STANDARD FOR CERTIFICATION
No. 2.4

ENVIRONMENTAL TEST SPECIFICATION FOR INSTRUMENTATION AND AUTOMATION EQUIPMENT

APRIL 2006

DET NORSKE VERITAS

FOREWORD

DET NORSKE VERITAS (DNV) is an autonomous and independent foundation with the objectives of safeguarding life, property and the environment, at sea and onshore. DNV undertakes classification, certification, and other verification and consultancy services relating to quality of ships, offshore units and installations, and onshore industries worldwide, and carries out research in relation to these functions.

Standards for Certification

Standards for Certification (previously Certification Notes) are publications that contain principles, acceptance criteria and practical information related to the Society's consideration of objects, personnel, organisations, services and operations. Standards for Certification also apply as the basis for the issue of certificates and/or declarations that may not necessarily be related to classification.

A list of Standards for Certification is found in the latest edition of Pt.0 Ch.1 of the ”Rules for Classification of Ships” and the ”Rules for Classification of High Speed, Light Craft and Naval Surface Craft”.

The list of Standards for Certification is also included in the current “Classification Services – Publications” issued by the Society, which is available on request. All publications may be ordered from the Society’s Web site http://exchange.dnv.com.

Comments may be sent by e-mail to *rules@dnv.com*
Comprehensive information about DNV and the Society's services is found at the Web site http://www.dnv.com

Computer Typesetting (FM+SGML) by Det Norske Veritas

Main changes from Standard for Certification 2.4 (issue April 2001)

This version of Standard for Certification 2.4 replaces the April 2001 version. A number of corrections and clarification have been made:

— *Vibration Sweep Sine Test Procedure* (3.6.2.1) is modified to allow for restricted frequency sweeping during endurance test, when several resonance frequency are detected close to each other.
— *Conducted Low Frequency test.* Figure for clarification of test set-up inserted. Harmonic used to define Frequency Sweep Range in table 3.17A.
— *Conducted Radio frequency Test.* The requirements to test from 10kHz to 150kHz removed, in line with E10.
— *"Radiated Susceptibility Test"* changed name to "Radiated Electromagnetic Field Immunity Test".
— *Emission test.* The tables are changed to one for "Radiated Emission Test" and one for "Conducted Emission" test. Reference to test basis corrected and measuring bandwidth for radiated emission test class B corrected to 9kHz. Figures showing test limit values inserted.
— The requirement for conducted emission test for signal and control circuits is removed. Now only applicable for power lines.
— Information regarding "Compass safe distance test" and "Acoustic noise test" inserted.

CONTENTS

1. Introduction

1.1 Scope

1.1.1

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's Rules for Classification of: Ships, High Speed & Light Craft and DNV's Offshore Standards.

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 are to be installed on Ships, MOUs and HSLC with DNV Class.

1.1.2

The scope of the tests required for a specific product will be determined on a case by case basis by Det Norske Veritas (DNV) depending on field of application and intended location on board.

1.1.3

DNV reserves the right, in justifiable cases, to request the performance of additional tests.

1.2 Reference to other Rules and Regulations

1.2.1

These requirements are harmonized with the following publications:

— IACS Unified Requirements E10,“Test Procedure for Electrical, Control and Instrumentation Equipment , Computers and Peripherals covered by Classification"
— IEC publication 60092-504,“Electrical installations in ships, part 504: Special features, control and instrumentation";
— DNV Rules for Classification, Part 4 Chapter 9,“Control and Monitoring Systems"

Note:

Equipment wished for use in navigation and radiocommunication systems is to 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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1.2.2

Standards other than those specified in 1.2.1 may be recognised, provided they are considered to be equivalent.

1.3 Definitions

For definitions, refer to DNV Rules for Classification, Part 4 Chapter 9, “Control and Monitoring Systems”, Sec.1 B.

1.4 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 appendix A.

1.5 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 appendix B.

2. Information on Environmental Testing and Testing arrangement

2.1 General

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

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

Clause 3.15 lists additional tests which may be required. Test procedures for these tests are to be agreed with DNV on a case by case basis.

2.2 Location classes

2.2.1 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 is to 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.

2.2.2 How to Select Location Classes

2.2.2.1 Instrumentation and automation equipment

Location classes may be selected directly from Table 2.2 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 2.1 may be used as follows:

— From column II in Table 2.1, 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 are to 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 Section 3 which are to be carried out, may now be obtained from Table 2. 2.

Note:

Tests listed in Table 2. 3 have severity levels independent of location on board.

Table 2-1 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, 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 Electromagnetic 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 2-2 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: +5°C to +55°C		Test 3.7. Not required if cyclic damp heat test (3.8.3) is performed
	B	Inside cubicles, desks, etc. with temperature rise of 5° C or more	Ambient temperatures: +5° C to +70°C		Test 3.7.
	C	Pump rooms, holds, rooms with no heating	Ambient temperatures: -25°C to +55°C		Test 3.7. and 3.9.
	D	Open deck, masts	Ambient temperatures: -25°C to +70°C		Test 3.7. and 3.9.
Humidity	A	Locations where special precautions are taken to avoid condensation	Relative humidity up to 96 % at all relevant temperatures.		Test 3.8.2 (no condensation)
	B	All other locations	Relative humidity up to 100 % at all relevant temperatures		Test 3.8.3 (condensation)
Vibration	A	On bulkheads, beams, deck, bridge	Frequency range: 3-13.2 Hz, Amplitude: 1.0 mm (peak value) Frequency range: 13.2-100 Hz, Acceleration amplitude: 0.7 g		Test 3.6.2 or Test 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: 3-25 Hz, Amplitude: 1.6 mm (peak value) Frequency range: 25-100 Hz, acceleration amplitude: 4.0 g		Test 3.6.2
	C	Masts	Frequency range: 3-13.2 Hz, Amplitude: 3.0 mm (peak value) Frequency range: 13.2-50 Hz, Acceleration amplitude: 2.1 g		
EMC	A	All locations except Bridge and Open Deck	Immunity	Reference Specifications:	
				Conducted Low Frequency	Test 3.14.4
				Electrical Fast Transient/Burst	Test 3.14.5
				Electrical Slow Transient Surge	Test 3.14.6
				Conducted Radio Frequency	Test 3.14.7 – Table 3.20
				Radiated Electromagnetic Field	Test 3.14.8
				Electrostatic Discharge	Test 3.14.9
			Emission	Radiated	Test 3.14.10 - 11
				Conducted	Test 3.14.10 - 12
	B	All locations including Bridge and Open Deck	Immunity	Conducted Low Frequency	Test 3.14.4
				Electrical Fast Transient/Burst	Test 3.14.5
				Electrical Slow Transient/Surge	Test 3.14.6
				Conducted Radio Frequency	Test 3.14.7 – Table 3.20/3.21
				Radiated Electromagnetic Field	Test 3.14.8
				Electrostatic Discharge	Test 3.14.9
			Emision	Radiated	Test 3.14.10 - 11
				Conducted	Test 3.14.10 - 12
Enclosure	A	Control rooms, accommodation, bridge	IP 22		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 3.10. and Test IEC Pub. no. 60529
	D	Submerged application, bilges	IP 68		

