

CLASS GUIDELINE

DNVGL-CG-0339

Edition November 2016

Environmental test specification for electrical, electronic and programmable equipment and systems

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FOREWORD

DNV GL class guidelines contain methods, technical requirements, principles and acceptance criteria related to classed objects as referred to from the rules.

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CHANGES – CURRENT

General

Changes in this document are highlighted in red colour. However, if the changes involve a whole chapter, section or sub-section, normally only the title will be in red colour.

Main changes November 2016

- **Sec.2 Information on environmental testing and testing arrangement**
 - Sec.2 Table 2: Minimum test levels updated for temperature classes A and B.

- **Sec.3 Environmental type test specification**
 - Sec.3 Figure 4: Corrected by removing one performance test
 - Sec.3 Table 25: ESD test levels corrected.

- **App.A EU-directives**
 - App.A: Directives and standards have been updated in [5.1] and [5.2].

Editorial corrections

In addition to the above stated changes, editorial corrections may have been made.

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SECTION 1 INTRODUCTION

1 Scope

Type approval is a systematic procedure used to confirm that a product type is in conformity with a set of pre-determined requirements.

The requirements are based on DNV GL rules for classification [DNVGL-RU-SHIP Pt.4 Ch.9 Control and monitoring systems](#).

This document specifies the environmental test specification applicable to all instrumentation and automation equipment such as: hydraulic, pneumatic, electrical, electromechanical and electronic equipment, including computers and peripherals that shall be installed on ships, offshore units and high speed, light crafts classed with the Society. The scope of the tests required for a specific product will be determined on a case by case basis by the Society, depending on field of application and intended location on board. The Society reserves the right, in justifiable cases, to request the performance of additional tests.

2 Reference to other rules and regulations

These requirements are harmonized with the following publications:

- IACS Unified Requirements E10 Rev.6, *Test Specification for Type Approval*
- IEC publication 60092-504, *Electrical installations in ships, part 504: Special features, control and instrumentation*
- [DNVGL-RU-SHIP Pt.4 Ch.9 Control and monitoring systems](#).

Guidance note:

Equipment intended for use in navigation and radiocommunication systems should comply with IEC publication No. 60945, *Maritime navigation and radiocommunication equipment and systems – General requirements – Methods of testing and required test results*.

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Standards other than those specified may be recognised, provided they are considered to be equivalent.

3 Definitions

For definitions, see [DNVGL-RU-SHIP Pt.4 Ch.9 Sec.1 \[2\]](#).

4 Procedures for type approval

The test specification found in this document is part of the type approval procedures. For more information on procedures for type approval, see the Society's document [DNVGL-CP-0203](#).

5 Directives from the European Union

Certain directives from the European Union (EU) have an impact on environmental tests to be performed on products to be marketed and sold within the European Economic Area (EEA). For ship and offshore installations these tests are defined through the relevant EU-directives, which are:

- the *Marine Equipment Directive* (MED)
- the *Electromagnetic Compatibility Directive* (EMC)
- the *Low Voltage Directive* (LVD).

For more information on these directives, see [App.A](#).

SECTION 2 INFORMATION ON ENVIRONMENTAL TESTING AND TESTING ARRANGEMENT

1 General

Type testing shall be carried out to an extent sufficient to verify compliance with the manufacturer's equipment specification, rules where applicable, and for satisfactory operation in environments normally to be expected on board.

The environmental tests specified are generally applicable for all control and monitoring equipment.

[Sec.3 \[16\]](#) lists additional tests which may be required. Test procedures for these tests shall be agreed with the Society on a case-by-case basis.

2 Location classes

2.1 Introduction

The influence of the ambient environment on instrumentation and automation equipment will depend upon the field of application on board. Environmental testing therefore implies tests being directly related to intended location on board as well as general tests, which are not directly related to location.

Temperature, humidity, vibration, enclosure and EMC classes define the different areas of location.

Upon installation on board, it shall be ensured that each of the five location classes stated for the equipment in question meets the minimum location class required for the actual location.

2.2 How to select location classes

2.2.1 Instrumentation and automation equipment

Location classes may be selected directly from [Table 2](#) below, which specifies minimum required equipment specification and tests related to various locations on board.

However, as a guide to select relevant combinations of the five location classes, [Table 1](#) may be used as follows:

- From column II in [Table 1](#), select main areas on board which are relevant for the equipment's intended field of application. From column I, select actual location within the main areas selected from column II. The actual locations shall be selected separately for each of the five parameters: temperature, humidity, vibration, enclosure and EMC.
- Required location class for each of the five parameters, related to location, are then given by a cross reference between column I and II.

Minimum required equipment specification for the location classes selected, as well as the corresponding tests in [Sec.3](#) which shall be carried out, may now be obtained from [Table 2](#).

Guidance note:

Tests listed in [Table 3](#) have severity levels independent of location on board.

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Table 1 Location classes – selection guide

Column I		Column II				
Parameters	Location within main area	Main areas on board				
		Machinery spaces	Control room, accommodation	Bridge	Pump room, holds, rooms with no heating	Open deck
Temperature	Inside cubicles, desks, consoles, etc. with temperature rise of 5°C or more	B	B	B	D	D
	All other locations	A	A	A	C	D
Humidity	Locations where special precautions are taken to avoid condensation	A	A	A	A	A
	All other locations	B	B	B	B	B
Vibration	On machinery such as internal combustion engines, compressors, pumps, including piping on such machinery	B	—	—	B	B
	Masts	—	—	—	—	C
	All other locations	A	A	A	A	A
EMC electro-magnetic compatibility	All locations within specified main areas	A	A	B	A	B
Enclosure	Submerged application	D	—	—	D	D
	Below floor plates in engine room	C	—	—	—	—
	All other locations	B	A	A	B	C

Table 2 Tests with severity levels depending on intended location on board

Parameters	Class	Location	Minimum equipment specification	Minimum test level
Temperature	A	Machinery spaces, control rooms, accommodation, bridge	Ambient temperatures: 0°C to 45°C	Test Sec.3 [7] at 55°C and test Sec.3 [9] at 5°C
	B	Inside cubicles, desks, etc. with temperature rise of 5°C or more	Ambient temperatures: 0°C to 55°C	Test Sec.3 [7] at 70°C and test Sec.3 [9] at 5°C
	C	Pump rooms, holds, rooms with no heating	Ambient temperatures: -25°C to 45°C	Test Sec.3 [7] at 55°C and test Sec.3 [9] at -25°C
	D	Open deck, masts	Ambient temperatures: -25°C to 55°C	Test Sec.3 [7] at 70°C and test Sec.3 [9] at -25°C

Parameters	Class	Location	Minimum equipment specification	Minimum test level	
Humidity	A	Locations where special precautions are taken to avoid condensation	Relative humidity up to 96% at all relevant temperatures	Test Sec.3 [8.2] (no condensation)	
	B	All other locations	Relative humidity up to 100% at all relevant temperatures	Test Sec.3 [8.3] (condensation)	
Vibration	A	On bulkheads, beams, deck, bridge	Frequency range: 2_{-0}^{+3} - 13.2 Hz, Amplitude: 1.0 mm (peak value) Frequency range: 13.2 - 100 Hz, Acceleration amplitude: 0.7 g	Test Sec.3 [6.2] or test Sec.3 [6.3] depending on available test equipment	
	B	On machinery such as internal combustion engines, compressors, pumps, including piping on such machinery	Frequency range: 2_{-0}^{+3} - 25 Hz, Amplitude: 1.6 mm (peak value) Frequency range: 25 - 100 Hz, Acceleration amplitude: 4.0 g Frequency range: 40 - 2000 Hz, acceleration 10.0 g, duration 90 minutes at 600°C, only for equipment installed on the exhaust gas pipes of diesel engines	Test Sec.3 [6.2]	
	C	Masts	Frequency range: 2_{-0}^{+3} - 15 Hz, Amplitude: 2.5 mm (peak value) Frequency range: 15 - 50 Hz, Acceleration amplitude: 2.3 g		
EMC	A	All locations except bridge and open deck	Immunity	Reference specifications:	
				Conducted low frequency	Test Sec.3 [14.4]
				Electrical fast transient/burst	Test Sec.3 [14.5]
				Electrical slow transient surge	Test Sec.3 [14.6]
				Conducted radio frequency	Test Sec.3 [14.7] - Table 22
				Radiated electromagnetic field	Test Sec.3 [14.8]
				Electrostatic discharge	Test Sec.3 [14.9]
	Emission	Radiated	Test Sec.3 [14.10] - Sec.3 [14.11]		
		Conducted	Test Sec.3 [14.10] - Sec.3 [14.12]		
	B	All locations including bridge and open deck	Immunity	Conducted low frequency	Test Sec.3 [14.4]
Electrical fast transient/burst				Test Sec.3 [14.5]	

Parameters	Class	Location	Minimum equipment specification		Minimum test level
				Electrical slow transient/ surge	Test Sec.3 [14.6]
				Conducted radio frequency	Test Sec.3 [14.7] - Table 22/Table 23
				Radiated electromagnetic field	Test Sec.3 [14.8]
				Electrostatic discharge	Test Sec.3 [14.9]
			Emission	Radiated	Test Sec.3 [14.10] - Sec.3 [14.11]
				Conducted	Test Sec.3 [14.10] - Sec.3 [14.12]
Enclosure	A	Control rooms, accommodation, bridge	IP 20		Test IEC Pub. no. 60529
	B	Engine room	IP 44		
	C	Open deck, masts, below floor plates in engine room	IP 56		Salt mist test Sec.3 [10] and Test IEC Pub. no. 60529
	D	Submerged application, bilges	IP 68		

Table 3 Tests with severity level independent of location on board

Tests	Item
Performance test	Sec.3 [3]
Power supply test	Sec.3 [4] , Sec.3 [5]
Inclination test	Sec.3 [11]
Insulation resistance test	Sec.3 [12]
High voltage test	Sec.3 [13]
Additional tests	Sec.3 [16]

3 Testing arrangement

3.1 Where to test

Environmental testing may be performed in:

- At an European laboratory accredited for all the required tests by an accreditation body being member of European accreditation, EA.
- At a non-European laboratory accredited by an organisation who has signed a multilateral agreement (MLA) with EA.
- At a laboratory having the quality system audited by the Society.

