PARTE III CONSTRUCTION COMPONENTS

TITLE 63 ELECTRICITY, NAUTICS AND ELECTRONICS

SEÇÃO 7 ELECTRICITY

A TESTING REQUIREMENTS FOR ROTATING MACHINERY

B REQUIREMENTS FOR CONSTRUCTION AND TYPE OR UNIT APPROVAL OF RECTIFIERS/CHARGERS OF BATTERIES

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CHAPTER A
TESTING REQUIREMENTS FOR ROTATING MACHINERY
[IACS UR E13]

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A1. APPROACH

100. Approach

101. All machines are to be tested by the manufacturer.

102. Manufacturer`s test records are to be provided for machines for essential services, for other machines they are to be available upon request.

103. All tests are to be carried out according to IEC Publication 60092-301, ABNT NBR 5052 or equivalent.

104. All machines of 100kW and over, intended for essential services, are to be surveyed by RBNA during test and, if appropriate, during manufacturing.

105. Note: An alternative survey scheme may be agreed by RBNA with the manufacturer whereby attendance of the Surveyor will not be required as required above.

A2. SHAFT MATERIAL

100. Shaft material

101. Shaft material for electric propulsion motors and for main engine driven generators where the shaft is part of the propulsion shafting is to be certified by RBNA.

102. Shaft material for other machines is to be in accordance with recognized international or national standard.

A3. DOCUMENTS TO BE SUBMITTED

100. Examination of the technical documentation, as appropriate and visual inspection

101. Technical documentation Technical documentation of machines rated at 100kW and over is to be available for examination by the Surveyor.

A4. TESTS

100. Tests

101. Type tests are to be carried out on a prototype machine or on the first of a batch of machines, and routine tests carried out on subsequent machines in accordance with Table T.A4.101.1.

102. Test requirements may differ for shaft generators, special purpose machines and machines of novel construction.

TABLE T.A4.101.1 – TEST REQUEREMENTS FOR ROTATING MACHINES

No	Tests	A.C. Generators		Motors	
		Type test [1]	Routine test [2]	Type test [1]	Routine test [2]
1.	Examination of the technical documentation, as appropriate and visual inspection	x	x	x	x
2.	Insulation resistance measurement	x	x	x	x
3.	Winding resistance measurement	x	x	x	x
4.	Verification of the voltage regulation system	x	x[3]		
5.	Rated load test and temperature rise measurements	x		x	
6.	Overload/overcurrent test	x	x[4]	x	x[4]
7.	Verification of steady short circuit conditions [5]	x			
8.	Overspeed test	x	x	x [6]	x [6]
9.	Dielectric strength test	x	x	x	x
10.	No-load test	x	x	x	x
11.	Verification of degree of protection	x		x	
12.	Verification of bearings	x	x	x	x

1. Type tests on prototype machine or tests on at least the first batch of machines.

2. The report of machines routine tested is to contain the manufacturer`s serial number of the machine which has been type tested and the test result.

3. Only functional test of voltage regulator system.

4. Only applicable for machine of essential services rated above 100kW.

5. Verification of steady short circuit condition applies to synchronous generators only.

6. Not applicable for squirrel cage motors.

A5. DESCRIPTION OF THE TESTS

100. Visual inspection

101. A visual examination is to be made of the machine to ensure, as far as is practicable, that it complies with technical documentation.

200. Insulation resistance and winding resistance measurement:

201. Immediately after the high voltage tests the insulation resistances are to be measured using a direct current insulation tester between:

a. all current carrying parts connected together and earth,

b. all current carrying parts of different polarity or phase, where both ends of each polarity or phase are individually accessible.

202. The minimum values of test voltages and corresponding insulation resistances are given in Table T.A5.202.1. The insulation resistance is to be measured close to the operating temperature, or an appropriate method of calculation is to be used.

TABLE T.A5.202.1 – MINIMUM VALUES OF TEST VOLTAGES AND CORRESPONDING INSULATION RESISTANCES

Related Voltage Un (V)	Minimum Test Voltage (V)	Minimum Insulation Resistance (MΩ)
Un ≤ 250	2 x Un	1
250 < Un ≤ 1000	500	1
1000 < Un ≤ 7200	1000	(Un / 1000) + 1
7200 < Un ≤ 15000	5000	(Un / 1000) + 1

203. Winding resistance measurement: The resistances of the machine windings are to be measured and recorded using an appropriate bridge method or voltage and current method.

300. Verification of the voltage regulation system

301. The alternating current generator, together with its voltage regulation system, is to be verified that, at all loads from no-load running to full load, the rated voltage at the rated power factor is maintained under steady conditions within ± 2.5%. These limits may be increased to ± 3.5% for emergency sets.

302. When the generator is driven at rated speed, giving its rated voltage, and is subjected to a sudden change of symmetrical load within the limits of specified current and power factor, the voltage is not to fall below 85% nor exceed 120% of the rated voltage.

303. The voltage of the generator is then to be restored to within plus or minus 3% of the rated voltage for the main

400. Rated load test and temperature rise measurements

401. The temperature rises are to be measured at the rated output, voltage, frequency and the duty for which the machine is rated and marked in accordance with the testing methods specified in IEC Publication 60034-1, or by means of a combination of other tests.

402 The limits of temperature rise are those specified in Table T.A5.402.1 of IEC Publication 60034-1 adjusted as necessary for the ambient reference temperatures specified in Part II, Title 11,Section 5, Subchapter D1.