Table 2-3 Tests with severity level independent of location on board	
Tests	*Item*
Performance Test	3.3
Power Supply Test	3.4, 3.5
Inclination Test	3.11
Insulation Resistance Test	3.12
High Voltage Test	3.13
Additional Tests	3.15

2.3 Testing Arrangement

2.3.1 Where to test

Environmental testing may be performed in:

a) DNV's laboratories at Høvik, Norway.

b) At an European Laboratory accredited for all the required tests by an Accreditation Body being member of European Accreditation, EA.

c) At a non-European Laboratory accredited by an organisation who has signed a multilateral agreement (MLA) with EA.

d) At a laboratory having the quality system audited by DNV. A quality audit by DNV 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.

e) At a laboratory recognised/certified by the Marine Administration of one EU Member State or by another Notified Body (MED).

f) At any laboratory when testing is witnessed by a DNV surveyor).

Note:

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

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2.3.2 Test and Measuring Equipment

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

Documentation is to be available upon request.

2.3.3 Equipment under Test (EUT)

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

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

2.3.4 Test Reports

The test reports, in English language, 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 are to 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 is to be provided stating that the requirements in the standard used fulfils the equivalent requirements in the standard as required by DNV. Alternatively, a cross reference between the requirements of the two standards is to be provided.

Note:

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

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3. Environmental Type Test Specification

3.1 General

3.1.1 Relevant Test Programme

Prior to testing, a relevant and detailed test programme is to be prepared for each particular EUT. The test programme is to be based on type of equipment, the manufacturer's equipment specification and the environmental tests required for the particular. 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 2.2 of this publication.

The relevant test programme is to specify how the performance tests are to be carried out, and specify what measurements/performance checks that are to 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 in "Standards for Certification No. 2.4". 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 are to be carried out prior to the humidity test.

The relevant test programme is to be approved by DNV prior to commencement of the testing.

3.1.2 Normal Ambient Conditions

Basis: IEC publication 60068-1

Normal ambient conditions are defined as follows:

Table 3-1 Normal ambient conditions	
Temperature:	T_N = 20°C ± 2° C.Temperatures between 15°C and 35°C may be accepted provided selected temperature is kept constant within ±2°C during all tests and actual temperature is stated in the test report.
Relative humidity:	RH_N = 25% to 75%
Atmospheric pressure:	860-1060 mbar.
Radiation:	Negligible
Vibration:	Negligible
Power supply:	Nominal value

3.2 Visual Inspection

The product is to be visually inspected for good workmanship, conformity with the manufacturer's drawings and specifications, and DNV Rules for Classification as applicable.

Appendix A. (Procedures for type approval) may be used as a guideline as far as applicable to the equipment under consideration. All relevant parts of the DNV Rules are to be used as a basis when checking conformity with these Rules.

3.2.1 General Instructions for Performance of visual inspections

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

3.3 Performance Test

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

3.3.1 Test Procedure

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

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

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

3.3.2 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.

3.4 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.

3.4.1 Test Procedure

— 3 interruptions within a 5-minute period.
— 30 seconds pause between switching off and switching back on.

3.4.2 General Instructions for Test Performance

None.

3.4.3 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.

3.5 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.

3.5.1 Test Procedure

Prior to testing, the EUT is to 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 3-2, are to be calculated from nominal value of voltage and frequency.

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

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

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

3.5.2 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 3-2 Electrical Supply (alternating voltage)

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

Table 3-3 Battery Power Supply

No	*Voltage deviation*
7	+ 30 %
8	- 25 %

Table 3-4 Pneumatic / Hydraulic Power Supply

No	*Control pressure deviation*
9	+ 20 %
10	- 20 %

3.5.3 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.

3.6 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.

3.6.1 Definitions

Table 3-5 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.

3.6.2 Sweep sine Test

3.6.2.1 Test Procedure

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

The EUT is to be fastened to the test board by means of its own fastening devices. The equipment is to 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 are to be mounted during the test.

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

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

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

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

Resonance search is to be run at the actual test level specified in 3.6.2.4. No mechanical amplification factor greater than 10 will be accepted.

Endurance test is to 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 is to be adjusted accordingly. The test level is to be as in the sweep test.

If no amplification factor higher than 2 is found, the endurance test is to be performed at the frequency of the highest one. If no resonance frequencies are found, the test is to 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 must 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 must be endurance tested in addition. If a centre close to the end of the total frequency range is selected the sweep must 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.

3.6.2.2 Tolerances

Velocity or acceleration tolerances at the control point: ± 10%, at the attachment point: ± 15%.

Distortion of the acceleration waveform is not to exceed 25%.

Transverse motion is not to exceed 25% of the specified value.

Measurement of frequency for resonance determination is to be made with a tolerance of ± 0,5 Hz.

3.6.2.3 Performance Test

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

3.6.2.4 Test Levels

The test levels and frequency ranges for the three vibration classes are given in Fig. 3.1 below.

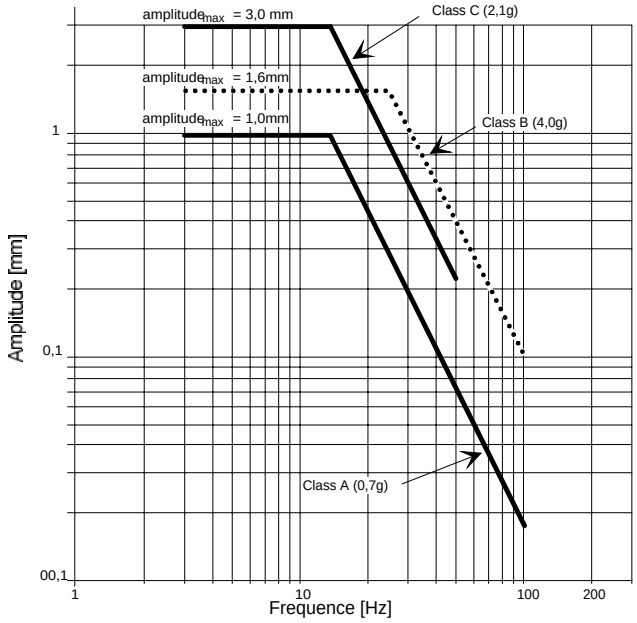

Figure 3-1
Vibration Curves

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 is to be used.

