3.6	55
6 - 6.6	7.2	90
10 - 11	12	120
15	17.5	160

10.6.60.3 Measurement of contact resistance.

Contact resistance shall be measured between movable and fixed parts of slip rings.

Values of measured resistance shall comply with the values given in the manufacturer's technical documentation.

10.6.60.4 Endurance tests.

Rotation tests with 1 r/min shall be carried out as follows:

100 rotations with 10 % rated current;

100 rotations with 90 % rated current;

1 rotation with 150 % rated current;

100 rotations without current.

After this test the contact resistance shall be measured..

10.6.60.5 Short circuit test.

High-voltage slip rings are subject to short-circuit tests.

The short-circuit value shall be determined by electric motor characteristics supplied via slip rings.

10.6.60.6 Impulse voltage withstand test.

The tests shall be carried out in accordance with standard IEC 60034-15:2009.

10.6.61 Bench functional tests of composite (hybrid) propulsive systems.

10.6.61.1 Test procedure.

Bench functional tests of composite (hybrid) propulsion systems (CPS) shall be carried out in maximum possible extent. If there is no possibility to carry out particular types of tests, these tests shall be transferred to the period of mooring and/or sea trials in compliance with 1.5.7 of this Part.

Equipment provided by the RS Nomenclature and being part of composite (hybrid) propulsion systems, prior to the beginning of bench trials shall pass post-manufacturing tests in appropriate scope and according to the requirements specified in the relevant Sections of this Part.

Bench trials shall be carried out by a calendar schedule developed by the manufacturer of CPS (or by a firm in charge for the tests) and agreed with RS on the basis of approved test program.

10.6.61.2 Documentation submitted before trials.

Bench tests of CPS shall be carried out according to the program approved by the Register. Prior to the bench tests commencement, the following documents shall be submitted:

document on readiness of the bench for tests;

structural bench scheme and plan of equipment location;

electrical and hydraulic wiring schemes (if any) of composite (hybrid) propulsion systems;

calibration records on the bench instrumentation and qualification of testing equipment;

working design documentation for the CPS equipment;

program and procedure for bench tests of CPS;

operating instructions for the CPS equipment;

service logs (data sheets) on the CPS equipment;

copies of the RS Certificates on the CPS equipment;

copies of reports for previously carried out tests of the CPS equipment.

10.6.61.3 Test conditions.

Prior to the tests, all installation, wiring, commissioning and adjustment works shall be completed.

The bench tests shall be carried out under conditions close to operational ones. Thus, the bench shall be equipped with the devices including loading ones, providing achievement of necessary features of tested system.

10.6.61.4 List of checks.

Scope of bench tests (regarding design and functionalities of the tested system) shall include:

.1 mandatory checks:

al inspection of the CPS equipment and quality of installation on the bench;

check of reliable work of turning gear;

inspection of minimal resistant idle speed of the main heat engine (ME) and at its load according to the propeller curve;

control check of heat ME and electrical propulsion plant (EPP) from remote control stations and local control station of the engine, inspection of reliable switches as well as compliance of reversing devices and speed regulation system to the imposed requirements by using oscillography records of transient processes;

check of simplicity and ease of manual controls switches as well as precise positioning of these controls;

check of start of the CPS engines under all design combinations;

check of frequency regulation of the CPS engines under all design combinations;

check of stop of the CPS engines under all design combinations;

check of emergency stop of the CPS engines under all design combinations;

check of reverse of the CPS engines under all design combinations;

check of reliable and stable functioning of RAC, control, alarm, blocking and protection systems;

CPS torsiography to verify that no barred speed range under all design combinations at speed ahead and astern is present;

check of service parameters (static and dynamic features) of automation facilities (speed regulation, etc.);

functional check of disengaging devices (couplings, reverse-reduction gears) shall be carried out in compliance with 5.7.12 of this Part;

functional check of the CPS equipment;

functional check of cooling and lubrication systems;

check of maintenance and repair ease of CPS with standard units, auxiliary machinery, systems and devices when using standard special tools and devices;

the equipment check after specified duration of bench tests (revision);

control check of CPS in operation with its standard units, auxiliary machinery, systems and devices. Check for correct assembly, adjustment and maintenance of main technical parameters within the limit specified in the technical documentation;

.2 check of modes if they are provided by the CPS structure:

check of generator operation mode of EPP;

check of electrical heat ME starting from the EPP;

check of other modes provided by the CPS design.

10.6.61.5 Duration of testing.

The duration of tests shall be sufficient to establish required modes and to control and measure the parameters.

10.6.61.6 Testing equipment and measurement tools.

Bench tests shall be carried out with all standard bench instrumentation including remote monitoring devices. When testing, additional (bench) instrumentation and devices are used the scope and quantity of which are determined by the nature and quantity of measured parameters specified in the test program.

Bench instrumentation applied during the tests shall have current calibration records. Prior to tests, relevant documents shall be submitted to the RS surveyor.

The features of the loading device shall provide comprehensive tests of CPS under all modes provided by the test program at speed ahead and astern. Maintenance of test specimen during testing shall be carried out according to the operating instructions with standard tools and devices.

10.6.61.7 Documents drawn-up after tests.

With the positive results of bench functional tests of CPS, a report on survey of the specimen on an established form is drawn up according to 1.5.10 of this Part.

With the negative results of bench functional tests of CPS in compliance with 1.5.9 of this Part the product is not approved to use onboard.

10.6.62 Tests for rated power supply deviation.

Voltage and frequency deviations from rated values during the tests of the electrical and electronic automation equipment shall comply with those given in Table 10.6.62-1.

Table 10.6.62-1

Combination	Voltage deviation permanent, %	Frequency deviation permanent, %
1	+6	+5
2	+6	-5
3	-10	+5
4	-10	-5
	voltage transient (1,5 s), %	frequency transient (5 s), %
5	+20	+10
6	-20	-10

D.c. voltage deviations from rated values during the tests of the electrical and electronic automation equipment shall comply with those given in Table 10.6.62-2.

Table 10.6.62-2

Parameter	Deviation from rated values, %
Voltage tolerance continuous	± 10
Voltage cyclic deviation	5
Voltage ripple	10

Categories of the equipment depending on type of power supply are given in Table 10.6.62-3.

Table 10.6.62-3

Category of equipment	Description
P1	The equipment supplied from the battery connected to a charging battery
P2	The equipment not connected to the battery during charging

The equipment of category P1 shall be tested at the continuous voltage tolerance within the range + 30 % to -25 %.

The equipment of category P2 shall be tested at the continuous voltage tolerance the range + 20 % to -25 %.