A quality audit by the Society means that a competent person has gone through the quality system of the laboratory in accordance with ISO/IEC 17025 (and EN45001) and that a statement of recognition has been issued.

- d) At a laboratory recognised/certified by the marine administration of one EU member state or by another notified body (MED).
- e) At any suitable laboratory when testing is witnessed by a Society surveyor.

Guidance note:

Other arrangements may be approved at the discretion of the Society.

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3.2 Test and measuring equipment

The calibration of the measuring equipment shall be traceable according to international standards.

Documentation shall be available upon request.

3.3 Equipment under test (EUT)

In the case of series-manufactured products, the EUT shall be taken from the current production cycle. The choice of EUT shall be agreed with the Society.

If the EUT is a prototype, the Society reserves the right to carry out subsequent comparative tests on series-manufactured products.

3.4 Test reports

The mandatory test reports, in English language, shall be prepared according to the requirements in ISO/IEC 17025. I.e. the reports shall show name and address of test site, date of issue and have a reference marking/report number that completely identifies the test report. Test reports in a native language with free translation to English language may be accepted on a case-by-cases basis.

The test reports shall be signed by the responsible test personnel and the surveyor witnessing the tests, if relevant, confirming that the tests have been carried out in accordance with the relevant test programme

For each separate test the test report is at least to contain a short description of important test parameters and applied severity levels. Reference to a test programme only is not accepted unless the test programme is included in the report.

In cases where tests are carried out according to a standard different from those specified in this document a confirmation from the testing laboratory shall be provided stating that the requirements in the standard used fulfils the equivalent requirements in the standard as required by the Society. Alternatively, a cross reference between the requirements given in the two standards shall be provided.

Guidance note:

Evaluation of test results for tests exceeding the minimum required test levels should be based on the same approval criteria as for tests carried out in accordance with the minimum requirements.

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SECTION 3 ENVIRONMENTAL TYPE TEST SPECIFICATION

1 General

1.1 Relevant test programme

Prior to testing, a relevant and detailed test programme shall be prepared for each particular EUT. The test programme shall be based on type of equipment, the manufacturer's equipment specification and the environmental tests required for the particular EUT. The environmental testing imply tests, which are independent of intended location on board, as well as tests dependent on the location classes selected in accordance with [Table 2](#).

The relevant test programme shall specify how the performance tests shall be carried out, and specify what measurements/performance checks that shall be carried out prior to, during, and after the various environmental tests.

If testing is carried out according to test specifications and/or standards other than those specified in this publication, then the relevant test programme shall verify that the test applied meet the corresponding tests specified herein. An example is where the test programme covers test requirements from several approval authorities.

All tests are normally to be carried out on the same unit. Dry heat test and vibration test should normally be carried out prior to the damp heat test.

The relevant test programme shall be approved by the Society prior to commencement of the testing.

1.2 Normal ambient conditions

Basis: IEC publication 60068-1

Normal ambient conditions are defined in [Table 1](#).

Table 1 Normal ambient conditions

Temperature	$T_N = 20^\circ\text{C} \pm 2^\circ\text{C}$. Temperatures between 15°C and 35°C may be accepted provided selected temperature is kept constant within $\pm 2^\circ\text{C}$ during all tests and actual temperature is stated in the test report.
Relative humidity	$RH_N = 25\%$ to 75%
Atmospheric pressure	860 mbar to 1060 mbar
Radiation	Negligible
Vibration	Negligible
Power supply	Nominal value

2 Visual inspection

The product shall be visually inspected for good workmanship, conformity with the manufacturer's drawings and specifications, and rules for classification as applicable.

The Society's document [DNVGL-CP-0203](#) may be used as a guideline as far as applicable to the equipment under consideration.

2.1 General instructions for performance of visual inspections

The visual inspection shall be carried out before commencement of testing and shall be repeated as found necessary after each stage of the test. The purpose of the inspection shall detect visible damage to the EUT.

3 Performance test

The functions (switching points, characteristic curves, self-monitoring etc.) shall be demonstrated.

3.1 Test procedure

Prior to performance testing the EUT shall reach its equilibrium state at normal ambient conditions with no power on.

The orientation of the EUT with regard to gravity force shall be as in normal service.

The performance tests, sufficiently extensive to verify compliance with the manufacturer's equipment specifications and the Society's rules where applicable, shall be carried out at normal ambient conditions according to the relevant test programme.

3.2 Test result

The test is deemed to have been passed if the specified functions are demonstrated, the results fall within the specified tolerance limits and no damage to the EUT is detected.

4 Electrical power supply failure test

This test serves to demonstrate that on restoration of the power supply, no damage is caused to the EUT and no permanent or temporary malfunctions occur.

4.1 Test procedure

- 3 interruptions within a 5-minute period
- for equipment that requires booting, one additional interruption during booting shall be performed
- 30 seconds pause between switching off and switching back on.

4.2 General instructions for test performance

None.

4.3 Test result

The test is deemed to have been passed if the specified functions are demonstrated, the results fall within the specified tolerance limits and no damage to the EUT is detected.

5 Power supply variation tests

This test serves to demonstrate that in case of power supply variations, no damage is caused to the EUT and that no permanent or temporary malfunctions occur.

5.1 Test procedure

Prior to testing, the EUT shall be powered according to nominal specifications and load conditions, unless otherwise stated in the relevant test programme. Before any power supply variations are applied, the EUT shall be allowed to reach its equilibrium state.

The deviations, as specified in Table 3, shall be calculated from nominal value of voltage and frequency.

The stationary deviations shall be applied for the time necessary to establish a new equilibrium state, but minimum for 15 minutes.

The transient deviations shall be superimposed on the nominal voltage and frequency.

Voltage and frequency transients shall be initiated at the same point of time.

5.2 Test levels

In the case of hydraulic/pneumatic components, the rated pressure in accordance with the equipment specification is the basis for the tests.

Table 2 Electrical supply (alternating voltage)

<i>Combination no.</i>	<i>Voltage deviation stationary (duration > 15 min)</i>	<i>Frequency deviation stationary (duration > 15 min)</i>
1	+6%	+5%
2	+6%	-5%
3	-10%	-5%
4	-10%	+5%
	<i>Voltage deviation transient (duration 1.5 s)</i>	<i>Frequency deviation transient (duration 5 s)</i>
5	+20%	+10%
6	-20%	-10%

Table 3 Electrical supply (direct voltage), battery power supply

<i>No.</i>	<i>Voltage deviation</i>
7	+30%
8	-25%

Table 4 Pneumatic/hydraulic power supply

<i>No.</i>	<i>Control pressure deviation</i>
9	+20%
10	-20%

5.3 Test result

The test is deemed to have been passed if the specified functions are demonstrated, the results fall within the specified tolerance limits and no damage to the EUT is detected.

6 Vibration tests

This test serves to demonstrate that under the influence of external initiated vibrations no damage is caused to the EUT and no permanent or temporary malfunctions occur. The wide band random test may be performed as an alternative to the sweep sine test for general vibration strain, class A.

6.1 Definitions

Table 5 Wide band random and sweep sine tests

sweep sine test	a vibration test where the frequency of the sinusoidal excitation signal is varied continuously (swept) over a frequency range
wide band random test	a test where the excitation signal is a complex wave with a flat power spectral density versus frequency and a Gaussian amplitude distribution

6.2 Sweep sine test

6.2.1 Test procedure

Basis: IEC publication 60068-2-6, *Test Fc*.

The EUT shall be fastened to the test board by means of its own fastening devices. The equipment shall be mounted in its normal position, and in accordance with the manufacturer's instructions.

If vibration dampers are intended to be used during service, these shall be mounted during the test.

The orientation of the EUT with respect to the gravity force shall be as in normal service during the test.

The EUT shall be supplied by power and shall be in operation under normal load condition unless otherwise specified in the relevant test programme. Outputs shall be monitored for possible change of output signal caused by the applied vibration stress.

The EUT shall be vibrated in three mutually perpendicular planes unless otherwise stated in the relevant test programme. These planes shall be chosen so that faults are most likely to be revealed.

The sweeping shall be continuous and logarithmic, and the sweep rate shall be maximum one octave per minute.

Resonance search shall be run at the actual test level specified in [6.2.4]. Resonance frequencies to be determined for mechanical amplification factors greater than 2. No mechanical amplification factor greater than 10 will normally be accepted. Amplification factors significantly greater than 10 can only be accepted by exception when the equipment is specifically designed for high vibrations, and after a technical assessment subject to the Society's acceptance has been performed.

Endurance test shall be carried out for at least 90 minutes at all actual resonance frequencies (and at upper frequency if amplification factor is increasing with increasing frequency) where the amplification factor is greater than 2. If the resonance frequency varies during the test, the control equipment shall be adjusted accordingly. The test level shall be as in the sweep test.

If no resonance frequencies are found, the test shall be carried out at 30 Hz for class A and B and at 10 Hz for class C.

If several resonance frequencies are detected close to each other, for example if there is chatter, a restricted frequency sweeping over the frequency range between 0.8 and 1.2 times the critical/highest gain frequency can be accepted.

