RUSSIAN MARITIME REGISTER OF SHIPPING

CIRCULAR LETTER **No.315-07-1434c** dated 26.08.2020

Re:

amendments to the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships, 2020, ND No. 2-020101-130-E

Item(s) of supervision:

automation equipment (codes of the RS Nomenclature 15XXXXXX)

Entry-into-force date: **01.10.2020** Valid till: **-** Validity period extended till: **-**

Cancels / amends / adds Circular Letter No. **-** dated **-**

Number of pages: 1+33

Appendices:

Appendix 1: information on amendments introduced by the Circular Letter

Appendix 2: text of amendments to Part IV "Technical Supervision during Manufacture of Products"

Director General Konstantin G. Palnikov

Text of CL:

We hereby inform that based on experience of technical supervision during manufacture of automation equipment, taking into consideration the provisions of standards of the International Electrotechnical Commission (IEC) in testing of electrical and automation equipment, and for harmonization of the requirements of Section 12, Part IV "Technical Supervision during Manufacture of Products" with the updated RS Nomenclature of items of technical supervision, the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships shall be amended as specified in the Appendices to the Circular Letter.

It is necessary to do the following:

1. Familiarize the RS surveyors, interested organizations and persons in the area of the RS Branch Offices' activity with the content of the Circular Letter.
2. Apply provisions of the Circular Letter during the review and approval of technical documentation for products and technical supervision during manufacture of products according to requests received 01.10.2020 or after this date.

List of the amended and/or introduced paras/chapters/sections:

Section 12

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Appendix 1 to Circular Letter
No. 315-07-1434c dated 26.08.2020

Information on amendments introduced by the Circular Letter
(for inclusion in the Revision History to the RS Publication)

Nos.	Amended paras/chapters/sections	Information on amendments	Number and date of the Circular Letter	Entry-into-force date
1	Section 12	The Section has been amended based on experience of technical supervision and considering the provisions of standards of IEC, and for harmonization with the updated RS Nomenclature of items of technical supervision, the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships	315-07-1434c of 26.08.2020	01.10.2020

Appendix 2 to Circular Letter
No. 315-07-1434c dated 26.08.2020

RULES FOR TECHNICAL SUPERVISION DURING CONSTRUCTION OF SHIPS AND MANUFACTURE OF MATERIALS AND PRODUCTS FOR SHIPS, 2020,

ND No. 2-020101-130-E

PART IV. TECHNICAL SUPERVISION DURING MANUFACTURE OF PRODUCTS

Section 12 is replaced by the following text:

"**12 AUTOMATION EQUIPMENT**

12.1 TERMS AND DEFINITIONS

Terms and definitions are given in Section 10 "Electrical equipment".

12.2 GENERAL

12.2.1 The provisions of this Sections apply during technical supervision of automation equipment listed in Section 10 "Automation" of the RS Nomenclature of items of technical supervision.

12.2.2 The Section contains the requirements of technical supervision of manufacture of the abovementioned items of technical supervision at the firm (manufacturer).

The technical instructions and test standards pertain equally to product prototypes, pilot specimens and products at steady production.

12.2.3 General regulations for technical supervision are specified in Part I "General Regulations for Technical Supervision", and for technical documentation – in Part II "Technical Documentation" and in 1.4 of this Part.

12.3 TECHNICAL DOCUMENTATION

12.3.1 The extent of technical documentation for the automation equipment to be submitted to the Register depending on the code of the Nomenclature is specified in Appendix 1.

Note. For the review of documentation, the manufacturer may refer to a checklist the form of which is specified in Appendix 3.

12.3.2 The codes of technical documentation applied in the Section are shown in Table 12.3.2-1.

Table 12.3.2-1

Code	Name	Description
C1	a set of documentation for programmable electronic systems	documentation for programmable electronic systems in compliance with Section 7, Part XV "Automation" of the Rules for the Classification and Construction of Sea-Going Ships
D1	assembly drawing	a document containing an assembly unit and other data necessary for its assembly (manufacture) and control
D2	general arrangement plan	a document specifying the product structure, interaction of its components and describing the product operation principle
D3	functional block diagram	a document specifying the basic functional components of the product, their purpose and interconnections
D4	circuit diagram	a 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	a document specifying the structure of assembly component, complex or set
T2	an explanatory note	a 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	a document containing the product requirements (combination of criteria, standards, rules and provisions), its manufacture, control, acceptance and delivery
T4	test program and test procedure	a 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). Recommendations for the failure mode and effects analysis are specified in Appendix 2
I1	explosion-proof certificate	a 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

Where necessary, RS may require to submit additional technical documentation including the reliability information.

When reviewing the technical documentation, 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 Rules for the Classification and Construction of Sea-Going Ships, including shipboard service conditions.

12.4 SCOPE AND PROCEDURE FOR THE AUTOMATION EQUIPMENT SURVEY

12.4.1 Prior to the tests of the automation equipment, it is necessary to check the availability of:

.1 a set of the RS-approved technical documentation on the equipment to be tested;

.2 documents on related parts confirming supervision by the Register during the manufacture thereof in accordance with the RS Nomenclature;

.3 the RS-approved test program and procedure;

.4 documents (certificates, test reports, etc.) of competent authorities confirming positive results of special test types if they are stipulated in the test program;

.5 testing equipment, as required by test program and procedure, with necessary documents confirming the characteristics thereof, Recognition Certificate or Report for Testing Laboratory;

.6 measuring instruments having a relative measuring accuracy not exceeding 1,5 %;

.7 documents of the competent bodies confirming compliance of measuring instruments with declared accuracy.

12.4.2 During survey, the surveyor shall make sure that tests are carried out in accordance with the Register approved program following the test procedures set forth in the Section or other equivalent procedures.

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

12.4.4 Tests of the prototypes of the automation systems (control, regulation, alarm and protection) shall be carried out at the firm (manufacturer) complete with the sensors and actuators or using the appropriate simulators. During the tests, the pneumatic components of the automation shall be mounted and interconnected as this will be provided in the automation units.

12.4.5 The remotely controlled fittings shall be generally tested complete with the extreme position signalling devices (especially during vibration-resistance and shock-resistance tests).

12.4.6 Regulators, sensors and signalling devices shall be generally tested on beds with real working media. Where it is not possible to conduct tests on beds with real working media, tests using the simulators are permitted.

12.4.7 Pneumatic and hydraulic pipelines of the automation systems shall be subjected to hydraulic tests to pressures according to Section 8. Tests of hydraulic and pneumatic components and devices for fail-safety at overloads shall be carried out in consistency with the Register approved technical documentation for the appropriate components and devices.

