



SPECIAL SERVICE AND TYPE
ADDITIONAL CLASS

Comfort Class

JANUARY 2011

*This chapter has been amended since the main revision (January 2011), most recently in July 2011.
See "Changes" on page 3.*

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FOREWORD

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The Rules lay down technical and procedural requirements related to obtaining and retaining a Class Certificate. It is used as a contractual document and includes both requirements and acceptance criteria.

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CHANGES

General

As of October 2010 all DNV service documents are primarily published electronically.

In order to ensure a practical transition from the “print” scheme to the “electronic” scheme, all rule chapters having incorporated amendments and corrections more recent than the date of the latest printed issue, have been given the date January 2011.

An overview of DNV service documents, their update status and historical “amendments and corrections” may be found through http://www.dnv.com/resources/rules_standards/.

Amendments July 2011

- **General**

— The restricted use legal clause found in Pt.1 Ch.1 Sec.5 has been added also on the front page.

Main changes

Since the previous edition (January 2009), this chapter has been amended, most recently in January 2010. All changes previously found in Pt.0 Ch.1 Sec.3 have been incorporated and a new date (January 2011) has been given as explained under “General”.

In addition, the layout has been changed to one column in order to improve electronic readability.

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SECTION 1 GENERAL REQUIREMENTS

A. Classification

A 100 Application

101 The rules in this chapter state requirements for noise, vibration and indoor climate on board ships.

102 The rules aim at attaining a ship with controlled environmental standards. Compliance with the rules shall be verified through measurements of defined environmental parameters.

A 200 Grouping of environmental standards

201 The environmental standards are divided in two groups:

- **V** Noise and vibration
- **C** Indoor climate.

202 The additional class notation may be given for each group separately, or for both groups.

A 300 Class notations

301 Vessels which fulfil the requirements of Sec.2 will be given the additional class notation **COMF-V(crn)**, where **crn** is a comfort rating number which quantifies the comfort rating of noise and vibration for the vessel.

302 Vessels which fulfil the requirements of Sec.3 will be given the additional class notation **COMF-C(crn)**, where **crn** is a comfort rating number which quantifies the comfort rating of the indoor climate for the vessel.

303 Vessels which fulfil all the requirements in this Chapter will be given the additional class notation **COMF-V(crn)C(crn)**.

B. Definitions

B 100 Definitions

101 The main parameters determining the comfort on board a vessel are defined below.

102 *Noise*: Audible air pressure fluctuations generated by ship machinery, systems or structure, i.e. in the frequency range 20 – 20 000 Hz.

103 *Vibration*: Structural motion in the frequency range 1 – 100 Hz.

104 *Indoor climate*: Ambient temperature, temperature gradient, air velocity, humidity and carbon dioxide concentration used as descriptors for indoor climate.

105 Only effects of the above parameters on the well-being of crew and passengers are considered by these rules. Possible influence on machinery, structure or other systems is considered in other relevant parts of the Rules.

C. Documentation

C 100 Noise and vibration

101 Required documentation is described in Sec.2

C 200 Indoor climate

201 Required documentation is described in Sec.3.

SECTION 2 NOISE AND VIBRATION

A. General

A 100 Rule applications

101 The rules give requirements for noise and vibration related to comfort on board ships. Reference is made to national and international standards on noise and vibration criteria related to hearing damage, speech intelligibility for safety reasons, and acceptable vibration for machinery and equipment.

102 The rules apply to the spaces specified in tables B1–B9.

A 200 International standards

201 International standards have been used as foundation for the rules, but have not necessarily been adhered to. When setting the noise and vibration limits, and determining the measuring procedure, due consideration has been given to technical and practical limitations inherent in the design and construction of different types of ship and localities.

202 The standards shown below contain provisions which are referred to in this text or have been used by the Society as basis when developing the rules. Unless a particular edition is referred to explicitly, the latest edition of each standard shall apply.