The centre shall be selected such that most resonance frequencies are covered, and the centre shall always be one of the resonance frequencies. A centre between 2 resonance frequencies is not accepted.

If some resonance frequencies are beyond the range, those frequencies shall be endurance tested in addition. If a centre close to the end of the total frequency range is selected the sweep shall cover the whole frequency range (0.8 and 1.2 times the critical frequency) even if it is beyond the total frequency range of 2 to 100 Hz. If sweep test is chosen the duration of the test shall be at least 120 min.

6.2.2 Tolerances

Velocity or acceleration tolerances at the control point: $\pm 10\%$, at the attachment point: $\pm 15\%$.

Distortion of the acceleration waveform shall not exceed 25%.

Transverse motion shall not exceed 25% of the specified value.

Measurement of frequency for resonance determination shall be made with a tolerance of ± 0.5 Hz.

6.2.3 Performance test

After the test, the EUT is subjected to final performance test as specified in the relevant test programme.

6.2.4 Test levels

The test levels and frequency ranges for the three vibration classes are given in [Figure 1](#) below.

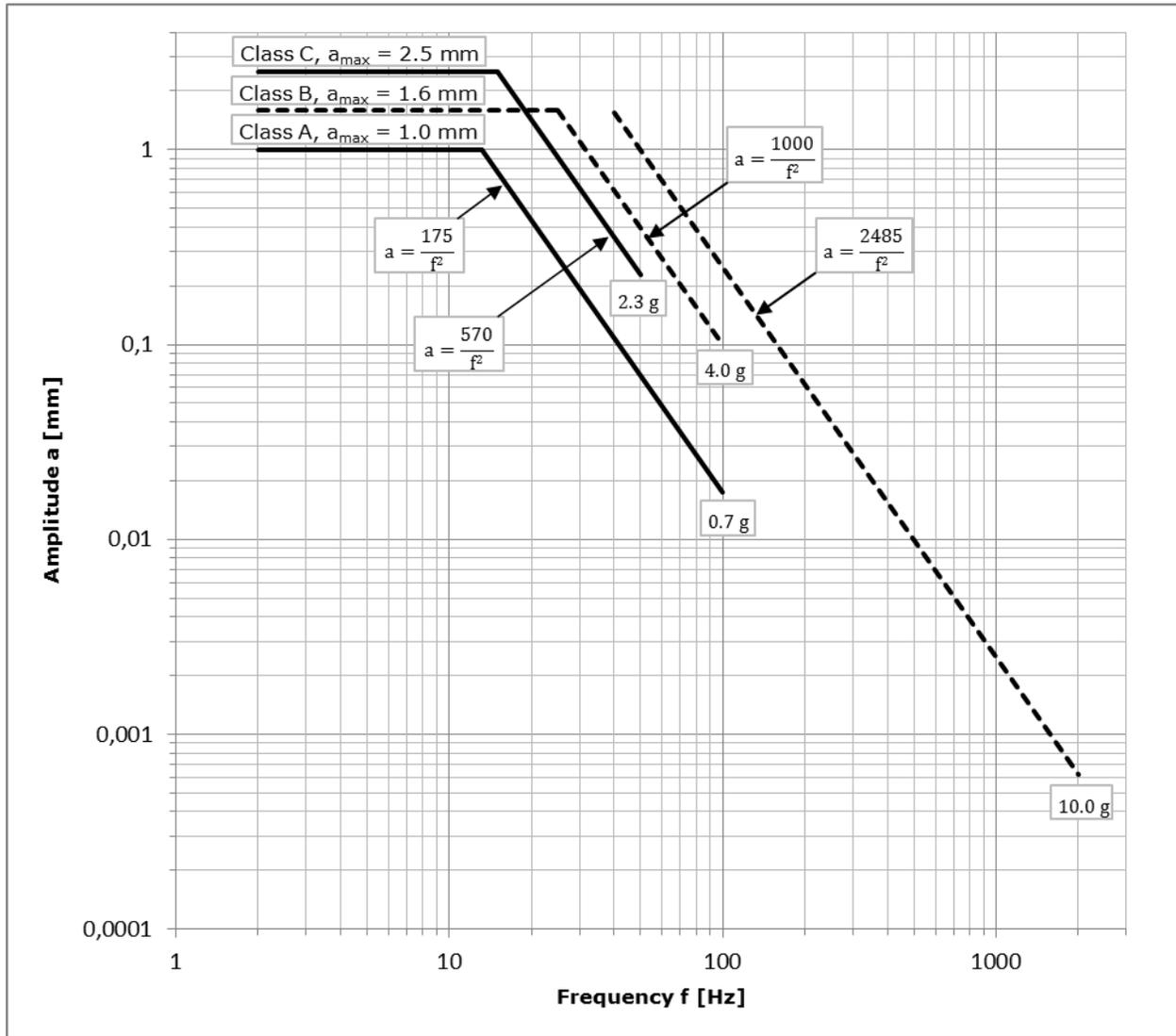


Figure 1 Vibration curves

The levels are measured at the control point (the vibration table, unless otherwise specified in the relevant test programme). If necessary, a good quality band pass filter shall be used.

Table 6 General vibration strain, class A

Frequency range	Displacement	Acceleration
2_{-0}^{+3} Hz to 13.2 Hz	1.0 mm (peak value)	
13.2 Hz to 100 Hz		0.7 g
Sweep rate	max. 1 octave/minute	

Table 7 High vibration strain, class B

<i>Frequency range</i>	<i>Displacement</i>	<i>Acceleration</i>
2 ⁺³ ₋₀ Hz to 25 Hz	1.6 mm (peak value)	
25 Hz to 100 Hz		4.0 g
Sweep rate	max. 1 octave/minute	

Table 8 Vibration strain on masts, class C

<i>Frequency range</i>	<i>Displacement</i>	<i>Acceleration</i>
2 ⁺³ ₋₀ Hz to 15 Hz	2.5 mm (peak value)	
15 Hz to 50 Hz		2.3 g
Sweep rate	max. 1 octave/minute	

Table 9 Extreme vibration strain

<i>Frequency range</i>	<i>Temperature</i>	<i>Acceleration</i>
40 Hz to 2000 Hz	600°C	10.0 g ¹⁾
Sweep rate	max. 1 octave/minute	
1) If more severe strain is expected at the location in question, this shall be considered for the test.		

The extreme vibration strain in [Table 9](#) applies to equipment and components installed on the exhaust gas pipes of diesel engines, especially for medium and high speed engines.

6.2.5 Test result

The test is deemed to have been passed if the specified functions are demonstrated, the results fall within the specified tolerance limits and no damage to the EUT is detected.

6.3 Wide band random test (class A only)

6.3.1 Test procedure

Basis: IEC publication 60068-2-64, *Test Fh*.

The EUT shall be fastened to the test board by means of its own fastening devices. The equipment shall be mounted in its normal position, and in accordance with the manufacturer's instructions.

If vibration dampers are intended to be used during service, these shall be mounted during the test.

The EUT shall be operating under normal load condition unless otherwise specified in the relevant test programme.

The orientation of the EUT with respect to the gravity force shall be as in normal service during the test.

The EUT shall be vibrated in three mutually perpendicular planes unless otherwise stated in the relevant test programme. These planes shall be chosen so that faults are most likely to be revealed.

Resonance search shall be run at the actual test level specified in [\[6.2.4\]](#) for class A. No mechanical amplification factor greater than 10 will normally be accepted. Amplification factors significantly greater than 10 can only be accepted by exception when the equipment is specifically designed for high vibrations, and after a technical assessment subject to the Society's acceptance.

Endurance test shall be carried out for at least 2.5 hour in each of the three planes.

6.3.2 Test levels

The spectrum shape is given in Figure 2.

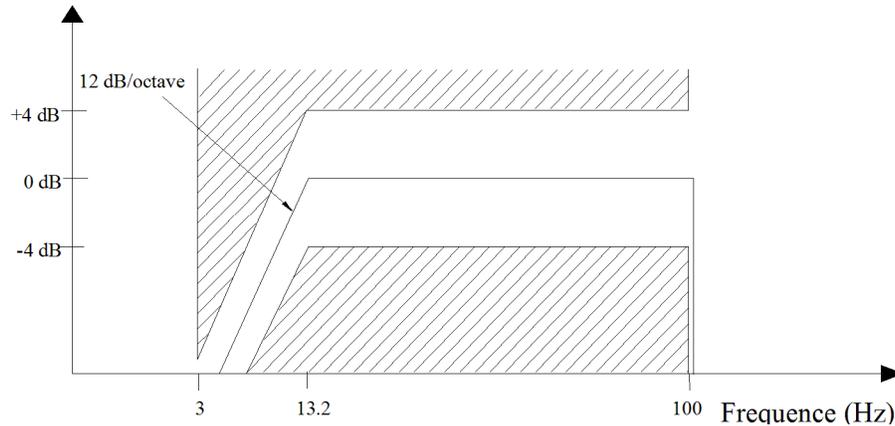


Figure 2 Wide band random power spectrum

The total RMS values measured through a good quality band pass filter are 1.0 g in the frequency range 3 - 100 Hz.

The levels are referred to the control point (the vibration table, unless otherwise specified in the relevant test programme).

6.3.3 Tolerances

Table 10 Tolerances

PSD	± 4 dB with bandwidth-time-product of minimum 300 with frequency resolution of 1/250 of maximum frequency
RMS g	± 1.5 dB

6.3.4 Performance tests

After the test, the EUT is subject to final performance test as specified in the relevant test programme.

6.3.5 Test result

The test is deemed to have been passed if the specified functions are demonstrated, the results fall within the specified tolerance limits and no damage to the EUT is detected.

7 Dry heat test

7.1 General

This test serves to demonstrate that under the influence of dry heat, no damage is caused to the EUT and no permanent or temporary malfunctions occur.

