GUIDANCE CHANGE NOTICE No.5

Part 1 Seagoing Ships

GUIDANCE FOR THE APPROVAL AND TYPE APPROVAL OF MATERIALS AND EQUIPMENT FOR MARINE USE

Volume W

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Foreword

This Guidance Change Notices (GCN) No. 5 provide amendment and corrigenda to the Guidance for The Approval and Type Approval of Materials and Equipment for Marine Use (Pt.1, Vol.W) 2022 edition along with effective date from which these changes are applicable. The amendments in this GCN refer to IACS UR E10 Rev.9, UR M73 Rev.2 and UR P2.11 Rev.6.

Amendments to the preceding edition are marked by strikethrough, red color, and expanded text. These new additions and amendments are to be read in conjunction with the requirements given in GCN Nos.1, 2, 3, 4 and the 2022 Edition of the Guidance.

The summary of current amendments for each section including the implementation date are indicated in *Table 1 - Amendments Incorporates in This Notice*.

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Any quires or comments concerning these Guidance are welcomed through communication with BKI Head Office.

Guidance Changes Notice No. 5 – April 2024

Table 1 – Amendments Incorporates in This Notice

These amendments will come into force as indicated in the Table.

Paragraph	Title/Subject	Status/Remark
Section 3 – Type Approval		
K.	Exhaust Gas Turbochargers *The amendments apply to certification applications dated on or after 1 July 2024*	
3.3	–	Added "for the low, medium, and high-speed engines" reflected in UR M73 Rev.2
Q.	Mechanical Joints *The amendments apply to (initial and renewal) approval application submitted from 1 January 2025*	
Table 3.17	Test items for mechanical joints	Added footnote 3 to Fire endurance test for Compression couplings and pipes unions and deleted low temperature test as a test item for mechanical joints according to UR.P2.11 Rev.6
3.4.2	–	Editorial changes in accordance with IACS UR P2.11 Rev.6
Table 3.18	The outlines of testing methods of mechanical joints	Adjusted some paragraphs in the table and added some new ones according to UR P2.11 Rev.6
V.	Automatic and Remote Control Systems *The amendments apply to type approval applications dated on or after 1 July 2024*	
1.1	–	Changed the requirements to be fulfilled by automatic and remote control systems and fire/gas detection system
1.1.1	–	Added standard to be met by fire detection system
1.1.3	–	Added standard to be met by gas detection system
2.1	General	Changed the paragraphs numbering
2.2	Hardware	Changed the paragraphs numbering
2.3	System functional description	Changed the paragraphs numbering
2.4	Software	Changed the paragraphs numbering
2.5	User interface	Changed the paragraphs numbering
3.2	–	Added new requirements regarding test laboratories
Table 3.34	Environmental test items, testing conditions and methods, and criteria	Added the latest standard terms of use and adjusted the table contents to align with IACS UR E10 Rev.9

Section 3 Type Approval

K. Exhaust Gas Turbochargers

1. Application

The requirements in this sub-section apply to the Type Approval of exhaust gas turbochargers (hereinafter referred to as the turbochargers) in accordance with the requirements in Rules for Machinery Installations (Pt.1, Vol.III) Sec.3 III. Turbochargers are to be type approved, either separately or as a part of an engine. The requirements are written for exhaust gas driven turbochargers, but apply in principle also for engine driven chargers.

2. Documents to be submitted

In addition to those specified in A.2, the documents in Rules for Machinery Installations (Pt.1 Vol.III) Sec.3.III.A.2.1 are to be submitted to BKI.

3. Type tests

3.1 Type tests are to be carried out for Categories B and C.

3.2 The type test for a generic range of turbochargers may be carried out either on an engine (for which the turbocharger is intended) or in a test rig.

3.3 Turbochargers for the low, medium, and high-speed engines are to be subjected to at least 500 load cycles at the limits of operation. This test may be waived if the turbocharger together with the engine is subjected to this kind of low cycle testing, see H.

Note:

The limits of operation are the operating conditions in which the (cyclic) stress range or strain range is maximum, i.e. which contribute to largest accumulated damage or shortest life, based on the criteria above and combined with temperature effect. Typical limits are alarm level speed, alarm level turbine inlet temperature, maximum permissible compressor inlet (or ambient) temperature for steady state operation and maximum permissible rates of acceleration and deceleration during start-up and shutdown operation. The limits of operation shall include any combination of the above which are realistic operating conditions. Load profile definition should be specified and documented.

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Q. Mechanical Joints

1. General

The requirements of this sub section apply to tests and inspection for the approval of mechanical joints in accordance with the requirements in Rules for Machinery Installations (Pt.1, Vol.III) Sec.11, D.

2. Data to be submitted

The following reference data are to be submitted to BKI in addition to those specified in A.2.

1) Complete description of the product
2) Typical sectional drawings with all dimensions necessary for evaluation of joint design
3) Complete specification of materials used for all components of the assembly

4) Test reports (when preliminary test is carried out) or other previous relevant tests.

5) Initial information

A) Maximum design pressures (pressure and vacuum)

B) Maximum and minimum design temperatures

C) Conveyed media

D) Intended services

E) Maximum axial, lateral and angular deviation, allowed by manufacturer

F) Installation details

3. Type tests

The aim of tests is to demonstrate ability of the pipe joints to operate satisfactory under intended service conditions. The scope and type of tests to be conducted e.g. applicable tests, sequence of testing, and the number of specimens, is subject to approval and will depend on joint design and its intended service in accordance with the requirements in the Rules.

Unless otherwise specified, the water or oil as test fluid is to be used.

3.1 Test items

Testing requirements for mechanical joints are to be as indicated in Table 3.17.

Table 3.17 Test items for mechanical joints

Test items		~~Notes and references~~ Types of mechanical joints			Notes and references
		Compression couplings and pipes unions	Slip-on joints		
			Grip type & Machine grooved type	Slip type	
1	Tightness test	O	O	O	Table 3.18
2	Vibration (fatigue) test	O	O	X	Table 3.18
3	Pressure pulsation test [1)]	O	O	X	Table 3.18
4	Burst pressure test	O	O	O	Table 3.18
5	Pull-out test	O	O	X	Table 3.18
6	Fire endurance test	O[3)]	O	O	Table 3.18 (If required in Rules for Machinery Installations (Pt.1, Vol.III) Sec.11. B, Table 11.1a)
7	Vacuum test	O [3)]	O	O	Table 3.18 (for suction lines only)
~~8~~	~~Low temperature test~~	~~X~~	~~X~~	~~X~~	~~Table 3.18 (for those used at low temperature)~~
8~~9~~	Repeated assembly test	O [2)]	O	X	Table 3.18

Abbreviations :

O : test is required.

X : test is not required.

Note:

1) For use in all class I and II systems and those class III systems where pressure pulsation other than water hammer is expected.

2) Except permanent joint type (e.g. press type and swage type).

3) Except joints with metal-to-metal tightening surfaces.

3.2 Alternative testing in accordance with national or international standards may be accepted where applicable to the intended use and application.

3.3 Unless otherwise specified, the water or oil as test fluid is to be used.

3.4 Selection of test specimen

3.4.1 Test specimens are to be selected from production line or at random from stock.

3.4.2 Where there ~~are various sizes from type~~ is a variety of joints requiring approval, a minimum of three separate sizes, representative of the range, from each type of joint~~s~~ ~~are~~ to be ~~subject to the tests listed in~~ tested in accordance with Table 3.17 are to be selected.

3.5 Mechanical joint assembly

3.5.1 Assembly of mechanical joints should consist of components selected in accordance with 3.4.2 and the pipe sizes appropriate to the design of the joints.

3.5.2 Where pipe material would affect the performance of mechanical joints, the selection of joints for testing is to take the pipe material into consideration.

3.5.3 Where not specified, the length of pipes to be connected by means of the joint to be tested is to be at least five times the pipe diameter.