APPENDIX 1

EXTENT OF TECHNICAL DOCUMENTATION TO BE SUBMITTED TO RS AND THE SCOPE OF TESTS TO BE CONDUCTED

Table 1

Code of item of technical supervision	Item of technical supervision	Prototype, pilot of test specimen, product of stable production, in case of CTO (Form 6.8.3) or C (Form 6.5.30) issuing when CTO is missing		Product of stable production in case of C (Form 6.5.30) issuing when CTO is available	
		list of documentation	list of tests	list of documentation[1]	list of tests[2]
1	2	3	4	5	6
11000000	**ELECTRICAL EQUIPMENT**				
11010000	**Electrical propulsion plant:**				
11010100	generators and generators of unified electric power plant	D2, T1, T3, T4, T9, T10[3], T11	10.6.1, 10.6.2, 10.6.4.1,10.6.12,10.6.17, 10.6.18, 10.6.23.1, 10.6.23.2, 10.6.23.5, 10.6.23.6[4], 10.6.23.7, 10.6.23.8	T4	10.6.1, 10.6.2, 10.6.4.1, 10.6.23.1, 10.6.23.2, 10.6.23.5, 10.6.23.7
11010200	electric propulsion motors (EPM)	D2, T1, T3, T4, T10[3], T11	10.6.1, 10.6.2, 10.6.4.1, 10.6.12, 10.6.17, 10.6.18, 10.6.23.1, 10.6.23.4, 10.6.23.5[5], 10.6.23.7, 10.6.23.8	-	-
11010300	podded azimuth drive's propulsion electrical motors	D2, T1, T3, T4, T10[3], T11	10.6.1, 10.6.2, 10.6.4.1, 10.6.12, 10.6.17, 10.6.18, 10.6.23.1, 10.6.23.4, 10.6.23.5[5], 10.6.23.7, 10.6.23.8	-	-
11010400	switchboards	D2, D4, T1, T3, T4, T6	10.6.1, 10.6.2, 10.6.3, 10.6.4.4, 10.6.18, 10.6.19, 10.6.32.1	-	-
11010410	type section/box of distribution switchboard	D2, D4, T1, T3, T4, T6	10.6.1, 10.6.2, 10.6.3, 10.6.4.4, 10.6.6[3], 10.6.7[3], 10.6.8, 10.6.12, 10.6.17, 10.6.18, 10.6.19, 10.6.32.1, 10.6.32.2	T4	10.6.1, 10.6.2, 10.6.3
11010500	power transformers, reactors	D2, T1, T3, T4, T6	10.6.1, 10.6.2, 10.6.3, 10.6.4.2, 10.6.5, 10.6.12, 10.6.17, 10.6.18, 10.6.24.1, 10.6.24.2, 10.6.24.4[6]	T4	10.6.1, 10.6.2, 10.6.3

Code of item of technical supervision	Item of technical supervision	Prototype, pilot of test specimen, product of stable production, in case of CTO (Form 6.8.3) or C (Form 6.5.30) issuing when CTO is missing		Product of stable production in case of C (Form 6.5.30) issuing when CTO is available	
		list of documentation	list of tests	list of documentation[1]	list of tests[2]
1	2	3	4	5	6
11010600	power semiconductor converters	D2, D4, T1, T3, T4, T6	10.6.1, 10.6.2, 10.6.3, 10.6.4.4, 10.6.12, 10.6.17, 10.6.18, 10.6.19, 10.6.20, 10.6.21, 10.6.22[8], 10.6.34.2, 10.6.62	T4	10.6.1, 10.6.2, 10.6.3
11010700	electrical machine converters	D2, T1, T3, T4	10.6.1, 10.6.2, 10.6.4.1, 10.6.12, 10.6.17, 10.6.20, 10.6.21, 10.6.23.7, 10.6.23.8	T4	10.6.1, 10.6.2, 10.6.4.1, 10.6.23.7
11010800	control systems, monitoring and protection systems	C1[7], D2, D3, D4, T1, T3, T4, T5	10.6.1, 10.6.2, 10.6.3, 10.6.4.5, 10.6.6-10.6.10, 10.6.12,10.6.17, 10.6.20-10.6.22, 10.6.58[7,12], 10.6.62	C1[7], D2, D3, T1, T4, T5	10.6.1, 10.6.2, 10.6.3
11010900	slip rings devices for podded azimuth propulsion	D2, T1, T3, T4, T6	10.6.1, 10.6.2, 10.6.3, 10.6.4.4, 10.6.6[13], 10.6.9, 10.6.12, 10.6.18, 10.6.60.1, 10.6.60.2, 10.6.60.3, 10.6.60.4, 10.6.60.5, 10.6.60.6	T4	10.6.1, 10.6.2, 10.6.3, 10.6.4.4, 10.6.60.3
11011000	electric drives for Azimuth drives	D2, T1, T3, T4, T10[3]	10.6.1, 10.6.2, 10.6.4.1, 10.6.12, 10.6.17, 10.6.23.1, 10.6.23.4, 10.6.23.7, 10.6.23.8, 10.6.62	T4	10.6.1, 10.6.2, 10.6.23.1, 10.6.23.7
11020000	**Main and emergency sources of electrical power:**				
11020100	**Generators:**				
11020101	power of 100 kW and over	D2, T1, T3, T4, T9, T10[3]	10.6.1, 10.6.2, 10.6.4.1, 10.6.12, 10.6.17, 10.6.23.1, 10.6.23.2, 10.6.23.5, 10.6.23.6[4], 10.6.23.7, 10.6.23.8	T4	10.6.1, 10.6.2, 10.6.4.1, 10.6.23.1, 10.6.23.2, 10.6.23.5, 10.6.23.7
11020102	power less than 100 kW	D2, T1, T3, T4, T9, T10[3]	10.6.1, 10.6.2, 10.6.4.1, 10.6.12, 10.6.17, 10.6.23.1, 10.6.23.2, 10.6.23.5, 10.6.23.6[4], 10.6.23.7, 10.6.23.8	T4	10.6.1, 10.6.2, 10.6.23.1, 10.6.23.2, 10.6.23.5, 10.6.23.7,

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		list of documentation	list of tests	list of documentation[1]	list of tests[2]
1	2	3	4	5	6
11020200	**Accumulators and batteries**	D2, T1, T3, T4	Acid accumulators and batteries: 10.6.1, 10.6.2, 10.6.3, 10.6.4.3, 10.6.9, 10.6.10, 10.6.12, 10.6.27.1 10.6.27.2, 10.6.27.5 Lithium-ion accumulator batteries: 10.6.1, 10.6.3, 10.6.6, 10.6.28 Local battery control system shall be tested in accordance with Section 12 of this Part to the extent prescribed for code 15020000 Supercapacitors and supercapacitor systems: 10.6.1, 10.6.3, 10.6.29	-	-
11020300	**Uninterruptible power supply units (UPS):**				
11020301	power of 63 kVA and over	D2, D4, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4.3, 10.6.6, 10.6.7[11], 10.6.9, 10.6.12, 10.6.17, 10.6.19, 10.6.20, 10.6.21, 10.6.22, 10.6.26.1, 10.6.26.2, 10.6.26.3, 10.6.26.4, 10.6.62	T4	10.6.1, 10.6.2, 10.6.3
11020302	power less than 63 kVA	D2, D4, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4.3, 10.6.6, 10.6.7[11], 10.6.9, 10.6.12, 10.6.17, 10.6.19, 10.6.20, 10.6.21, 10.6.22, 10.6.26.1, 10.6.26.2, 10.6.26.3, 10.6.26.4, 10.6.62	T4	10.6.1, 10.6.2, 10.6.3
11030000	**Transformers and convertors:**				
11030100	Power transformers	D2, T1, T3, T4, T6	Transformers for the voltage of less than 15 kV: 10.6.1, 10.6.2, 10.6.3, 10.6.4.2, 10.6.5, 10.6.12, 10.6.17, 10.6.24.1, 10.6.24.2, 10.6.24.4[6]	T4	10.6.1, 10.6.2, 10.6.3