203 *Noise:*

- IMO Resolution A. 468 (XII), “Code on noise levels onboard ship”.
- ISO 2923, “Acoustics – Measurement of noise on board vessels”.
- ISO 31/VII, “Quantities and units of acoustics”.
- IEC Publication 651, “Sound level meters”.
- IEC Publication 225, “Octave, half-octave and third-octave band filters intended for the analysis of sound and vibration”.
- IEC Publication 804, and amendment no. 1, 1989, “Integrating-averaging sound level meters”.
- IEC Publication 942, “Sound calibrators”.
- ISO R717/1, “Acoustics – Rating of sound insulation in buildings and of building elements – Part 1: Airborne sound insulation in buildings and interior elements”.
- ISO 717/2, “Acoustics – Rating of sound insulation in buildings and of building elements – Part 2: Impact sound insulation”.
- ISO 140/4, “Acoustics – Measurements of sound insulation in buildings and of building elements – Part 4: Field measurements of airborne sound insulation between rooms”.
- ISO 140/7, “Acoustics – Measurements of sound insulation in buildings and of building elements – Part 7: Field measurements of impact sound insulation of floors”.

204 *Vibration:*

- ISO 6954, “Mechanical vibration and shock – Guidelines for the overall evaluation of vibration in merchant ships”.
- ISO 2041, “Vibration and shock – Vocabulary”
- ISO 4867, “Code for the measurement and reporting of shipboard vibration data”
- ISO 4868, “Code for the measurement and reporting of local vibration data of ship structures and equipment”.
- ISO 2631, “Guide for the evaluation of human exposure to whole-body vibration”.

A 300 Definitions

301 Basic noise and vibration quantities and units are defined in ISO 31/VII and ISO 2041.

302 *Crew Accommodation:* Cabins, offices, hospitals, mess rooms, recreation rooms, and open deck areas to be used by officers and crew.

303 *Passenger Accommodation:* All areas intended to be used by passengers.

304 *Public spaces:* Communal indoor areas, e.g. restaurants, theaters, cinema, discos, shops, reading rooms, game rooms, gymnasiums, hobby rooms etc. Corridors, washrooms and toilets are excluded.

A 400 Abbreviations

401 *ISO:* International Organization for Standardization

402 *IMO:* International Maritime Organization

403 *IEC:* International Electrotechnical Commission.

B. Noise and Vibration Requirements

B 100 General

101 Compliance with the rules shall be verified through measurements. It may, however, be advantageous to carry out calculations at an early project stage in order to ensure that necessary noise and vibration control measures are included.

102 The required test conditions are given in Chapter E.

103 The requirements for noise and vibration are set up for several types of ships related to the main class issued for the ship. The requirements for each type of ship are divided in groups for specified locations.

104 All locations specified in the tables below shall comply with the criteria in order to be assigned the additional class notation **COMF-V**. However, in special cases small deviations from the requirements may be accepted. This will be decided by the Society in each particular case. Guidelines for handling of excessive noise and vibration levels are given in Appendix A.

105 The noise and vibration criteria are divided into three groups depending on the level of comfort achieved, i.e. comfort rating number (**crn**) **1**, **2** and **3**, where (**crn**) **1** represents the highest comfort level and (**crn**) **3** represents an acceptable level of comfort.

106 The highest comfort rating number achieved for noise or vibration will determine the overall rating for noise and vibration, e.g. a vessel meeting (**crn**) **2** for vibration and (**crn**) **1** for noise will be denoted (**crn**) **2**.

107 For offshore service vessels to be operated at DP (Dynamic Positioning) mode, noise and vibration measurements shall be carried out with the side thrusters in operation. The operating condition shall correspond to contractual conditions or with at least 40% power on the thrusters.

108 For passenger ships the given comfort rating number applies to the passenger accommodation only. The crew accommodation shall comply with minimum rating (**crn**) **3** for cargo ships.

B 200 Noise criteria

201 The maximum allowed noise levels for different ships, localities and comfort standards are given in Table B1, B2, B3 and B4.

202 In Table B4 Yacht, the noise levels specified for the transit condition apply to yachts not intended for overnight cruising. For yachts intended for overnight cruising, the rules for passenger ships shall apply for the transit condition.