7.1.1 Chamber temperature and humidity measurement

The test chamber shall be so constructed that the specified conditions in the working space can be maintained within the tolerances given. The conditions at any point of the working space shall be uniform and as similar as possible to those prevailing in the immediate vicinity of temperature and humidity sensing devices installed. These devices shall be located at such a distance from the EUT, that the effect of dissipation is negligible.

7.1.2 Air flow

Forced convection in the chamber shall not be used when testing heat generating specimen.

7.2 Test procedure

Basis: IEC publication 60068-2-2, *Tests Bb and Be*.

7.2.1 Preconditioning

Prior to the dry heat test the EUT shall be visually inspected, electrically and mechanically checked and has been subject to performance tests at normal ambient conditions in accordance with the relevant test programme.

7.2.2 Temperature cycle

After the preconditioning time, the temperature cycle is started at normal ambient temperature T_N and run as shown in Figure 3.

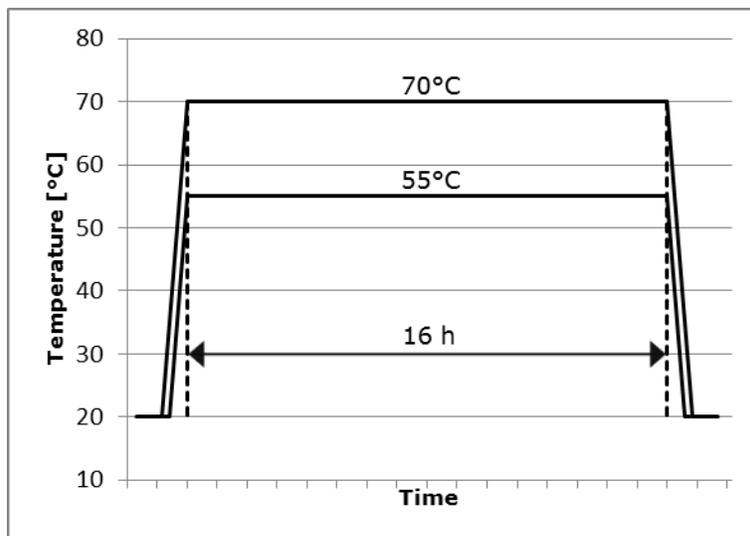


Figure 3 Dry heat, temperature cycle

The rate of change of temperature when the chamber temperature is shifted from one level to another is normally limited by the thermal time constant of the EUT. The EUT shall be in thermal equilibrium with its surroundings during this period to enable reproducible performance tests to be carried out as specified in the relevant test programme. If no performance testing is required during this period, the maximum rate of change of temperature is 1°C per min. average over a period of not more than 5 minutes.

Normal power supply for the particular specimen shall be applied in the temperature rise and temperature fall intervals. Unless otherwise stated in the relevant test programme, the most unfavourable power supply for the particular specimen shall be applied in the test temperature interval.

7.2.3 Performance tests

During the last hour of the upper test temperature interval, performance testing according to the relevant test programme shall be carried out.

After completion of the complete test cycle the EUT shall be kept at normal ambient conditions and fed by normal power supply for performance testing under load according to the relevant test programme.

7.2.4 Test levels

Relative humidity: RH = max. 50%.

Table 11 Upper test levels according to temperature class

<i>Class</i>	<i>Test temperature</i>	<i>Test duration</i>
A	55°C	16 hours
B	70°C	16 hours
C	55°C	16 hours
D	70°C	16 hours

The lower test levels for the different temperature classes specified in this test, are given in [9], *Cold test*.

7.2.5 Tolerances

Temperature: $\pm 2^\circ\text{C}$.

Relative humidity: $\pm 10\%$.

7.3 Test result

The test is deemed to have been passed if the specified functions are demonstrated, the results fall within the specified tolerance limits and no damage to the EUT is detected.

8 Damp heat test

8.1 General

This test serves to demonstrate that under the influence of damp heat, no damage is caused to the EUT and no permanent or temporary malfunctions occur.

Notice that only one of the tests are required (class A or class B), depending on the actual relevant location class.

8.1.1 Chamber temperature and humidity measurement

See item [7.1.1].

8.1.2 Air flow

The air velocity across the humidity sensor shall be 1.5 m/s to 2.0 m/s.

8.1.3 Humidifying

Only distilled water or water filtered and passed through an ion-exchanger shall be used for humidifying, and for the wet bulb thermometer (if used).

8.1.4 Preconditioning

Prior to the damp heat test the EUT shall be visually inspected, electrically and mechanically checked and has been subject to performance tests at normal ambient conditions in accordance with the relevant test programme.

Insulation resistance test, where appropriate, shall be carried out in accordance with [12].

8.2 Class A – static (non-condensation)

8.2.1 Test procedure

Basis: IEC publication 60068-2-78, *Test Cab: Damp heat, steady state*.

8.2.2 Additional preconditioning

Care shall be taken when introducing the EUT into the test chamber, to avoid the formation of water droplets on the EUT. This can be done by pre-heating the EUT to the chamber temperature.

8.2.3 Temperature and humidity conditions

The temperature and relative humidity in the working chamber shall be maintained at 40°C and 93%, respectively, for a period of 4 days.

8.2.4 Recovery

At the end of the conditioning, the specimen shall be subject to normal ambient conditions for recovery for not less than 1 h and not more than 2 h. See IEC 60068-2-78, *Test Cab* for details on how this can be accomplished.

8.2.5 Performance tests

Unless otherwise agreed the EUT should be connected to the power supply and switched on throughout the test, as per normal operation. Performance tests shall be carried out on the EUT within the first 2 hours after the specimen has been introduced into the chamber.

Within one hour at normal ambient humidity and temperature after the damp heat test, performance test shall be carried out in accordance with the relevant test programme.

8.2.6 Tolerances

Temperature: $\pm 2^\circ\text{C}$.

Relative humidity: +2%/-3%.

8.2.7 Test result

The test is deemed to have been passed if the specified functions are demonstrated, results fall within the specified tolerance limits and no damage to the EUT is detected.

8.3 Class B – cyclic (condensation)

8.3.1 Test procedure

Basis: IEC publication 60068-2-30, *Test Db: Damp heat cyclic*.

8.3.2 Additional preconditioning

Prior to exposure to high humidity, the EUT shall reach its equilibrium state at an ambient temperature of $25^\circ\text{C} \pm 3^\circ\text{C}$, with no power on.

During the last hour of the preconditioning time, the relative humidity shall be raised to not less than 95%.

8.3.3 Temperature and humidity cycle

After the preconditioning, humidity and temperature cycling shall be carried out in accordance with Figure 4.

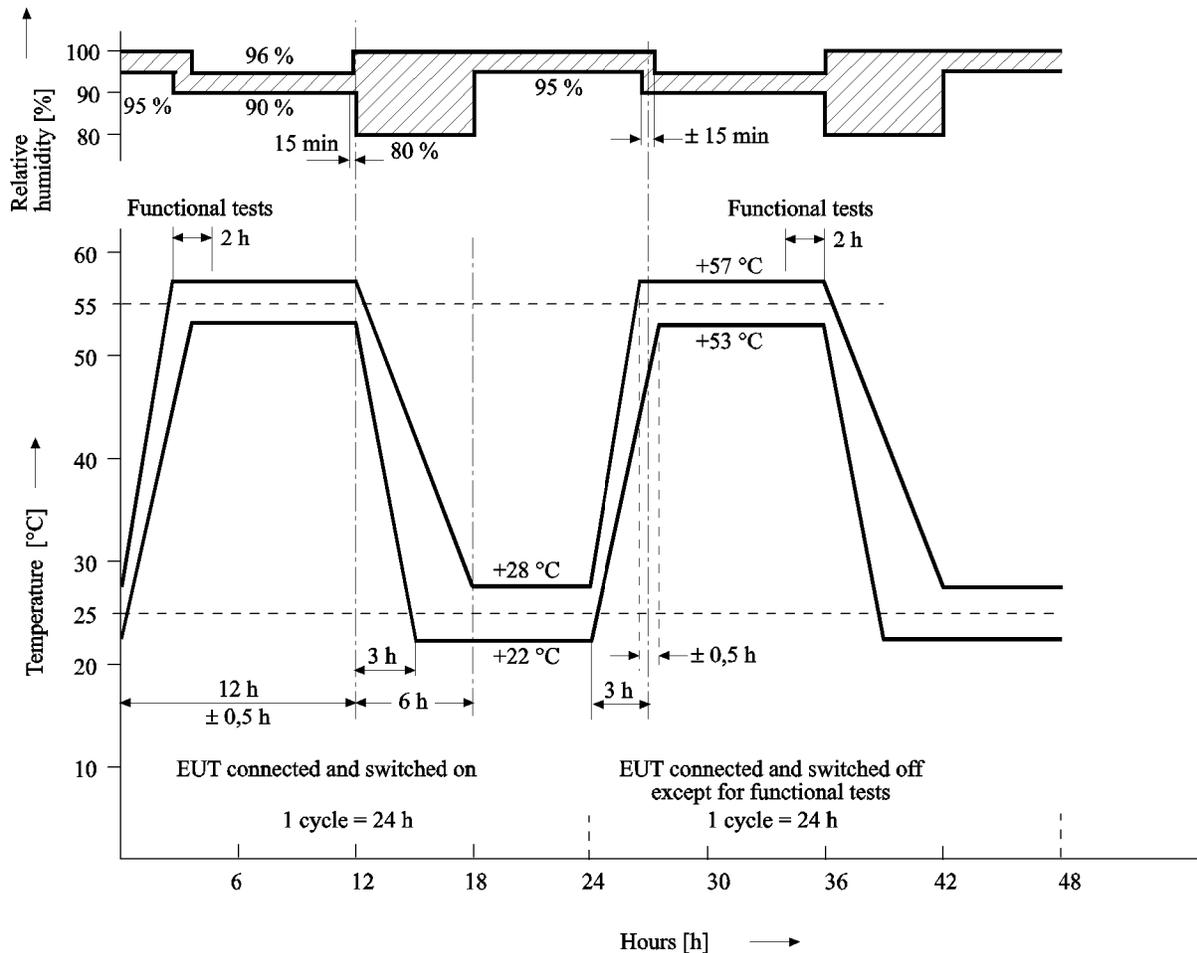


Figure 4 Damp heat test cycle

The EUT shall be placed in the test chamber at room temperature and the power supply shall be connected and switched on throughout the first test cycle. During the second test cycle, the EUT shall be switched off, except for duration of the performance test.