3.5.4 Before assembling the joint, conformity of components to the design requirements is to be verified.

3.5.5 In all cases the assembly of the joint shall be carried out only according to the manufacturer instructions.

3.5.6 No adjustment operations on the joint assembly, other than that specified by the manufacturer, are permitted during the test.

3.6 Test results acceptance criteria

3.6.1 Where a mechanical joint assembly does not pass all or any part of the tests in Table 3.17, two assemblies of the same size and type that failed are to be tested.

3.6.2 In this case, only those tests which mechanical joint assembly failed in the first instance, are to be repeated. In the event where one of the assemblies fails the second test, that size and type of assembly is to be considered unacceptable.

3.6.3 The methods and results of each test are to be recorded and reproduced as and when required.

4. Methods of tests

4.1 The outlines of testing methods in Table 3.17 are as given in Table 3.18.

Table 3.18 The outlines of testing methods of mechanical joints

Test item	Kinds	Type test method
1.Tightness test	All mechanical joints	In order to ensure correct assembly and tightness of the joints, all mechanical joints are to be subjected to a tightness test, as follows. (1) Mechanical joint assembly test specimen is to be connected to the pipe or tubing in accordance with the requirements of 3.5 and the manufacturers instructions, filled with test fluid and de-aerated. Mechanical joints assemblies intended for use in rigid connections of pipe lengths, are not to be longitudinally restrained. Rigid connections are joints, connecting pipe length without free angular or axial movement. Pressure inside the joint assembly is to be slowly increased to 1,5 times of design pressure. This test pressure is to be retained for a minimum period of 5 minutes. In the event ~~where there is~~ of a drop in pressure ~~and there is visual indication of~~ or visible leakage, the test (including fire test) shall be repeated for two ~~test pieces~~ further specimens. If during the repeat test one test piece fails, the ~~testing~~ coupling is regarded as having failed. ~~Other~~ An alternative tightness test procedure, such as pneumatic test, may be accepted. (2) For compression couplings a static gas pressure test is to be carried out to demonstrate the integrity of the mechanical joints assembly for tightness under the influence of gaseous media. The pressure is to be raised to maximum pressure or 7 MPa which ever is less. (3) Where the tightness test is carried out using gaseous media as permitted in (1) above, then the static pressure test mentioned in (2) above need not be carried out.
2. Vibration (fatigue) test	General	(1) In order to establish the capability of the mechanical joint assembly to withstand fatigue, which is likely to occur due to vibrations under service conditions, mechanical joints assembly is to be subject to the following vibration test. (2) Conclusions of the vibration tests should show no leakage or damage~~, which could subsequently lead to a failure~~.
	Compression couplings, pipe unions	Compression couplings and pipe unions ~~or other similar joints~~ intended for use in rigid connections of pipe are to be tested ~~in accordance with this method described~~ as follows. (A) Two lengths of pipe is to be connected by means of the joint to be tested. (B) One end of the pipe is to be rigidly fixed while the other end is to be fitted to the vibration rig. (C) The test rig and the joint assembly specimen being tested is to be arranged as shown in Fig 3.7.

Table 3.18 The outlines of testing methods of mechanical joints *(continued)*

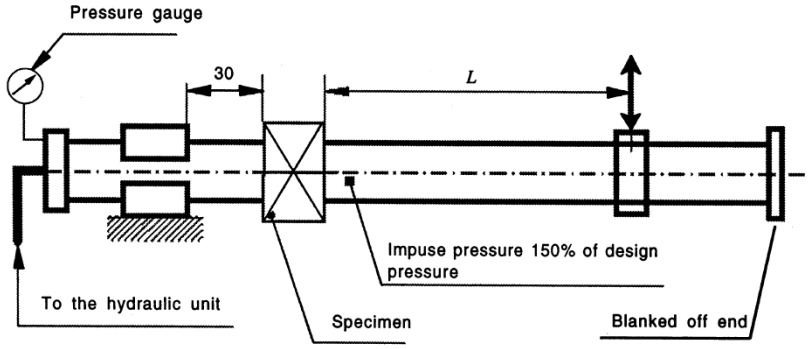
Test item	Kinds	Type test method
2. Vibration (fatigue) test	Compression couplings, pipe unions	 Fig 3.7 Example of equipment for vibration (fatigue) test (D) The joint assembly is to be filled with test fluid, de-aerated and pressurised to the design pressure of the joint. (E) Pressure during the test is to be monitored. (F) In the event of a drop in the pressure and ~~visual signs of~~ visible leakage the test is to be repeated as described in 3.6. (G) Visual examination of the joint assembly is to be carried out ~~for signs of damage which may eventually lead to joint leakage~~. (H) Re-tightening may be accepted once during the first 1000 cycles. (I) Vibration amplitude is to be within 5% of the value calculated from the following formula: $A = \frac{2 \times S \times L^2}{3 \times E \times D}$ where: A = single amplitude (mm) L = length of the pipe (mm) S = allowable bending stress in N/mm^2 based on 0,25 of the yield stress E = modulus of elasticity of tube material (for mild steel, E = 210 kN/mm^2) D = outside diameter of tube (mm) (J) Test specimen is to withstand not less than 10^7 cycles with frequency 20~50 Hz without leakage or damage.
	Grip Type and Machine grooved type joints	Grip type joints and other similar joints containing elastic elements are to be tested in accordance with the following method. A test rig of cantilever type used for testing fatigue strength of components may be used. (A) The test specimen being tested is to be arranged in the test rig as shown in Fig 3.8 (B) Two lengths of pipes are to be connected by means of joint assembly specimen to be tested (C) One end of the pipe is to be rigidly fixed while the other end is to be fitted to the vibrating element on the rig.

Table 3.18 The outlines of testing methods of mechanical joints *(continued)*

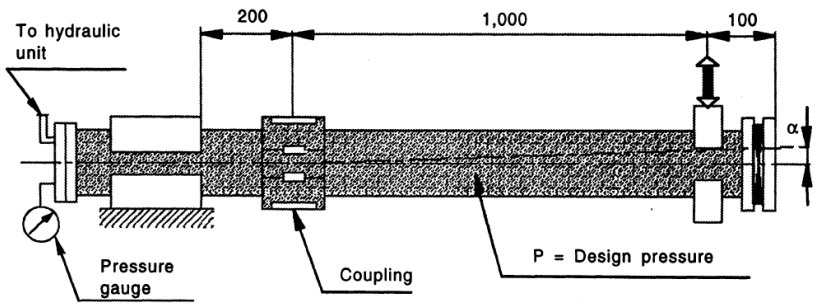
<table>
<tr><th>Test item</th><th>Kinds</th><th>Type test method</th></tr>
<tr><td>2. Vibration (fatigue) test</td><td>Grip Type and Machine grooved type joints</td><td>