TABLE T.A5.402.1 - ADJUSTED LIMITS OF TEMPERATURE RISE AT THE TEST SITE (ΔΘ T) FOR WINDINGS INDIRECTLY COOLED BY AIR TO TAKE ACCOUNT OF TEST SITE OPERATING CONDITIONS

Item	Test condition		Adjusted limit at test site $\Delta\theta_T$
1	Temperature difference of reference coolant at test site (θ_{cT}) and operating site (θ_c)	Absolute value of $(\theta_c - \theta_{cT}) \leq 30$ K	$\Delta\theta_T = \Delta\theta$
		Absolute value of $(\theta_c - \theta_{cT}) > 30$ K	By agreement
2	Difference of altitudes of test site (H_T) and operating site (H)	1 000 m < H ≤ 4 000 m H_T < 1 000 m	$\Delta\theta_T = \Delta\theta\left(1 - \frac{H - 1\,000\text{ m}}{10\,000\text{ m}}\right)$
		H < 1 000 m 1 000 m < H_T ≤ 4 000 m	$\Delta\theta_T = \Delta\theta\left(1 + \frac{H_T - 1000\text{ m}}{10\,000\text{ m}}\right)$
		1 000 m < H ≤ 4 000 m 1 000 m < H_T ≤ 4 000 m	$\Delta\theta_T = \Delta\theta\left(1 + \frac{H_T - H}{10\,000\text{ m}}\right)$
		H > 4 000 m or H_T > 4 000 m	By agreement

NOTE 1 $\Delta\theta$ is given in Table 7 and adjusted if necessary in accordance with Table 9.

NOTE 2 If temperature rise is to be measured above the temperature of the water where it enters the cooler, the effect of altitude on the temperature difference between air and water should strictly be allowed for. However, for most cooler designs, the effect will be small, the difference increasing with increasing altitude at the rate of roughly 2 K per 1 000 m. If an adjustment is necessary, it should be by agreement.

500. Overload/overcurrent tests

501. Overload test is to be carried out as a type test for generators as a proof of overload capability of generators and excitation system, for motors as a proof of momentary excess torque as required in IEC Publication 60034-1.

502. The overload test can be replaced at routine test by the overcurrent test. The over current test shall be the proof of current capability of windings, wires, connections etc. of each machine. The overcurrent test can be done at reduced speed (motors) or at short circuit (generators).

600. Verification of steady short-circuit conditions

601. It is to be verified that under steady-state short-circuit conditions, the generator with its voltage regulating system is capable of maintaining, without sustaining any damage, a current of at least three times the rated current for a duration of at least 2 s or, where precise data is available, for a duration of any time delay which may be fitted in a tripping device for discrimination purposes.

700. Overspeed test

701. Machines are to withstand the overspeed test as specified in to IEC Publication 60034- 1. This test is not applicable for squirrel cage motors.

800. Dielectric strength test

801. Machines are to withstand a dielectric test as specified in IEC Publication 60034-1.

802. For high voltage machine an impulse test is to be carried out on the coils according to Part II, Title 11, Section 7, Chapter I of the rules.

900. Other tests

901. **No load test:**

a. Machines are to be operated at no load and rated speed whilst being supplied at rated voltage and frequency as a motor or if a generator it is to be driven by a suitable means and excited to give rated terminal voltage.

b. During the running test, the vibration of the machine and operation of the bearing lubrication system, if appropriate, are to be checked.

902**. Verification of degree of protection:** As specified in IEC Publication 60034-5.

903**. Verification of bearings:** upon completion of the above tests, machines which have sleeve bearings are to be opened upon request for examination by RBNA Surveyor, to establish that the shaft is correctly seated in the bearing shells.

CHAPTER B
REQUIREMENTS FOR CONSTRUCTION AND TYPE OR UNIT APPROVAL OF RECTIFIERS/CHARGERS OF BATTERIES [PART OF IACS UR E10]

CHAPTER CONTENTS

B1. APPROACH

100. Scope

101. These requirements apply to the construction and type or unit testing of chargers and rectifiers for batteries.

102. The tests contained herein are to be carried out at the manufacturers. The on-board tests are described in Part II, Title 11, Section 7 of these Rules.

103. In addition to the compliance with the standards specific for electrical installations in ships, a reference is made to the standard IEC 60335-2-29 (Household and similar electrical appliances – Safety – Particular requirements for battery chargers) and its Test Report Form IEC/TRF 60335-2-29. Other equivalent national or international standards may be accepted.

B2. DOCUMENTS TO BE SUBMITTED

100. Documents to be submitted to RBNA

101. Drawings and documents should be submitted to RBNA's assessment and approval in digital files ('pdf' format) or in three hard copies of each.

102. The documents should include at least the following:

a. manufacturer's specification (including the indication of the type of voltage regulator, e.g., ferroresonant transformers, SCR regulators and/or switched power supplies);
b. electric diagrams;

B3. CONSTRUCTION REQUIREMENTS

100. Constructional requirements

101. The battery chargers must include voltage regulation and must be appropriate for use with the batteries for which they are intended.

102. The battery chargers must be able to charge a fully discharged battery up to 80% of its capacity within a period of 10 hours, without exceeding the maximum current allowed for charging. Other battery charging rates necessary for specific applications can be submitted to the analysis of RBNA as, for example batteries that need to be completely charged in 6 hours, for motor starting.