Table B1 Passenger Ships - Passenger Accommodation Noise levels in dB(A)			
Locations	Comfort rating number (crn)		
	1	2	3
Passenger top grade cabins	44	47	50
Passenger cabins, standard	49	52	55
Public spaces	55	58	62
Open deck recreation ^{1) 2)}	65	65	70
1) 5 dB(A) relaxation in sports areas and passage ways			
2) 5 dB(A) relaxation near ventilation inlets and outlets			

Table B2 Cargo ships ¹⁾ - Crew Accommodation Noise levels in dB(A)			
Locations	Comfort rating number (crn)		
	1	2	3
Wheelhouse	60	60	65
Radio room	55	55	60
Crew cabins	50	55	60
Crew public spaces	55	60	65
Hospital	55	55	60
Offices	60	60	65
Engine control room	70	70	75
Open deck recreation	70	70	75
1) For working areas and engine room it is referred to IMO Res. A. 468 (XII).			

Table B3 High Speed and Light Craft - Length above and below 50m Noise levels in dB(A)						
<i>Locations</i>	<i>Comfort rating number (crn)</i>					
	<i>50m and below</i>			<i>Above 50m</i>		
	<i>1</i>	<i>2</i>	<i>3</i>	<i>1</i>	<i>2</i>	<i>3</i>
Passenger localities	65	70	75	60	65	68
Navigation bridge	60	60	65	60	60	65
Service areas /hops/kiosk	68	73	78	65	65	70

Table B4 Yacht - Owner and Guest Areas Noise levels in dB(A)						
<i>Locations</i>	<i>Comfort rating number (crn)</i>					
	<i>In harbour condition</i>			<i>Transit condition</i>		
	<i>1</i>	<i>2</i>	<i>3</i>	<i>1</i>	<i>2</i>	<i>3</i>
Sleeping rooms	35	40	45	-	-	-
Lounges / Saloons	40	45	50	53	58	62
Outdoor re-creation areas	50	55	60	75	80	85
Navigation bridge	-	-	-	60	60	65

Table B5 Sound Insulation Indexes	
<i>Positions</i>	<i>$L_p + RW'$ (dB)</i>
Cabin to cabin (crew)	88
Cabin to cabin (passenger)	90
Cabin to corridor	87
Cabin to stairways	100
Cabin to engine rooms	100
Cabin to public spaces	100
Machinery/ technical spaces to passenger corridor	100

B 300 Sound insulation

301 The acoustic insulation between accommodation spaces, is at least to satisfy the requirements for weighted apparent sound insulation indexes given in Table B5. Note that the requirements are stated as the sum of the relevant noise criterion L_p and the weighted apparent sound insulation index. This has been done because a low background noise level will require a stricter requirement to sound insulation in order to achieve a satisfactory level of comfort.

302 For cabins in areas with a low background noise level (below 45 dB(A)) precautions shall be taken when a boundary of such a cabin is facing an entertainment area. For such cases a minimum weighted apparent sound insulation index of 65 dB is recommended. Care should also be exercised when mounting loudspeakers to the structure, so that noise transmission from the loudspeaker in the structure is avoided.

B 400 Impact sound insulation, passenger ships

401 For passenger cabins the normalized impact sound pressure level is not to exceed 50 dB. For passenger cabins below areas with wooden deck, marble deck or similar hard deck covering materials, the above requirement may be relaxed to 60 dB due to constructional limitations.

402 For passenger cabins located below dance floors, stages and gymnasiums, a normalized impact sound pressure level shall not exceed 45 dB.

Table B6 Passenger Ships - Passenger Accommodation Vibration level in mm/s peak for single frequency components between 5 and 100 Hz ¹⁾			
<i>Locations</i>	<i>Comfort rating number (crn)</i>		
	<i>1</i>	<i>2</i>	<i>3</i>
Passenger top grade cabins	1.5	2.0	2.5
Passenger cabins, standard	1.5	2.5	4.0
Public spaces	1.5	2.5	4.0
Open decks recreation	2.5	3.5	5.0

1) For frequencies below 5 Hz the requirements follow constant acceleration curves corresponding to the acceleration at 5 Hz.

Table B7 Cargo Ships - Crew Accommodation and Work Places			
Vibration level in mm/s peak for single frequency components between 5 and 100 Hz ¹⁾			
<i>Locations</i>	<i>Comfort rating number (crn)</i>		
	<i>1</i>	<i>2</i>	<i>3</i>
Cabins	2.5	3.5	5.0
Mess/recreation rooms	2.5	3.5	5.0
Offices	2.5	3.5	5.0
Navigation bridge	2.5	3.5	5.0
Control rooms	3.5	4.5	6.0
Work places	3.5	4.5	6.0
1) For frequencies below 5 Hz the requirements follow constant acceleration curves corresponding to the acceleration at 5 Hz.			