Fig 3.8 Example of Equipment for vibration (fatigue) test
(D) The length of pipe connected to the fixed end should be kept as short as possible and in no case, exceeds 200 mm.
(E) Mechanical joint assemblies are not to be longitudinally restrained.
(F) The assembly is to be filled with test fluid, de-aerated and pressurized to the design pressure of the joint.
(G) Preliminary angle of deflection of pipe axis is to be equal to the maximum angle of deflection, recommended by the manufacturer.
(H) The amplitude is to be measured at 1m distance from the center line of the joint assembly at free pipe end connected to the rotating element of the rig. (See Fig. 3.8)
(I) Parameters of testing are to be as indicated below and to be carried out on the same assembly
<table>
<tr><th>Number of cycles</th><th>Amplitude (mm)</th><th>Frequency (Hz)</th></tr>
<tr><td rowspan="3">3 x 10^6</td><td>± 0,06</td><td>100</td></tr>
<tr><td>± 0,5</td><td>45</td></tr>
<tr><td>± 1,5</td><td>10</td></tr>
</table>
(J) Pressure during the test is to be monitored.
(K) In the event of a drop in the pressure and visual signs of leakage the test is to be repeated as described in 3.6.
(L) Visual examination of the joint assembly is to be carried out for signs of damage which may eventually cause leakage.
</td></tr>
<tr><td>3. Pressure pulsation test</td><td>Mechanical joint assembly</td><td>
In order to determine capability of mechanical joint assembly to withstand pressure pulsation likely to occur during working conditions, joint assemblies intended for use in rigid connections of pipe lengths, are to be tested in accordance with the following method. The mechanical joint test specimen for carrying out this test may be the same as that used in the test in 1. (1) of this Table provided it passed that test.
(1) The vibration test in 2. of this Table and the pressure pulsation test are to be carried out simultaneously for compression couplings and pipe unions.
(2) The mechanical joint test specimen is to be connected to a pressure source capable of generating pressure pulses of magnitude as shown in Fig 3.9
(3) Impulse pressure is to be raised from 0 to 1,5 times the design pressure of the joint with a frequency equal to 30~100 cycles per minute.
(4) The number of cycles is not to be less than 5×10^5
(5) The mechanical joint is to be examined visually for sign of leakage or damage during the test. The specimen may have small deformation whilst under test pressure, but no leakage or visible cracks are permitted.
</td></tr>
</table>

Table 3.18 The outlines of testing methods of mechanical joints *(continued)*

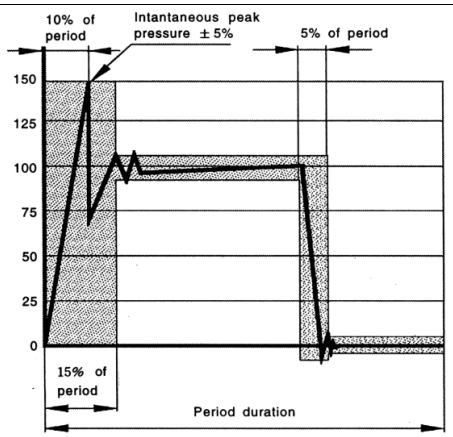
Test item	Kinds	Type test method
		 Fig 3.9 Example of equipment for pressure pulsation test
4. Burst pressure test	Mechanical joint assembly	In order to determine the capability of the mechanical joint assembly to withstand a pressure 4 times the design pressure, the following burst test is to be carried out. For design pressure above 20 MPa the required burst pressure will be specially considered by BKI. (1) Mechanical joint test specimen is to be connected to the pipe or tubing in accordance with the requirements of 3.5, filled with test fluid, de-aerated and pressurized to test pressure with an increasing rate of 10 % per minute of test pressure. (2) The mechanical joint assembly intended for use in rigid connections of pipe lengths is not to be longitudinally restrained. (3) Duration of this test is not to be less than 5 minutes at the maximum pressure. (4) Where consider convenient, the mechanical joint test specimen used in tightness test in 1. of this Table, same specimen may be used for the burst test provided it passed the tightness test. (5) The specimen may have small deformation whilst under test pressure, but no leakage or visible cracks are permitted.
5. Pull-out test	Mechanical joint assembly	In order to determine ability of a mechanical joint assembly to withstand axial load likely to be encountered in service without the connecting pipe from becoming detached, following pull-out test is to be carried out. (1) Pipe length of suitable size is to be fitted to each end of the mechanical joints assembly test specimen. (2) The test specimen is to be pressurized to design pressure. When pressure is attained, an external axial load is to be imposed with a value calculated by the following formula: $L = \frac{\pi}{4} \cdot D^2 \cdot \rho$ where: D = pipe outside diameter (mm) ρ = design pressure (N/mm^2) L = applied axial load (N) The pressure and axial load are to be maintained for a period of 5 minutes (3) During the test, pressure is to be monitored and relative movement between the joint assembly and the pipe measured. (4) The mechanical joint assembly is to be visually examined for drop in pressure and signs of leakage or damage. (5) There is to be no movement between mechanical joint assembly and the connecting pipes.

Table 3.18 The outlines of testing methods of mechanical joints *(continued)*

Test item	Kinds	Type test method
6. Fire endurance test	Mechanical joint assembly	(1) In order to establish capability of the mechanical joints to withstand effects of fire which may be encountered in service, mechanical joints are to be subjected to a fire endurance test. The fire endurance test is to be conducted on the selected test specimens as per the following standards. (a) ISO 19921:2005 Ships and marine technology – Fire resistance of metallic pipe components with resilient and elastomeric seals – Test methods (b) ISO 19922:2005 Ships and marine technology – Fire resistance of metallic pipe components with resilient and elastomeric seals – Requirements imposed on the test bench. (2) Clarifications to the standard requirements in ISO19921:2005, Paragraphs 7.2, 7.4, 7.6 and 7.7: ~~(2)~~ (a) If the fire test is conducted with circulating water at a pressure different from the design pressure of the joint (however of at least 5 bar) the subsequent pressure test is to be carried out to 1,5 times the design pressure. ~~(3)~~ (b) If the fire test is required in Rules for Machinery Installation (Pt.1, Vol.III) Table 11.14 to be "8 min dry + 22 min wet" or "30 min dry", ~~i.e.~~ conducted for a period of time without circulating of water, the following test conditions apply: ~~(a)~~ (i) Test condition "8 min dry + 22 min wet" The test piece is not required to be rinsed with the test medium (water) in preparation for the test as required in Paragraph 7.2 of ISO 19921:2005. The exposure to fire is to be started and continued for 8 minutes with the sample dry; after 8 minutes of dry test condition the piping system is to be filled with water and test pressure is to be increased up to at least 5 bar within 2 minutes, then maintained to at least 5 bar. After further 22 minutes (i.e. 30 minutes from initial exposure to fire) the exposure to fire is to be stopped and a hydrostatic pressure test as specified in ~~(2)~~ (a). is to be carried out. ~~(b)~~ (ii) Test condition "30 min dry" The exposure to fire is to be started and continued for 30 minutes with the sample dry. After 30 minutes the exposure to fire is to be stopped and a hydrostatic pressure test as specified in ~~(2)~~ (a) is to be carried out. ***Note*** *1. For fire tests in dry condition the pressure inside the test specimen is to be monitored for a rise due to heating of the enclosed air. Means of pressure relief should be provided where deemed necessary.* *2. High pressures created during this test can result in failure of the test specimen. Precautions shall be taken to protect personnel and facilities.* *3. Paragraph 7.5 of ISO 19921:2005 does not apply to the dry tests and no forced air circulation is to be arranged.* *4. For fire endurance test requiring exposure time greater than 30 minutes test conditions are adjusted to meet the extended required total exposure time. In all cases for dry-wet test the minimum dry test exposure time is 8 minutes.* ~~(4)~~ (c) A selection of representative nominal bores may be tested in order to evaluate the fire resistance of a series or range of mechanical joints of the same design. When a mechanical joint of a given nominal bore (Dn) is so tested then other mechanical joints falling in the range Dn to 2xDn (both inclusive) are considered accepted. ~~(5)~~ (d) Alternative test methods and/or test procedures considered to be at least equivalent may be accepted at the discretion of BKI in cases where the test pieces are too large for the test bench and cannot be completely enclosed by the flames.