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		list of documentation	list of tests	list of documentation[1]	list of tests[2]
1	2	3	4	5	6
			Transformers for the voltage of 15 kV-220 kV: 10.6.1, 10.6.25		
11030200	lighting, measuring and other transformers	-	-	-	-
11030300	**Rotary converters:**				
11030301	power of 100 kW and over	D2, T1, T3, T4	10.6.1, 10.6.2, 10.6.4.1, 10.6.12, 10.6.17, 10.6.20, 10.6.21, 10.6.23.7, 10.6.23.8	T4	10.6.1, 10.6.2, 10.6.23.7
11030302	power less than 100 kW	D2, T1, T3, T4	10.6.1, 10.6.2, 10.6.4.1, 10.6.12, 10.6.17, 10.6.20, 10.6.21, 10.6.23.7, 10.6.23.8	T4	10.6.1, 10.6.2, 10.6.23.7
11030400	**Elrectric machine amplifiers:**				
11030401	power of 100 kW and over	D2, T1, T3, T4	10.6.1, 10.6.2, 10.6.4.1, 10.6.12, 10.6.17, 10.6.20, 10.6.21, 10.6.23.7, 10.6.23.8	T4	10.6.1, 10.6.2, 10.6.23.7
11030402	power less than 100 kW	D2, T1, T3, T4	10.6.1, 10.6.2, 10.6.4.1, 10.6.12, 10.6.17, 10.6.20, 10.6.21, 10.6.23.7, 10.6.23.8	T4	10.6.1, 10.6.2, 10.6.23.7
11030500	**Static and semi-conductor converters (rectifiers, inverters, frequency converters) with rated current:**				
11030501	power of 100 kW and over	D2, D4, T1, T3, T4, T6	10.6.1, 10.6.2, 10.6.3, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.4.4, 10.6.12, 10.6.17, 10.6.18, 10.6.19, 10.6.20, 10.6.21, 10.6.62	T4	10.6.1, 10.6.2, 10.6.3
11030502	power less than 100 kW	D2, D4, T1, T3, T4, T6	10.6.1, 10.6.2, 10.6.3, 10.6.4.4, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.17, 10.6.18, 10.6.19, 10.6.20, 10.6.21, 10.6.62	T4	10.6.1, 10.6.2, 10.6.3
11040000	**Switchboards and control and**				

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		list of documentation	list of tests	list of documentation[1]	list of tests[2]
1	2	3	4	5	6
	monitoring desks:				
11040100	main switchboards	D2, D4, T1, T3, T4, T6	Main switchboards for the voltage of less than 15 kV: 10.6.1, 10.6.2, 10.6.3, 10.6.4.4, 10.6.18, 10.6.19, 10.6.32.1 Switchboards for the voltage of 15 kV-220 kV: 10.6.1, 10.6.33	-	-
11040101	emergency switchboards	D2, D4, T1, T3, T4, T6	10.6.1, 10.6.2, 10.6.3, 10.6.4.4, 10.6.18, 10.6.19, 10.6.32.1	-	-
11040110	type section/box of distribution switchboards	D2, D4, T1, T3, T4, T6	10.6.1, 10.6.2, 10.6.3, 10.6.4.4, 10.6.6, 10.6.7[11], 10.6.8, 10.6.12, 10.6.17, 10.6.18, 10.6.19, 10.6.32.1, 10.6.32.2	T4	10.6.1, 10.6.2, 10.6.3
11040200	distribution and other switchboards	D2, D4, T1, T3, T4, I1[10]	10.6.1, 10.6.2, 10.6.3, 10.6.4.4, 10.6.12, 10.6.17, 10.6.19,	T4	10.6.1, 10.6.2, 10.6.3
11040300	navigation light switchboards	D2, D4, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4.4, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.20, 10.6.21, 10.6.22[8], 10.6.62	T4	10.6.1, 10.6.2, 10.6.3
11040400	control, monitoring and alarm panels and switchboards for essential services	D2, D4, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4.4, 10.6.6, 10.6.7[11], 10.6.14, 10.6.17, 10.6.62	T4	10.6.1, 10.6.2, 10.6.3
11040500	switchgear and control gear, alarm and indicating devices:				
11040502	switches	D2, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.18, 10.6.34.3	-	-
11040503	contactors, relays	D2, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.18, 10.6.22.1, 10.6.34.1, 10.6.34.2, 10.6.34.3	-	-

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		list of documentation	list of tests	list of documentation[1]	list of tests[2]
1	2	3	4	5	6
11040504	tripping devices	D2, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.18, 10.6.34.3	-	-
11040505	switches, limit switches	-	-	-	-
11040507	relay and semiconductor switching devices for non-motor loads	-	-	-	-
11040509	indicating lamps, manual switches of control circuits (push buttons, switchers, joysticks, etc.)	-	-	-	-
11040600	protective devices:				
11040601	relays *I* > 63 A	D2, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.18, 10.6.34.1, 10.6.34.2, 10.6.34.3	T4	10.6.1, 10.6.2, 10.6.3
11040602	relays *I* ≤ 63 A	D2, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.18, 10.6.34.1, 10.6.34.2, 10.6.34.3	-	-
11040603	fuses	-	-	-	-
11040605	complex protective devices	D2, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.17, 10.6.22[8], 10.6.18, 10.6.34.1, 10.6.34.2, 10.6.34.3	T4	10.6.1, 10.6.2, 10.6.3
11040606	zenner-barriers for intrinsically-safe circuits of *Exi* type	I1	-	I1	-
11040607	circuit breakers *I* > 63 A	D2, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.17, 10.6.18, 10.6.22.1, 10.6.34.1, 10.6.34.2, 10.6.34.3, 10.6.34.4	T4	10.6.1, 10.6.2, 10.6.3
11040608	circuit breakers *I* ≤ 63 A	D2, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.17, 10.6.18,	-	-

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		list of documentation	list of tests	list of documentation[1]	list of tests[2]
1	2	3	4	5	6
			10.6.22.1, 10.6.34.1, 10.6.34.2, 10.6.34.3		
11040700	controllers:				
11040701	voltage controller	D2, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4, 10.6.6, 10.6.7[11], 10.6.9, 10.6.12, 10.6.14, 10.6.17, 10.6.20, 10.6.21, 10.6.22[8], 10.6.62	T4	10.6.1, 10.6.2, 10.6.3
11040800	stationary electrical measuring instruments	D2, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4.8, 10.6.6, 10.6.7[11], 10.6.9, 10.6.12, 10.6.14, 10.6.17, 10.6.22[8]	-	-
11050000	**Electric drives for machinery referred to in codes 07000000, 09000000, 12000000, 14000000МК, 17000000, 18050000, 19000000МК:**				
11050100	electric motors:				
11050101	electric motors with power of 100 kW and over	D2, T1, T3, T4, T10[3], I1[10]	10.6.1, 10.6.2, 10.6.4.1, 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.20[15], 10.6.21[15], 10.6.23.1, 10.6.23.4[9], 10.6.23.5[5], 10.6.23.7, 10.6.23.8, 10.6.62	T4	10.6.1, 10.6.2, 10.6.4.1, 10.6.23.1, 10.6.23.4[9], 10.6.23.5[5], 10.6.23.7
11050102	electric motors with power from 2 kW to 100 kW	D2, T1, T3, T4, T10[3], I1[10]	10.6.1, 10.6.2, 10.6.4.1, 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.20[15], 10.6.21[15], 10.6.23.1, 10.6.23.4[9], 10.6.23.5[5], 10.6.23.7, 10.6.23.8, 10.6.62	T4	10.6.1, 10.6.2, 10.6.4.1, 10.6.23.4[9], 10.6.23.5[5], 10.6.23.7
11050103	electric motors with power up to 2 kW	-	-	-	-
11050200	starting devices:				