103. In floating condition or in another condition when the loads are connected to the batteries while they are being charged, the maximum voltage at the batteries must not exceed the safe voltage for any connected equipment. The effects of temperature variation at the batteries should be considered.

104. The chargers must be designed so the charging current will remain between the values of the floating current used for keeping the battery fully charged, and the maximum current allowed according to the batteries' specification when they are discharged.

105. To compensate the internal losses of the batteries, the charger must be able to trickle charge. An indication of the voltage applied by the charger to the batteries must be provided.

106. The charger must be protected against attempts of applying the charging current with reverse polarity to the batteries.

107. The chargers should be designed in a way to make their operation and maintenance as easy as possible. Indicators of normal operation and failure conditions must be provided.

B4. TESTS

100. Procedure for test of the battery chargers

101. After the examination of the documents submitted, the tests must be carried out according to Table T.B4.101.1, in the presence of a surveyor from RBNA. The electronic components of the battery chargers must withstand the tests as per Part III, Title 63, Section 8, Table T.A2.104.1 of these Rules (also refer to IACS UR E10),

102. The type approval tests must be performed with the prototype of the charger or at least with the first batch of chargers produced.

103. The routine tests are to be performed for the next produced chargers, the serial number of the equipment and the test results are to be mentioned in the corresponding certificates.

104. Battery charges of 5kW and over must be type approved as tested in the presence of RBNA surveyor.

TABLE T.B4.101.1 – TESTS FOR TYPE AND UNITS APPROVAL FOR RECTIFIERS/BATTERY CHARGERS

Item	Tests	Type Approval	Routine Test
1	Visual inspection[1] (including degree of protection IP of the enclosure and labeling of the equipment)	X	X
2	Verification of earth continuity	X	X
3	Functional tests (current and voltage regulation; quick, slow and floating charging; alarms, control and monitoring[2])	X	X
4	Voltage and frequency tolerance tests[3]	X	X
5	Stored energy and restored energy tests[4]	X	
5	Temperature rise test	X	
6	Dielectric strength test (high voltage)[5]	X	X
7	Insulation resistance measurement[6]	X	X
8	Short circuit test[7]	X	
9	Cooling failure test[8]	X	X
10	Discharge of capacitors[9]	X	
11	Pressure test in coolant pipes/hoses[10]		X

Notes to Table T.B4.101.1:

1- Visual inspection to assure, as far as possible, that the equipment was manufactured according to the technical documentation submitted to RBNA.

2- An alarm must be given in case of supply failure or unit tripping. In case of liquid cooling, where the liquid is in touch with live parts, the conductivity shall be monitored; an alarm must be given in case of high conductivity. The alarms must be given to a manned control station.

3- For power supply variations see RBNA Rules, Part III, Title 63, Section 8, Table T.A4.101.2, item 4.(a).

4- The battery chargers must be able to charge a fully discharged battery up to 80% of its capacity within a period of 10 hours, without exceeding the maximum current allowed for charging.

5- High voltage test – separate circuits shall be tested against each other and all the circuits connected to each other tested against the earth. Printed circuit boards with electronic components must be removed during the test. The period for application of the high voltage must be of 1 minute. See RBNA Rules, Part III, Title 63, Section 8, Table T.A4.101.2, item 10, with the voltages to be applied depending on the nominal voltage of the circuit.

6- Insulation resistance measurement – with megger between the circuits and the earth, and between phases where applicable, as per RBNA Rules, Part III, Title 63, Section 8, Table T.A4.101.2, item 9. Certain circuits, like for EMC protection, must be disconnected during this test.

7- Chargers operating as power supplies shall afford a short circuit current enough for the tripping of the downstream protection devices without internal damage.

8- In case of forced cooling, unless particularly required, the charger cannot remain loaded if the cooling or another effective means of protection against overheating is not available.

9- Capacitors in the equipment must be discharged to less than 60 Volts in less than 5 s after removal of the power supply. Warning advices must be fitted if this requirement cannot be achieved.

10- In case of liquid cooling, the pipes or hoses must be tested with hydrostatic pressure of 1.5 times the working pressure.

CHAPTER C
TESTING AND TYPE TESTING OF ELECTRIC CABLES

CHAPTER CONTENTS

C1. APPROACH

100. Approach

101. All electrical cables are to be tested in accordance with the standard IEC 60092-350.

102. Equivalent standards are acceptable by the Society.

C2. MANUFACTURER APPROVAL

100. Manufacturer approval for Type Approval

101. Electric cables are to be certified by the Type Approval method according to the requirements of Part I, Title 01, Section 2, Sub-chapter T

C3. TYPE TESTS

100. Application

101. This Subchapter C3 is based on the IEC 60092 series of standards.
102. This Subchapter applies to unit routine testing, special testing, design and product type approval of electric cables for electrical installations on ships.
103. All electrical cables are to be tested in accordance with the standard IEC 60092-350 or equivalent.