Before the temperature rise interval, the relative humidity shall be raised to the upper test level. The temperature is then to be raised from normal ambient temperature to the upper test temperature within a period of 3 h ± 30 min.

The rate of temperature change during the temperature rise interval shall be such that condensation takes place on the EUT. For smaller EUTs, which have a small thermal time constant, the rate of temperature change shall be increased sufficiently to give condensation, even if this gives a rise time below 2 h 30 min.

The upper test temperature shall be maintained until the end of the high temperature period, which is 12 h ± 30 min from the start of the temperature cycle.

The temperature is then to be lowered to normal ambient temperature within 3 h to 6 h. The EUT shall be in equilibrium with its surroundings during this period.

The ambient temperature is then to be maintained until the end of the 24 h temperature cycle.

Two cycles shall be carried out.

After completion of the last temperature cycle, the relative humidity shall be lowered to normal ambient humidity.

Where heaters or other devices to prevent condensation are an integral part of the EUT, they may be used during the test.

8.3.4 Performance test

Performance tests shall be performed at upper test temperature within the first 2 hours of the first and the last 2 hours of the second test cycle.

Within one hour at normal ambient humidity and temperature, the following tests shall be carried out:

- performance test in accordance with the relevant test programme
- insulation resistance test, where appropriate, according to [12].

8.3.5 Test levels

See Figure 4.

8.3.6 Tolerances

Temperature: $\pm 2^{\circ}\text{C}$.

Relative humidity: $\pm 3\%$.

8.3.7 Test result

The test is deemed to have been passed if the specified functions are demonstrated, results fall within the specified tolerance limits and no damage to the EUT is detected.

9 Cold test

9.1 General

This test serves to demonstrate that under the influence of cold, no damage is caused to the EUT and no permanent or temporary malfunctions occur.

9.1.1 Chamber temperature and humidity measurement

See item [7.1.1].

9.1.2 Air flow

Forced convection in the chamber shall not be used when testing heat generating specimen.

9.2 Test procedure

Basis: IEC publication 60068-2-1, *Tests Ab and Ad*.

9.2.1 Preconditioning

The EUT shall be kept at normal ambient conditions for initial performance testing according to the relevant test programme.

Insulation resistance test, where appropriate, shall be carried out in accordance with [12].

9.2.2 Temperature cycle

After the preconditioning time, the temperature cycle is started at normal ambient temperature T_N and run as shown in Figure 5.

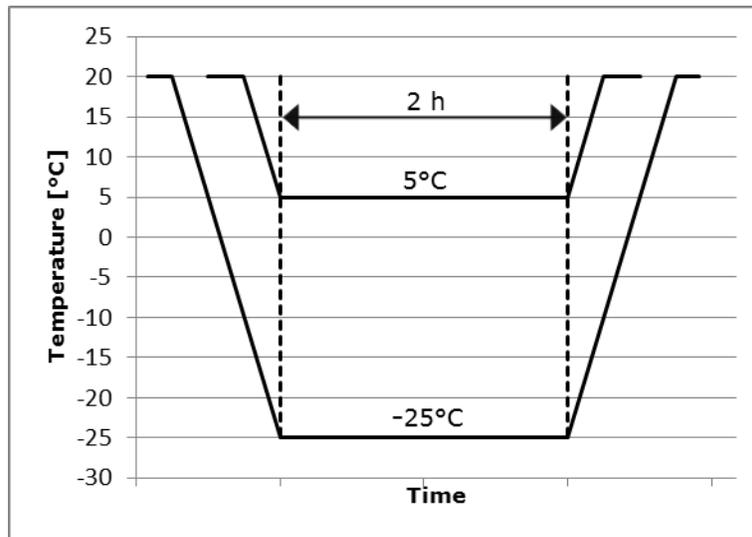


Figure 5 Cold, temperature cycle

The permitted rate of change of temperature when the chamber temperature is shifted is normally limited by the thermal time constant of the EUT. The EUT shall be in thermal equilibrium with its surroundings during this period to enable reproducible performance tests to be carried out as specified in the relevant test programme. If no performance testing is required during this period, the maximum rate of change of temperature is 1°C per min. average over a period of not more than 5 minutes.

The EUT should not be operating during conditioning and testing, except for the performance test. Unless otherwise stated in the relevant test programme, the most unfavourable power supply for the particular specimen shall be applied in the test interval.

9.2.3 Performance tests

During the last hour at the test temperature, performance testing according to the relevant test programme shall be carried out.

After completion of the temperature rise interval, the EUT shall be kept at normal ambient condition and fed by normal power supply for performance testing under load according to the relevant test programme.

Insulation resistance test, where appropriate, shall be carried out in accordance with [12].

9.2.4 Test levels

Testing time: test interval = 2 hours.

Table 12 Lower test levels according to temperature class

Temperature	Class A	+5°C
	Class B	+5°C
	Class C	-25°C
	Class D	-25°C

The upper test levels for the different temperature classes specified in this test, are given in [7], *Dry heat test*.

9.2.5 Tolerances

Temperature: $\pm 2^\circ\text{C}$.

9.3 Test result

The test is deemed to have been passed if the specified functions are demonstrated, the values of the insulation resistance measurement fall within the specified tolerance limits and no damage to the EUT is detected.

10 Salt mist test

10.1 General

This test serves to demonstrate that under the influence of a saline atmosphere, no damage (corrosion) is caused to the components of the EUT and no functional affections occur.

10.1.1 Salt solution

The salt solution shall be made from NaCl analytical reagent quality and distilled water.

The solution shall be kept at the chamber temperature during the test.

The pH value of the solution shall be between 6.5 and 7.2.

10.2 Test procedure

Basis: IEC publication 60068-2-52, *Test Kb*.

Before commencing the test, an insulation resistance measurement shall be taken in accordance with [12], and a functional test shall be performed.

The test consists of 4 sprayings and 7 days storage in the damp chamber after each spraying.

On the 7th day of each storage period, functional tests shall be performed.

On completion of the test, a functional test shall be performed and an insulation resistance measurement to be taken in accordance with [12]. The condition of the EUT shall be evaluated (visual inspection).

10.3 Test conditions

Table 13 Test conditions

Number of spraying	4
Storage period in damp chamber	7 days after each spraying, 28 days total
Spray duration	2 hours
Temperature	25°C ± 10°C
Saline solution	5% NaCl, pH 6.5 to 7.2 at 20°C ± 2°C
Storage temperature	40°C ± 2°C
Humidity in chamber during storage	93% +2%/-3%

10.4 Test result

The test is deemed to have been passed if the EUT test exhibits no significant corrosion, the specified functions are demonstrated and the value of the insulation resistance measurement fall within the specified tolerance limits.

11 Inclination test

This test serves to demonstrate that under the influence of inclinations, the EUT remains operational and no unintentional switching operations or functional changes occur.

11.1 Test procedure

Basis: IEC publication 60092-504.

The EUT shall be fastened on a platform in its normal mounting position, and in accordance with the manufacturer's instructions. The position relative to the direction of gravity shall be as during normal use.

The EUT shall be operating under normal load unless otherwise specified in the relevant test programme. If necessary the EUT shall have reached its equilibrium state prior to testing.

The test shall be carried out in two mutually perpendicular planes referred to the EUT's normal position.

11.2 Test levels

Table 14 Dynamic test levels

Level	up to 22.5° in each direction
Period	10 seconds
Test duration	min. 15 minutes

Table 15 Static test levels

Level	22.5° in each direction
Test duration	sufficient to allow the behaviour of the EUT to be evaluated

The inclination tests are normally not required on equipment with no moving parts.

11.3 Test result

The test is deemed to have been passed if the specified functions are demonstrated, the results fall within the specified tolerance limits and no damage to the EUT is detected.

12 Insulation resistance test

12.1 General

This test serves to demonstrate that the insulation resistance at the electrical connections of the EUT meets the requirements.

The insulation resistance test comprises two tests:

- Test A, which is an initial test.
- Test B, which shall be carried out within one hour after:
 - damp heat test [8]
 - cold test [9]
 - salt mist test [10]

- high voltage test [13]

when these tests are required according to the relevant test programme.

Test B shall demonstrate that the insulation resistance remains within the minimum resistance limits.

12.2 Test procedure

12.2.1 Preconditioning

Any filters installed between circuit and earth to avoid problems with EMI may be removed before the test. Prior to insulation test A, the EUT shall reach its equilibrium state at normal ambient condition with no power on.

12.2.2 Tests

The insulation resistance shall be measured between supply terminals and earth.

Test voltage and minimum insulation resistance is given in [Table 16](#) below. Test A specifies minimum insulation resistance during initial test. Test B specifies minimum insulation within one hour after a damp heat-, cold-, salt mist- and high voltage test.