12.4.8 For the automation systems some tests other than the functional tests conducted previously on the components and devices being part of this systems or the tests of the systems itself conducted previously may be taken into account, provided that those tests have been conducted according to the standards not lower than the Register standards. Test results shall be confirmed by reports. Therewith, the manufacturer shall confirm the stability of structure, software and earlier declared technical parameters of material or product or changes in the structure do not result in changes of working process, load to the product components, service life or other essential parameters of the product.

12.4.9 Upon completion of the mechanical and environmental tests, any types of special tests and checks following which mechanical damages of individual components are likely to occur as well as when the normal operation during any tests is disturbed, the equipment shall be subjected to detailed examination and the possibility of further tests shall be determined.

12.4.10 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.

12.4.11 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 these tests shall be agreed with the Register.

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

Note. To arrange the test process, the manufacturer may refer to a checklist the Form of which is specified in Appendix 4.

12.4.13 Programmable electronic system testing shall be in compliance with Section 7, Part XV "Automation" of the Rules for the Classification and Construction of Sea-Going Ships.

12.4.14 When the test results are satisfactory, the certificate of the appropriate form shall be issued in accordance with Part I "General Regulations for Technical Supervision".

12.4.15 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".

12.4.16 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.

12.4.17 In case of changes to the design of automation equipment resulting in the changes working process, load to the product components, service life or other essential parameters of the product, or changes in software and 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.

12.5 INSTRUCTIONS ON TESTS AND CHECKS PERFORMANCE

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

12.5.2 Irrespective of the sequence specified 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 fungus resistance.

12.6 DESCRIPTION OF TESTS AND CHECKS

The complete list of tests and checks is given in Table 12.6-1.

Table 12.6-1

Code	Test
12.4.13	Programmable electronic system testing
12.6.1	Visual inspection
12.6.2	Insulation resistance measurement
12.6.3	Insulation resistance test
12.6.4	Functional tests
12.6.5	Vibration tests
12.6.6	Shock tests
12.6.7	Tests for resistance to motions and prolonged inclinations
12.6.8	Tests for heat stability
12.6.9	Tests for cold endurance
12.6.10	Damp heat tests
12.6.11	Tests for exposure to salt mist (corrosion resistance)
12.6.12	Protective enclosure testing
12.6.13	Test for rated power supply deviation
12.6.14	Test for tolerable levels of radiated electromagnetic emission
12.6.15	Test for resistance to external electromagnetic interference.
12.6.15.1	Tests for level of radiated emissions field strength
12.6.15.2	Tests for resistance to conductive radio frequency interference
12.6.15.3	Test for resistance to nanosecond pulse interference due to fast transient processes in the circuits of the a.c. supply sources, signal and control circuits
12.6.15.4	Tests for resistance to microsecond pulse interference
12.6.15.5	Tests for electrostatic discharge resistance
12.6.15.6	Tests for resistance to electromagnetic field
12.6.16	Test for tolerable levels of radiated conductive interference
12.6.17	Flame retardant tests
12.6.18	Fungus resistance tests

12.6.1 Visual inspection.

The inspection shall be carried out to determine:

compliance of products with the approved technical documentation;

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

the readiness of the product to be tested;

the repairability of the automation systems and devices; the following shall be checked using the prototype or pilot specimen the possibility of replacement of the components (shall not be accompanied by complicated adjustments and fine adjustments) of the automation equipment.

When checking the repairability, the availability of numbers, marking, tags and other indices designating the appropriate spare parts as well as their position in the automation system and in the diagrams shall be considered.

During the visual inspection (including openings-up and single disassemblies if needed), the following shall be checked:

assembly parts and materials used in the product;

quality of the product mounting;

structural design of the product;

strength of connecting and fastening units, welded, screwed and other structural and contact joints;

availability of anticorrosion coatings in the points subject to corrosion;

availability of necessary markings and inscriptions;

contact and protective terminations of cables and wires, connections of hydraulic and pneumatic pipelines;

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

12.6.2 Insulation resistance measurement.

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

before and after electrical insulation strength tests;

before and after dry heat test;

before and after cold endurance test;

before and after damp heat test;

before and after the test for exposure to salt mist.

Insulation resistance shall be measured:

among 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.);

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

among 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.

Insulation resistance shall not be lower the values given in Table 12.6.2-1.

Table 12.6.2-1

Rated supply voltage, V	Test Voltage (D.C. voltage), V	Minimum permissible insulation resistance, MOhm	
		before test	after test
$U_n \leq 65$	$2xU_n$, min. 24V	10	1,0
$U_n > 65$	500	100	10

12.6.3 Insulation resistance tests.

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

The test voltage shall be alternately applied between current-carrying parts of inconnected electrical circuits, as well as between current-carrying parts and the case of the product.

The semiconductor components of automation equipment that may be damaged under tests, may be disconnected during tests. During shutoff of the specified components the test voltage value shall be defined by the manufacturer with due regard to specifications of such components.

The electric insulation of the automation equipment shall stand up without any flashover, within 1 min, under normal environmental conditions, to the alternating sine voltage with a frequency of 50 or 60 Hz and with a value given below in Table 12.6.3:

Table 12.6.3

Nominal supply voltage, V	Test voltage (50 or 60 Hz), V
$U_n \leq 65$	$2xU_n + 500$
66 — 250	1500
251 — 500	2000
501 — 690	2500

12.6.4 Functional tests.

Each sample at the firm (manufacturer) shall be subjected to functional tests. The tests shall be carried out under standard environmental conditions. Automation equipment shall be checked for functioning and proper performance under conditions specified by the technical documentation.

The following shall be checked during functional tests:

all characteristics for compliance with the requirements of the technical documentation (accuracy, speed of response or sluggishness, responsivity, dynamic and static output characteristics, etc.) and automation algorithms, that is the whole scope, procedure and sequence of the control, regulation, monitoring and protection functions fulfilled by the system or device;

automatic 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.;

protection against unauthorized alteration of threshold limit values of alarm and protection actuation;

effect of faults in particular system components, including short-circuits and breaks in the circuits of sensors, communication channels and actuators, on the operability of the particular channels and the system in general. In case of simulation of faults of the equipment, short-circuits and breaks in the particular circuits and communication channels, the operability of the adjacent circuits, particular channels and the system in general shall be maintained.

12.6.5 Vibration tests.

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

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 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. Shock-mounted products shall be hard-mounted in tests for detecting resonance frequencies.