104. Equivalent standards are acceptable by the Society.

105. **Definitions**

a. **Insulated cable**: assembly consisting of:

a.1. One or more cores;

a.2. Individual covering(s), if any

a.3. Assembly protection, if any

a.4. Protective coverings, if any

a.5. Additional non-insulated conductor(s) may be included in the cable.

b. **Radial field cable:** cable in which each core is covered with an individual screen.

c. **Screen**: conducting layer(s) having the function of control of the electric field within the insulation. It may also provide smooth surfaces at the boundaries of the insulation and assist in the elimination of spaces at these boundaries.

d. **Conductor**: part of the cable which has the specific function of carrying current.

e. **Stranded conductor**: conductor consisting of a number of individual wires, all or the major part of which should have a helical form. Note: the stranded conductor may be circular or shaped.

f. **Core**: assembly comprising a conduction and its own insulation.

g. **Core screen**: electric screen of non-metallic and/or metallic materials covering the insulation.

h. **Shield**: surrounding earthed metallic layer to confine the electric field within the cable and / or protect the cable from external electric influence.

i. **Flexible cable:** cable which is required to be capable of being flexed while in service and of which the structure and materials are such as to fulfil this requirement.

j. **Cord**: cable with a limited number of conductors of small cross-sectional area.

k. **Length of lay**: axial length of one complete turn of the helix formed by one of the cable components.

l. **Separator**:, thin layer used as a barrier to prevent mutually detrimental effects between different components of a cable, for example between the conductor and insulation or between insulation and sheath.

m. **Fiber**: material used to fill the interstices between the cores of a multi-conductor cable.

n. **Inner covering**: non-metallic covering which surrounds the assembly of the cores (and fillers, if any) of a multicore cable and over which the protective covering is applied.

o. **Sheath**: uniform and continuous tubular covering consisting of non-metallic material, generally extruded.

p. **Oversheath**: non-metallic sheath applied over a metallic covering, constituting the outermost sheath of the cable.

q. **Armour**: covering consisting of metal tape(s) or wires, generally used to protect the cable form external mechanical effects.

r. **Braid**: covering made of plaited metallic or non-metallic material.

s. **Routine tests**: routine tests are made on all finished cable lengths to demonstrate the integrity of the cable.

200. Summary of tests according to the standard under reference

201. The manufacturer of the electric cables is to submit the plans and specifications to the RBNA for approval. A Design Type Approval will be issued upon satisfactory results of the analysis.

202. After the Design Type Approval has been issued, the product type approval will follow standard IEC 60092-350. For each test there is an applicable standard, whose requirements are to be considered not only during the product type approval, but also during the plan / specifications assessment for unit or type approval.

300. Test conditions

301. Ambient temperature: unless otherwise specified in the details for a particular test, voltage tests shall be made at an ambient temperature of 20ºC ± 15ºC and other tests at an ambient temperature of 20ºC ± 5ºC

302. Frequency and waveform of power frequency test voltages: the frequency of the alternating test voltages shall be in the range 49 Hz to 61 Hz. The waveform shall be substantially sinusoidal. The values quoted are r.m.s. values.

400. Routine tests

401. **Routine tests**: routine tests are made on all finished cable lengths to demonstrate the integrity of the cable.

a. Visual inspection;

b. Measuring of the electrical resistance of conductors according to IEC 60092-350 and IEC 60228);

c. High voltage test according to IEC 60092-350);

d. Insulation resistance test according to IEC 60092-350 e IEC 60092-351;

e. Dimensional verifications, as necessary

402. The routine tests shall normally be carried out in all finished cable lengths, but the number of lengths may be reduced by agreement between the purchaser, the manufacturer and the approval organization.

403. The routine tests may be carried out, at the manufacturers' option, either on delivery lengths or on manufacturing lengths before they are cut into delivery lengths.

500. Special tests

501. **Special tests:** tests made by the manufacturer on samples of completed cable or component taken from a completed cable, so as to verify that the finished product meets the design specification.

a. Conductor examination: compliance with IEC 60228 for conductor construction shall be checked by inspection and measurement when practicable;

b. Check of dimensions:

b.1. Measurement of the thickness of the insulation (IEC 60092-350 and IEC 60811-1-1 clause 8);

b.2. Measurement of external diameter (IEC 60092-350 and IEC 60811-1-1 clause 8);

c. Hot-set test for insulation and for sheaths (IEC 60092-350);

c.1. Procedure: the sampling and test procedure shall be carried out in accordance with clause of IEC 60811-2-1 employing the conditions given in table 4 of IEC 60092-351 for insulation and table II of IEC 60092-359 for sheaths.

c.2. Requirements: the tests shall comply with the requirements given in table 4 of IEC 60091-351 for insulations and table II of IEC 60092-359 for sheaths.

d. Test of the behaviour at low temperatures of PVC insulation and PVC SHF 1 and SHF 2 sheaths;

d.1. Procedure: the sampling and test procedure shall be in accordance with clause 8 of IEC 60811-1-4, employing the test temperature specified in table 4 of IEC 60092-51 for the insulation, or table III of IEC 60092-359 for the sheath.

d.2. Requirements: the test results shall comply with the requirements given in clause 8 of IEC 60811-1-4.

e. Water tightness (IEC 60092-350 clause 11.10);

f. Test of the metal coating of copper wires:

f.1. The metal coating should be considered satisfactory if, on visual inspection, the wire surface appears smooth and uniform and the insulation is not adherent to the conductor.

f.2. If a chemical test is required, it should be carried out with the method and requirements specified in Annex E (colorimetric method) of IEC-60092-350.

g. Galvanizing tests for steel wires (IEC 60092-350).

g.1. When a galvanizing test is required for checking the resistance of steel wires against rusting, the immersion test specified in annex F of IEC 60092-350 should be carried out on wire specimens taken from the cable sample. If pain is applied on the armour this test should be made on specimens taken from wires prior to their application of the cable.