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		list of documentation	list of tests	list of documentation[1]	list of tests[2]
1	2	3	4	5	6
11050201	starters	D2, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.18, 10.6.22.1, 10.6.34.1, 10.6.34.2, 10.6.34.3	-	-
11050204	controllers	D2, T1, T3,T4	10.6.1, 10.6.2, 10.6.3, 10.6.4, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.22[8], 10.6.62	T4	10.6.1, 10.6.2, 10.6.3
11050205	soft starters with power of 100 kW and over	D2, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.18, 10.6.20, 10.6.21, 10.6.22[8], 10.6.34.2, 10.6.34.3	T4	10.6.1, 10.6.2, 10.6.3
11050206	control systems of electric drives	D2, D3, D4, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.18, 10.6.20, 10.6.21, 10.6.22[8], 10.6.62	T4	10.6.1, 10.6.2, 10.6.3
11050207	soft starters with power up to 100 kW	D2, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.18, 10.6.20, 10.6.21, 10.6.22[8], 10.6.34.2, 10.6.34.3	-	-
11050208	electric drives of valves for I and II class of responsible devices	D2, T1, T3, T4, I1[10]	10.6.1, 10.6.2, 10.6.9, 10.6.10, 10.6.4.1, 10.6.12, 10.6.14, 10.6.17, 10.6.20[15], 10.6.21[15],10.6.23.1, 10.6.23.7, 10.6.23.8, 10.6.62	-	-
11050209	electric drives of valves for other systems and devices	-	-	-	-
11050300	electromagnetic brakes	-	-	-	-
11050400	electromagnetic clutches	D2, T1, T3, T4	10.6.1, 10.6.2, 10.6.4.1, 10.6.5 10.6.12, 10.6.14, 10.6.17, 10.6.23.7, 10.6.23.8, 10.6.62	-	-

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		list of documentation	list of tests	list of documentation[1]	list of tests[2]
1	2	3	4	5	6
11060000	**Main and emergency lighting:**				
11060001	stationary lighting fixtures, projectors	D2, D4, T1, T3, T4, I1[10]	10.6.1, 10.6.2, 10.6.3, 10.6.4, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.20[16], 10.6.21[16], 10.6.40, 10.6.62	-	-
11060002	lighting and setting fittings	-	-	-	-
11070000	**Control and monitoring devices:**				
11070100	engine room telegraphs	D2, D4, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4.5, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.17, 10.6.20, 10.6.21, 10.6.22[8], 10.6.41.2, 10.6.62	T4	10.6.1, 10.6.2, 10.6.3
11070200	rudder angle indicators	D2, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4.5, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.17, 10.6.20, 10.6.21, 10.6.22[8], 10.6.41.2, 10.6.62	-	-
11070300	CPP position indicator	D2, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4.5, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.17, 10.6.20, 10.6.21, 10.6.22[8], 10.6.41.2, 10.6.62	-	-
11070400	tachometers	-	-	-	-
11080000	**Internal service communication**				
11080100	Sound-powered telephones	D2, T1, T3, T4, I1[10]	10.6.1, 10.6.2, 10.6.3, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.20,10.6.41.2	-	-
11080200	Commutators and telephone communication sets	D2, T1, T3, T4, I1[10]	10.6.1, 10.6.2, 10.6.3, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.20, 10.6.41.2	-	-
11090000	General alarm system	D2, D4, T1, T3, T4, I1[10]	10.6.1, 10.6.2, 10.6.3, 10.6.4.5, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.20,	D3, T4	10.6.1, 10.6.2, 10.6.3

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		list of documentation	list of tests	list of documentation[1]	list of tests[2]
1	2	3	4	5	6
			10.6.21, 10.6.22[8], 10.6.41.2, 10.6.62		
11100000	**Fire detection and fire alarm system and release indication on fire smothering system:**	C1[7], D2, D4, T1, T3, T4, I1[10]	10.6.1, 10.6.2, 10.6.3, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.20, 10.6.21, 10.6.22[8], 10.6.41.2, 10.6.58[7,12], 10.6.62	T4	10.6.1, 10.6.2, 10.6.3
11100102	manually operated detectors and detectors of fire detection and fire alarm system	D2, D4, T1, T3, T4, I1[10]	10.6.1, 10.6.2, 10.6.3, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.20, 10.6.21, 10.6.22[8], 10.6.41.2, 10.6.62	T4	10.6.1, 10.6.2, 10.6.3
11100200	Release indication of fixed local application fire extinguishing system	C1[7], D2, D4, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4.5, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.20, 10.6.21, 10.6.22[8], 10.6.41.2, 10.6.58[7,12], 10.6.62	D3, T4	10.6.1, 10.6.2, 10.6.3
11100300	Sewage holding tanks level alarm	C1[7], D2, D4, T1, T3, T4, I1[10]	10.6.1, 10.6.2, 10.6.3, 10.6.4.5, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.20, 10.6.21, 10.6.22[8], 10.6.41.2, 10.6.58[7,12], 10.6.62	D3, T4	10.6.1, 10.6.2, 10.6.3
11100400	Sound signals engineers accommodation spaces	C1[7], D2, D4, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4.5, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.20, 10.6.21, 10.6.22[8], 10.6.41.2, 10.6.58[7,12], 10.6.62	D3, T4	10.6.1, 10.6.2, 10.6.3
11100500	Alarm system about presence of people in cooled holds	C1[7], D2, D4, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4.5, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.13, 10.6.14, 10.6.17, 10.6.20, 10.6.21, 10.6.22[8], 10.6.41.2, 10.6.58[7,12], 10.6.62	D3, T4	10.6.1, 10.6.2, 10.6.3

Code of item of technical supervision	Item of technical supervision	Prototype, pilot of test specimen, product of stable production, in case of CTO (Form 6.8.3) or C (Form 6.5.30) issuing when CTO is missing		Product of stable production in case of C (Form 6.5.30) issuing when CTO is available	
		list of documentation	list of tests	list of documentation[1]	list of tests[2]
1	2	3	4	5	6
11100600	Indication of door position in ro-ro passenger ships and ro-ro cargo ships	C1[7], D2, D4, T1, T3, T4, I1[10]	10.6.1, 10.6.2, 10.6.3, , 10.6.4.5 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.20, 10.6.21, 10.6.22[8], 10.6.41.2, 10.6.58[7,12], 10.6.62	D3, T4	10.6.1, 10.6.2, 10.6.3
11100700	Television surveillance and indication system	C1[7], D2, D4, T1, T3, T4, I1[10]	10.6.1, 10.6.2, 10.6.3, 10.6.4.5,10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.20, 10.6.21, 10.6.22[8], 10.6.41.2, 10.6.58[7,12], 10.6.62	D3, T4	10.6.1, 10.6.2, 10.6.3
11100800	Alarm of ultimate concentration of noxious gases	C1[7], D2, D4, T1, T3, T4, I1[10]	10.6.1, 10.6.2, 10.6.3, 10.6.4.5, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.20, 10.6.21, 10.6.22[8], 10.6.41.2, 10.6.58[7,12], 10.6.62	D3, T4	10.6.1, 10.6.2, 10.6.3
11100900	Cargo hold water level alarm system on bulk carriers, ore carriers, combination carriers, passengers ships carrying 36 persons and more, and single-hold cargo ships other than bulk carriers ore carriers, combination carriers and tankers	C1[7], D2, D4, T1, T3, T4, I1[10]	10.6.1, 10.6.2, 10.6.3, 10.6.4.5, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.20, 10.6.21, 10.6.22[8], 10.6.58[7,12], 10.6.59, 10.6.62	D3, T4	10.6.1, 10.6.2, 10.6.3
11110000	Indication of closing watertight and fire doors	C1[7], D2, D4, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4.5, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.20, 10.6.21, 10.6.22[8], 10.6.41.2, 10.6.58[7,12], 10.6.62	D3, T4	10.6.1, 10.6.2, 10.6.3