Categories of equipment according to vibration resistance depending on the operating conditions are given in Table 12.6.5.

Table 12.6.5

Category of equipment	Description
V1	Equipment operated under normal service conditions.
V2	The 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	The 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 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.

12.6.6 Shock tests.

The tests shall be 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 shall be checked 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 12.6.6-1.

Table 12.6.6-1

Category of equipment	Description
G0	The equipment intended for installation on berth-connected ships and fixed offshore platforms.
G3	The equipment not related to the category G0 intended for installation on floating offshore oil-and-gas production units, ships of no ice class or ships of **Ice1**, **Ice2**, **Ice3** ice classes.
G5	The equipment intended for installation on ships of ice classes **Arc4** — **Arc9**, **Icebreaker6** — **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 12.6.6-2.

Table 12.6.6-2

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

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

12.6.7 Tests for resistance to motions and prolonged inclinations.

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 motions and prolonged inclinations 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 program.

The tests for resistance to static and dynamic inclination are normally not required for equipment without moving parts.

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

Automation equipment shall stand the tests using the following procedure:

.1 installation of the equipment on bed, switching-on and measurement of parameters. Holding of the equipment under motions conditions when installed sequentially in two mutually perpendicular positions and measurements of parameters in each position, and whilst so doing:

limiting inclination angle: 22,5°;

motions period: 10 s;

test duration: at least 15 min in each position;

.2 conditioning of equipment sequentially in two mutually perpendicular positions at an angle of 22,5° to the horizontal and measurement of parameters during any period sufficient for measurement of parameters but at least 3 min in each position;

.3 removal of equipment from bed, measurement of parameters, switching-out and examination.

Note. On ships for the carriage of liquefied gases and chemicals, the emergency power supply is to remain operational with the ship flooded up to a maximum final athwart ship inclination of 30°.

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

12.6.8 Tests for heat stability.

The tests shall be carried out in compliance with standard IEC 60068-2-2 (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 12.6.8.

Table 12.6.8

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	The 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.

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

12.6.9 Tests for cold endurance.

The tests shall be carried out in compliance with standard IEC 60068-2-1 (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 12.6.9.

Table 12.6.9

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 the following conditions:
temperature: 10°C below design ambient temperature (**DAT**), or at – 40 ± 3°C, whichever is lower;
test duration: 2 h.
The equipment shall be in inoperative condition operating during the complete testing period, expect for the functional test shall be carried out during the last hour at the test temperature.
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 in the process of effect it retains its parameters within the prescribed limits and remains undamaged.

12.6.10 Damp heat tests

The tests shall be carried out in compliance with standard IEC 60068-2-30 (test D_b).
Before and after the tests the insulation resistance measurement of equipment shall be carried out under standard environmental conditions.
The test shall start with +25 °C ± 3 °C and at least 95 % humidity.
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 4 (IPX4) 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.
The equipment shall be considered to have passed the tests, if in the process of effect it retains its parameters within the prescribed limits and remains undamaged.

12.6.11 Tests for exposure to salt mist (corrosion resistance)

The tests shall be carried out in compliance with standard IEC 60068-2-52, test K_b.
Categories of equipment according to corrosion resistance depending on the operating condition are given in Table 12.6.11.

Table 12.6.11

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 operating during conditioning.

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.

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

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.

12.6.12 Tests of enclosure protection.

Tests of enclosure protection against solid foreign matter and water intrusion shall be carried in compliance with standard IEC 60529.

Method of testing shall be selected taking into consideration the characteristics and operating conditions of the equipment. Substantiation of the testing method shall be specified in the test procedure.

It is allowed to perform tests of the enclosure with the installed and mounted components (cable entries, indicators, control components, ventilation components, etc.) on the external surfaces of the enclosure without the equipment located inside thereof. During the tests of the enclosure without the equipment inside thereof, the documentation for the product shall contain the information on the arrangement of dangerous parts inside the equipment enclosure or the objects that may be damaged in case of penetration inward of foreign hard objects or ingress of water.

The enclosure shall comply with the protection degree that is designated by the first characteristic numeral, provided that it also complies with all lower degrees of protection designated by the first characteristic numeral. Therewith, no tests are required verifying the compliance with any lower protection degree, provided that these tests will be definitely carried out, where necessary.

The enclosure having the protection degree designated by the second characteristic numeral up to and including IPX6, also complies with all lower degrees of protection designated by the second characteristic numeral. Therewith, no tests are required verifying the compliance with any lower protection degree, provided that these tests will be definitely carried out, where necessary.

The enclosure having the protection degree designated by the second characteristic numeral IPX9 shall be considered as not applicable at the exposure to water jets (IPX5 or IPX6) and at water immersion (IPX7 or IPX8) and need not comply with the protection degrees IPX5, IPX6, IPX7 and IPX8. When the enclosure complies with several protection degrees indicated by the second characteristic numeral, the symbol shall apply as specified in Table 12.6.12.

Table 12.6.12

Enclosure passes test for:		Designation and marking	Range of application[1]
Water jets second characteristic numeral	Temporary/continuous immersion second characteristic numeral		
5	7	IPX5/IPX7	versatile
5	8	IPX5/IPX8	versatile
6	7	IPX6/IPX7	versatile
6	8	IPX6/IPX8	versatile
9	7	IPX7/IPX9	versatile
9	8	IPX8/IPX9	versatile
5 and 9	7	IPX5/IPX7/IPX9	versatile
5 and 9	8	IPX5/IPX8/IPX9	versatile
6 and 9	7	IPX6/IPX7/IPX9	versatile
6 and 9	8	IPX6/IPX8/IPX9	versatile
-	7	IPX7	restricted
-	8	IPX8	restricted
9	-	IPX9	restricted
5 and 9	-	IPX5/IPX9	versatile
6 and 9	-	IPX6/IPX9	versatile
[1]Enclosures for "versatile" application indicated in the last column shall meet requirements for exposure to both water jets and temporary or continuous immersion; enclosures for "restricted" application are considered suitable only for the conditions to which they were tested.			

12.6.13 Tests for of 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 12.6.13-1.

Table 12.6.13-1

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 12.6.13-2.

Table 12.6.13-2

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 12.6.13- 3.

Table 12.6.13-3

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 %.

Thrice-repeated interruption of the power supply for 30 s within 5 min shall not affect the proper performance of the automation equipment. The time of 5 min may be exceeded if the equipment under test needs a longer time for start up, e.g. booting sequence, the total time of tests for power supply interruption may exceed 5 min.