Table 3-6 General Vibration Strain, Class A.		
Frequency Range	*Displacement*	*Acceleration*
2^{+3}_{-0} Hz to 13.2 Hz	1.0 mm (peak value)	
13.2 Hz to 100 Hz		0.7g
Sweep rate	max. 1 octave/minute	

Table 3-7 High Vibration Strain, Class B.		
Frequency Range	*Displacement*	*Acceleration*
2^{+3}_{-0} Hz to 25 Hz	1.6 mm (peak value)	
25 Hz to 100 Hz		4.0g
Sweep rate	max. 1 octave/minute	

Table 3-8 Vibration Strain, Class C.		
Frequency Range	*Displacement*	*Acceleration*
2^{+3}_{-0} Hz to 13.2 Hz	3.0 mm (peak value)	
13.2 Hz to 50 Hz		2.1g
Sweep rate	max. 1 octave/minute	

3.6.2.5 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.

3.6.3 Wide Band Random Test (Class A only)

3.6.3.1 Test Procedure

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

The EUT is to be fastened to the test board by means of its own fastening devices. The equipment is to 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 are to be mounted during the test.

The EUT is to 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 is to be as in normal service during the test.

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

Resonance search is to be run at the actual test level specified in 3.6.2.4 for Class A. No mechanical amplification factor greater than 10 will be accepted.

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

3.6.3.2 Test Levels

The spectrum shape is given in Fig. 3.2.

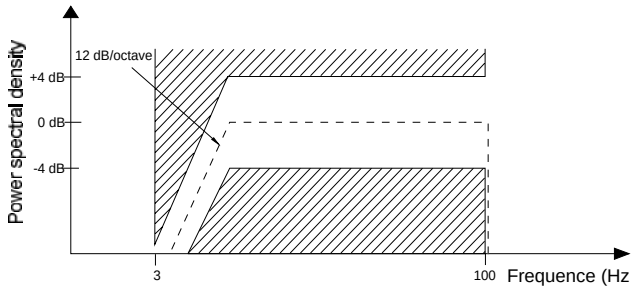

Figure 3-2
Wide band random power spectrum

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).

3.6.3.3 Tolerances

Table 3-9 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.

3.6.3.4 Performance Tests

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

3.6.3.5 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.

3.7 Dry Heat Test

3.7.1 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.

3.7.1.1 Chamber Temperature and Humidity Measurement

The chamber is to 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 are to be uniform and as similar as possible to those prevailing in the immediate vicinity of temperature and humidity sensing devices installed. These devices are to be located at such a distance from the , that the effect of dissipation is negligible.

3.7.1.2 Air Flow.

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

3.7.2 Test Procedure

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

3.7.2.1 Preconditioning

Prior to the dry heat test the EUT is to 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.

3.7.2.2 Temperature Cycle

After the preconditioning time, the temperature cycle is started at normal ambient temperature TN and run as shown in Fig. 3.3.

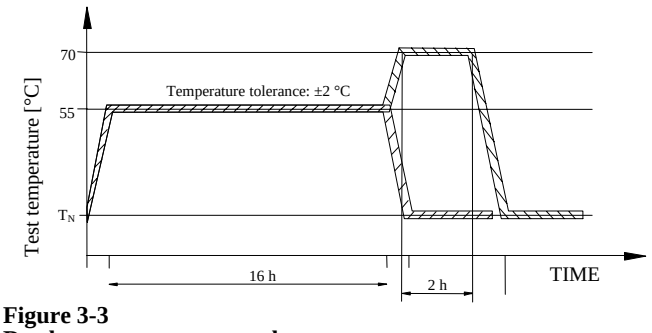

Figure 3-3
Dry heat, temperature cycle

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 is to 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 is to 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 is to be applied in the test temperature interval.

3.7.2.3 Performance Tests

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

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

3.7.2.4 Test Levels

Relative humidity: RH = max. 55%.

Table 3-10 Upper test levels according to temperature class		
Class	*Test temperature*	*Test duration*
A	55°C	16 hours
B	70°C	16 hours at 55°C + 2 hours at 70°C
C	55°C	16 hours
D	70°C	16 hours at 55°C + 2 hours at 70°C

The lower test levels for the different temperature classes specified in this test, are given in 3.9, Cold Test.

For environmental testing according to temperature class A or B, cold test may be required. This is to be specified in the relevant test programme. For environmental testing according to temperature class C or D, cold test will always be required.

3.7.2.5 Tolerances

Temperature: ± 2° C.

Relative humidity: ± l0%.

3.7.3 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.

3.8 Damp Heat Test

3.8.1 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.

3.8.1.1 Chamber Temperature and Humidity Measurement

See item 3.7.1.1.

3.8.1.2 Air Flow

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

3.8.1.3 Humidifying

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

3.8.1.4 Preconditioning

Prior to the damp heat test the EUT is to 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, is to be carried out in accordance with 3.12.

3.8.2 CLASS A – Static (Non-condensation)

3.8.2.1 Test Procedure

Basis: IEC publication 60068-2-3, Test Ca: Damp heat steady state.

3.8.2.2 Additional Preconditioning

Care shall be taken when introducing the 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.

3.8.2.3 Temperature and Humidity Conditions

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

3.8.2.4 Recovery

At the end of the conditioning, the specimen shall be subject to normal ambient conditions for recovery for not less than 1h and not more than 2h. Ref. IEC 60068-2-3, Test Ca for details on how this can be accomplished.

3.8.2.5 Performance Tests

Performance tests are to 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 is to be carried out in accordance with the relevant test programme.

3.8.2.6 Tolerances

Temperature: ± 2°C.

Relative humidity: +2%/-3%.

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.

3.8.3 CLASS B – Cyclic (Condensation)

3.8.3.1 Test Procedure

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

3.8.3.2 Additional Preconditioning

Prior to exposure to high humidity, the EUT is to reach its equilibrium state at an ambient temperature of 25°C ± 3°C, with no power on.