Table 3.18 The outlines of testing methods of mechanical joints *(continued)*

Test item	Kinds	Type test method
		~~(6)~~ (e) Where thermal insulation is acceptable as a means of providing fire resistance, following requirements apply: ~~(a)~~ (i) Thermal insulation materials applied on couplings are to be non-combustible according to ISO 1182:2010 as required by the Fire Test Procedures Code defined in Regulation 3 of SOLAS Chapter II-2 as amended by IMO resolutions up to MSC. 421(98). Precautions are to be taken protect the insulation from being impregnated with flammable oils. ~~(b)~~ (ii) At least the fire endurance and the vibration testing in Table 3.17 are to be carried out with thermal insulation in place. ~~(c)~~ (iii) A service restriction is to be stated on the type approval certificate that the mechanical joints are to be fitted with thermal insulation during the installation in cases where the mechanical joints are used where fire resistance is required, unless mechanical joints are delivered already fitted with thermal insulation before installation.
7. Vacuum test	Mechanical joint assembly	In order to establish capability of mechanical joint assembly to withstand internal pressures below atmosphere, similar to the conditions likely to be encountered under service conditions, following vacuum test is to be carried out. (1) Mechanical joint assembly is to be connected to a vacuum pump and subjected to a pressure 170 hPa absolute. (2) Once this pressure is stabilized the ~~mechanical joint assembly test~~ specimen under test ~~are~~ is to be isolated from the vacuum pump and ~~this~~ the pressure is to be ~~retained~~ maintained for a period of 5 minutes. (3) No internal pressure rise is permitted.
8. Repeated assembly test	Mechanical joint assembly	Mechanical joint test specimen ~~are~~ is to be dismantled and reassembled 10 times in accordance with manufacturer's instructions and then subjected to a tightness test as defined in 1. of this Table.

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V. Automatic and Remote Control Systems

1. Application

1.1 The requirements of this Sub-section apply to tests and inspection for the type approval of the automatic and remote-control systems (device, units and sensors, etc) including basic softwares (if any) for use in the marine environment in accordance with the requirements in the Rules for Automation (Pt.1, Vol.VII) Sec. 7.E. However, ~~fire detection system and gas detection system are to comply with the following requirements.~~ the automatic and remote control systems that are to be installed less than 5 m from magnetic compass are to comply with the requirement in 1.1.4 and fire detection system and gas detection system are to comply with the requirements in following 1.1.1 to 1.1.3.

1.1.1 Fire detection system is to comply with the EN 54 series or ~~Recognized~~ equivalent standard.

1.1.2 Design requirements and performance tests for gas detection system for measurement and detection of fixed/portable combustible gases are to comply with IEC 60079-29-1 or equivalent standard. However audible alarm level and signal characteristics are to comply with IMO Res. A.830(19).

1.1.3 Gas detection system for oxygen detection and measurement is to comply with the EN 50104 or equivalent ~~Recognized~~ standard. However, audible alarm level and signal characteristics are to comply with IMO Res. A.830(19).

1.1.4 Compass safe distance test for the automatic and remote control systems that are to be installed less than 5 m from magnetic compass is to be carried out in accordance with IEC 60945:2002, paragraph 11.2.

1.2 Electrical and electronic equipment on board ships, required neither by BKI Rules nor by International conventions, liable to cause electromagnetic disturbance are to be of type which fulfil the test requirements of test specification item 20 and 21 of Table 3.34

1.3 The automatic and remote control systems are to be provided with a degree of protection appropriate to the location in accordance with the requirements in Rules for Electrical Installations (Pt.1, Vol.IV) Sec. 1, K.

2. Documents to be submitted

The following reference data are to be submitted to BKI in addition to those specified in A.2.

2.1 General

~~2.1.1~~ 1) All documentation shall provide relevant information in a clear and unambiguous manner.

~~2.1.2~~ 2) Symbols and abbreviations used shall be explained, or referenced to an appropriate international standard or code recognized by BKI.

2.2 Hardware

~~2.2.1~~ 1) System block diagram, showing the arrangement, input and output devices and interconnections

~~2.2.2~~ 2) Wiring diagram (electrical systems), piping diagram (pneumatic or hydraulic systems)

~~2.2.3~~ 3) Details of input and output devices

~~2.2.4~~ 4) Details of power supplies

2.3 System functional description

~~2.3.1~~ 1) System specifications

~~2.3.2~~ 2) System performance for normal or abnormal equipment operation.

~~2.3.3~~ 3) Instructions for normal and abnormal operating modes;

~~2.3.4~~ 4) Transfer of control

~~2.3.5~~ 5) Redundancy or reversionary mode

~~2.3.6~~ 6) Test facilities

~~2.3.7~~ 7) Failure detection and identification facilities (automatic and manual)

~~2.3.8~~ 8) Data security

~~2.3.9~~ 9) Access restriction

~~2.3.10~~ 10) Special aspects requiring user attention.

~~2.3.11~~ 11) In addition, documentation shall be provided concerning procedures for:

a) start-up

b) restoration of functions
c) maintenance and periodical testing
d) data back-up
e) software reloads and system regeneration
f) failure location and repair

2.4 Software

~~2.4.1~~ 1) Quality plan

~~2.4.2~~ 2) Software shall be fully described, e.g.:

a) a description of the basic software installed in each hardware unit;
b) a description of the communication software installed on nodes in a network;
c) descriptions of application software (not program listings);
d) tools for system set-up and process equipment configuration.

~~2.4.3~~ 3) The description of application software shall include, e.g.:

a) information of system modules that must be operative in order to maintain functions including dependencies on other systems;
b) detail of each module at a level sufficient to understand its function;
c) relationship between the software modules that must be operative in order to maintain each function;
d) data and control flow between software modules;
e) configuration of the software, including priority schemes;
f) switching mechanisms for redundant systems.

~~2.4.4~~ 4) A schedule of anticipated equipment operation ranges and limits for alarm and safety functions shall be provided.

2.5 User interface

~~2.5.1~~ 1) Control station design and arrangement shall be detailed including drawings, dimensions, pictures, etc. of each user input or output device at a level sufficient to assess the working principles.

~~2.5.2~~ 2) Details of screen based computer dialogue shall be produced, including:

a) description of the functions allocated to each input device;
b) details of individual screen views, e.g. schematics, colour photos, etc.;
c) description of menu operation.

2.6 Failure analysis for safety related functions only is to be carried out using appropriate means such as FMEA and the results are to be submitted to BKI

3. Type test report

3.1 Upon completion of the type test, the manufacturer is to submit to BKI the complete test report including test conditions, test results and required information.

3.2 Test result may be accepted in cases where test has been carried out as follows.

1) At a laboratory accredited for all the required tests by an accreditation body in accordance with ISO/IEC 17025
2) At a laboratory having the quality system audited by BKI.
3) At any suitable laboratory when testing is witnessed by BKI surveyor.

4. Type test

4.1 Hardware

4.1.1 General

1) Tests are to be carried out under following atmosphere conditions, rated electrical source voltage and rated electrical source frequency unless otherwise specified.

   ~~J)~~ A) temperature: 25 ± 10 °C

   ~~K)~~ B) relative humidity: 60 ± 30 %

   ~~L)~~ C) atmospheric pressure: 96 kPa ± 10 kPa

2) Measuring and testing equipment used in the type test are to be calibrated in accordance with the related standards and/or codes.
3) The number of EUT (Equipment Under Test) is, as a rule, to be one for each type. However, additional EUT may be required when deemed necessary by BKI.
4) Raising and lowering rate of temperature is to be within 1 °C /min (mean value for 5 minutes) unless otherwise specified.
5) Power supply variation test and pressure test are applied on pneumatic and hydraulic type equipment only.
6) Flame retardant test is to be generally applied by manufacturer's option to demonstrate that plastic components of the equipment under test with a large mass are flame retardant and self-extinguishing under the influence of flame.

4.1.2 Test methods and criteria

1) After the drawings and documents submitted in accordance with the requirements in 2. have been examined, tests are to be carried out in accordance with the testing condition and method of Table 3.34 in the presence of BKI's surveyor, and they are to be proven to satisfy the criteria of Table 3.34.
2) Where tests which do not fully comply with the testing condition and method, and the criteria of Table 3.34, they may comply with a standard deemed appropriate by BKI such as IEC, Standard Nasional Indonesia (SNI) or other recognized standard.
3) In contrast to a complete performance test, a functional test is a simplified test sufficient to verify that the equipment under test (ETU) has not suffered any deterioration caused by the individual environmental tests.
4) In application to high voltage test of Table 3.34, if agreed by BKI, the test may be carried out by referring of Rules for Electrical Installations (Pt.1, Vol.IV) Sec.20.