Table B8 High Speed and Light Craft			
Vibration level in mm/s peak for single frequency components between 5 and 100 Hz ¹⁾			
<i>Locations</i>	<i>Comfort rating number (crn)</i>		
	<i>1</i>	<i>2</i>	<i>3</i>
Passenger localities	2.0	3.5	5.0
Navigation bridge	2.0	3.5	5.0
Offices	2.0	3.5	5.0
Control rooms	3.0	4.5	6.0
1) For frequencies below 5 Hz the requirements follow constant acceleration curves corresponding to the acceleration at 5 Hz.			

Table B9 Yacht - Owner and Guest Areas						
Vibration level in mm/s peak for single frequency components between 5 and 100 Hz ¹⁾						
<i>Locations</i>	<i>Comfort rating number (crn)</i>					
	<i>In harbour conditions</i>			<i>Transit conditions</i>		
	<i>1</i>	<i>2</i>	<i>3</i>	<i>1</i>	<i>2</i>	<i>3</i>
Accommodation	0.5	1.0	2.0	1.0	2.0	3.0
Outdoor re-creation areas	0.5	1.0	2.0	2.0	3.0	4.0
Navigation bridge	-	-	-	1.5	2.5	4.0
1) For frequencies below 5 Hz the requirements follow constant acceleration curves corresponding to the acceleration at 5 Hz.						

B 500 Vibration criteria

501 The standards to be met are given in Tables B6, B7, B8 and B9.

502 The vibration limits are given in vibration velocity, peak amplitude. If RMS (Root Mean Square) values are measured, each frequency component may be converted to peak amplitude by multiplication of $\sqrt{2}$ (1.41).

503 It should be noted that ISO 6954 defines a conversion factor to be multiplied with the time averaged peak values. The obtained “max repetitive value” should be compared to the guideline. In these rules, the time averaged peak values shall be directly compared to the given limits, since a conversion factor is already incorporated in the limits.

504 The specified vibration levels apply to the maximum single frequency component of vertical, fore and aft and athwartship vibration which shall be assessed separately.

C. Certification and Testing, Noise

C 100 General

101 The measurements shall be carried out according to the procedures described in ISO 2923. When the procedure described in ISO 2923 deviates from any requirements or procedure mentioned in these rules, the requirements in these rules take precedence.

102 The instrumentation to be used for the measurements shall comply with the requirements given in ISO 2923.

103 A test program shall be approved prior to the measurements. The test program is at least to include the following information:

- specification of measuring locations
- required loading conditions
- required operating conditions for machinery
- instrumentation to be used.

104 The measuring positions shall be selected such as to give a representative description of the noise situation on board the ship. Since the noise levels normally are higher close to the major sources such as propellers and main/auxiliary engines, a higher density of measuring positions will be required in areas near noise sources.

105 The number and location of measuring positions shall be approved by the Society prior to the noise survey.

106 If the specified criterion is exceeded, octave band analysis of the noise shall be performed.

C 200 Distribution of measuring positions in sleeping cabins

201 For conventional cargo ships with less than 100 cabins and the accommodation restricted to a separate section in the aft-ship, in the midship area or in the fore-ship, noise measurements shall be taken in all cabins.

202 For ships with a large number of cabins distributed over a major portion of the ship, e.g. a passenger ship, measurements may be limited to a selected number of cabins. By dividing the length of the ship in three parts, the minimum number of measuring positions is given in Table C1. The measuring positions shall be evenly distributed amongst the cabins within each of the aft-, mid- and foreship sections of the ship.

Table C1 Distribution and number of measuring positions for cabins	
<i>Measuring region</i>	<i>Minimum percentage of cabins in the region to be measured</i>
Aftship (Aft end to 1/3 L)	40%
Midship (1/3 L to 2/3 L)	25%
Foreship (2/3 L to fore end)	15%
L is the distance from the aft to the forward perpendicular.	

C 300 Distribution of measuring positions for public spaces

301 The noise level shall be measured in all the public spaces on board. The measuring positions shall be selected such as to give a representative description of the noise situation in the public spaces on board the ship.