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

3.8.3.3 Temperature and Humidity Cycle

After the preconditioning, humidity and temperature cycling is to be carried out in accordance with Fig. 3.4.

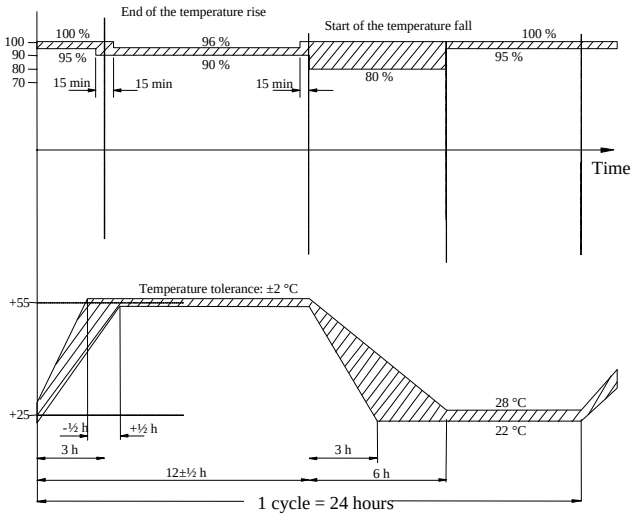

Figure 3-4
Damp Heat Test Cycle

The EUT is to be placed in the test chamber at room temperature and the power supply is to be connected and switched on throughout the first test cycle. During the second test cycle, the EUT is to be switched off.

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

The upper test temperature is to 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 to 6 h. The EUT is to 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 are to be carried out.

After completion of the last temperature cycle, the relative humidity is to 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.

3.8.3.4 Performance Test

Performance tests are to 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 are to be carried out:

— Performance test in accordance with the relevant test programme.
— Insulation resistance test, where appropriate, according to 3.12.

3.8.3.5 Test Levels

See fig. 3.4.

3.8.3.6 Tolerances

Temperature: ± 2° C.

Relative humidity: ±3%.

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.

3.9 Cold Test

3.9.1 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.

3.9.1.1 Chamber Temperature and Humidity Measurement

See item 3.7.1.1.

3.9.1.2 Air Flow

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

3.9.2 Test Procedure

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

3.9.2.1 Preconditioning

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

Insulation resistance test, where appropriate, is to be carried out in accordance with 3.12.

3.9.2.2 Temperature Cycle

After the preconditioning time, the temperature cycle is started at normal ambient temperature TN and run as shown in Fig. 3.5.

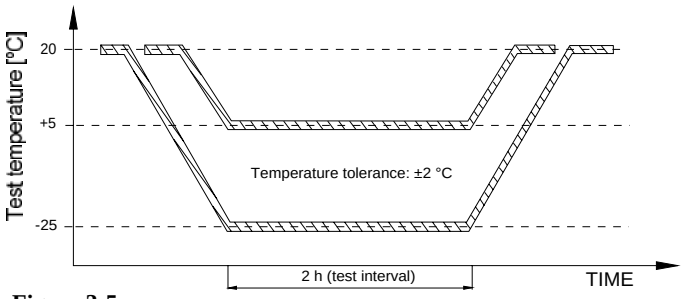

Figure 3-5
Cold, temperature cycle

The permitted rate of change of temperature when the chamber temperature is shifted is normally limited by the thermal time constant of the . The EUT is to 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 is to be applied in the temperature fall and temperature rise intervals. Unless otherwise stated in the relevant test programme, the most unfavourable power supply for the particular specimen is to be applied in the test interval.

3.9.2.3 Performance Tests

During the test interval, performance testing according to the relevant test programme is to be carried out.

After completion of the temperature rise interval, the EUT is to 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, is to be carried out in accordance with 3.12.

3.9.2.4 Test Levels

Testing time: test interval = 2 hours.

Table 3-11 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 3.7, Dry Heat Test.

3.9.2.5 Tolerances

Temperature: ± 2° C.

3.9.3 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.

3.10 Salt Mist Test

3.10.1

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.

3.10.1.1 Salt Solution

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

The solution is to be kept at the chamber temperature during the test.

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

3.10.2 Test Procedure

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

Before commencing the test, an insulation resistance measurement is to be taken in accordance with 3.12 and a functional test is to 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 are to be performed.

On completion of the test, a functional test is to be performed and an insulation resistance measurement to be taken in accordance with 3.12. The condition of the EUT is to be evaluated (visual inspection).

3.10.3 Test Conditions

Table 3-12 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%

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.

3.11 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.

3.11.1 Test Procedure

Basis: IEC publication 60092-504.

The EUT is to 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 is to be as during normal use.

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

The test is to be carried out in two mutually perpendicular planes referred to the

EUT`s normal position.

3.11.2 Test Levels

Table 3-13 Dynamic test levels	
Level	up to 22.5° in each direction
Period	10 seconds
Test duration	min. 15 minutes

Table 3-14 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.

3.11.3 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.

3.12 Insulation Resistance Test

3.12.1 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 is to be carried out within one hour after the Damp Heat Test (3.8).

Test B is also to be carried out within one hour after Cold Test (3.9), Salt Mist Test (3.10) or High Voltage Test (3.13) when these tests are required according to the relevant test programme.

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

3.12.2 Test Procedure

3.12.2.1 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 is to reach its equilibrium state at normal ambient condition with no power on.

3.12.2.2 Tests

The insulation resistance is to be measured between supply terminals and earth.

Test voltage and minimum insulation resistance is given in table 3.15 below. Test A specifies minimum insulation resistance during initial test. Test B specifies minimum insulation within one hour after a humidity-, cold-, salt mist- or high voltage test.

Table 3-15 Minimum insulation resistance			
Rated supply voltage	*Test voltage D.C.*	*Minimum insulation resistance*	
		Test A	*Test B*
Up to 65 V	2 x supply voltage minimum 24V	10 MΩ	1 MΩ
Over 65 V	500 V	100 MΩ	10 MΩ

3.12.3 Test Results

The test is deemed to have been passed if the values are not lower than those specified in the table.

3.13 High Voltage Test

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

3.13.1 Test Procedure

3.13.1.1 Preconditioning

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

3.13.1.2 Test Levels

Unless higher test voltage is specified by the equipment specification for the EUT, the high voltage test (where appropriate) is to be carried out at a frequency of 50 or 60 Hz with an A.C. test voltage according to the table 3.16 below.