For equipment which requires booting, one additional power supply interruption during booting shall be performed.

During the tests, the equipment behavior shall be checked at supply failure and resumption, as well as possible fault of software or data stored in the memory of programmable electronic systems, where applicable.

The pneumatic and hydraulic components and devices shall be tested at fluctuations of the working medium ±20 % from the rated value during 15 min.

12.6.14 Tests for the level of radiated electromagnetic emission

The tests shall be carried out in accordance with standards CISPR 16-2-3 and IEC 60945 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 12.6.14.

Table 12.6.14

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 dBmV/m;

0,3 — 30 MHz- 52 — 34 dBmV/m;

30 — 1000 MHz - 54 dBmV/m;

1000 — 6000 MHz - 54 dBmV/m;

except for the range 156 — 165 MHz where 24 dBmV/m shall be established.

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 dBmV/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 dBmV/m;

30 MHz — 100 MHz - 60 — 54 dBmV/m;

100 — 2000 MHz - 54 dBmV/m;

1000 — 6000 MHz - 54 dBmV/m;

except for the range from 156 to165 MHz where 24 dBmV/m shall be established.

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.

The wireless equipment (wi-fi router, etc.) may be exempted from limit, within its communication frequency range.

12.6.15 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).

12.6.15.1 Tests for resistance to conducted radio 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 harmonic components. 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;

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.

12.6.15.2 Tests for resistance to conducted radio frequency interference.

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

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 12.6.14), 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 12.6.14), 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.

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

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

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.

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

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

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;

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

Short circuit current:

pulse rise time: 8 μs (front time);

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

repetition rate: ≥ 1 pulse/min;

No. of pulses: 5 per polarity.

12.6.15.5 Tests for electrostatic discharge resistance.

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

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 per 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.

12.6.15.6 Tests for resistance to electromagnetic field.

The tests shall be carried out in compliance with standard IEC 61000-4-3.

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.

If an equipment is intended to receive radio signals for the purpose of radio communication (e.g. wi-fi router, remote radio controller), then the immunity limits at its communication frequency do not apply.

12.6.16 Test for tolerable levels of radiated and conducted interference.

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

For the equipment of category E1 (refer to Table 12.6.14), 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 dBmV/m;

150 — 350kHz - 60 — 50 dBmV/m;

350 kHz — 30 MHz - 50 dBmV/m;

For the equipment of category E2 (refer to Table 12.6.14), 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 dBmV/m;

150 — 500 kHz - 79 dBmV/m;

500 kHz — 30 MHz - 73 dBmV/m.

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 and not exceed 0,8 m in length. 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.

12.6.17 Flame retardant tests.

The tests shall be carried out in compliance with standards IEC 60695-11-5.

The part of the product enclosure shall be tested that most likely is liable to flame during the normal operation or at fault.

The tests shall be carried out under the following conditions:

flame applications: 5 times 15 s each;

interval between each application: 15 s or 1 time 30 s at once.

The test is performed with the equipment or housing of the equipment shall be tested.

Criteria of assessment of the test results:

the burnt-out or damaged part of the specimen by 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 needle flame without full combustion of the test specimen;

any dripping material shall extinguish itself in such a way as not to ignite a wrapping tissue. The drip height is 200 mm ± 5 mm.

For the one-off products or single shipment of products, for which no CTO is required, it is allowed not to perform flame retardant tests, and the manufacturer shall confirm (submit the appropriate certificates for materials of the product or the manufacturer written statement of compliance) compliance of the product with the requirements for flame retardant.

12.6.18 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.

APPENDIX 1

EXTENT OF TECHNICAL DOCUMENTATION TO BE SUBMITTED TO RS AND THE SCOPE OF TESTS TO BE CONDUCTED

Code of item of technical supervision	Item of technical supervision	Prototype 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
15000000	AUTOMATION				
15010000	Integrated control system of technical means Integrated Marine Automation Systems	C1, T1—T4, T5[4], D3, I1[5]	12.4.13, 12.6.1, 12.6.2[3],12.6.3[3], 12.6.4, 12.6.5[3], 12.6.6[3,6], (12.6.7—12.6.16)[3]	C1, T1—T4, T5[4], D3, I1[5]	12.4.13, 12.6.1-12.6.4
15020000	Centralized alarm and monitoring systems including computer-based systems	C1[7], T1—T4, D3, I1[5]	12.4.13[7], 12.6.1, 12.6.2[3],12.6.3[3], 12.6.4, 12.6.5[3], 12.6.6[3,6], (12.6.7—12.6.16)[3]	C1[7], T1—T4, D3, I1[5]	12.4.13[7], 12.6.1-12.6.4
15030000	Remote control systems:				
15030100	Remote control systems of main internal combustion engines/ICE	C1[7], T1—T4, D3, I1[5]	12.4.13[7], 12.6.1, 12.6.2[3],12.6.3[3], 12.6.4, 12.6.5[3], 12.6.6[3,6], (12.6.7—12.6.16)[3]	C1[7], T1—T4, D3, I1[5]	12.4.13[7], 12.6.1-12.6.4
15030200	Remote control systems of main machinery with CPP	ditto	ditto	ditto	ditto
15030300	Remote control systems of main steam turbine installations	ditto	ditto	ditto	ditto
15030400	Remote control systems of azimuth propulsion thrusters	ditto	ditto	ditto	ditto
15030500	Control systems of ship and MODU dynamic positioning systems	C1[7], T1—T4, T5[4], D3, I1[5]	12.4.13[7], 12.6.1, 12.6.2[3],12.6.3[3], 12.6.4, 12.6.5[3], 12.6.6[3,6], (12.6.7—12.6.16)[3]	-	-
15030510	computer systems, their software and interfaces intended for automated control of propulsion machinery with the use of one control (joystick) or several controls	ditto	ditto	C1[7], T1—T4, T5[4], D3, I1[5]	12.4.13[7], 12.6.1—12.6.4