4.2 Software

4.2.1 Module tests

Software module tests are to provide evidence that each module performs its intended function and does not perform unintended functions.

4.2.2 Subsystem tests

Sub-system testing is to verify that modules interact correctly to perform the intended functions and do not perform unintended functions.

4.2.3 System test

System testing is to verify that subsystems interact correctly to perform the functions in accordance with specified requirements and do not perform unintended functions.

4.3 Performance tests

4.3.1 Integration tests

Programmable electronic system integration testing is to be carried out using satisfactorily tested system software, and as far as practicable intended system components.

4.3.2 Fault simulation

Faults are to be simulated as realistically as possible to demonstrate appropriate system fault detection and system response. The results of any required failure analysis are to be observed.

Table 3.34 Environmental test items, testing conditions and methods, and criteria

No.	Test Item	Testing condition and method [1)]	Criteria
1	Visual inspection	Examine the external, structure, etc., of the equipment.	The equipment complies with the specifications.
2	Performance test	- Check the operation of the equipment. - Check the self-monitoring features if provided. - Check the specified protection against an access to the memory. - Check against the effect of un-erroneous use of control elements in the case of computer systems. - When the EUT is required to comply with an international performance standard, e.g. protection relays, verification of requirements in the standard are to be part of the performance testing required in this initial test and subsequent performance tests after environmental testing.	The equipment operates satisfactory.
3	Electrical power supply failure test	- Check the operation of the equipment when the electrical power supply is interrupted 3 times for 5 minutes. (interruption time is 30 seconds each time) - The time of 5 minutes may be exceeded if the equipment under test needs a longer time for start-up, e.g. booting sequence. For equipment which requires booting, one additional power supply interruption during booting to be performed - Check the possible corruption of programme or data held in programmable electronic systems (where applicable)	The equipment operates satisfactory without manual calibration after restoration of the electrical power supply.

Table 3.34 Environmental test items, testing conditions and methods, and criteria *(continued)*

<table>
<tr><th>No.</th><th>Test Item</th><th>Testing condition and method</th><th>Criteria</th></tr>
<tr><td>4</td><td>Electrical power supply variation test</td><td>
- Check the operation of the equipment when the electrical power supply varies as shown in the following
AC supply
<table>
<tr><td>Combination</td><td>Voltage variation permanent (%)</td><td>Frequency variation permanent (%)</td></tr>
<tr><td>1</td><td>+6</td><td>+5</td></tr>
<tr><td>2</td><td>+6</td><td>-5</td></tr>
<tr><td>3</td><td>-10</td><td>-5</td></tr>
<tr><td>4</td><td>-10</td><td>+5</td></tr>
<tr><td rowspan="2"></td><td>Voltage transient (%)</td><td>Frequency transient (%)</td></tr>
<tr><td>1,5 sec</td><td>5 sec</td></tr>
<tr><td>5</td><td>+20</td><td>+10</td></tr>
<tr><td>6</td><td>-20</td><td>-10</td></tr>
</table>
DC supply
<table>
<tr><td rowspan="3">For the equipment not related to a battery (%)</td><td>Voltage tolerance continuous</td><td>± 10</td></tr>
<tr><td>Voltage cyclic variation</td><td>5</td></tr>
<tr><td>Voltage ripple</td><td>10</td></tr>
<tr><td rowspan="2">For the equipment related to a battery (%)</td><td>For thr equipment connected to a battery during charging</td><td>-25 ~ +30</td></tr>
<tr><td>For the equipment not connected to a battery charging</td><td>-25 ~ +20</td></tr>
</table>
- Check the possible corruption of programme or data held in programmable electronic systems (where applicable)
</td><td>- No abnormality is observed.
- The equipment operates satisfactory.</td></tr>
<tr><td>5</td><td>Power supply variation test</td><td>Check the operation of the equipment when the pneumatic and the hydraulic power supplies are maintained continuously +20 % and -20 % of the working pressure for at least 15 minutes.</td><td>- No abnormality is observed.
- The equipment operates satisfactory.</td></tr>
<tr><td>6</td><td>Dry heat test</td><td>
- The test shall be carried out at 25 ±2 °C in atmospheric temperature.
- The absolute humidity shall not exceed 20 g of water vapor per cubic meter of air (corresponding approximately to 50 % relative humidity at 35°C).
- Test A: The equipment is at an operating condition and apply the environmental condition of +70±2°C for 16 hours. And check the operation of the equipment during the last 1 hour at the test temperature and after recovery. Dry heat at 70 °C is to be carried out to automation, control and instrumentation equipment subject to high degree of heat, for example mounted in consoles, housings, etc. together with other heat dissipating power equipment. (see Fig. 3.13)
- Test B: For the equipment installed in air-conditioned spaces, the environmental condition of +55 ±2°C for 16 hours may be applied. Check the operation of the equipment during the last 1 hour at the test temperature and after recovery. Where the equipment is attached with other equipment in the console and housing, test A is to be performed. (see Fig 3.13)
- Detailed test methods are referred to Test Bb for non-heat dissipating equipment or Test Be for heat dissipating equipment of IEC 60068-2-2:2007.
</td><td>- No abnormality is observed.
- The equipment ~~operates satisfactory~~ is comply with the requirements of performance test and functional test.</td></tr>
</table>

Table 3.34 Environmental test items, testing conditions and methods, and criteria *(continued)*

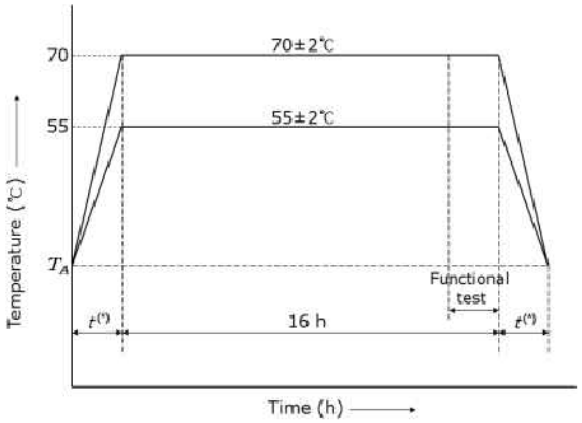
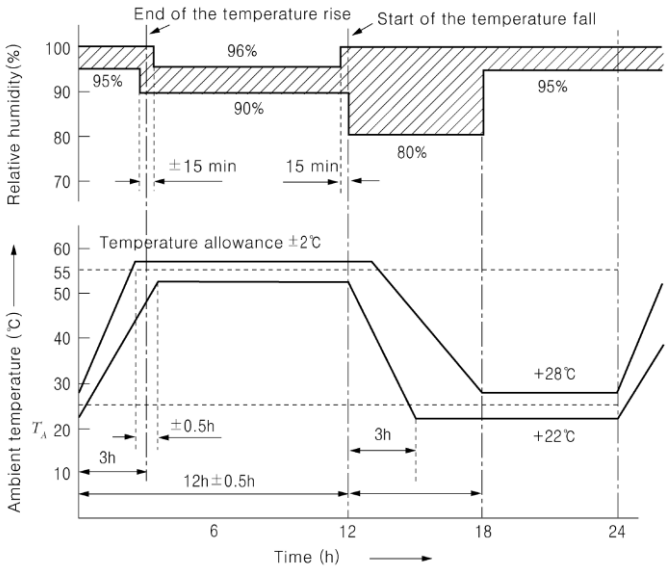
No.	Test Item	Testing condition and method	Criteria
		 Fig 3.13 Program of dry heat test ***Note*** *(*) Raising and lowering rate of temperature is to be within 1°C/min.(mean value for a period within 5 minutes)*	
7	Damp heat test	- The test shall start with 25°C ± 3°C and at least 95% humidity. - The temperature in the chamber shall be continuously raised to 55 ±2 °C during 3h±30 min. During this period, the relative humidity shall be not less than 95 %, except during the last 15min when it shall be not less than 90 %. (see Fig 3.14) - The temperature shall then be maintained 55 ±2 °C until 12h ±30 min from the start of the cycle. During this period, the relative humidity shall be 93±3%, except for the first and last 15 min when it shall be between 90% and 100%.  Fig 3.14 Program of damp heat test - 2 cycles shall be carried out as shown in Fig 3.14. The equipment is kept under operating condition during complete 1st cycle and switched off during 2nd cycle except for the operation test. And check the operation of the equipment during the first 2 hours of the 1st cycle at the environmental condition, during the last 2 hours of 2nd cycle at the environmental condition and after recovery - Insulation resistance measurements are carried out before and after test. - Detailed test methods are referred to Test Db of IEC 60068-2-30:2005.	- No abnormality is observed. - The equipment ~~operates satisfactory~~ is comply with the requirements of performance test and functional test.