Table 3-16 High voltage test level	
Rated voltage U_n (V)	*Test voltage (V) a.c.*
up to 65	2 x U_n + 500
66 to 250	1500
251 to 500	2000
501 to 1000	2 x U_n + 1000
above 1000	3 x U_n

The high voltage is to be applied for a period of one minute.

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

Contact pieces are to 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.

3.13.1.3 Performance Test

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

3.13.1.4 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.

3.14 Electromagnetic Compatibility (EMC)

3.14.1 Immunity Tests - General

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

3.14.2 Performance Criteria

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

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 relevant equipment standard and in the technical specification published by the manufacturer.

Performance criterion B:

The EUT is to 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.

3.14.3 Preconditioning

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

3.14.4 Conducted Low Frequency Immunity Test

3.14.4.1 Test Procedure

During the conducted low frequency test, the EUT is to conform to its normal operational configuration with the r.m.s test voltages specified in Table 3-17A and 3-17B, 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 2W.

3.14.4.2 Performance Test

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

Table 3-17A AC 50/60 Hz Supply Voltage	
Frequency Sweep Range (Hz)	*Test voltage: % of U_N, Min: 3V r.m.s. Max. power: 2W*
up to 15th harmonics	10% of U_N
15th to 100th harmonics	Decreasing from 10% to 1% of U_N
100th to 200th harmonics	1% of U_N

Table 3-17B DC Supply Voltage	
Frequency Sweep Range (Hz)	50 Hz to 10 kHz
Signal Level	3 V r.m.s. – max 2W

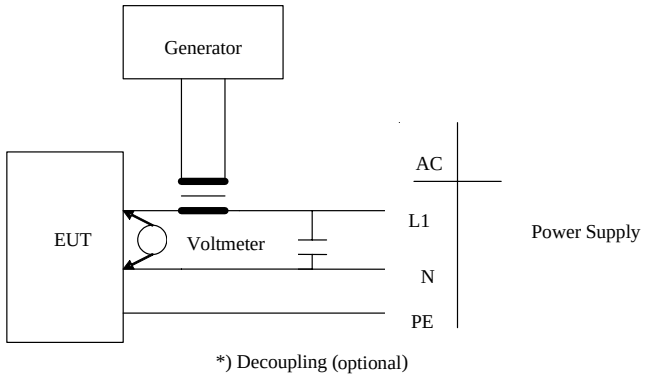

Figure 3-6
Test Set-up - Conducted Low Frequency Test

3.14.4.3 Test Results

In accordance with performance criterion A.

3.14.5 Electrical Fast Transient/Burst Immunity Test

3.14.5.1 Test Procedure

Basis: IEC Publication 61000-4-4.

During the electrical fast transient/burst test, the EUT is to 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 is to 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 is to be in accordance with test levels specified in Table 3-18.

Table 3-18 Fast transients signals	
Test Levels	
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
Repetition rate	5 kHz
Tolerances	
Burst duration and period	±20%
Source impedance	±20%
Amplitude	±10%

3.14.5.2 Performance Test

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

3.14.5.3 Test Results

In accordance with performance criterion B.

3.14.6 Electrical Slow Transient/Surge Immunity Test

3.14.6.1 Test Procedure

Basis: IEC Publication 61000-4-5.

During the electrical slow transient/surge test, the EUT is to 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 is to be superimposed on each of the power supply lines (AC and DC), both in differential mode and common mode. The slow transient signal to be in accordance with test levels as specified in Table 3-19.

Table 3-19 Slow transient signal test levels	
Test Levels	
Pulse	1.2/50 μs voltage surge 8/20 μs current surge
Amplitude	0.5 kV, differential mode 1 kV, common mode
Polarities	±
Number of pulses	5 per polarity
Repetition rate	1 per minute
Tolerances	
Amplitude, open/short circuit	±10%

3.14.6.2 Performance Test

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

3.14.6.3 Test Results

In accordance with performance criterion B.

3.14.7 Conducted Radio Frequency Immunity Test

3.14.7.1 Test Procedure

Basis: IEC Publication 61000-4-6.

During the conducted radio frequency test, the EUT is to 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 is to be superimposed in common mode on each of the power supply lines (AC and DC), and to signal/control lines. The test is to 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 is to be in accordance with test levels specified in Table 3-20 and Table 3-21.

Table 3-20 Conducted Radio frequencies: EMC Class A	
Test Levels	
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 x 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.	
Tolerances	
Amplitude	± 10%

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

Table 3-21 Conducted Radio frequencies: EMC Class B	
Test Levels	
In addition to the tests specified for Class A, Table 3.20, tests at spot frequencies are to 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.

3.14.7.2 Performance Test

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

3.14.7.3 Test Results

In accordance with performance criterion A.

3.14.8 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.

3.14.8.1 Test Procedure

Basis: IEC publication 61000-4-3

The EUT is to 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 metres (minimum 1 metre). If doubt exists regarding the most sensitive side, all six faces may, if this is considered necessary, be presented to the antenna.

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

Unless otherwise stated in the relevant test programme, the EUT is to 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 is to 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 is to be exposed to an electromagnetic field in accordance with test levels specified in Table 3-22.

Table 3-22 Electromagnetic field sweep frequency test levels	
Test Levels	
Frequency range	80 MHz to 2 GHz
Electric field strength	10 V/m
Amplitude modulation	80% at 1 kHz [1)]
Max. sweep rate	1.5x10-3 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.	
Tolerances	
Electric field strength	-0/+6 dB

3.14.8.2 Performance Test

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

3.14.8.3 Test Result

In accordance with performance criterion A.

3.14.9 Electrostatic Discharge Immunity Test

3.14.9.1 Test Procedure

Basis:IEC publication 61000-4-2.

The electrostatic discharge test is to be carried out using an electrostatic discharge generator with typical characteristics in accordance with test levels specified in Table 3-23.

The EUT is to 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 is to be minimum 1 m.

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

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

During the discharge test, the EUT is to be fed by normal power supply and is to 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 is to be selected.

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

Ten discharges shall be applied at each preselected spot.

Table 3-23 Electrostatic discharge test levels

Test Levels	
Output voltage	Air: 8 kV Contact: 6 kV
Polarities	±
Tolerances	
Energy storage capacitor	± 10%
Discharge resistor	± 10%
Output voltage	± 5%

3.14.9.2 Performance test

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

3.14.9.3 Test Result

In accordance with performance criterion B.

3.14.10 Emission Tests - General

The scope of the EMC emission tests is to 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.

3.14.10.1 Preconditioning

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

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

3.14.10.2 Test Procedure

Basis: CISPR 16-1, 16-2

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

The tests are to 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.