Table 16 Minimum insulation resistance

Rated supply voltage	Test voltage D.C.	Minimum insulation resistance	
		Test A	Test B
Up to 65 V	2 × supply voltage minimum 24 V	10 MΩ	1 MΩ
Over 65 V	500 V	100 MΩ	10 MΩ

12.3 Test results

The test is deemed to have been passed if the values are not lower than those specified in [Table 16](#).

13 High voltage test

This test serves to demonstrate that the dielectric characteristics at the electrical connections of the EUT meet the requirements for the test standard.

13.1 Test procedure

13.1.1 Preconditioning

Prior to the high voltage test, the EUT is allowed to reach its equilibrium state at normal ambient conditions with no power on.

13.1.2 Test levels

Unless higher test voltage is specified by the equipment specification for the EUT, the high voltage test (where appropriate) shall be carried out at a frequency of 50 Hz or 60 Hz with an AC test voltage according to the [Table 17](#) below.

Table 17 High voltage test level

Rated voltage U_N (V)	Test voltage (V) AC
up to 65	$2 \cdot U_n + 500$
66 to 250	1500
251 to 500	2000
501 to 690	2500
Test duration	1 minute per test

Separate circuits shall be tested against each other, and all circuits connected to each other shall be tested against earth.

Contact pieces shall be tested across their open points of contacts. In case contact pieces which, owing to engineering reasons, show very small opening distance at the point of contact, e.g. in thermal relays, the test voltage at the point of contact may be reduced to twice the rated voltage, but not less than 500 V.

Printed circuit boards with electronic components that could be damaged may be removed during the high voltage test.

13.1.3 Performance test

On completion of the high voltage test, insulation resistance test and performance tests according to the relevant test programme shall be carried out.

13.1.4 Test results

The test is deemed to have been passed if no flashover is observed and correct functionality and insulation resistance is within specified limits.

14 Electromagnetic compatibility (EMC)

14.1 Immunity tests – general

The scope of the EMC immunity tests shall verify the robustness of the EUT to electromagnetic disturbance due to sources such as RF transmitters and other equipment.

14.2 Performance criteria

The following performance criteria are used during this section for the various EMC immunity tests.

Performance criterion A (for continuous/high-frequency phenomena):

The EUT shall continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed as defined in the relevant equipment standard and in the technical specification published by the manufacturer.

Performance criterion B (for transient phenomena):

The EUT shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed as defined in the relevant equipment standard and in the technical specification published by the manufacturer. During the test, degradation or loss of function or performance that is self-recoverable is however allowed but no change of actual operating state or stored data is allowed.

14.3 Preconditioning

Prior to the electromagnetic compatibility immunity tests, the EUT shall reach its equilibrium state at normal ambient conditions. Initial performance test shall be carried out in accordance with the relevant test programme.

14.4 Conducted low frequency immunity test

This test simulates the effects of power supply harmonics on AC supplies, and alternator ripple on DC supplies. Historically this test originates from IEC 60945 Ed.3.

14.4.1 Test procedure

During the conducted low frequency test, the EUT shall conform to its normal operational configuration with the r.m.s test voltages specified in [Table 18](#) and [Table 19](#), superimposed on the power lines.

The frequency sweep rate shall be sufficiently low to allow the detection of any malfunction of the EUT. In conducting the above tests, when the impedance is too low to maintain the signal level, then the maximum applied power to the supply lines may be limited to 2 W.

To protect the power supply from the low frequency test voltage, the power supply may be decoupled with a 10 μF AC capacitor with short leads (for AC supply) or a 440 μF electrolytic capacitor with short leads (for DC supply).

The low frequency generator shall be coupled in series with each phase, in turn (for AC supplies), or in series with the positive terminal (for DC supplies). The coupling impedance shall be $< 1 \Omega$.

The test setup is illustrated in [Figure 6](#).

14.4.2 Performance test

Performance test shall be carried out in accordance with the relevant test programme.

Table 18 AC 50/60 Hz supply voltage

<i>Frequency sweep range (Hz)</i>	<i>Test voltage: % of U_N, Min: 3 V r.m.s. Max. power: 2 W</i>
Up to 15 th harmonics	10% of U_N
15 th to 100 th harmonics	Decreasing from 10% to 1% of U_N
100 th to 200 th harmonics	1% of U_N
Step size	Supply frequency, 50 or 60 Hz
Dwell time	5 s per harmonic frequency ¹⁾
1) 5 seconds is recommended. The sweep rate shall be sufficiently slow to allow influences on the operational behaviour of the equipment under test to be readily detected.	

Table 19 DC supply voltage

<i>Frequency sweep range (Hz)</i>	<i>50 Hz to 10 kHz</i>
Signal Level	3 V r.m.s. – max. 2 W
Sweep rate	1.5×10^{-3} decades/s (or 1%/3s)

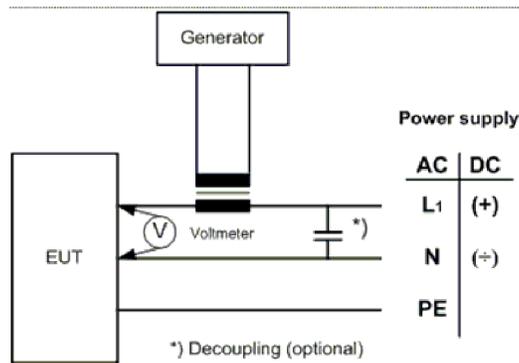


Figure 6 Test set-up - conducted low frequency test

Alternative test setup with versatile power supply where the test signal can be superimposed on the supply voltage will also be accepted.

14.4.3 Test results

In accordance with performance criterion A.

14.5 Electrical fast transient/burst immunity test

14.5.1 Test procedure

Basis: IEC publication 61000-4-4.

During the electrical fast transient/burst test, the EUT shall be in operation under normal load and power supply, and to be connected to external wiring in accordance with the manufacturer's recommended procedure.

A fast transient signal shall be superimposed on each of the power supply lines (AC and DC) in turn, and to signal lines via a capacitive coupling clamp. The fast transient signal shall be in accordance with test levels specified in [Table 20](#).

Table 20 Fast transient signal test level

<i>Test levels</i>	
Single pulse time	5 ns (between 10% and 90% value)
Single pulse width	50 ns, (50% value)
Amplitude	2 kV line on power supply port/ earth; 1 kV on I/O data control and communication ports (coupling clamp)
Polarities	±
Pulse period	300 ms
Pulse duration	15 ms
Duration	5 minutes per polarity

<i>Test levels</i>	
Repetition rate	5 kHz
<i>Tolerances</i>	
Burst duration and period	± 20%
Source impedance	± 20%
Amplitude	± 10%

14.5.2 Performance test

Performance test shall be carried out in accordance with the relevant test programme.

14.5.3 Test results

In accordance with performance criterion B.

14.6 Electrical slow transient/surge immunity test

14.6.1 Test procedure

Basis: IEC publication 61000-4-5.

During the electrical slow transient/surge test, the EUT shall be in operation under normal load and power supply, and be connected to external wiring in accordance with the manufacturer's recommended procedure. A slow transient signal shall be superimposed on each of the power supply lines (AC and DC), both line-to-line and line-to-ground. The slow transient signal shall be in accordance with test levels as specified in [Table 21](#).

Table 21 Slow transient signal test levels

<i>Test levels</i>	
Pulse	1.2/50 μ s voltage surge 8/20 μ s current surge
Amplitude	0.5 kV, line-to-line 1 kV, line-to-ground
Polarities	±
Number of pulses	5 per polarity
Repetition rate	1 per minute
<i>Tolerances</i>	
Amplitude, open/short circuit	± 10%

14.6.2 Performance test

Performance test shall be carried out in accordance with the relevant test programme.

14.6.3 Test results

In accordance with performance criterion B.

14.7 Conducted radio frequency immunity test

14.7.1 Test procedure

Basis: IEC publication 61000-4-6.

During the conducted radio frequency test, the EUT shall be in operation under normal load and power supply, and be connected to external wiring in accordance with the manufacturer's recommended procedure. A radio frequency signal shall be superimposed in common mode on each of the power supply lines (AC and DC), and to signal/control lines. The test shall be performed with the test generator connected to each of the coupling and decoupling devices in turn while the other non-excited RF input ports of the coupling devices are terminated by a 50 Ω load resistor.

The radio frequency signal for EMC class A and B shall be in accordance with test levels specified in [Table 22](#) and [Table 23](#).

Table 22 Conducted radio frequencies: EMC class A

<i>Test levels</i>	
Frequency range	150 kHz - 80 MHz
Voltage level (e.m.f.)	3 V r.m.s.
Amplitude Modulation	80% AM at 1000 Hz ¹⁾
Max. sweep rate	1.5×10^{-3} decades/s (or 1%/3sec.)
1) For equipment requiring an input signal with a modulation frequency of 1000 Hz, the test should be carried out with a modulation frequency of 400 Hz.	
<i>Tolerances</i>	
Amplitude	$\pm 10\%$

If continuous sweep cannot be performed, the test may be carried out at discrete frequencies. The frequency steps shall be maximum 1% of the initial frequency.

Table 23 Conducted radio frequencies: EMC class B

<i>Test levels</i>	
In addition to the tests specified for class A, Table 22 , tests at spot frequencies shall be carried out as listed below	
Spot frequencies	Voltage level (e.m.f.)
2/3/4/6.2/8.2/12.6/16.5/ 18.8/22/25 MHz	10 V r.m.s.

14.7.2 Performance test

Performance test shall be carried out in accordance with the relevant test programme.

14.7.3 Test results

In accordance with performance criterion A.

14.8 Radiated electromagnetic field immunity test

This test serves to demonstrate that under the influence of electromagnetic fields, no damage is caused to the EUT and no permanent or temporary malfunctions occur.