600. Type Approval Tests:

601. Electrical type approval tests electrical:

a. Insulation resistance measurement at room temperature: according to IEC 60092-350 for the tests and according to table 2 of IEC 60092-351 for the assessment of the results;

b. Insulation resistance measurement at the maximum rated temperature: according to IEC 60092-350 for the tests and according to table 2 of IEC 60092-351 for the assessment of the results;

c. Increase of the a.c. capacity after immersion in the water: tests according to IEC 60092-350 and IEC 60092-351 for water absorption;

d. High voltage test for 4 h (IEC 60092-350).

700. Type Approval tests, non-electrical:

701. Measurement of the thickness of the insulation (IEC 60092-350 and procedure according to IEC 60811-1-1);

702. Measurement of thickness of non-metallic sheaths (excluding inner coverings) (IEC 60092-350 and procedures according to clause 8 of IEC 60811-1-1);

703. Tests for determining the mechanical properties of insulation and sheaths before and after ageing:

a. To be carried out in accordance with IEC 60092-350;

b. Sampling as per clause 9 of IEC 60811-1-1;

c. Ageing treatments: to be carried out in accordance with clause 8 of IEC 60811-1-2 under the conditions specified in Table 3 of IEC 60092-351;

d. Conditioning and mechanical tests: according to clause 9 of IEC 60811-1-1;

e. The test results for non-aged and aged pieces shall comply with the requirements given in table 3 of IEC 60092-351.

704. Additional ageing tests on completed cables (compatibility test):

a. This test is intended to check that the insulation and sheath are not liable to deteriorate in operation due to contact with other components in the cable.

b. The test is applicable to cables of all types.

c. Sampling: according to clause 8 of IEC 60811-1-2

d. Ageing treatment: to be carried out in an air oven, as described in clause 8 of IEC 60811-1-2 under the following conditions:

d.1. Temperature: 10 ± 2 °C above the rated operating conductor temperature of the cable, or, if the operating temperature of the cable is not known, 10 ± 2 °C above the highest rated temperature for the insulation material, according to table 1 of IEC 60091-351.

d.2. Duration: 7 x 24 hours.

e. Mechanical tests: test pieces of insulation and sheath from the aged pieces of cables prepared as per clause 8 of IEC 60811-1-2 and subjected to mechanical tests.

f. Requirements: the variations between the median values of tensile strength and elongation at break before and after ageing shall not exceed the corresponding values applying to the tes for ageing in an air oven specified in table 3 of IEC 60092-351 for insulation and table II of IEC 60092-359 for sheath.

705. Loss of mass test on PVC insulation and sheaths

a. Procedure to be in accordance with clause 8 of IEC 60811-3-2;

706. Test for the behaviour at high temperature of PVC insulation and PVC and SHF 1 sheaths (pressure test)

a. Sampling and test procedure in accordance with clause 8 of IEC 60811-3-1;

b. Test conditions given in the test method and in table 4 of IEC 60092-351 for insulation, and table III of IEC 60092-359 for sheaths.

c. Test results shall comply with the requirements given in table 4 of IEC 60092-351 for insulation, and table III of IEC 60092-359 for sheaths.

707. Test for the behaviour at low temperature of PVC insulation and PVC, SHF 1 and SHF 2 sheaths

a. Sampling procedure according to clause 8 of IEC 60811-1-4;

b. Test temperatures as per table 4 of IEC 60092-351 for insulation and table III of IEC 60092-359 for sheaths;

c. Test results shall comply with clause 8 of IEC 60811-1-4.

708. Test for resistance to cracking of PVC insulation and PVC and SHF 1 sheaths (heat shock test)

a. Sampling and procedure in accordance with clause 9 of IEC 60811-3-1;

b. Test temperature and period of heating in accordance with table 4 of IEC 60092-351 for insulation and table III of IEC 60092-359 for sheaths;

c. Test results shall comply with clause 9 of IEC 60811-3-1.

709. Ozone resistance test for insulation and for sheaths (see table T.C3.718.1 and T.C3.719.1 for applicability of compounds in the test method)

a. Procedure: sampling in accordance with clause 8 of IEC 60811-2-1;

b. Test parameters: table 4 of IEC 60092-351 for insulation and table III of IEC 60092-359 for sheaths;

c. Test results shall comply with the requirements of clause 8 of IEC 60811-2-1.

710 Hot-set test for insulations and for sheaths (see tables T.C3.718.1 and T.C3.719.1 for applicability of approved of in the test method)

a. Procedure: sampling and test procedure according to clause 9 of IEC 60811-2-1, employing the conditions given in table 4 of IEC 60092-351 for insulation and table II of IEC 60092-359 for sheaths;

b. Requirements: test results shall comply with the requirements given in table 4 of IEC 60092-351.

711. Oil immersion test for elastomeric sheaths

a. Procedure: sampling and testing in accordance with clause 10 of IEC 60811-2-1 employing the conditions given in table II of , IEC 60092-359 ;

712. Flame retardant test to be carried out on pieces of completed cable. The methods of test and requirements shall be those specified in IEC 60332-3 for Category A.

713. Test for fire-proof or fire-resisting cables:

a. This test shall be carried out on pieces of completed cable only when specially required.

b. The method of test and requirements shall be those specified in IEC 60331.

714. Determination of hardness for HEPR and HF HEPR insulations:

a. Procedure: sampling and test procedure according to annex A of IEC 60092-351;

715. Determination of elastic modulus for HEPR and HF HEPR insulation:

a. Procedure: sampling and test procedure according to annex B of IEC 60092-351;

716. Determination of degree or acidity of gases evolved during the combustion of insulating materials by measuring pH and conductivity:

a. Procedure: sampling and test procedure according to annex B of IEC 60754-2;

b. Test results shall comply with requirements given in table 4 of IEC 60091-351.