Code of item of technical supervision	Item of technical supervision	Prototype 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
15030520	operator panel system with controls and data display units	C1[7], T1—T4, D2, D3, I1[5]	12.4.13[7], 12.6.1, 12.6.2[3],12.6.3[3], 12.6.4, 12.6.5[3], 12.6.6[3,6], (12.6.7—12.6.16)[3]	C1[7], T1—T4, D2, D3, I1[5]	12.4.13[7], 12.6.1—12.6.4
15030530	position reference systems	C1[7], T1—T4, D3, I1[5]	12.4.13[7], 12.6.1, 12.6.2[3],12.6.3[3], 12.6.4, 12.6.5[3], 12.6.6[3,6], (12.6.7—12.6.16)[3]	-	-
15030600	remote automated control systems of electrical propulsion plants with podded azimuth thrusters	C1[7], T1—T5, D3, I1[5]	12.4.13[7], 12.6.1, 12.6.2[3],12.6.3[3], 12.6.4, 12.6.5[3], 12.6.6[3,6], (12.6.7—12.6.16)[3]	C1[7], T1—T5, D3, I1[5]	12.4.13[7], 12.6.1—12.6.4
15030700	automated control systems of self-elevating MODU	C1[7], T1—T4, D3, I1[5]	12.4.13[7], 12.6.1, 12.6.2[3],12.6.3[3], 12.6.4, 12.6.5[3], 12.6.6[3,6], (12.6.7—12.6.16)[3]	C1[7], T1—T4, D3, I1[5]	12.4.13[7], 12.6.1—12.6.4
15030800	remote automated control system of ballast systems of column-stabilized MODU	ditto	ditto	ditto	ditto
15030900	remote automated control systems of azimuth and tunnel thrusters	T1-T4, D3, I1[5]	12.6.1, 12.6.2[3],12.6.3[3], 12.6.4, 12.6.5[3], 12.6.6[3,6], (12.6.7—12.6.16)[3]	T1—T4, D3, I1[5]	12.6.1—12.6.4
15031000	remote control and automated hull stabilization systems of high-speed craft	C1[7], T1-T4, D3, I1[5]	12.4.13[7], 12.6.1, 12.6.2[3],12.6.3[3], 12.6.4, 12.6.5[3], 12.6.6[3,6], (12.6.7-12.6.16)[3]	C1[7], T1-T4, D3, I1[5]	12.4.13[7], 12.6.1—12.6.4
15040000	Control systems of electric power plants:				
15040100	remote automated starting and stopping systems of diesel generator sets	C1[7], T1-T4, D3, I1[5]	12.4.13[7], 12.6.1, 12.6.2[3],12.6.3[3], 12.6.4, 12.6.5[3], 12.6.6[3,6], (12.6.7—12.6.16)[3]	C1[7], T1-T4, D3, I1[5]	12.4.13[7], 12.6.1—12.6.4
15040200	remote automated starting and stopping systems of turbo generator sets	ditto	ditto	ditto	ditto

Code of item of technical supervision	Item of technical supervision	Prototype 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
15040300	remote automatedstarting and stopping systems of shaft generator sets (where coupling control system is provided)	ditto	ditto	ditto	ditto
15040400	remote automated control systems of ship electric power plants	ditto	ditto	ditto	ditto
15050000	Control systems of boiler installations:				
15050100	automated control systems of main boiler installations	C1[7], T1—T4, D3, I1[5]	12.4.13[7], 12.6.1, 12.6.2[3],12.6.3[3], 12.6.4, 12.6.5[3], 12.6.6[3,6], (12.6.7—12.6.16)[3]	C1[7], T1—T4, D3, I1[5]	12.4.13[7], 12.6.1— 12.6.4
15050200	remote automated control systems of auxiliary boiler installations auxiliary boiler installations	T1—T4, D3, I1[5]	12.6.1, 12.6.2[3],12.6.3[3], 12.6.4, 12.6.5[3], 12.6.6[3,6], (12.6.7—12.6.16)[3]	T1—T4, D3, I1[5]	12.6.1—12.6.4
15050300	remote automated control systems of of exhaust gas boiler installations	ditto	ditto	ditto	ditto
15050400	remote automated control systems of hot water boiler installations	ditto	ditto	ditto	ditto
15060000	Control systems of auxiliary machinery:				
15060100	remote automated control systems of compressors	T1—T4, D3, I1[5]	12.6.1, 12.6.2[3],12.6.3[3], 12.6.4, 12.6.5[3], 12.6.6[3,6], (12.6.7—12.6.16)[3]	T1—T4, D3, I1[5]	12.6.1—12.6.4
15060200	remote automated control systems of separators	ditto	ditto	ditto	ditto
15060300	remote automated control systems of filters	ditto	ditto	ditto	ditto
15060400	remote automated control systems of pumps (oil, fuel, cooling, etc.)	ditto	ditto	ditto	ditto

Code of item of technical supervision	Item of technical supervision	Prototype 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
15060500	remote automated control systems of fuel preparation (temperature, viscosity)	C1[7], T1—T4, D3, I1[5]	12.4.13[7], 12.6.1, 12.6.2[3],12.6.3[3], 12.6.4, 12.6.5[3], 12.6.6[3,6], (12.6.7—12.6.16)[3]	C1[7], T1—T4, D3, I1[5]	12.4.13[7], 12.6.1—12.6.4
15070000	Remote control of ships systems and remote level gauges:				
15070100	remote control systems of ballast and bilge system (together with remote controlled valves)	C1[7], T1—T4, D3, I1[5]	12.4.13[7], 12.6.1, 12.6.2[3],12.6.3[3], 12.6.4, 12.6.5[3], 12.6.6[3,6], (12.6.7—12.6.16)[3]	C1[7], T1-T4, D3, I1[5]	12.4.13[7], 12.6.1—12.6.4
15070200	remote control systems of heel and trim systems	ditto	ditto	ditto	ditto
15070300	remote control systems of cargo piping systems of oil tankers	ditto	ditto	ditto	ditto
15070400	remote control systems of cargo piping systems of liquid gas carriers	ditto	ditto	ditto	ditto
15070500	remote control systems of ships carrying dangerous chemicals in bulk	ditto	ditto	ditto	ditto
15080000	Automation systems of deck machinery	T1—T4, D3, I1[5]	12.6.1, 12.6.2[3],12.6.3[3], 12.6.4, 12.6.5[3], 12.6.6[3,6], (12.6.7—12.6.16)[3]	T1—T4, D3, I1[5]	12.6.1—12.6.4
15090000	Devices:				
15090100	automation devices as part of control systems listed in codes 15010000 to 15080000	T1—T4, D2, D3, I1[5]	12.6.1 — 12.6.5, 12.6.6[6], 12.6.7—12.6.17	-	-
15090500	oil mist detectors in crankcases of internal combustion engines (as well as internal combustion engines bearing temperature monitors or equivalent devices for the prevention of explosion in the crankcase) explosion in the crankcase)	ditto	ditto	T1—T4, D2, D3, I1[5]	12.6.1—12.6.4