14.8.1 Test procedure

Basis: IEC publication 61000-4-3

The EUT shall be placed in a shielded enclosure with its most sensitive side facing the radiating antenna. The distance between the EUT and the antenna is preferably to be 3 meters (minimum 1 meter). If doubt exists regarding the most sensitive side, all six faces may, if this is considered necessary, be presented to the antenna.

The EUT shall be insulated to prevent metallic contact between housing and the shielded enclosure. However, grounding of the EUT's housing or case shall be carried out in accordance with the manufacturer's installation procedure.

Unless otherwise stated in the relevant test programme, the EUT shall be in its housing with all covers and access panels in place. If the EUT is designed to be mounted in panels, rack or cabinet, equivalent protection may be provided.

During the radiation test, the EUT shall be in operation under normal load and power supply, and be connected to external wiring in accordance with the manufacturer's recommended procedure.

If the manufacturer does not specify external wiring, unshielded twisted-pair wiring shall be used for a length equal to one metre from the point of connection to the EUT.

The EUT shall be exposed to an electromagnetic field in accordance with test levels specified in [Table 24](#).

Table 24 Electromagnetic field sweep frequency test levels

<i>Test levels</i>	
Frequency range	80 MHz to 2 GHz
Electric field strength	10 V/m
Amplitude modulation	80% at 1 kHz ¹⁾
Max. sweep rate	$1.5 \cdot 10^{-3}$ decade/s (or 1%/3sec.)
1) For equipment requiring an input signal with a modulation frequency of 1000 Hz, the test should be carried out with a modulation frequency of 400 Hz.	
<i>Tolerances</i>	
Electric field strength	-0/+6 dB

14.8.2 Performance test

Performance test during the radiation test shall be carried out in accordance with the relevant test programme.

14.8.3 Test result

In accordance with performance criterion A.

14.9 Electrostatic discharge immunity test

14.9.1 Test procedure

Basis: IEC publication 61000-4-2.

The electrostatic discharge test shall be carried out using an electrostatic discharge generator with typical characteristics in accordance with test levels specified in [Table 25](#).

The EUT shall be placed on an earth reference plane made out of a metallic sheet, which shall project beyond the EUT at least 0.1 m on all sides. The distance between the EUT and the walls of the laboratory and any other metallic structure shall be minimum 1 m.

The earth cable of the electrostatic discharge generator shall be connected to the earth reference plane.

Connection of the EUT to the earth system shall be in accordance with the manufacturer's specification. No additional earth connections shall be provided.

During the discharge test, the EUT shall be fed by normal power supply and shall be in operation as specified in the relevant test programme.

The static electricity discharges shall be applied only to such points and surfaces of the EUT, which are normally accessible to the operator. A minimum of ten spots shall be selected.

Contact discharges shall be applied to conductive surfaces and coupling planes. Air discharges shall be applied to insulating surfaces.

Ten discharges shall be applied at each preselected spot.

Table 25 Electrostatic discharge test levels

<i>Test levels</i>		
Output voltage	Air	2 kV, 4 kV and 8 kV
	Indirect	6 kV
	Contact	6 kV
Polarities		±
<i>Tolerances</i>		
Energy storage capacitor		± 10%
Discharge resistor		± 10%
Output voltage		± 5%

14.9.2 Performance test

After the electrostatic discharge test, performance test shall be carried out in accordance with the relevant test programme.

14.9.3 Test result

In accordance with performance criterion B.

14.10 Emission tests - general

The scope of the EMC emission tests shall verify that the EUT does not generate any type of electromagnetic disturbance that will influence on the performance of radio or telecommunication equipment or other type of electronic equipment.

14.10.1 Preconditioning

Prior to the electromagnetic compatibility emission tests, the EUT shall reach its equilibrium state at normal ambient conditions.

Initial performance test shall be carried out in accordance with the relevant test programme.

14.10.2 Test procedure

Basis: CISPR 16-2-1, 16-2-3

The measurements shall be made in operational mode producing the largest emission in the frequency band being investigated consistent with normal applications.

The tests shall be carried out within the specified operating conditions for the EUT and at its rated supply voltage.

Measurements of conducted and radiated emission shall be performed in well-defined and reproducible conditions.

14.11 Radiated emission test

The radiated emission from the enclosure port of the EUT shall be measured over the frequency range and measuring bandwidth specified in [Table 26](#).

The distance from the enclosure of the EUT to the antenna shall be 3 m.

Table 26 Radiated emission test

<i>Enclosure Port</i>	<i>Frequency range</i>	<i>Measuring bandwidth</i>	<i>Limits (quasi-peak)</i>
EMC A All locations except bridge and open deck	0.15 - 30 MHz	9 kHz	80 - 50 dB μ V/m
	30 - 100 MHz	120 kHz	60 - 54 dB μ V/m
	100 - 2000 MHz	120 kHz	54 dB μ V/m
	Except: 156 - 165 MHz	9 kHz	24 dB μ V/m ¹⁾
EMC B All locations including bridge and open deck	150 - 300 kHz	9 kHz	80 - 52 dB μ V/m
	0.30 - 30 MHz	9 kHz	52 - 34 dB μ V/m
	30 - 2000 MHz	120 kHz	54 dB μ V/m
	Except: 156 - 165 MHz	9 kHz	24 dB μ V/m ¹⁾
1) Alternatively 30 dB μ V/m peak limit can be applied.			

14.11.1 Test results

The test is deemed to have passed if the radiated emission does not exceed the limits specified in [Table 26](#).

See also [Figure 7](#).

14.12 Conducted emission test

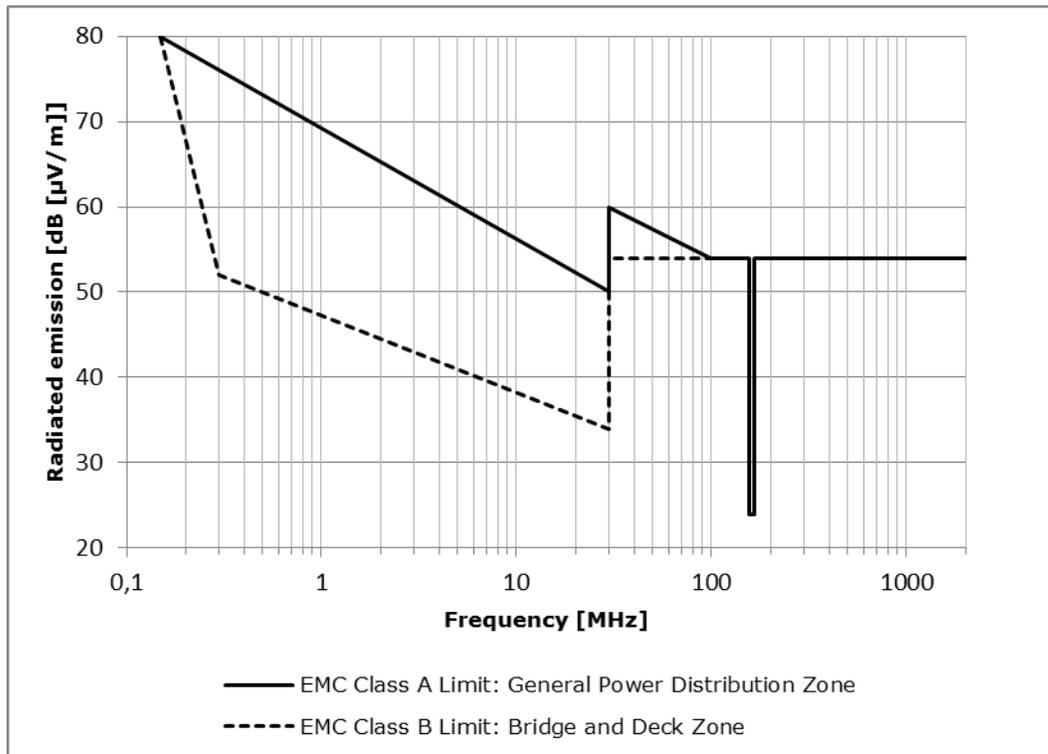
The conducted emission on the power supply port of the EUT shall be measured over the frequency range and measuring bandwidth specified in [Table 27](#).

Table 27 Conducted emission test

Power Port	Frequency range	Measuring bandwidth	Limits (quasi-peak)
EMC A All locations except bridge and open deck	10 - 150 kHz	200 Hz	120 - 69 dB μ V
	150 - 500 kHz	9 kHz	79 dB μ V
	0.50 - 30 MHz	9 kHz	73 dB μ V
EMC B All locations including bridge and open deck	10 - 150 kHz	200 Hz	96 - 50 dB μ V
	150 - 350 kHz	9 kHz	60 - 50 dB μ V
	0.35 - 30 MHz	9 kHz	50 dB μ V

14.12.1 Test results

The test is deemed to have passed if the conducted emission does not exceed the limits specified in [Table 27](#). See also [Figure 8](#).