717. Determination of the amount of halogen acid gas for sheathing materials:

a. Procedure: sampling and test procedure according to IEC 60754-1;

b. Test results shall comply with requirements given in table III of IEC 60092-359.

718. Table T.C3.718.1, shows the requirements for non-electric type tests for insulation in accordance with IEC 60092-350.

TABLE 3 T.C3.716.1 – NON-ELECTRICAL TYPE TESTS FOR INSULATION

0		1	2	3	4	5	6	7	8	9	10
Designation of compounds		Insulation									
		Thermo-plastic	Elastomeric								
		PVC/A	S 95	HFS 95	EPR	HF EPR	HEPR	HF HEPR	XLPE	HF XLPE	HF 85
1	Dimensions										
1a	Measurement of thickness	x	x	x	x	x	x	x	x	x	x
2	Mechanical properties (tensile strength and elongation)										
2a	Before ageing	x	x	x	x	x	x	x	x	x	x
2b	After ageing in air bomb	–	–	–	x	x	x	x	–	–	–
2c	After ageing in air oven	x	x	x	x	x	x	x	x	x	x
2d	After additional ageing in air oven (compatibility)	x	x	x	x	x	x	x	x	x	x
3	Thermoplastic properties										
3a	Hot pressure test (indentation)	x	–	–	–	–	–	–	–	–	–
3b	Behaviour at low temperature	x	–	–	–	–	–	–	–	–	–
4	Miscellaneous										
4a	Loss of mass test in air oven	x	–	–	–	–	–	–	–	–	–
4b	Heat shock test (cracking)	x	–	–	–	–	–	–	–	–	–
4c	Ozone resistance test	–	–	–	x	x	x	x	–	–	x
4d	Hot set test	–	x	x	x	x	x	x	x	x	x
4f	Hardness	–	–	–	–	–	x	x	–	–	–
4g	Elastic modulus	–	–	–	–	–	x	x	–	–	–
4h	pH	–	–	x	–	x	–	x	–	x	x
4j	Conductivity	–	–	x	–	x	–	x	–	x	x
x	Indicates that the type test is to be applied										

TABLE T.C3.717.1– NON-ELECTRICAL TYPE TESTS FOR NON-METALLIC SHEATHS

0		11	12	13	14	15	16
Designation of compounds		Non-metallic sheaths					
		Thermoplastic			Elastomeric		
		ST 1	ST 2	SHF1	SE 1	SH	SHF2
1	Dimensions						
1a	Measurement of thickness	x	x	x	x	x	x
2	Mechanical properties (tensile strength and elongation)						
2a	Before ageing	x	x	x	x	x	x
2b	After ageing in air bomb	–	–	–	–	–	–
2c	After ageing in air oven	x	x	x	x	x	x
2d	After additional ageing in air oven (compatibility)	x	x	x	x	x	x
2e	After immersion in hot oil	–	–	–	x	x	x
3	Thermoplastic properties						
3a	Hot pressure test (indentation)	x	x	x	–	–	–
3b	Behaviour at low temperature	x	x	x	–	–	x
4	Miscellaneous						
4a	Loss of mass test in air oven	–	x		–	–	
4b	Heat shock test (cracking)	x	x	x	–	–	–
4c	Ozone resistance test	–	–	–	x	x	x
4d	Hot set test	–	–	–	x	x	x
4e	Flame retardance test	x	x	x	x	x	x
4f	Hardness	–	–	–	–	–	–
4g	Elastic modulus	–	–	–	–	–	–
4h	Determination of the amount of halogen acid gas	–	–	x	–	–	x
x	Indicates that the type test is to be applied						

CHAPTER D
TESTING AND TYPE TESTING OF ELECTRIC PANELS AND SWITCHBOARDS

100. Application

101 The panels and switchboards to be tested at Works in the presence of a RBNA surveyor are as follows:

a. Main electric switchboard

b. Emergency switchboard

c. Consoles and panels for motors

d. Distribution panels associated to the control of motors

e. Equipment starters (over 100 kW only)

f. Panels associated to the UPS system

g. Panels associated to the transitory power system for batteries for the automation system emergency

102. For other switchboards and for starters under 100 kW the manufacturer's test report will be accepted, but the manufacturer is to issue the reports and forward them to RBNA.

103. Reference standard: IEEE St45 Chapter 8.3.

200. Plan approval

201. Detailed plans of the switchboards and panels are to be submitted to RBNA approval prior to the testes, which can only be carried out when the approved plans are available. The plans are to include:

Plans to be submitted for approval:

a. Wiring diagram;

b. Front panel arrangement;

c. Technical specifications;

d. Connections;

e. List of materials.

Plans and documents for information, to be submitted:

a. Specification of components;

b. Operating instructions;

c. External wiring diagram.