Code of item of technical supervision	Item of technical supervision	Prototype 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
15090600	ships computers and programmable logic controllers (PLC) electronic devices	ditto	ditto	-	-
15090700	electronic devices of operation of internal combustion engines	T1—T4, D2, D3, I1[5]	12.6.1 — 12.6.5, 12.6.6[6], 12.6.7—12.6.17	-	-
15100000	Indirect action controllers of:				
15100101	level	T1—T4, D2, D3, I1[5]	12.6.1 — 12.6.5, 12.6.6[4], 12.6.7—12.6.17	-	-
15100102	pressure	ditto	ditto	-	-
15100103	temperature	ditto	ditto	-	-
15100104	viscosity	ditto	ditto	-	-
15100105	speed	ditto	ditto	-	-
15110000	Sensors and indicators of:				
15110101	level	T1—T4, D2, D3, I1[5]	12.6.1 — 12.6.5, 12.6.6[6], 12.6.7—12.6.17	-	-
15110102	pressure	ditto	ditto	-	-
15110103	temperature	ditto	ditto	-	-
15110104	flow	ditto	ditto	-	-
15110105	salinity	ditto	ditto	-	-
15110106	vibration	ditto	ditto	-	-
15110107	position	ditto	ditto	-	-
15110108	sensors of position ship and external force sensors	ditto	ditto	-	-
15110110	gas concentration	ditto	ditto	-	-

Code of item of technical supervision	Item of technical supervision	Prototype 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
15119999	other	-	-	-	-
15120000	Panels, switchboards and other enclosures for automation systems	-	-	-	-
15130000	Remote-reading measuring devices, instruments	-	-	-	-
15130100	Equipment diagnostic facilities	-	-	-	-

[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, except for 12.6.1—12.6.4;

[3] tests shall be carried out for each component of the system;

[4] for the integrated systems of gas carriers and dynamic positioning systems of classes 2 and 3;

[5] for the equipment to be installed in the explosive area;

[6] shall be carried out for the equipment taking into consideration the operating conditions in accordance with Table 12.6.6-1;

[7] when programmable logic controllers are used in the system.

"-" means "not applicable".

RECOMMENDATIONS FOR THE FAILURE MODE AND EFFECTS ANALYSIS (FMEA) PROCESS

1 GENERAL

1.1. Introduction

For conducting of the failure mode and effects analysis (FMEA) of dynamic positioning control systems, internal combustion engine (ICE) control systems and may also be applied to other programmable electronic systems.

1.2. Objectives

The primary objective of an FMEA is to provide a comprehensive, systematic and documented analysis, which establishes the important failure conditions and assesses their significance with regard to acceptable safety and performance criteria. One of the objectives of an FMEA is to demonstrate that single failure in the control system will not result in the working parameters out-of-limits established by the performance criteria of operation related to the consideration of only one component failure mode at a time, i.e. no combination of failure modes; however, it considers the possibility of common-cause failures. The single fault means the only one component failure mode at a time, i.e. no combination of failure modes. However, it considers the possibility of common-cause failures.

General acceptable performance and safety criteria for the engine, as well as criteria specific to the particular application (refer to 2.1.1 for ICE), shall be stated in the FMEA report and all identified failure modes evaluated against these criteria. This Appendix contains the recommendations for the FMEA process and the technical documentation to be submitted. The FMEA process and procedure is comprehensively documented in the appropriate normative documents (standards), such as the International Code of Safety for High-Speed Craft / HSC-Code, Annex 3 and Annex 4 and International Marine Contractors Association/ IMCA M 166.

1.3. System FMEA

The control system FMEA shall be performed as a system FMEA.

A system FMEA is carried out in a top-down manner, i.e. it starts from the overall system level and progresses to the next level down, or subsystem level, and further down to the equipment item or component level. If it can be justifiably shown that at a certain level there is no further effect on the overall system if a failure occurs, then it is not necessary to continue to the next level down. In this case, it would not be necessary to continue to analyze all of the system levels down to component level.

The FMEA for diesel engine control systems shall be based on a single-failure concept under which a subsystem or equipment item at various levels of the system's functional hierarchy is assumed to fail by one probable cause (initiating event) at a time. The effects of the postulated failure are analyzed and classified according to their severity. Any failure mode which may cause an effect on the system beyond previously agreed acceptance criteria shall be mitigated by measures such as system or equipment redundancy. An exception is a "hidden failure" in which a second failure must occur in order to expose the "hidden failure". A "hidden failure" is a special case because the failure effects are not apparent under normal circumstances (for example, it may be a failure of protective relay with normally open contacts).

A test program of selected items shall be drawn up to verify the assumptions and confirm the conclusions made in the FMEA.

1.4. Definitions and explanations

In the Appendix, the definitions given in Table 1.4 apply.

Table 1.4

Term	Definition
CCF, Common Cause Failure.	Failures of different items, resulting from a single event, where these failures are not consequences of each other.
Automation component, component	The definition of the automation component is given in 1.2, Part XV "Automation" of the Rules for the Classification and Construction of Sea-Going Ships. In the context of control systems e.g. a sensor, a relay, a logic component, etc.
Automation device, the device	The definition of the automation device is given in 1.2, Part XV "Automation" of the Rules for the Classification and Construction of Sea-Going Ships.
Design intent	A detailed explanation of the ideas, concepts, and criteria that are defined by the designer to be important. Typically included: system requirements; design conditions; system limitations.
Essential services	Equipment and systems necessary for the design intent and safe operation of the control item (e.g. for ICE – fuel oil, lubrication, cooling water supply, etc.)
Failure	Termination of the ability of an item or component to perform a required function under stated conditions.
Failure effect	Immediate consequences of a failure on operation, function or functionality, operability status of some item or component.
Failure mode	The specific manner or way by which a failure occurs in terms of failure of the item (being a part or system (subsystem) function under investigation. the failure occurs or the observed effect. It may generally describe the way the failure occurs or the observed effect.
FMEA	Failure mode and effects analysis. A systematic technique for failure analysis of the systems to whatever level of detail is required to identify the potential failure modes, their causes and effects on the performance of a system.
FMECA	Failure Mode, Effects and Criticality Analysis. An extension to the FMEA to include a means of ranking the severity of the failure modes to allow prioritization of countermeasures. This is done by combining the severity measure and frequency of occurrence to produce a metric called criticality
Function	A function is what the system or equipment item is designed to do. Each function shall be documented as a function description, an object on which the function acts, and FMEA standard(s). Failure Mode, Effects and Criticality Analysis. An extension to the FMEA to include a means of ranking the severity of the failure modes to allow prioritization of countermeasures. This is done by combining the severity measure and frequency of occurrence to produce a metric called criticality.
Interface	A point at which independent systems, devices or components interact or communicate.
Redundancy	Reliability is the ability of an item to perform a required function for a stated period of time under stated conditions.
Reliability	Reliability is the ability of an item to perform a required function for a stated period of time under stated conditions.
Safety	The absence of unacceptable direct or indirect risks of injury or damage to persons' health as a result of direct or indirect damage of property or environment.
Severity	The magnitude of the consequence as a result of a failure mode occurring. Severity considers the worst potential consequence of a failure mode.
System	Set of interrelated or interacting elements. In the FMEA context, a system shall have defined purposes expressed in: terms of the particular purpose in the form of functions performed by it; stated conditions of operation use; a defined boundary. The structure of a system is hierarchical.
System boundary	The system boundary forms the physical and functional interface between the system and its environment, including other systems with which the analyzed system interacts. The definition of the system boundary for the analysis shall correspond to the boundary as defined for design and maintenance. This shall apply to a system at any level. Systems, devices and components outside the boundaries shall explicitly be defined for exclusion.