3.14.11 Radiated Emission Test

The radiated emission from the enclosure port of the EUT is to be measured over the frequency range and measuring bandwidth specified in Table 3-24.

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

Table 3-24 Radiated Emission Test

Enclosure Port	*Frequency range*	*Measuring bandwidth*	*Limits (quasi-peak)*
EMC A All locations except Bridge and Open deck	0.15-30 MHz	9 kHz	80-50 dBμV/m
	30-100 MHz	120 kHz	60-54 dBμV/m
	100-2000 MHz	120 kHz	54 dBμV/m
	Except: 156-165 MHz	9 kHz	24 dBμV/m
EMC B All locations including Bridge and Open deck	0.15-0.3 MHz	9 kHz	80 - 52 dBμV/m
	0.30-30 MHz	9 kHz	52 - 34 dBμV/m
	30-2000 MHz	120 kHz	54 dBμV/m
	Except: 156-165 MHz	9 kHz	24 dBμV/m

3.14.11.1 Test Results

The test is deemed to have passed if the radiated emission does not exceed the limits specified in Table 3-24.

3.14.12 Conducted Emission Test

The conducted emission on the power supply port of the EUT is to be measured over the frequency range and measuring bandwidth specified in Table 3-25.

Table 3-25 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 dBμV
	0.15-0.50 MHz	9 kHz	79 dBμV
	0.50-30 MHz	9 kHz	73 dBμV
EMC B All locations including Bridge and Open deck	10-150 kHz	200 Hz	96 – 50 dBμV
	150-350 kHz	9 kHz	60 – 50 dBμV
	0.35 - 30 MHz	9 kHz	50 dBμV

3.14.12.1 Test Results

The test is deemed to have passed if the conducted emission does not exceed the limits specified in Table 3-25.