300. Materials

301. The materials to be employed in the switchboards are to be certified. The list below indicates, but is not limited to, the main certificates required:

a. Type Approval of thermal relays, circuit breakers, contactors, switches, fuses and cables

b. Calibration certificate of all measuring, monitoring and controlling instruments

See Part III, Title 63, Section 8

400. Tests for low-voltage switchboards (600 V ac and less for ANSI; 1000 V ac and less for IEC).

401. Inspections: the surveyor should request the certificates, catalogue or specifications of the components to check whether they are according to the following IEEE St45 Chapter 8.3):

a. Switchboards operating at a root-mean-square (RMS) voltage less than 1000 V should meet the requirements of UL 891 or **IEC 60947** for dead-front switchboards or IEEE Std. C37.20.1-1993, UL 1558-1999, or **IEC 60947** for low-voltage, metal-enclosed **power circuit breaker switchgear**.

b. Circuit breakers installed in low-voltage switchboards should meet the following requirements for the class of service intended:

b.1. Power circuit breakers installed in low-voltage switchboards should meet the requirements of IEEE Std C37.13-1990 or IEC 60947-2. When installed in low-voltage, metal-enclosed switchgear in accordance with IEEE Std. C37.20.1-1993 or IEC 60947-2, these breakers shall be draw-out type.

b.2. Power circuit breakers with proper insulation barriers may also be installed in dead-front switchboards per UL 891-1998 or IEC 60947-2. These breakers shall be draw-out type.

b.3. Low-voltage moulded or insulated case circuit breakers installed in switchboards shall meet the requirements of UL 489-1996 including all marine supplements, or shall meet the requirements of IEC 60947-2 including the additional performance requirements as defined in the marine supplements of UL 489-1996. The insulated case circuit breakers shall be draw-out type, and the moulded case breakers shall be mounted on marine dead-front removable (plug-in) connectors (both line and load) to facilitate maintenance and replacement without a complete switchboard outage.

b.4. Properly marked terminal blocks should be provided for all outgoing instrument and control wires, and for wire connections from one shipping section of the switchboard to another.

b.5. Current transformer (CT) secondary windings shall not be fused. The secondary leads of current transformers shall be wired through current transformer shorting terminal blocks prior to connecting

b.6. to components or terminal blocks.

b.7. Internal switchboard wiring for control and instrument circuits should be either Type SIS, wire type equivalent to SIS and meeting the VW-1 flame test requirement, or one conductor wire meeting the requirements of IEC 60502-1 and IEC 60332-1. Minimum sizes shall be as follows: For control circuits 15 AWG (1.5 mm2 for IEC wiring systems; see 1.7), for instrument circuits 18 AWG (1.0mm2), or as allowed by IEEE Std. C37.20-1987 or IEC 60947.

b.8. Connections to hinged panels should be with extra-flexible type wire.

b.9. Where twisted and shielded pairs are required for analogue and digital signals within the switchboard, minimum #18 AWG (1.0 mm2) conductors may be used. Circuit speed and the reduction of noise may require the use of shield over the individual pairs. For other cable types such as ribbon, fibre optic, and computer, used in low-power instrumentation, monitoring, or control circuits, the size of the wire should be based on manufacturer's recommendation.

b.10. All groups of internal wiring should be adequately secured to the switchboard panels or framework in such a manner as to prevent chafing, cutting of the insulation, or excessive motion caused by vibration.

b.11. All power cables should be secured adequately to prevent motion caused by vibration and to

b.12. Withstand the maximum short-circuit current.

402. Tests: As a minimum, the tests below are to be carried out without prejudice of additional tests to be required by RBNA. Equivalent tests according to national / international standards may be accepted in case the test program is and the related standards are submitted to RBNA for approval.

403. High voltage test: by applying the following voltages at commercial frequencies for a period of 60 seconds between all current-carrying parts connected together and earth as well as between all current-carrying parts of opposite polarities and phases. The test voltages are given in the table below:

Nominal voltage	**Test voltage**
< 60V	500 V
≥ 60 V	1000 V + twice the rated voltage (minimum 1500 V)

a. During the high voltage test, measuring instruments, ancillary apparatus and electronic devices may be disconnected and tested separately in accordance with the appropriate requirements.

b. The test voltage at the moment of application is not to exceed half of the prescribed value. It is then to be increased steadily within a few seconds to its full value. The prescribed test voltage is to be maintained for 1 minute.

404. Insulation resistance test: Immediately after such high voltage tests have been performed, the insulation resistance between all current-carrying parts connected, earths and current-carrying parts of opposite polarities and phases is not to be less than 1 M Ω when tested with d.c. voltages of at least 500 V.

a. Interlocking test

b. Phase sequence test

405. Functioning test: For the main and emergency electric switchboard, and depending on the complexity of other switchboards, an electrical functioning test is to be carried out. The test procedure and the number of tests depend on whether or not the switchboard includes complicated interlocks, sequence control facilities, etc. In some cases it may be necessary to conduct or repeat this test following installation on board.

a. Ensaio de subtensão dos quadros elétricos (para os itens 101.(a) e 101.(b) acima) de modo a comprovação do desarme dos circuitos na tensão de aproximadamente 85% do valor nominal

b. Ensaio de sobrecarga para os quadros, painéis e demarradores (item A acima) que disponham deste tipo de proteção

c. Teste operacional em simulação da operação dos quadros elétricos, painéis e demarradores (conforme o item 101 acima) com todos os circuitos de comando e proteção energizados na tensão nominal, de modo a comprovação do funcionamento dos instrumentos de monitoração, ventilação e contato com as partes vivas

d. Exame visual em conformidade com o projeto

500. Nameplates

501. Each switchboard should be fitted with a nameplate stating that it has been constructed for a marine application and should provide the voltage and ampere rating of the main bus, the manufacturer's name, the date of manufacture, and the RBNA stamp .

502. Nameplates of nonabsorbent and corrosion-resistant material should be provided for each piece of apparatus to clearly indicate its service. Stainless steel should be considered for this application.