2. FMEA PROCESS

The FMEA process can be divided into several steps as shown in Fig. 2. These steps are further described in the following paragraphs, as referenced in Fig. 2. The FMEA report shall describe all necessary information used as input for the FMEA process as well as the assumptions and results. The FMEA report is described in Section 3.

		Refer to para
1.	Define and describe the application of system and control item	2.1
▼		
2.	Establish performance acceptance criteria	2.2
▼		
3.	Identify all potential failure modes and their causes	2.3
▼		
4.	Evaluate the effects for each failure mode	2.4
▼		
5.	Identify the failure detection methods	2.5
▼		
6.	Assess the severity and frequency of occurrence	2.6
▼		
7.	Evaluate the established risk index	2.7
▼		
8.	Identify corrective measures for failure modes	2.8
▼		
9.	Document the analysis	2.9
▼		
10.	Describe input to test program	2.10

N o t e . The process may require iterations not represented in this scheme.

Fig. 2. Control system FMEA process

2.1 Define and describe the application of system and control item

As a basis for the FMEA, the system to be analyzed shall be described through narrative text, use of drawings and reference to equipment manuals. The narrative description of the system, its operational modes, boundaries and functional requirements shall address the following:

2.1.1 Description of application of the control item. For example, the following variants are possible for ICE:

single main engine propulsion (and limitations of application, e.g. controllable pitch propeller only);

main engine multiple engines (diesel-electric and diesel-mechanic);

engine of main input power; emergency engine; engine for auxiliary or deck machinery.

2.1.2 Functional description of system operation, structure and boundaries.

Description of system boundaries (physical, e.g. diesel engine and control system elements considered in the analysis as well as operational boundaries, e.g. performance parameters):

I/O signal specification, sensors and actuators; interface signal specification;

monitoring system, including human-machine-interfaces; network connection, e.g. CAN bus, Ethernet; protection, e.g. galvanic isolation; hardwired safety circuits; power supply arrangement;

definitions of interactions with external systems (e.g. ship alarm system, control system of ship automated electrical power plant);

definition of limiting performance parameters influenced by the control system, e.g. temperature, pressure, power, speed, etc;

design intent(s) and system operational modes for the electronic control system: description of manual operation;

description of local/remote mode; alarms/warnings.

Any interface to the engine safety system, if applicable.

Illustration of the interrelationships of functional elements of the system by means of block diagram(s).

The block diagram(s) shall provide a graphical representation of the system and its components for the subsequent analysis. As a minimum, the block diagram shall contain:

breakdown of the system into major sub-systems and/or components;

all appropriately labelled inputs and outputs and identification numbers by which each sub-system/component is referenced;

all redundancies, alternative signal paths and other engineering features, which provide "fail-safe" measures.

It may be necessary to develop a different set of block diagrams for each operational mode.

2.1.3 Functional relationships among the system elements, including:

listing of all component units and components within the control system boundary (part list, names, functions);

redundancy level and nature of the redundancies, separation, independency;

description of multiple CPU operation from a system architecture perspective; distributed control system architecture.

2.1.4 System requirements and function with acceptable functional performance limits of the system and its constituent elements in each of the typical operational modes: acceptance criteria for the electronic control – and safety system performance depending on control item application.

2.1.5 System constraints.

2.2 Establish safety and performance acceptance criteria

Performance acceptance criteria shall be established considering:

the pertinent class and flag requirements;

the acceptable operating criteria set by the engine designer with respect to safety and performance availability;

application of control item, e.g. a single engine propulsion application may have stricter acceptance criteria than a multiple engine propulsion application, for instance higher redundancy requirements and design for fault tolerance, meaning that the system can maintain safe operation in the presence of a certain number and certain types of failures.

2.2.1 The acceptable performance criteria need to be stated in a manner, which enables the evaluation of each failure mode against these criteria. It is recommended to apply a risk matrix, using a severity index, reflecting the impact of a failure mode to the safety and to the performance, and a frequency index reflecting the frequency of occurrence of the event.

2.2.2 The assumptions made in the evaluation of the severity and frequency indices shall be documented

2.2.3 The examples of indices and the resulting risk matrix (risk index table) are given in tables 2.2.3-1, 2.2.3-2 and 2.2.3-3 accordingly. Depending on the specific analysis, a different scale or number of index steps may be used, the risk matrix may be divided into three areas: an area with an acceptable risk index (Table 2.2.3-3, here lower left with indices 2 and 3), the area with not-acceptable risk indices (Table 2.2.3-3, here upper right with

indices 5, 6 and 7), and the area between the before mentioned two (Table 2.2.3-3 , here the diagonal with index 4), where the acceptance depends on further description of the event, for instance means of detection of the failure and the possibility of a manual mode of operation after a failure has occurred. In this area every effort shall be made to make the risk as low as reasonably practicable.

Table 2.2.3-1

Example of Severity Index (SI) table

SI	Name	Definition
3	High	Serious impact on safety, e.g. fatality and/or serious impact on the control item performance e.g. ICE stop.
2	Medium	Medium impact on safety, e.g. injury and/or medium impact on the control item performance e.g. ICE de-rated.
1	Low	Negligible to low impact on safety and/or negligible to low impact on the control item performance.