Code of item of technical supervision	Item of technical supervision	Prototype, pilot of test specimen, product of stable production, in case of CTO (Form 6.8.3) or C (Form 6.5.30) issuing when CTO is missing		Product of stable production in case of C (Form 6.5.30) issuing when CTO is available	
		list of documentation	list of tests	list of documentation[1]	list of tests[2]
1	2	3	4	5	6
11110100	Warning alarm system for automatic sprinkler fire extinguishing system	C1[7], D2, D4, T1, T3, T4, I1[10]	10.6.1, 10.6.2, 10.6.3, 10.6.4.5, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.20, 10.6.21, 10.6.22[8], 10.6.41.2, 10.6.58[7,12], 10.6.62	D3, T4	10.6.1, 10.6.2, 10.6.3
11120000	Engine room personnel alarm system	C1[7], D2, D4, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4.5, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.20, 10.6.21, 10.6.22[8], 10.6.41.2, 10.6.58[7,12], 10.6.62	D3, T4	10.6.1, 10.6.2, 10.6.3
11130000	**Cabling:**				
11130100	cables and hookup wires:				
11130101	cable of supply circuits for voltage above 1000 V	T1, T3, T4	10.6.1, 10.6.3, 10.6.4.6, 10.6.9, 10.6.42.2, 10.6.42.3, 10.6.42.4, 10.6.42.5, 10.6.42.6[17], 10.6.42.7[14]	T4	10.6.1, 10.6.3
11130102	cable of supply circuits for voltage of 1000 V and less	T1, T3, T4	10.6.1, 10.6.3, 10.6.4.6, 10.6.9, 10.6.42.2, 10.6.42.3, 10.6.42.4, 10.6.42.5, 10.6.42.6[17], 10.6.42.7[14]	T4	10.6.1, 10.6.3
11130103	cable of control circuit and information transfer circuit	T1, T3, T4	10.6.1, 10.6.3, 10.6.4.6, 10.6.9, 10.6.42.2, 10.6.42.3, 10.6.42.4, 10.6.42.5, 10.6.42.6[17], 10.6.42.7[14]	T4	10.6.1, 10.6.3
11130104	coaxial cables	-	-	-	-
11130105	optical-fiber cables	T1, T3, T4	10.6.1, 10.6.42.2, 10.6.42.3, 10.6.42.4, 10.6.42.5, 10.6.42.6[17], 10.6.42.7[14]	T4	10.6.1
11130106	hookup wires	-	-	-	-
11130107	Current leads and busbars uninsulated for voltage of 1000 V and less	D2, T1, T3, T4, T6	10.6.1, 10.6.43	T4	10.6.1
11130108	Current leads and busbars insulated for voltage of 1000 V and less	D2, T1, T3, T4, T6	10.6.1, 10.6.43	T4	10.6.1, 10.6.3
11130109	Current leads and busbars uninsulated for	D2, T1, T3, T4, T6	10.6.1, 10.6.43	T4	10.6.1

Code of item of technical supervision	Item of technical supervision	Prototype, pilot of test specimen, product of stable production, in case of CTO (Form 6.8.3) or C (Form 6.5.30) issuing when CTO is missing		Product of stable production in case of C (Form 6.5.30) issuing when CTO is available	
		list of documentation	list of tests	list of documentation[1]	list of tests[2]
1	2	3	4	5	6
	voltage above 1000 V				
11130110	MODU/FOP power and/or control and instrumentation, and/or telecommunication and data cables for submarine use	T1, T3, T4	10.6.1, 10.6.3, 10.6.4.6, 10.6.42.2, 10.6.42.3, 10.6.42.4, 10.6.42.5, 10.6.42.7[14]	T4	10.6.1, 10.6.3
11130111	Current leads and busbars insulated for voltage above 1000 V	D2, T1, T3, T4, T6	10.6.1, 10.6.43	T4	10.6.1, 10.6.3
11130112	Cryogenic cables	T1, T3, T4	10.6.1, 10.6.57	T4	10.6.1, 10.6.57.1, 10.6.57.2, 10.6.57.3
11130200	Items and devices for installation, splicing and connection of cables	D2, T1, T3, T4	10.6.45	-	-
11140000	Impressed current protection	D2, T1, T3, T4	tests are carried out according to the manufacturer's procedure	-	-
11150000	**Heating and cooking appliances, stationary appliances:**				
11150001	oil fuel, lubricating oil and water heating appliances with pressure equal to or more than 0,07 MPa	D2, D4, T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4.7, 10.6.18, 10.6.62	T4	10.6.1, 10.6.2, 10.6.3
11150005	heating cables	T1, T3, T4	10.6.1, 10.6.2, 10.6.3, 10.6.4.6, 10.6.42.2, 10.6.42.3, 10.6.42.4, 10.6.42.5, 10.6.62	-	-
11150006	cooking stationary heating equipment	-	-	-	-
11170100	Cargo and ballast pump bearing temperature alarm system	D2, D4, T1, T3, T4, I1[10]	10.6.1, 10.6.2, 10.6.3, 10.6.4.5, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.20, 10.6.21, 10.6.22[8], 10.6.41.2, 10.6.62	D3, T4	10.6.1, 10.6.2, 10.6.3
11170200	High and limit-level alarms in cargo tanks	D2, D4, T1, T3, T4, I1[10]	10.6.1, 10.6.2, 10.6.3, 10.6.4.5, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10,	D3, T4	10.6.1, 10.6.2, 10.6.3

Code of item of technical supervision	Item of technical supervision	Prototype, pilot of test specimen, product of stable production, in case of CTO (Form 6.8.3) or C (Form 6.5.30) issuing when CTO is missing		Product of stable production in case of C (Form 6.5.30) issuing when CTO is available	
		list of documentation	list of tests	list of documentation[1]	list of tests[2]
1	2	3	4	5	6
			10.6.12, 10.6.14, 10.6.17, 10.6.20, 10.6.21, 10.6.22[8], 10.6.41.2, 10.6.62		
11180000	Alarm about failures in MODU jacking system	D2, D4, T1, T3, T4, I1[10]	10.6.1, 10.6.2, 10.6.3, 10.6.4.5, 10.6.6, 10.6.7[11], 10.6.9, 10.6.10, 10.6.12, 10.6.14, 10.6.17, 10.6.20, 10.6.21, 10.6.22[8], 10.6.41.2, 10.6.62	D3, T4	10.6.1, 10.6.2, 10.6.3
11190000	Housings for electrical items	-	-	-	-

1 when CTO for the products is available and no changes to the equipment structure are made, the repeated review and approval of technical documentation are not required;
2 when CTO for the products is available and no changes to the equipment structure are made, the repeated tests in the scope of the prototype/test specimen is not required;
3 for the equipment installed on board the ship with ice classes Arc4 — Arc9, Icebreaker6 — Icebreaker9;
4 only for synchronous generators;
5 does not apply for squirrel-cage motors;
6 for transformers of power 6,3 kVA and over and 3-phase transformers and single-phase transformers of 4 kVA and over;
7 for computer based systems;
8 applies when using as a part of equipment of electronic components;
9 applies only for propulsion motors, motors intended for direct drive of steering gear, as well as motors for drive of anchor and mooring machinery;
10 for the equipment to be installed in the explosive area;
11 shall be carried out for the equipment taking into consideration the operating conditions in accordance with Table 10.6.7-1;
12 when issuing CTO, tests may not be carried out, provided that these tests are carried out when issuing certificate C;
13 test conditions for equipment of V2 category;
14 for cable products intended for use on decks of the mobile offshore drilling units (MODU), fixed offshore platforms (FOP), floating offshore oil-and-gas product units (FPU), drilling ships, supply vessels for drilling platforms as well as in those premises of the above ships and structures where drilling mud may spill on these products;
15 for synchronous electric motors and d.c. electric motors;
16 applies for lighting fixtures with LED and with gas discharge lamps;
17 for cables connected to the equipment required for operation under fire conditions and running through high fire risk spaces.
"-" means "not applicable".