Table 3.34 Environmental test items, testing conditions and methods, and criteria *(continued)*

<table>
<tr><th>No.</th><th>Test Item</th><th>Testing condition and method</th><th>Criteria</th></tr>
<tr><td>8</td><td>Vibration test</td><td>
- The equipment is at an operating condition and apply the sweeping of vibration specified in the following over the frequency range of 2 (+3,-0) Hz ~ 100 Hz in order to find resonance points. (points of which amplification factor: Q ≥ 2 are considered resonance points.)
<table>
<tr><th>Frequency</th><th>Amplitude or Acceleration</th></tr>
<tr><td>2 (+3, 0) ~ 13,2 Hz</td><td>Amplitude ± 1,0 mm</td></tr>
<tr><td>13,~~5~~2 ~ 100 Hz</td><td>Acceleration ± 0,7 g</td></tr>
</table>
- When resonance points do not exist, apply the vibration of acceleration ±0,7 g at 30 Hz for 90 minutes as an endurance test.
- When resonance points exist, repeat the test with necessary provisions to avoid resonance or apply the vibration (same amplitude or acceleration of resonance point) at the resonance frequency for 90 minutes as an endurance test. However, where sweep test is to be carried out instead of the discrete frequency test and a number of resonant frequencies is detected close to each other, duration of the test is to be 120 min.
- Sweep over a restricted frequency range between 0,8 and 1,2 times the critical frequencies can be used where appropriate. Critical frequency is a frequency at which the equipment being tested may exhibit:
  - malfunction and/or performance deterioration
  - mechanical resonances and/or other response effects occur, e.g. chatter
- during the vibration test, functional tests are to be carried out;
- The test is carried out in three axis directions.
- It is recommended as guidance that Q does not exceed 5.
- For the equipment intended to be installed in severe vibration conditions such as diesel engines, air compressors, the vibration level specified in the following is applied.
<table>
<tr><th>Frequency</th><th>Amplitude or Acceleration</th></tr>
<tr><td>2 (+3, 0) ~ 25,0 Hz</td><td>Amplitude ± 1,6 mm</td></tr>
<tr><td>25,0 ~ 100 Hz</td><td>Acceleration ± 4,0 g</td></tr>
</table>
- More severe conditions may exist for example on exhaust manifolds or fuel oil injection systems of diesel engines. For equipment specified for increased vibration levels the vibration test is to be conducted at the agreed vibration level, frequency range and duration. Values may be required to be in these cases 40 Hz to 2000 Hz - acceleration ±10,0 g at 600 °C duration 90 minutes.
- Detailed test methods are referred to Test Fc of IEC 60068-2-6:2007.
</td><td>
- No abnormality is observed.
- The equipment ~~operates satisfactory~~ is comply with the requirements of performance test and functional test.
</td></tr>
<tr><td>9</td><td>Inclination test</td><td>
a) inclined to the vertical at an angle of at least 22,5°
b) inclined to at least 22,5° on the other side of the vertical and in the same plane as in a),
c) inclined to the vertical at an angle of at least 22,5° in plane at right angles to that used in a),
d) inclined to at least 22,5° on the other side of the vertical and in the same plane as in c).
Note: *The period of testing in each position should be sufficient to fully evaluate the behaviour of the equipment.*
- Using the directions defined in a) to d) above, the equipment is to be rolled to an angle of 22,5° each side of the vertical with a period of 10 seconds.
- The test in each direction is to be carried out for not less than 15 minutes.
</td><td>
- No abnormality is observed.
- The equipment operates satisfactory.
</td></tr>
</table>

Table 3.34 Environmental test items, testing conditions and methods, and criteria *(continued)*

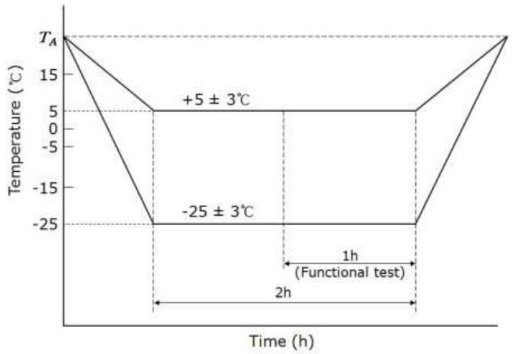
<table>
<tr><th>No.</th><th>Test Item</th><th>Testing condition and method</th><th>Criteria</th></tr>
<tr><td></td><td></td><td>- On ships for the carriage of liquified gases and chemicals, the emergency power supply is to remain operational with the ship flooded up to a maximum final athwart ship inclination of 30°.
Note: These inclination tests are normally not required for equipment with no moving parts.
- Detailed test methods are referred to IEC 60092-504:2016.</td><td></td></tr>
<tr><td>10</td><td>Insulation resistance test</td><td>- Measure the insulation resistance between current carrying parts and between current parts and earth when measured with the following application voltage.
<table>
<tr><th>Rated voltage : Un (V)</th><th>Test voltage (D.C Voltage) (V)</th></tr>
<tr><td>Un ≤ 65</td><td>2 x Un, min. 24</td></tr>
<tr><td>Un > 65</td><td>500</td></tr>
</table>
- Measurements are carried out before and after; other series of environmental tests, damp heat test, cold test and salt mist test.
- For the equipment containing circuits in which the application of the test voltage is not desirable, the test voltage is applied after removing the circuits.
Note: Certain components e.g. for EMC protection may be required to be disconnected for this test.</td><td>- The insulation resistance (MΩ) is not less than the value specified in the following.
<table>
<tr><th>Rated voltage</th><th>Before test</th><th>After test</th></tr>
<tr><td>Un ≤ 65</td><td>10</td><td>1,0</td></tr>
<tr><td>Un > 65</td><td>100</td><td>10</td></tr>
</table></td></tr>
<tr><td>11</td><td>High voltage test</td><td>- Apply the following test voltage, alternating of a frequency of 50 Hz or 60 Hz, between current carrying parts and between current-carrying parts connected and earth for 1 minute.
<table>
<tr><th>Rated voltage : Un (V)</th><th>Test voltage (V)</th></tr>
<tr><td>Un ≤ 65</td><td>2 x Un + 500</td></tr>
<tr><td>65 < Un ≤ 250</td><td>1500</td></tr>
<tr><td>250 < Un ≤ 500</td><td>2000</td></tr>
<tr><td>500 < Un ≤ 690</td><td>2500</td></tr>
</table>
- For the equipment containing circuits in which the application of the test voltage is not desirable, the test voltage is applied after removing the circuits.</td><td>- No abnormality is observed.</td></tr>
<tr><td>12</td><td>Cold test</td><td>- The test shall be carried out at 25 ± 10 °C in atmospheric temperature.
- The equipment is switched off except for the operation test and apply the environmental condition of +5 ± 3 °C for 2 hours. And check the operation of the equipment during the last hour at the test temperature and after recovery.
- For the equipment installed in open decks, etc., the environmental condition of -25 ± 3 °C is applied for 2 hours.
- Insulation resistance measurements are carried out before and after cold test.
- Detailed test methods are referred to test Ab or test Ad of IEC 60068-2-1:2007
 