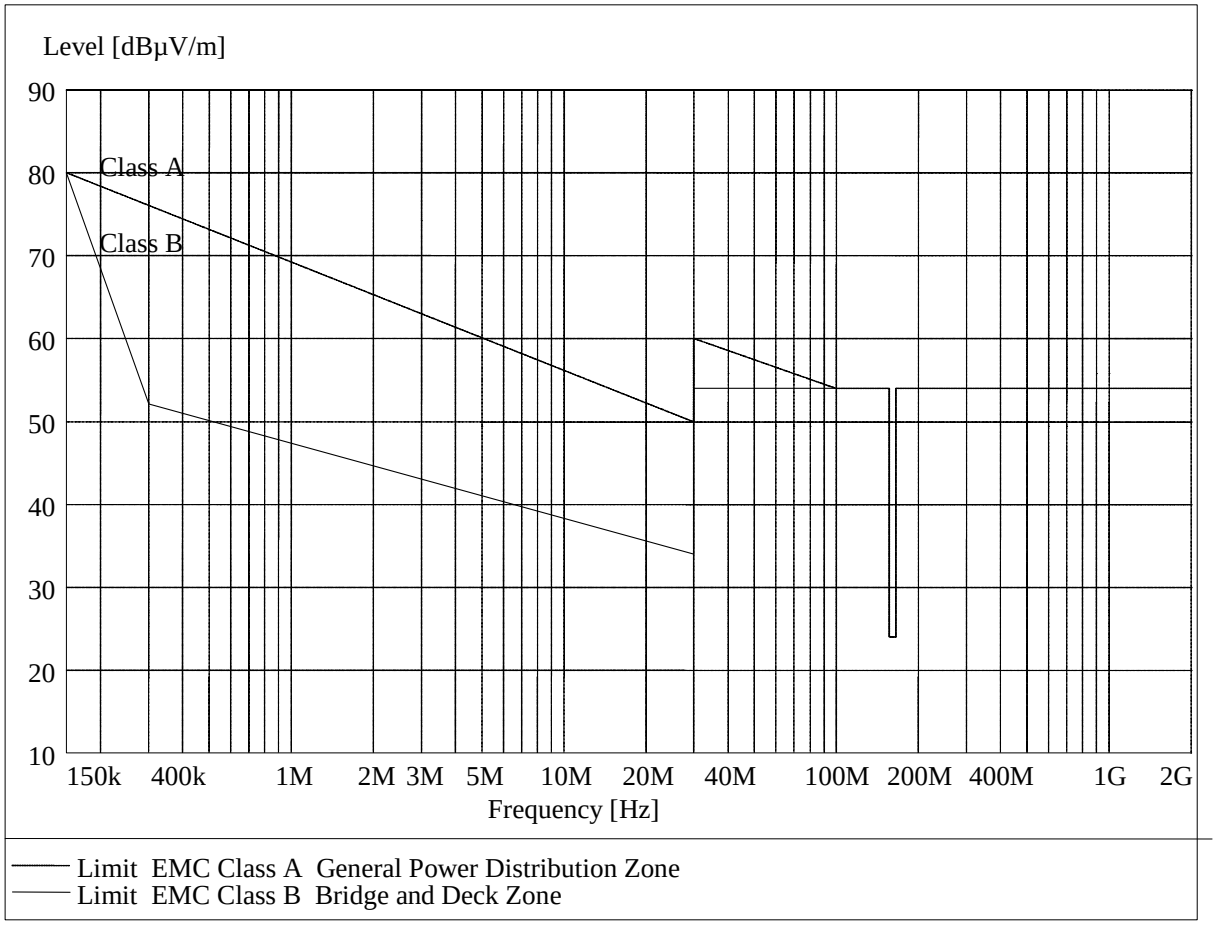

Figure 3-7
Radiated Emission Test, Limit Values

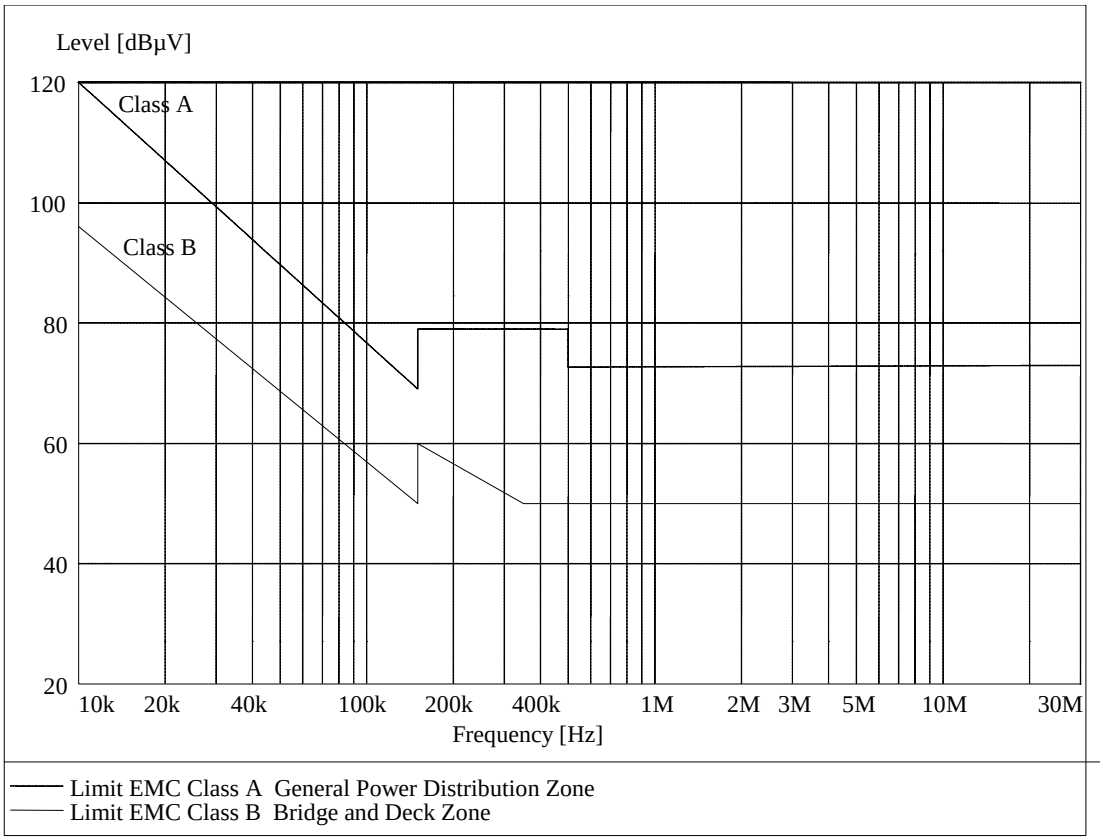

Figure 3-8
Conducted Emission Test, Limit Values

3.15 Special Purpose Tests

3.15.1 Compass Safe Distance Test

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

3.15.2 Acoustic noise and Alarm Signal Levels for Equipment Installed on the Bridge.

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

3.16 Additional Tests

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

3.16.1 Flame-retardant test.
3.16.2 Ice test.
3.16.3 High temperature test.
3.16.4 Temperature shock test.
3.16.5 Low pressure test.
3.16.6 High pressure test.
3.16.7 Mechanical shock test.
3.16.8 Wind-pressure test.
3.16.9 Sealing test.
3.16.10 Soldering test.
3.16.11 Mould growth test.
3.16.12 Storage test.
3.16.13 Working medium quality test for pneumatic and hydraulic equipment.
3.16.14 Radiation test.
3.16.15 Explosion safety or intrinsic safety test for electrical equipment.
3.16.16 Air pollution, sensitivity test.
3.16.17 Acceleration test.

Appendix A
Procedures for type approval.

A.1 Scope

This appendix gives information on the procedure to be followed to obtain DNV Type Approval for instrumentation and automation equipment and systems.

The following documents describe the DNV type approval system in general:

— Certification Notes No. 1.2 “Det Norske Veritas conformity certification services Type approval".

Products granted Type Approval, based on DNV Rules for Classification, will be accepted for use on board vessels and mobile offshore units classed with DNV, provided they are installed in accordance with the Rules.

Type approval of instrumentation and automation components or systems is normally not compulsory, but is an alternative to the case-by-case approval granted for each specific vessel.

A.2 Register of TA Products and Systems

Type Approved products will be listed in DNV’s “Register of Type Approved Products.” This Register, which is up-dated at regular intervals, is available via the DNV internet homepage: http://www.dnv.com.

A.3 Procedure

The Type Approval procedure normally consists of the following steps:

— Application for Type Approval
— Quotation
— Assessment of Type Approval Documentation
— Environmental Testing
— Type Test of Software (if relevant)
— Issuance of Type Approval Certificate
— Renewal of Type Approval Certificate
— Certificate Retention Survey
— Production Control
— Type Approval Fees

A.3.1 Application for Type Approval

The manufacturer, or his representative, may apply for type approval of a certain product. The manufacturer is responsible to maintain the quality of a type approved product during the validity time of the type approval certificate. Therefore, application for type approval of a product is normally to be submitted by the manufacturer.

Application submitted by the manufacturer's representative is to be accompanied by a statement from the manufacturer confirming that the representative may act on behalf of him. The application is to be sent to the local DNV survey station, which will forward the application to DNV office responsible for Type Approval. Application forms and assistance with the application may be obtained at the local DNV survey station. The type approval certificate will be issued in the name of the manufacturer. When applying for type approval, the manufacturer is to specify type number, which completely identifies the product according to drawings/equipment specification. All optional features, for which type approval is requested, are to be listed, either by separate type numbers or by suffixes to the equipment's basic type number. The manufacturer is also to specify the location classes for which he requests the product type approved. Please see “How to Select Location Classes” Section 2.2.2. The application shall include Type Approval documentation as specified in Section 4.3.3

A.3.2 Quotation

The DNV approval office will give a quotation, which is to be confirmed by the client.

A.3.3 Assessment of Design Approval Documentation

A.3.3.1 General

Together with the application, the manufacturer is to submit drawings, equipment specification and data sheets in accordance with 4.3.3.2 below. Documentation received by DNV will be treated confidentially, and will not be available to any third party.

All documentation is to be marked with either drawing/reference number, date of printing or similar which identifies the documentation as such. Marking of the documentation by means of the equipment's type number only is not considered as sufficient marking of the documentation.

The manufacturer is to also submit a proposed «Relevant Test Programme» according to section 3.1 of this publication. This test programme is to be approved by DNV prior to commencement of the testing.

All documentation is to be submitted in triplicate, of which one copy will be returned in stamped order.

Documents are to be submitted in accordance with the Certification Notes No. 1.2 “Det Norske Veritas conformity certification services Type approval” and DNV Rules for Classification of Ships, Pt.4 Ch. 9 Sec.1C. The lists contained in the above requirements are by way of example. If necessary, further documents may be required.