**Figure 7 Radiated emission test, limit values**

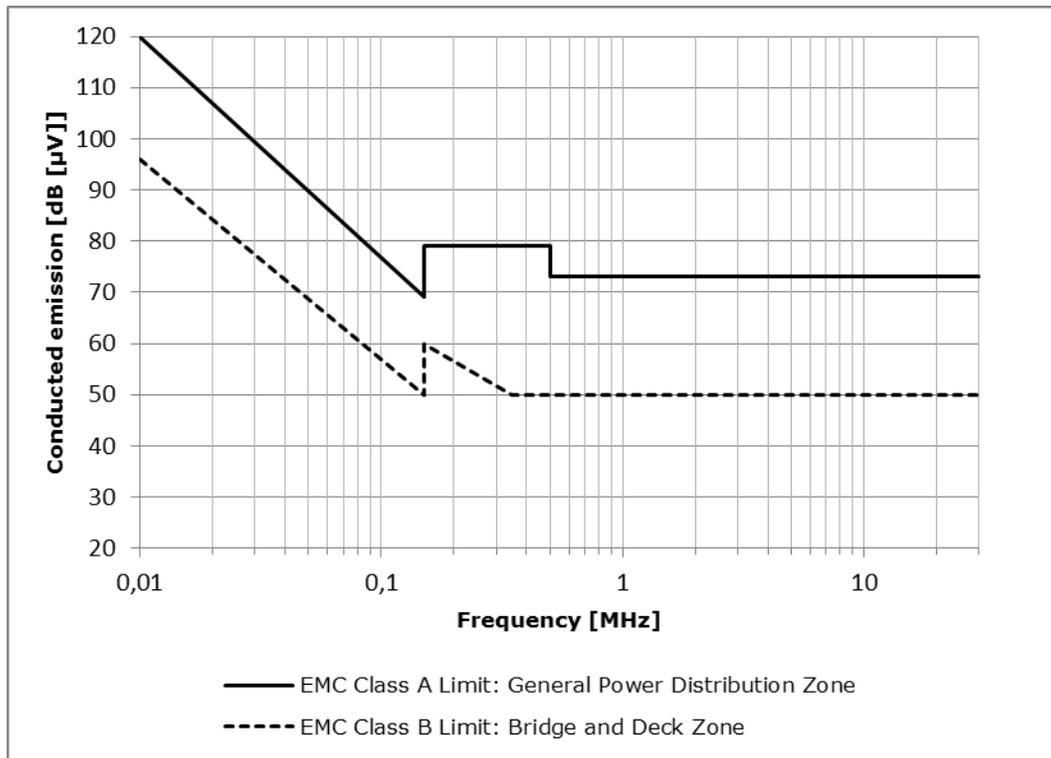


Figure 8 Conducted emission test, limit values

15 Special purpose tests

15.1 Compass safe distance test

Equipment for installation within a distance of 5 m from a standard or a steering magnetic compass shall be tested for compass safe distance in accordance with IEC 60945.

15.2 Acoustic noise and alarm signal levels for equipment installed on the bridge

Equipment intended for installation on the bridge shall be examined for acoustic noise and alarm signal levels in accordance with IEC 60945.

Note:

For systems reference is made to IMO Resolution MSC.302(87) *Adoption of Performance Standards for Bridge Alert Management (BAM)* and IMO Resolution A.1021(26) *Code on Alerts and Indicators*.

---e-n-d---o-f---n-o-t-e---

16 Additional tests

Additional tests may be specified in the relevant test programmes. Such tests may comprise:

- 16.1 Flame-retardant test.
- 16.2 Ice test.
- 16.3 High temperature test.
- 16.4 Temperature shock test.
- 16.5 Low pressure test.
- 16.6 High pressure test.
- 16.7 Mechanical shock test.
- 16.8 Wind-pressure test.
- 16.9 Sealing test.
- 16.10 Soldering test.
- 16.11 Mould growth test.
- 16.12 Storage test.
- 16.13 Working medium quality test for pneumatic and hydraulic equipment.
- 16.14 Radiation test.
- 16.15 Explosion safety or intrinsic safety test for electrical equipment.
- 16.16 Air pollution, sensitivity test.
- 16.17 Acceleration test.

APPENDIX A EU-DIRECTIVES

1 Scope

This appendix gives information on relevant EU directives and guidance on how to proceed in order to be able to claim conformity with the applicable directive.

2 General principles

The council of the European Union produces formal directives covering a wide range of products intended for marketing, distribution and sale within the European economic area (EEA).

Compliance with the relevant EU-directives will ensure that the products fulfil relevant safety and reliability requirements and provide access and free market admission of the product within the EEA.

3 The Society as notified body

Notified and competent bodies are independent organisations appointed by a European national authority, authorised to undertake conformity assessment before a product may be CE marked.

The Society has been appointed as notified body to perform conformity assessment for a range of EU-directives. Examples are:

- *Marine Equipment Directive (MED)*
- *Electromagnetic Compatibility Directive (EMC)*
- *Low Voltage Directive (LVD)*
- *Radio and telecommunications terminal equipment (R&TTE)*
- *Explosive Atmospheres Directive (ATEX).*

4 Classification systematic vs. EU-directives

There are some important differences between the classification rules systematic and the EU-Directives requirements that one should be aware of.

Classification rules are international, while EU-directives only concern EEA flagged ships.

Most directives are explicitly excluding ships from their scope. Examples are:

- *Machinery Directive*
- *ATEX Directive*
- *Pressure Equipment Directive.*

Many directives have limited third party intervention; self-declaration from the producer is often sufficient.

Some directives only require third party intervention in the design phase, i.e. do not cover the production phase.

Many directives only have requirements for component or sub-system level, i.e. do not cover system integration and safety of the total functionality.

A ship, and consequently the installed equipment, is subject to classification as long as it is in operation. CE-mark of a product is a one go action and does not require any follow up during the product life cycle.

As can be seen from the above list a CE-mark does not give any guarantee that a product fulfils the requirements for approval by a classification society.

However, a product or system to be installed on e.g. a vessel classed with the Society may also have to be compliant in accordance with the appropriate EU directives. Notice that this requires a separate verification procedure independent of the design approval or type approval procedures.

5 Relevant EU directives

The relevant directives for installations on ships, MOUs and HSLC are:

- the *Marine Equipment Directive* (MED)
- the *Electromagnetic Compatibility Directive* (EMC)
- the *Low Voltage Directive* (LVD).

More information on these directives is provided in the following:

5.1 Marine Equipment Directive (MED) – 2014/90/EU

The scope of the *Marine Equipment Directive* is to enhance safety at sea and the prevention of marine pollution. This shall be achieved through a uniform use and free movement (access) to equipment in the categories listed below within the European community:

- life-saving appliances
- marine pollution prevention
- fire protection equipment
- navigation equipment
- radiocommunication equipment
- equipment required under COLREG 72
- bulk carrier safety equipment
- equipment under SOLAS Ch.II-1.

For these equipment categories, the other EU directives do not apply.

For instance for navigation and radio-communication equipment the EMC aspects are covered directly by the *Marine Equipment Directive* and the EMC directive does not apply. The EMC aspects are in this case handled according to MED and IEC 60945.

For a given product the manufacturer can often choose between several conformity assessment procedures (modules) leading to the conformity mark. The assessment may for instance consist of EU-type examination (module B) in combination with production quality assurance, in accordance with ISO 9002 (module D), or alternatively full unit verification (module G) with issuing of certificate of conformity on a case by case basis from the notified body.

Notice that the conformity mark for the *Marine Equipment Directive* is not the CE-mark but a steering wheel. It is recommended, for a given product, to investigate carefully which standards do apply and which tests shall be performed.

5.2 Electromagnetic Compatibility Directive (EMC) – 2014/30/EU

Characteristic standards are: EN 55011, 55032, IEC/EN 60945, 61000-6-x, 61000-4-x.

The scope of the EMC directive is to prevent undesired interference between electrical and electronic equipment due to electromagnetic disturbances generated and/or absorbed by such equipment.

I.e. the EMC directive and the related standards provide test requirements to ensure that:

The equipment has an adequate level of intrinsic immunity of electromagnetic disturbance to enable it to operate as intended (immunity).

The electromagnetic disturbance generated by the equipment does not exceed a specified level allowing radio and telecommunications equipment and other apparatus to operate as intended (emission).

It is useful to have a basic understanding of the applicability of the different types of EMC standards.

Four types of EMC standards exist: Basic, Generic, Product family and Product standards.

Basic EMC standards relate to general information, to the disturbing phenomena and to measurement or testing techniques.

Generic EMC standards are general product standards for EMC in that they specify a number of disturbances and tests applicable to products operating in a given environment.

Product family and product EMC standards relate to particular type of products or a specific product, respectively, for which specific conditions should be considered.

Product family/product EMC standards take precedence over generic EMC standards.

Product EMC standards take precedence over product family EMC standards.

Where neither product nor product family EMC standards exist for a particular product, the relevant generic standard applies.

It is recommended, for a given product, to investigate carefully which standards do apply and which tests shall be performed.

5.3 Low Voltage Directive (LVD) – 2014/35/EU

Typical standards: IEC/EN 62040-1, 60034-x, 60051-x, 60204-x, 60529, 60947-x and 60950.

The scope of the LVD directive is to take care of safety of personnel & property related to electrical installations (electric shock, ignition, fire etc.).

The safety provisions defined by the *Low Voltage Directive* and the appropriate standards are related to the design of the products in terms of selection of materials and components, mechanical strength, appropriate dimensions to avoid excessive heat dissipation etc.

It applies to electrical equipment with input or output voltages between 50 V and 1000 V AC and between 75 V and 1500 V DC.

Typical products are IT equipment, machines, measuring instruments and commodities.

Examples of items not covered by the *Low Voltage Directive* are:

- electrical equipment for use in an explosive atmosphere (EX equipment)
- electrical equipment for radiology and medical purposes
- electrical parts for goods and passenger lifts.

Specialised electrical equipment, for use on ships, which complies with the safety provisions drawn up by international bodies in which the member states participate.

As a consequence of the latter, certification according to the LVD directive may strictly not be needed for certain installations on board ships. However, in these cases the safety aspects are covered by other governmental requirements, which again are in accordance with recognised international safety provisions.

Safety matters of the other items listed above are covered by other directives.

It is recommended, for a given product, to investigate carefully which standards do apply and which tests shall be performed.



CHANGES – HISTORIC

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This is a new document.

DNV GL

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