Fig 3.15 Program of cold test</td><td>- No abnormality is observed.
- The equipment ~~operates satisfactory~~ is comply with the requirements of performance test and functional test.</td></tr>
</table>

Table 3.34 Environmental test items, testing conditions and methods, and criteria *(continued)*

<table>
<tr><th>No.</th><th>Test Item</th><th>Testing condition and method</th><th>Criteria</th></tr>
<tr><td>13</td><td>Salt mist test ~~1)~~</td><td>- Salt mist test is to be carried out for equipment installed in weather exposed areas.
- The equipment is switched off except when its operation is checked. Apply four cycles of the environmental condition of spraying NaCl liquid (saline solution, 5 % NaCl, pH 6,5 ~ 7,2, 20 ±2 °C) for 2 hours and leaving for 7 days. Check the operation of the equipment during the 7th day of each cycle and after recovery.
- Damp chamber conditions for storage are to be maintained as follows;
  - Temp.: 40 °C ± 2 °C
  - Relative humidity: 93% +2% -3%
- The test is carried out according to the following procedure
  - Insulation resistance and functional test before test
  - Functional test on the 7th day of each cycle period
- Insulation resistance and functional test: 4 to 6 hours after recovery
- On completion of exposure, the equipment is to be examined to verify that deterioration or corrosion (if any) is superficial in nature.
- Detailed test methods are referred to Test Kb of IEC 60068-2-52:2017.</td><td>- No abnormality is observed.
- The equipment ~~operates satisfactory~~ is comply with the requirements of performance test and functional test.</td></tr>
<tr><td>14</td><td>Electrostatic discharge immunity test.</td><td>- Check the operation of the equipment when the electrostatic discharge immunity test is carried out according to the following condition.
<table><tr><td>Contact Discharge</td><td>6 kV</td></tr><tr><td>Air Discharge</td><td>2 kV, ~~6~~ 4 kV, 8 kV</td></tr><tr><td>Interval between single discharge</td><td>1 sec.</td></tr><tr><td>No. of Pulses</td><td>10 per polarity</td></tr></table>- The test is to be confined to the points and surfaces that can normally be reached by the operator.
- Detailed test methods are referred to Level 3 of IEC 61000-4-2:2008.</td><td>Performance Criterion B 2)</td></tr>
<tr><td>15</td><td>~~Radiated radio frequency~~ Electromagnetic field immunity test</td><td>- Check the operation of the equipment when the radiated radio frequency immunity test is carried out according to the following condition.
<table><tr><td>Frequency range</td><td>80 MHz ~ ~~2~~ 6 GHz</td></tr><tr><td>Modulation</td><td>80 % AM at 1000 Hz</td></tr><tr><td>Field strength</td><td>10 V/m</td></tr><tr><td>Frequency sweep rate</td><td>≤ 1,5 x 10^{-3} decades/ sec.
(or 1 %/ 3 sec.)</td></tr></table>- If for tests of equipment an input signal with a modulation frequency of 1000 Hz is necessary, a modulation frequency (80 % AM) of 400 Hz may be chosen.
- The test is to be confined to the appliances exposed to direct radiation by transmitters at their place of installation.
- If an equipment is intended to receive radio signals for the purpose of radio communication (e.g. wifi router, remote radio controller), then the immunity limits at its communication frequency do not apply, subject to the requirements in Rules for Electrical Installations (Pt.1, Vol.IV) Sec.10, E.2.
- Detailed test methods are referred to Level 3 of IEC 61000-4-3:2020 or IEC 61000-4-3:2006+AMD1:2007+AMD2:2010.</td><td>Performance Criterion A 3)</td></tr>
</table>

Table 3.34 Environmental test items, testing conditions and methods, and criteria *(continued)*

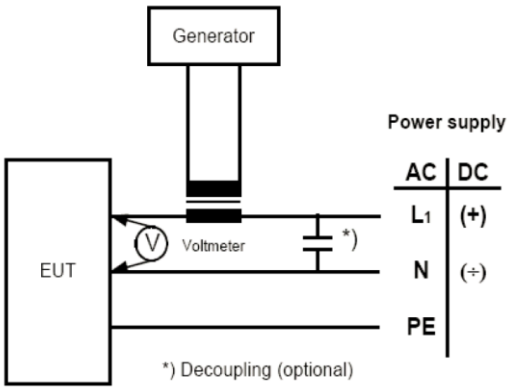
<table>
<tr><th>No.</th><th>Test Item</th><th>Testing condition and method</th><th>Criteria</th></tr>
<tr><td>16</td><td>Conducted low frequency immunity test</td><td>
- Check the operation of the equipment when the conducted low frequency immunity test is carried out according to the following condition. (values in round brackets are shown where the rated frequency of the equipment is 50 Hz)


Fig 3.16 Test set-up – Conducted Low Frequency Test
<table>
<tr><td>Frequency Range</td><td colspan="3">60 Hz ~ 12 kHz
(50 Hz~10 kHz)</td></tr>
<tr><td rowspan="4">Test Voltage</td><td rowspan="3">AC</td><td>10 % of supply voltage</td><td>60 Hz ~ 900 Hz
(50 Hz~750 Hz)</td></tr>
<tr><td>10 % to 1 % of supply voltage</td><td>900 Hz ~ 6 Hz
(750 Hz~5 kHz)</td></tr>
<tr><td>1 % of supply voltage</td><td>6 kHz ~ 12 kHz
(5 kHz~10 kHz)</td></tr>
<tr><td>DC</td><td>1 % of supply voltage
(at least 3 V)</td><td>50 Hz ~ 10 kHz</td></tr>
<tr><td rowspan="2">Maximum power</td><td>AC</td><td colspan="2">Min 3 V r.m.s, max 2 W.</td></tr>
<tr><td>DC</td><td colspan="2">max 2 W</td></tr>
</table>
- For keeping max. 2 W, the voltage of the test signal may be lower.
- In case of marine navigational and radiocommunication equipment and systems, this test can be exempted.
</td><td>Performance Criterion A [3]</td></tr>
<tr><td>17</td><td>Conducted ~~high~~ radio frequency immunity test</td><td>
- Check the operation of the equipment when the conducted high frequency immunity test is carried out according to the following condition.
<table>
<tr><td>Frequency range</td><td>150 kHz ~ 80 MHz</td></tr>
<tr><td>Modulation</td><td>80 % AM at 1000 Hz</td></tr>
<tr><td>Amplitude</td><td>3 V rms [4][5]</td></tr>
<tr><td>Frequency sweep rate</td><td>≤ 1,5 x 10^{-3} decades/ sec.
(or 1 %/ 3 sec.)</td></tr>
</table>
- If for tests of equipment an input signal with a modulation frequency of 1 kHz is necessary a modulation frequency (80 % AM) of 400 Hz should be chosen.
- Detailed test methods are referred to Level 2 of IEC 61000-4-6:2013.
</td><td>Performance Criterion A [3]</td></tr>
</table>

Table 3.34 Environmental test items, testing conditions and methods, and criteria *(continued)*