APPENDIX 2 (RECOMMENDED)

CHECK LIST OF DOCUMENTATION

Name of equipment (system): Designation of equipment (system):		
Code of document	Title of document	Designation
C1	Documentation for computer based system in compliance with Section 7, Part XV "Automation" of the Rules for the Classification and Construction of Sea-Going Ships	
D1	Assembly drawing	
D2	General arrangement plan	
D3	Electrical schematic diagram	
D4	Functional block diagram	
T1	Specification	
T2	Explanatory note	
T3	Technical specifications	
T4	Test program and test procedure	
T5	Failure mode and effects analysis (FMEA)	
T6	Calculation of electrodynamic and thermal short circuit strength	
T7	Calculation of immunity to static or dynamic interference	
T8	Measures for interference suppression	
T9	Documentation on the transient mode of an AC generator during a sudden short circuit with excitation and at the rated rotational speed	
T10	Calculation of mechanical vibration and impact loads	
T11	Rotor shaft (armature) calculation of electric machines	
I1	Explosion-proof certificate	

APPENDIX 3 (REFERENCE)

ENVIRONMENTAL VERSIONS OF PRODUCTS ALLOWED FOR USE IN SEA-GOING SHIPS

Version	Designations[1]	
For ships designed for service in macroclimatic areas with boreal maritime climate[2]	M	M
For ships designed for service only in macroclimatic areas with tropical maritime climate[3]	TM	MT
For ships of unrestricted service	OM	MU
For all macroclimatic areas on land and at sea	B	B

[1] Designations: Russian letters are for Russia, the Latin ones are for some European countries.
[2] These areas include seas and oceans located north of latitude 30°N and south of latitude 30°S.
[3] These areas include seas and oceans located between latitude 30°N and latitude 30°S.

APPENDIX 4 (REFERENCE)

RUSSIA-ADOPTED DESIGNATIONS OF PRODUCTS BY CLIMATIC CATEGORIES OF LOCATION AND ARRANGEMENT OF THESE PRODUCTS IN SHIPS (GIVEN ONLY THE FIRST KEY NUMERALS OF DESIGNATIONS)

Location category	Arrangement of electrical equipment
1	On open decks
2	In spaces where air temperature and humidity variations are unessentially different from those outdoors and access of outside air is available (e.g. in metallic spaces of superstructures and deckhouses having no thermal insulation, in spaces under the bulkhead deck having no thermal insulation and other spaces below); on open decks, but in areas beyond the reach of the direct exposure to solar radiation, atmospheric precipitation and seawater pouring or splashing; in enclosures of products having location category 1
3	In spaces having thermal insulation and natural ventilation without artificially regulated environmental conditions or with prolonged breaks in regulation, wherein air temperature and humidity variations, wind and atmospheric precipitation effect are essentially less than outdoors, dew and the direct exposure to solar radiation are lacking
4	In spaces with artificially-regulated environmental conditions (heating, ventilation) including full or partial air-conditioning
5	In spaces with increased humidity (particularly wet) wherein the long-time presence of water or frequent condensation of moisture on bulkheads and deckheads is feasible

".

12 AUTOMATION EQUIPMENT

12.6 DESCRIPTION OF TESTS AND CHECKS

Para 12.6.5. The eighth paragraph is amended as follows:

"…The tests shall be carried out on regular shock-mounts, if any. ~~Shock-mounted products shall be hard-mounted in tests for detecting resonance frequencies.~~".

Table 12.6.6-1 is replaced by the following:

"Table 12.6.6-1

Category of equipment	Description
G0	Equipment intended for installation on jack-up ships, non-ice-class ships, ships with ice classes **Ice1**, **Ice2**, **Ice3**, fixed offshore platforms, and floating offshore oil and gas production units
G3	Equipment not belonging to Category G0, intended for installation on ships with ice classes **Arc4** — **Arc6** and icebreakers **Icebreaker6**.
G5	Equipment intended for installation on ships with ice classes **Arc7** — **Arc9** and icebreakers **Icebreaker7** — **Icebreaker9**.

".

Table 12.6.6-2 is replaced by the following:

"Table 12.6.6-2

Category of equipment	Form of the shock pulse	Acceleration, g	Shock duration, ms	Number of shocks in each position	Shocks per minute
G0	no tests required				
G3	half-sinusoid	3,0	6 or 30	100 ± 5	40 to 80
G5	half-sinusoid	5,0	6 or 30	100 ± 5	40 to 80

".

15 RADIO EQUIPMENT

APPENDIX

LIST OF REQULATORY DOCUMENTS APPLICABLE TO THE TYPE APPROVAL WORK OF SHIPBORNE EQUIPMENT[1]

Column 4 of the Table. The following Standards are replaced by the following updated versions:

IEC 61097-7, Ed. 1.1 (2018-01) is replaced by IEC 61097-7 Ed. 2.0 (2025-06);
IEC 61097-9, Ed. 1.0 (1997-11) is replaced by IEC 61097-9 Ed. 2.0 (2025-06);
IEC 61097-12, Ed. 1.1 (2017-07) is replaced by IEC 61097-12 Ed.1.2 (2023-11);
IEC 62288, Ed. 3.0 (2021-12) is replaced by IEC 62288 Ed. 3.1 (2024-11).

Table is supplemented by the line reading as follows:

"

RS nomenclature code	Item designation, SOLAS-74 regulation which determines ship's equipment	SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, ensures compliance with the requirements that the item shall meet (testing standards)
04400000	Other shipborne radio equipment (satellite communication stations, power supply units, VHF radiotelephones, portable radiotelephones, etc.)	A.694(17) MSC.191(79) MSC.466(101)	IEC 60945 series: - IEC 60945 Ed. 4.0/Cor.1 (2008-04) - ГОСТ Р IEC 60945-2007 IEC 62288 Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1 Ed. 6.0 (2024-04) - IEC 61162-2 Ed. 2.0 (2024-04) - IEC 61162-3 Ed. 1.2 (2014-07) - IEC 61162-450 Ed. 3.0 (2024-04)

".

16 NAVIGATIONAL EQUIPMENT

Appendix to Section 16 is amended as follows:

"APPENDIX

LIST OF REGULATORY DOCUMENTS APPLICABLE TO THE TYPE APPROVAL OF SHIPBORNE NAVIGATIONAL EQUIPMENT

RS nomenclature code	Item designation, SOLAS-74 regulation that defines the ship equipment	RS rules, SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations which the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, provides compliance with the requirements that the item shall meet (testing standards)
05010000MK	Standard magnetic compass V/19.2.1.1	SOLAS-74, Reg. V/19.2.1.1 MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) A.382(X)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 ISO 1069:1973 ISO 25862:2019/Amd 1:2024
05010200MK	Transmitting heading device THD (magnetic method) V/19.2.3.5	SOLAS-74, Reg. V/19.2.3.5 MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) MSC.116(73) MSC.191(79) MSC.466(101)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 ISO 22090-2:2014 IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)

RS nomenclature code	Item designation, SOLAS-74 regulation that defines the ship equipment	RS rules, SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations which the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, provides compliance with the requirements that the item shall meet (testing standards)
05010100MK	Transmitting heading device THD (GNSS method) V/19.2.3.5	SOLAS-74, Reg. V/19.2.3.5 MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) MSC.116(73) MSC.191(79) MSC.466(101)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 ISO 22090-3:2014 IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)
05010300MK	Transmitting heading device THD (Gyroscopic method) V/19.2.3.5	SOLAS-74, Reg. V/19.2.3.5 MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) MSC.116(73) MSC.191(79) MSC.466(101)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 ISO 22090-1:2014 IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)