Table 2.2.3-2

Example of Frequency Index (FI) table

FI	Name	Definition
4	High	1 or more events per year of operation
3	Medium	1 event in 10 to less than 1 event in 1 item per year of operation
2	Low	1 event in 100 to less than 1 event in 10 engines per year of engine operation
1	Very low	Less than 1 event in 100 engines per year of engine operation

Table 2.2.3-3

Example of Risk Index Matrix

	FI	1	2	3	4
SI		Very low	Low	Medium	High
3	High	4	5	6	7
2	Medium	3	4	5	6
1	Low	2	3	4	5

2.2.4 Identify all potential failure modes and their causes.

A failure mode is the specific effect by which a failure is observed. When used in conjunction with functional performance specifications governing the inputs and outputs on the system block diagram, all potential failure modes can be thus identified and described.

Each (sub-) system shall be considered in a top-down approach starting from the system's functional output. A failure shall be assumed by one possible cause at a time. Since a failure mode may have more than one cause, all potential independent causes for each failure mode shall be identified.

All potential common cause failures shall be identified; it is not sufficient to consider only random and independent failures. Some common-cause failures (CCF) can occur, that cause system performance degradation or failure through simultaneous deficiency in several system components, due to a single source, environmental stresses, or human error. CCFs are those failures, which defeat the fundamental assumption that the failure modes under consideration in the FMEA are independent. The CCF will cause more than one item to fail simultaneously, or within a sufficiently short period of time as to have the effect of simultaneous failures.

Typically, sources of CCF include environmental influences, such as electrical interference, temperature cycling, vibration, as well as human factors like incorrect operating or maintenance actions.

2.2.5 Evaluate the effects for each failure mode.

The consequence of a failure mode on the operation, function, or status of a component or a system is called a 'failure effect'. The failure effects shall be evaluated regarding safety and availability in two respects locally, (i.e. related to the engine, considering effects to the engine safety system as well, if applicable; and globally, i.e. related to the engine application, e.g. single prime mover in a ship or multiple engine installation.

2.2.6 Identification of the failure detection methods.

A failure detection method can be a visual or audible warning device, automatic sensing devices, sensing instrumentation, manual inspection or other unique indications. These shall be identified for every failure mode and its causes, as appropriate.

2.2.7 The severity of each failure effect, as well as the frequency of occurrence of each failure mode dependent on the acceptable performance and safety criteria.

The severity of each failure effect, as well as the frequency of occurrence of each failure mode shall be assessed using elaborated index tables dependent on the acceptable performance and safety criteria as described in 2.2 above. Local and global effects on safety and availability shall be considered when determining the severity index.

2.2.8 Evaluate the established Risk Index.

The risk index for each failure mode shall be evaluated as described in 2.2.3 and the example in Table 2.2.3-3.

2.2.9 Identify corrective measures for failure modes.

The response of any back-up equipment, or any corrective action (manual or automatic) initiated at a given system level to prevent or reduce the effect of the failure mode of a system element or component shall be identified and evaluated.

2.2.10 Document the FMEA.

The FMEA results may be documented on worksheets with a structure similar to the example below.

The worksheet(s) shall start with the highest system level and then proceed down through the system hierarchy.

Example of FMEA worksheet

Name of system — Reference(s)
Mode of operation — System block diagram
Sheet No.
Date
FMEA participants — Drawings

Identification No.	Item description	Function	Failure mode	Failure effects		Severity Index of failure effects	Failure causes	Frequency Index of event	Risk Index	Detection method	Corrective action	Remarks, testing
				local	common							
	Refer to 2.1	Refer to 2.1.4	Refer to 2.2.4	Refer to 2.2.5	Refer to 2.2.2	Refer to 2.2.7	Refer to 2.2.4	Refer to 2.2.7	Refer to 2.2.8	Refer to 2.2.6	Refer to 2.2.9	Refer to 2.2.11

2.2.11 Describe input to test program.

A test program shall be developed to confirm the conclusions of the FMEA results and check of all the assumptions made.

3 FMEA REPORT

The FMEA report shall include a technical description of the control system, its subsystems and their functions and the proposed operating and environmental conditions for the failure modes, causes and effects to be understood. The analysis assumptions, system block diagrams, performance acceptance criteria, worksheets (ref. to 2.2.10), as well as the reference to a test program and any other test reports shall be included. The report shall contain a summary of the main conclusions, such as the results of the evaluation against the acceptance criteria.

APPENDIX 3 (recommended)

CHECK-LIST OF THE SCOPE OF DOCUMENTATION

Name of equipment (system): Description of equipment (system):		
Code of document	Document title	Symbol
C1	Documentation for programmable electronic systems shall be 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	Functional block diagram	
D4	Circuit diagram	
T1	Specification	
T2	Explanatory notes	
T3	Technical specifications	
T4	Test program and test procedure	
T5	Failure mode and effects analysis (FMEA)	
I1	Explosion-proof certificate	

APPENDIX 4 (recommended)

CHECK-LIST OF THE TEST PROGRAM

Name of equipment (system): Description of equipment (system):		
Test item No.	Test	Test report[1]
12.4.13	Programmable electronic system testing	
12.6.1	Visual inspection	
12.6.2	Insulation resistance measurement	
12.6.3	Insulation resistance test	
12.6.4	Functional tests	
12.6.5	Vibration tests	
12.6.6	Shock tests	
12.6.7	Tests for resistance to motions and prolonged inclinations	
12.6.8	Tests for heat stability	
12.6.9	Tests for cold endurance	
12.6.10	Damp heat tests	
12.6.11	Tests for exposure to salt mist (corrosion resistance)	
12.6.12	Protective enclosure testing	
12.6.13	Test for rated power supply deviation	
12.6.14	Test for the level of radiated electromagnetic emission	
12.6.15	Test for resistance to external electromagnetic interference.	
12.6.15.1	Tests for resistance to conducted radio frequency interference	
12.6.15.2	Tests for resistance to conducted radio frequency interference	
12.6.15.3	Test for resistance to nanosecond pulse interference due to burst electrical fast transient in the AC supply lines, signal, data and control circuits	
12.6.15.4	Tests for resistance to microsecond pulse interference	
12.6.15.5	Tests for resistance to electrostatic discharges	
12.6.15.6	Tests for resistance to electromagnetic field	
12.6.16	Test for tolerable levels of radiated and conducted interference	
12.6.17	Flame retardant tests	
12.6.18	Fungus resistance tests	
[1]Report number and date of test conducting shall be indicated in case the tests are performed by ACS or without witnessing of the surveyor at the RS recognized laboratory		

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