<table>
<tr><th>No.</th><th>Test Item</th><th>Testing condition and method</th><th>Criteria</th></tr>
<tr><td>18</td><td>~~Burst/~~ Electrical fast transient/ Burst immunity test</td><td>- Check the operation of the equipment when the electrical ~~burst~~ fast transient/burst immunity test is carried out according to the following condition.
<table>
<tr><td>Single pulse rise time</td><td>5 ns (10 ~ 90% value)</td></tr>
<tr><td>Single pulse width</td><td>50 ns (50 % value)</td></tr>
<tr><td rowspan="2">Amplitude (peak)</td><td>line on power supply port/ earth : 2 kV</td></tr>
<tr><td>line/line on I/O data control and signal lines : 1 kV</td></tr>
<tr><td>Pulse period</td><td>300 ms</td></tr>
<tr><td>Burst duration</td><td>15 ms</td></tr>
<tr><td>Duration</td><td>5 min./polarity</td></tr>
</table>
- Detailed test methods are referred to Level 3 of IEC 61000-4-4:2012.</td><td>Performance Criterion B [2)]</td></tr>
<tr><td>19</td><td>Surge immunity test</td><td>- Check the operation of the equipment when the surge immunity test is carried out according to the following condition.
<table>
<tr><td colspan="3">Test applicable to AC and DC power ports</td></tr>
<tr><td rowspan="3">Open-circuit voltage</td><td>Pulse rise time</td><td>1,2 µs (~~10 ~ 90% value~~ front time)</td></tr>
<tr><td>Pulse width</td><td>50 µs (~~50 % value~~ time to half value)</td></tr>
<tr><td rowspan="2">Amplitude (peak)</td><td>line/earth : 1 kV</td></tr>
<tr><td>line/line : 0,5 kV</td></tr>
<tr><td rowspan="2">Short-circuit current</td><td>Pulse rise time</td><td>8 µs (front time)</td></tr>
<tr><td>Pulse width</td><td>20 µs (time to half value)</td></tr>
<tr><td colspan="2">Repetition rate</td><td>at least 1 pulse/min</td></tr>
<tr><td colspan="2">No. of pulse</td><td>5 per polarity</td></tr>
</table>
- Detailed test methods are referred to Level 2 of IEC 61000-4-5:2017.</td><td>Performance Criterion B [2)]</td></tr>
<tr><td>20</td><td>Radiated emission test</td><td>- Radiated emission test is to be carried out according to the following.
For limits below 1000 MHz
<table>
<tr><td colspan="2">For equipment installed in the bridge and deck zone</td></tr>
<tr><td>Frequency range</td><td>Limits</td></tr>
<tr><td>150 kHz – 300 kHz</td><td>80 – 52 dBµV/m</td></tr>
<tr><td>300 kHz – 30 MHz</td><td>52 – 34 dBµV/m</td></tr>
<tr><td>30 MHz – 1000 MHz</td><td>54 dBµV/m</td></tr>
<tr><td>156 MHz – 165 MHz</td><td>24 dBµV/m</td></tr>
<tr><td colspan="2">For equipment installed ~~in the bridge~~ in a zone other than bridge and deck zone</td></tr>
<tr><td>Frequency range</td><td>Limits</td></tr>
<tr><td>150 kHz – 300 kHz</td><td>80 – 50 dBµV/m</td></tr>
<tr><td>30 MHz – 100 MHz</td><td>60 – 54 dBµV/m</td></tr>
<tr><td>100 MHz – 1000MHz</td><td>54 dBµV/m</td></tr>
<tr><td>156 MHz – 165 MHz</td><td>24 dBµV/m</td></tr>
</table>
For limits above 1000 MHz
<table>
<tr><td>Frequency range</td><td>Limits</td></tr>
<tr><td>1000 MHz – 6000MHz</td><td>54 dBµV/m</td></tr>
</table>
- Distance between equipment and antenna is to be 3 m.
- For the frequency band 156 MHz to 165 MHz the measurement shall be repeated with a receiver bandwidth of 9 kHz (as per IEC 60945:2002).</td><td>Radiated emission is to be within limits in the table [5)]</td></tr>
</table>

Table 3.34 Environmental test items, testing conditions and methods, and criteria *(continued)*

<table>
<tr><th>No.</th><th>Test Item</th><th>Testing condition and method</th><th>Criteria</th></tr>
<tr><td></td><td></td><td>- Alternatively the radiation limit at a distance of 3 m from the enclosure port over the frequency 156 MHz to 165 MHz shall be 30 dBµV/m peak (as per IEC 60945:2002)
- Equipment intended to transmit radio signals for the purpose of radio communication (e.g. wifi router, remote radio controller) may be exempted from limit, within its communication frequency range, subject to the provisions in Rules for Electrical Installations (Pt.1, Vol.IV) Sec. 10. E.2.
- Detailed test methods are referred to CISPR 16-2-3:2016, IEC 60945:2002 for 156-165 MHz</td><td></td></tr>
<tr><td>21</td><td>Conducted emission test</td><td>- Conducted emission test is to be carried out according to the following.
<table>
<tr><td colspan="2">For equipment installed in the bridge and deck zone</td></tr>
<tr><td>Frequency range</td><td>Limits</td></tr>
<tr><td>10 kHz – 150 kHz</td><td>96 – 50 dBµV ~~/ m~~</td></tr>
<tr><td>150 kHz – 350 kHz</td><td>60 – 50 dBµV ~~/ m~~</td></tr>
<tr><td>350 kHz – 30 MHz</td><td>50 dBµV ~~/ m~~</td></tr>
</table>
<table>
<tr><td colspan="2">For equipment installed ~~in the bridge~~ in a zone other than bridge and deck zone</td></tr>
<tr><td>Frequency range</td><td>Limits</td></tr>
<tr><td>10 kHz – 150 kHz</td><td>120 – 69 dBµV ~~/ m~~</td></tr>
<tr><td>150 kHz – 500 kHz</td><td>79 dBµV ~~/ m~~</td></tr>
<tr><td>500 kHz – 30 MHz</td><td>73 dBµV ~~/ m~~</td></tr>
</table>
- Test applicable to AC and DC power ports
- Detailed test methods are referred to CISPR 16-2-1:2017</td><td>Conducted emission is to be within limits in the table</td></tr>
<tr><td>22</td><td>Flame resistance test</td><td>- Flame resistance test is to be carried out according to the following condition.
<table>
<tr><td>Flame application</td><td>5 times 15 sec. each</td></tr>
<tr><td>Interval between each application</td><td>15 sec. or 1 time 30 sec.</td></tr>
</table>
- The test is performed with the EUT or housing of the EUT applying needle-flame test method.
- Detailed test methods are referred to IEC 60092-101:2018 or IEC 60695-11-5:2016</td><td>- 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.</td></tr>
<tr><td>23</td><td>Pressure test</td><td>- Apply the pneumatic or hydraulic pressure of 1,5 times the designed pressure.</td><td>No abnormality is observed.</td></tr>
</table>

Table 3.34 Environmental test items, testing conditions and methods, and criteria *(continued)*

Note:

~~1~~ ~~Salt mist test is to be carried out for equipment installed in weather exposed areas.~~

1) Later versions (including revisions) of the international standards are acceptable for use, provided BKI determines them to be equivalent to the technical specifications.

2) Performance Criterion B: The Equipment Under Test is to continue to operate as intended after the tests. No degradation of performance or loss of function is allowed as defined in the technical specification published by the manufacturer. During the test, degradation or loss of function or performance which is self-recoverable is however allowed but no change of actual operating state or stored data is allowed.

3) Performance Criterion A: The EUT is to continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed as defined in the technical specification published by the manufacturer.

4) For equipment installed on the bridge and deck zone, the test levels shall be increased to 10 Vrms for spot frequencies in accordance with IEC 60945 at 2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22, 25 MHz.

5) The upper frequency of the radiated emission test may be reduced depending on the highest internal frequency of the EUT, as per 7.6.6.2.2 of CISPR 16-2-3:2016. If the highest frequency of the EUT is:

- below 108 MHz : emission shall be measured up to 1 GHz,
- between 108 MHz and 500 MHz : emission shall be measured up to 2 GHz,
- between 500 MHz and 1 GHz : emission shall be measured up to 5 GHz,
- above 1 GHz : emission shall be measured up to the lower of 5 times of the highest internal frequency and 6 GHz.

The conditional testing procedure cannot be applied unless the highest internal frequency of the EUT isdocumented.

---------- *end* ----------