RS nomenclature code	Item designation, SOLAS-74 regulation that defines the ship equipment	RS rules, SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations which the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, provides compliance with the requirements that the item shall meet (testing standards)
05020000MK	Gyro compass V/19.2.5.1	SOLAS-74, Reg. V/19.2.5.1 A.694(17) A.424(XI) MSC.191(79) MSC.466(101)	IEC 60945: series - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 ISO 8728:~~2014~~2024 IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)
05020010MK	Gyro compass for high-speed craft HSC Code (2000) 13.2.6	MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) A.821(19) MSC.191(79) MSC.466(101)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 ISO 16328:2014 IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)

RS nomenclature code	Item designation, SOLAS-74 regulation that defines the ship equipment	RS rules, SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations which the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, provides compliance with the requirements that the item shall meet (testing standards)
05030000MK	Speed and distance measuring equipment through the water (SDME) V/19.2.3.4	SOLAS-74, Reg. V/19.2.3.4 MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) MSC.96(72) MSC.191(79) MSC.466(101)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 61023, Ed. 3.0 (2007-06) IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)
05030100MK	Speed and distance measuring equipment over the ground in the forward and athwartships direction (SDME) V/19.2.9.2	SOLAS-74, Reg. V/19.2.9.2 MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) MSC.96(72) MSC.191(79) MSC.466(101)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 61023, Ed. 3.0 (2007-06) IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)

RS nomenclature code	Item designation, SOLAS-74 regulation that defines the ship equipment	RS rules, SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations which the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, provides compliance with the requirements that the item shall meet (testing standards)
05050000МК	Echo-sounding equipment V/19.2.3.1	SOLAS-74, Reg. V/19.2.3.1 MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) MSC.74(69) MSC.191(79) MSC.466(101)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 ISO 9875:2000 incl. ISO Technical Corr. 1:2006 IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)
05060000МК	Heading control system (HCS) V/19.2.8.2	SOLAS-74, Reg. V/19.2.8.2 A.694(17) MSC.64(67) MSC.191(79) MSC.466(101)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 ISO 11674:2019 IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)

RS nomenclature code	Item designation, SOLAS-74 regulation that defines the ship equipment	RS rules, SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations which the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, provides compliance with the requirements that the item shall meet (testing standards)
05060010MK	Heading control system for high-speed craft HSC Code (2000) 13.12	MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) A.822(19) MSC.191(79) MSC.466(101)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 ISO 16329:2003 IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)
05060100MK	Track control system V/19.2.8.2	SOLAS-74, Reg. V/19.2.8.2 A.694(17) MSC.74(69) MSC.191(79) MSC.466(101)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 62065, ~~Ed. 2.0 (2014-02)~~Ed. 3.0 (2025-10) IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)

RS nomenclature code	Item designation, SOLAS-74 regulation that defines the ship equipment	RS rules, SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations which the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, provides compliance with the requirements that the item shall meet (testing standards)
05070000MK	Integrated navigation system	MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) MSC.252(83) MSC.452(99) MSC.302(87) MSC.191(79) MSC.466(101)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 61924-2, Ed. 2.0 (2021-02) IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04) IEC 62923-1, Ed. 1.0 (2018-08) IEC 62923-2, Ed. 1.0 (2018-08)
05120000MK	Rate-of-turn indicator V/19.2.9.1	SOLAS-74, Reg. V/19.2.9.1 MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) A.526(13) MSC.191(79) MSC.466(101)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 ISO 20672:2022 IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)

RS nomenclature code	Item designation, SOLAS-74 regulation that defines the ship equipment	RS rules, SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations which the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, provides compliance with the requirements that the item shall meet (testing standards)
05130000МК	Electronic chart display and information system (ECDIS) V/19.2.10	SOLAS-74, Reg. V/19.2.1.4 MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) MSC.232(82) MSC.191(79) MSC.466(101) MSC.1/Circ.1503. Rev.1	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 61174, Ed. 4.0 (2015) IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)
05140210МК	Radar equipment for ships less than 500 gt (CAT 3) V/19.2.3.2	SOLAS-74, Reg. V/19.2.3.2 A.694(17) MSC.192(79) MSC.191(79) MSC.466(101) ITU-R M.1177-4 (2011)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 62388, Ed. 2.0 (2013-06) IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)

RS nomenclature code	Item designation, SOLAS-74 regulation that defines the ship equipment	RS rules, SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations which the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, provides compliance with the requirements that the item shall meet (testing standards)
05140220MK	Radar equipment for ships less than 10000 gt (CAT 2) V/19.2.7.1	SOLAS-74, Reg. V/19.2.7.1 A.694(17) MSC.192(79) MSC.191(79) MSC.466(101) ITU-R M.1177-4 (2011)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 62388, Ed. 2.0 (2013-06) IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)
05140230MK	Radar equipment for ships of 10000 gt and upwards (CAT 1) V/19.2.8.1	SOLAS-74, Reg. V/19.2.8.1 A.694(17) MSC.192(79) MSC.191(79) MSC.466(101) ITU-R M.1177-4 (2011)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 62388, Ed. 2.0 (2013-06) IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)

RS nomenclature code	Item designation, SOLAS-74 regulation that defines the ship equipment	RS rules, SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations which the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, provides compliance with the requirements that the item shall meet (testing standards)
05140231МК	Radar equipment for high-speed craft (CAT 1H, CAT 2H) V/19.2.8.1 V/19.2.3.2 HSC Code (2000) 13.5	MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) MSC.192(79) MSC.191(79) MSC.466(101) ITU-R M.1177-4 (2011)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 62388, Ed. 2.0 (2013-06) IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)
05140232МК	Chart radar equipment (CAT 1C, CAT 2C)	A.694(17) MSC.192(79) MSC.191(79) MSC.466(101) ITU-R M.1177-4 (2011)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 62388, Ed. 2.0 (2013-06) IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61174, Ed. 4.0 (2015-08) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)

RS nomenclature code	Item designation, SOLAS-74 regulation that defines the ship equipment	RS rules, SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations which the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, provides compliance with the requirements that the item shall meet (testing standards)
05140233MK	Chart radar equipment for high-speed craft (CAT 1HC, CAT 2HC)	MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) MSC.192(79) MSC.191(79) MSC.466(101) ITU-R M.1177-4 (2011)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 62388, Ed. 2.0 (2014-02) IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61174, Ed. 4.0 (2015-08) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)
05140240	Radar ice display	A.694(17) MSC.191(79) MSC.466(101) Part V of the RS Rules/E, Appendix 1, Section 4	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11)

RS nomenclature code	Item designation, SOLAS-74 regulation that defines the ship equipment	RS rules, SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations which the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, provides compliance with the requirements that the item shall meet (testing standards)
05140300MK	GNSS receiver (GPS) V/19.2.1.6	SOLAS-74, Reg. V/19.2.1.6 MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) MSC.112(73) MSC.191(79) MSC.466(101) ITU-R M.823-3 (2006)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 61108-1, Ed. 2.0 (2003-07) IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)
05140310MK	GNSS receiver (GLONASS) V/19.2.1.6	SOLAS-74, Reg. V/19.2.1.6 MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) MSC.113(73) MSC.191(79) MSC.466(101) ITU-R M.823-3 (2006)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 61108-2, Ed. 1.0 (1998-06) IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)

RS nomenclature code	Item designation, SOLAS-74 regulation that defines the ship equipment	RS rules, SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations which the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, provides compliance with the requirements that the item shall meet (testing standards)
05140320МК	GNSS receiver (Galileo) V/19.2.1.6	SOLAS-74, Reg. V/19.2.1.6 MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) MSC.233(82) MSC.191(79) MSC.466(101) ITU-R M.823-3 (2006)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 61108-3, Ed. 1.0 (2010-05) IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)
05140330МК	Combined GPS/GLONASS equipment V/19.2.1.6	SOLAS-74, Reg. V/19.2.1.6 MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) MSC.115(73) MSC.191(79) MSC.466(101) ITU-R M.823-3 (2006)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 61108-1, Ed. 2.0 (2003-07) IEC 61108-2, Ed. 1.0 (1998-06) IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)