503. Nameplates for generator, bus-tie, feeder, and branch circuit breakers should include the circuit number and designation, and the rating of the circuit breaker trip elements, or fuse sizes, required for the circuit.

CHAPTER E
TYPE APPROVAL PROCEDURE FOR CABLE TRAYS/PROTECTIVE CASINGS MADE OF PLASTICS MATERIALS
[IACS UR E16]

CHAPTER CONTENTS

E1. GENERAL DESIGN REQUIREMENTS

100. Ambient Temperatures

101. Cable trays/protective casings should be designed to the following ambient temperatures**:**

a. -25 ^{o}C to 90 ^{o}C for outdoor use

b. +5 ^{o}C to 90 ^{o}C for indoor use.

200. Safe Working Load

201. Cable tray/protective casings should be assigned a Safe Working Load.

E2. MECHANICAL REQUIREMENTS

100. Impact Resistance Test

101. The test should be performed according to IEC 60068-2-75 using the pendulum hammer.

a. The test should be carried out on samples of cable tray lengths or cable ladder

b. lengths, of 250 mm ± 5 mm long. Samples of ladder should consist of two side-members with one rung positioned centrally. Samples of mesh trays should be prepared in such a way that there will be a wire in the centre.

c. Before the test, plastics components should be aged at a temperature of 90 ^{o}C ± 2 ^{o}C for 240 h continuously.

d. The samples should be mounted on wooden fibreboard of thickness 20 mm ± 2 mm.

e. The samples to be tested should be placed in a refrigerator, the temperature within which is maintained at the declared temperature according to 1.1 above with a tolerance

f. of ± 2 ^{o}C.

g. After 2 h, the samples should, in turn, be removed from the refrigerator and immediately placed in the test apparatus.

h. At 10 s ±1 s after removal of each sample from the refrigerator the hammer should be allowed to fall with impact energy, the mass of the hammer and the fall height :

i. Note: ***** Consideration will be given to the use of plastics cable trays/protective casings in the cold environment where the ambient temperature is below -25^{o}C provided the mechanical properties of the plastics can be maintained for the intended purpose and the installation location. In this particular instance, the cold bend and cold impact properties of the material should also be considered.

j. The impact should 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 should be applied to the centre of the face being tested.

k. After the test, the samples should show no signs of disintegration and/or deformation that will impair the safety.

200. Safe Working Load (SWL) Test

101 Cable trays/protective casings and joints should be assigned a Safe Working Load (SWL) satisfying the follow-

ing criteria, tested at the declared temperatures according to 1.1 above (see note) :

a. the maximum deflection should not exceed L/100 where L is the distance between the supports,

b. no mechanical defects or failure are observed when tested to 1.7 x SWL.

c. All loads should be uniformly distributed (UDL) over the length and width of the samples as shown in Appendix 1.

d. The loads should 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, should be applied and held for at least 5 min, after which the measurement

e. apparatus should be calibrated to zero.

f. The load should 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 should not exceed about a quarter of the safe working load. The load increments should be distributed through the load plates longitudinally and transversely as evenly as is practical.

g. After loading, the deflection should be measured at the points specified to give a practical mid-span deflection.

h. The samples should be left and the deflections measured every 5 minutes 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.

i. When subject to the test load the samples, their joints and internal fixing devices, should show no damage or crack visible to normal view or corrected vision without magnification. Approximate Mass of hammer Fall height energy J kg mm 10 5.0 200 ± 2

j. The load should then be increased to l.7 times the test load. The samples should 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 should sustain the increased loading without collapsing. Buckling and deformation of the samples is permissible at this loading.

Note: 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, or, 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, or - at maximum and minimum temperature only. Tests should 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.

E3. FIRE PROPERTIES

100. Flame Retardant Test:

101. The cable trays/protective casings should be at least flame retardant. They should be tested in accordance with URE10, test 21.

200. Smoke and Toxicity Test

201. The cable tray/protective casings should be tested in accordance with the IMO Fire Test Procedures Code (FTPC), Resolution MSC.61(67), Part 2 — Smoke and Toxicity Test, or any international or national standard,

E4. SPECIAL REQUIREMENTS

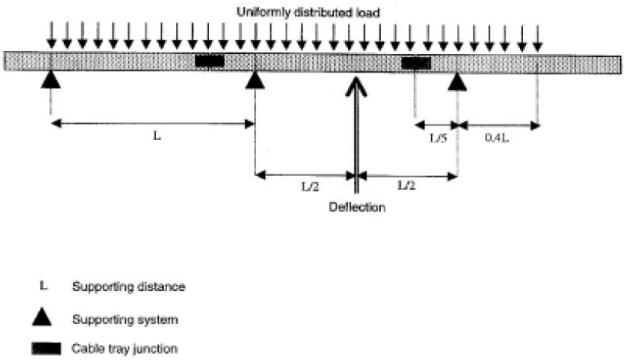
100. Resistivity Test

101. Cable trays/protective casings passing through a hazardous area should be electrically conductive.

102. The volume resistivity level of the cable trays/protective casings and fittings should be below 105 ohm and the surface resistivity should be below 106 ohm. The cable tray/protective casings should be tested in accordance with IEC60093.

103. Note: The resistance to earth from any point in these appliances should not
exceed 106 ohm.

E5. IEC 61 537 LOADING TEST PROCEDURE SUMMARY



Rgmm14en-PIIIT63S7-abcde-00