A.3.3.2 Documentation

The Manufacturer shall provide for the local DNV office or Type Approval Centre, documentation as listed in the following:

For Product Type Approval:

— Identification / marking
— Physical dimensions / weight
— Functional description
— Expected compatibility with specified environmental conditions.
— Reference to rules and standards (if any)
— Detailed block diagrams or one line diagrams
— Data Sheet:

The data sheet is to include all technical data that is necessary for a plant designer. The list of data sheet requirements, given in Table 4-1 below, is of general nature, and the manufacturers will have to evaluate which items are applicable to their equipment.

In addition for System Type Approval:

— Functional description
— System block diagrams
— User interface description
— Power supply arrangement
— Arrangement and layout
— Cable routing layout drawing
— Instrument and equipment list
— Data sheets with environmental specifications
— Documentation related to software (including software version numbers)
— Failure mode description (for essential systems only, typically systems for propulsion and steering)
— Test programme for application software at manufacturer.

For details of the above document types, please refer to the DNV Rules for Classification, Pt.4, Ch. 9, Instrumentation and Automation.

The Type Approval documentation is assessed by DNV Approval office to verify that it is in conformity with the specified requirements.

For product type approval, the assessment includes environmental testing to verify the operational parameters stated by

the manufacturer.

Testing may be performed at laboratories as specified under item 2.3.1 of this publication.

For System Type Approval the environmental laboratory testing is not required providing the system is built from previously Type Approved sub-components. Performance testing will in this case be carried out as for normal product Type Approval.

A.3.4 Type Test of Software

For computer based systems, where full system overview is not possible from evaluation of the documentation only, a Type Test of Software will be required. This test is regarded as part of the Type Approval, and will be carried out in presence of a DNV surveyor.

A.3.5 Issuance of Type Approval Certificate

When the steps explained above have been successfully carried out, the Type Approval Centre will evaluate the results, and issue a Type Approval Certificate.

The Type Approval Certificate is valid for 2 or 4 years, depending on type of equipment.

A.3.6 Renewal of Type Approval Certificate

Before the expiry date of the certificate, the local DNV office serving the manufacturer will forward a letter of enquiry to the manufacturer, requesting if a renewal of the type approval is desirable.

A.3.7 Certificate retention Survey

The manufacturer will also be requested to state if any changes are made in the design or construction of the equipment during the validity period. If changes are major, additional tests may be requested before renewal of the certificate.

A.3.8 Production Control

During the validity time of the type approval certificate it is the manufacturer's responsibility to ensure that the product is manufactured in accordance with the equipment specification on which the type approval was based.

A.3.9 Type Approval Fees

Type approval fees will be charged according to the current scale of fees. The fees include the costs related to evaluation of design and administration (issuance of certificates, updates of “Register of Type Approved Products”, keeping of records, etc.). The costs for laboratory tests, running of computer programmes, witnessing of tests, travelling and subsistence are not included in the scale of fees and will be charged in addition.

Table A-1 Data sheet requirements

Data	*Comments*
Component/unit name and type number	Sufficient for identification of equipment.
Functional description	Stating, if necessary, the medium the equipment is designed to work with/in and possible limitations.
Physical dimensions	With necessary scaled sketches/drawings.
Weight	Weight of main units.
Mounting method	With necessary scaled sketches/drawings.
Mounting limitations	Position-, distance-, environmental limitations, etc.
Connection method	Giving type of plugs, tag boards, nipples, fittings, etc.
Voltage/frequency	Nominal voltage/frequency with tolerances.
Power consumption	Specified for the different modes of operation.
Pressure	Nominal pressure with tolerances (for pneumatic and hydraulic equipment).
Air/oil consumption	Specified for the different modes of operation.
Air/oil purification	Requirements as to purification of air/oil. Also specify type of hydraulic oil.
Ambient temperature	Temperature range for specified performance. Where applicable temperature range of medium is to be specified. Also specify temperature range for storage and transportation of equipment.
Ambient humidity	Humidity range at specified performance and for storage and transportation.
Ambient pressure	To be specified in case of transportation limitations.
Capacity/speed	Amount of input/output per second, storage capacity, instruction speed, etc.
Warm up time	Including off-stand-by, stand-by-on, necessary time between successive on-off.
Accuracy	To be clearly defined. Accuracy to be related to environmental parameters, in particular temperature. Warming-up time, short time (8 hours), long time (90 days), temperature- and voltage stability, hysteresis, reproducibility, reading accuracy, linearity, etc. is to be taken into account.
Response	Over- and undershoot, rise- and fall time, etc.
Safety devices	Electrical, pressure, mechanical, etc.
Overload safety factor	Tested values are to be given.
Acoustic noise level	
Maintenance	Necessary periodical adjustments, cleaning, lubrication, etc.
Material/surface treatment	
Enclosure/gaskets	With necessary material specifications.
Operation time	Assumed operation time if operated within given specifications. To be specified in months or number of operations.
Input/output parameters	Levels and impedance, maximum/minimum value, accuracy. Effect on accuracy from temperature, vibration, humidity, power supply, etc.

Status of calibration	If equipment is factory calibrated, how long before delivery?
No./date on data sheet	To be used for identification of the data sheet.
Noise susceptibility	Possible disturbance of functions of equipment due to variation/noise in power supply, electromagnetic interference, radiation, etc.
Generation of noise	Audible, electromagnetic, radiation, noise through power connections, etc.

Appendix B
EU-Directives

B.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.

B.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.

B.3 DNV 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.

DNV has been appointed as Notified and/or Competent Body to perform conformity assessment for a range of EU-Directives. Examples are:

The Marine Equipment Directive (MED) – Notified Body, the Electromagnetic Compatibility Directive (EMC) – Notified and Competent Body, The Low Voltage Directive (LVD) – Notified Body and the Explosive Atmospheres Directive (ATEX) – Notified body.

B.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 on component or subsystem 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 DNV Classed ship 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.

B.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:

B.5.1 Marine Equipment Directive (MED) – 96/98/EC as amended.

The Scope of the Marine Equipment Directive is to enhance safety at sea and the prevention of marine pollution. This is to 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 equipment
— Fire protection equipment
— Navigation equipment
— Radio communication equipment

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 consists 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 are to be performed.

B.5.2 Electromagnetic Compatibility Directive (EMC) – 89/336/EEC

Characteristic standards are: EN/IEC 60945, IEC 60533, IEC/EN 61000-4-x, EN 50081/82.

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 are to be performed.

B.5.3 Low Voltage Directive (LVD) – 73/23/EEC

Typical standards: EN 50091-1, IEC/EN 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 50V and 1000V AC and between 75V and 1500V 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 are to be performed.