RS nomenclature code	Item designation, SOLAS-74 regulation that defines the ship equipment	RS rules, SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations which the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, provides compliance with the requirements that the item shall meet (testing standards)
05140340МК	Differential beacon receiver for DGPS and DGLONASS equipment	MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) MSC.114(73) ITU-R M.823-3 (2006)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 61108-4, Ed. 2.0 (2004-07) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)
05140350МК	GNSS receiver (Beidou) V/19.2.1.6	SOLAS-74, Reg. V/19.2.1.6 MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) MSC.379(93) MSC.191(79) MSC.466(101) ITU-R M.823-3 (2006)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 61108-5, Ed. 1.0 (2020-03) IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)

RS nomenclature code	Item designation, SOLAS-74 regulation that defines the ship equipment	RS rules, SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations which the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, provides compliance with the requirements that the item shall meet (testing standards)
05140360MK	IRNSS receiver V/19.2.1.6	SOLAS-74, Reg. V/19.2.1.6 MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) MSC.449(99) MSC.191(79) MSC.466(101) ITU-R M.823-3 (2006)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 61108-6, Ed. 1.0 (2023-02) IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)
05140400MK	Radar reflector~~ – passive type~~ V/19.2.1.7	SOLAS-74, Reg. V/19.2.1.7 MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 MSC.164(78)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 ISO 8729-1:2010 / ISO 8729-2:2009

RS nomenclature code	Item designation, SOLAS-74 regulation that defines the ship equipment	RS rules, SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations which the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, provides compliance with the requirements that the item shall meet (testing standards)
05150000MK	Class A shipborne equipment of the automatic identification system (AIS) V/19.2.4	SOLAS-74, Reg. V/19.2.4.5 MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) MSC.74(69) MSC.191(79) MSC.466(101) Radio Regulations 2024 ITU-R M.1371-5 (2014)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 61993-2, Ed. 3.0 (2018-07) IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)
05150000	Class B shipborne equipment of the automatic identification system (AIS)	A.694(17) Radio Regulations 2024 ITU-R M.1371-5 (2014) Part V of the RS Rules/E, Appendix 1, Section 6	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 62287-1, Ed. 3.1 (2022-11) IEC 62287-2, Ed. 2.0 (2017-02) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)

RS nomenclature code	Item designation, SOLAS-74 regulation that defines the ship equipment	RS rules, SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations which the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, provides compliance with the requirements that the item shall meet (testing standards)
05160100MK	Voyage data recorder (VDR) V/20.1	SOLAS-74, Reg. V/20.1 MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) MSC.333(90) MSC.494(104) MSC.191(79) MSC.466(101)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 61996-1, Ed. 2.1 (2021-05) IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)
05160200MK	Simplified voyage data recorder (S-VDR) V/20.2	SOLAS-74, Reg. V/20.2 A.694(17) MSC.163(78) MSC.214(81) MSC.493(104) MSC.191(79) MSC.466(101)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 61996-2, Ed. 1.0 (2007-11) IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)

RS nomenclature code	Item designation, SOLAS-74 regulation that defines the ship equipment	RS rules, SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations which the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, provides compliance with the requirements that the item shall meet (testing standards)
05170000MK	Sound reception system V/19.2.1.8	SOLAS-74, Reg. V/19.2.1.8 MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) MSC.86(70) MSC.191(79) MSC.466(101)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 ISO 14859:2012 IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)
05180000MK	Bridge Central Alert Management System	A.694(17) MSC.302(87) MSC.191(79) MSC.466(101)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 62923-1, Ed. 1.0 (2018-08) IEC 62923-2, Ed. 1.0 (2018-08) IEC 62288, Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)

RS nomenclature code	Item designation, SOLAS-74 regulation that defines the ship equipment	RS rules, SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations which the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, provides compliance with the requirements that the item shall meet (testing standards)
05190000MK	Bridge Navigational Watch Alarm System (BNWAS) V/19.2.2.3	A.694(17) MSC.128(75) MSC.191(79) MSC.466(101)	IEC 60945 series: - IEC 60945 Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 62616:2010 / incl. Cor.1 (2012) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)
05200000MK	Equipment with Long Range Identification and Tracking (LRIT) capability V/19-1.4.1, 2	SOLAS-74, Reg. V/19-1 A.694(17) MSC.263(84) MSC.1/Circ.1307	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 62729, Ed. 1.0 (2012-06) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)

RS nomenclature code	Item designation, SOLAS-74 regulation that defines the ship equipment	RS rules, SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations which the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, provides compliance with the requirements that the item shall meet (testing standards)
05220100МК	Night vision equipment for high-speed craft HSC Code (2000), 13.10	MSC.36(63) (1994 HSC Code) 13 MSC.97(73) (2000 HSC Code) 13 A.694(17) MSC.94(72) MSC.191(79) MSC.466(101)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 ISO 16273:2020 IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)
05230000МК	Electronic inclinometer V/19.2.12	SOLAS-74, Reg. V/19.2.12 A.694(17) MSC.363(92) MSC.191(79) MSC.466(101)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 ISO 19697:2016 IEC 62288, ~~Ed. 3.0 (2021-12)~~Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)

RS nomenclature code	Item designation, SOLAS-74 regulation that defines the ship equipment	RS rules, SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations which the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, provides compliance with the requirements that the item shall meet (testing standards)
05220000	Meteorological complex	A.694(17) Part V of the RS Rules/E, Appendix 1, Section 1	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)
05300000	Other shipborne navigational equipment	A.694(17) MSC.191(79) MSC.466(101)	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 62288 Ed. 3.1 (2024-11) IEC 61162 series: - IEC 61162-1, Ed. 6.0 (2024-04) - IEC 61162-2, Ed. 2.0 (2024-04) - IEC 61162-3, Ed. 1.2 (2014-07) - IEC 61162-450, Ed. 3.0 (2024-04)
05411000	450-Node	A.694(17) Part V of the RS Rules/E, Appendix 1, Section 1	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 61162 series: - IEC 61162-460, Ed. 3.0 (2024-04)

RS nomenclature code	Item designation, SOLAS-74 regulation that defines the ship equipment	RS rules, SOLAS-74 regulations, IMO resolutions and circulars, ITU recommendations which the item shall comply with	List of documents in the field of standardization and other documents, whose application, on a voluntary basis, provides compliance with the requirements that the item shall meet (testing standards)
05412000	460-Node	A.694(17) Part V of the RS Rules/E, Appendix 1, Section 5	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 61162 series: - IEC 61162-460, Ed. 3.0 (2024-04)
05413000	460-Switch	A.694(17) Part V of the RS Rules/E, Appendix 1, Section 5	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 61162 series: - IEC 61162-460, Ed. 3.0 (2024-04)
05414000	460-Forwarder	A.694(17) Part V of the RS Rules/E, Appendix 1, Section 5	IEC 60945: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 61162 series: - IEC 61162-460, Ed. 3.0 (2024-04)
05415000	460-Gateway	A.694(17) Part V of the RS Rules/E, Appendix 1, Section 5	IEC 60945 series: - IEC 60945, Ed. 4.0/Cor.1 (2008-04) - GOST R IEC 60945-2007 IEC 61162 series: - IEC 61162-460, Ed. 3.0 (2024-04)

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Russian Maritime Register of Shipping

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