302 In large rooms, such as lounges, restaurants, etc., several measuring positions may be necessary to get a representative description of the noise situation. No distance between measuring positions or between measuring positions and walls shall exceed 7 m.

303 The measured noise levels in the different positions in a room form a set of measurements for this room. This set of measurements shall be compared to the noise criteria taking into account the allowable standard deviation for public spaces, see Appendix A.

C 400 Measuring positions open deck recreation areas

401 Several measuring positions will normally be required to cover these areas. If more than one noise registration is made for positions which naturally belong together, a set of measurements for the area shall be applied for the comparison with the noise criteria according to the procedures described above.

C 500 High speed and light craft

501 In the passenger saloons of high speed and light craft, measurements shall be taken in at least the following positions:

- at the aft seat row / seat position, near starboard side, near centreline and near port side, but at least 0.5 m from reflecting surfaces.
- for vessels with length over all 50 m and below, in positions near centreline and ship sides at distances not exceeding 4 m in longitudinal directions and at least 0.5 m from reflecting surfaces
- for vessels with length over all above 50 m, at distances not exceeding 4 m from the aft seat-position to a position beyond half the length over all of the vessel, near starboard side, near centreline and near port side, but at least 0.5 m from reflecting surfaces. Forward of the mid-ship position, at distances not exceeding 7 m in longitudinal direction.

502 The criteria given in Table B3, apply in each measuring location in the passenger saloon for high speed and light craft.

C 600 Reporting

601 The report shall comply with the requirements in ISO 2923.

602 The positions of the noise measurements shall be plotted on general arrangement drawings of the ship.

603 The dB(A) levels shall be listed in tables and preferably plotted on general arrangement drawings of the ship.

604 If the specified noise criterion is exceeded, octave band readings shall be reported.

D. Certification and Testing, Vibration

D 100 General

101 The measurements shall be carried out according to the procedures described in ISO 4868. When the procedure described in ISO 4868 deviates from any requirements or procedure mentioned in these rules, the requirements in these rules take precedence.

102 The instrumentation to be used for the measurements shall be of an electronic type. The signal may be stored on tape, analysed directly by means of a FFT-analyser, or by means of PC-based equipment.

103 A test program shall be approved prior to the measurements. The test program is at least to include the following information:

- specification of measuring locations
- required loading conditions
- required operating conditions for machinery
- instrumentation to be used.

104 The measuring positions shall be selected such as to give a representative description of the vibration situation on board the ship.

105 The number and location of measuring positions shall be approved by the Society prior to the vibration survey.

D 200 Measuring positions

201 Vibration measurements in cabins are normally to be taken at the floor in the center of the room and shall reflect the vibration of the steel structure.

202 For larger spaces (public rooms, messes, recreation areas, etc.) it may be necessary to distribute a number of measuring positions.

203 The measured vibration levels in the different positions in a public room form a set of measurements for this room. This set of measurements shall be compared to the vibration criteria taking into account the allowable standard deviation for public spaces, see Appendix A.

204 On decks where the accommodation extends over a large proportion of the length of the ship, as for instance for passenger vessels, it is recommended that the measuring positions should be distributed according to the Table D1. The distribution shall be applied on each deck.

Table D1 Distribution and number of measuring positions for cabins	
<i>Measuring region</i>	<i>Percentage of measuring positions to be placed in the region</i>
Aftship (Aft end to 1/3 L)	60%
Midship (1/3 L to 2/3 L)	30%
Foreship (2/3 L to fore end)	10%
L is the distance from the aft to the forward perpendicular.	

205 Vibration levels in vertical, longitudinal and transverse direction are subjected to assessment. Recording of vibration levels in longitudinal and transverse direction is not required in all positions, but must be taken in sufficient number of positions in order to represent the global vibration of the deck according to the paragraphs below.

206 For ships with the accommodation placed in a deck house, transverse vibration to be recorded at the front and aft end, and longitudinal vibration at the port and starboard side of the deck house at each deck level.

207 For ships where the accommodation extends over a large portion of the length of the vessel, as for instance for passenger ships, the transverse vibration to be recorded at approximately 25% of the positions, evenly distributed along the ship. The longitudinal vibration to be recorded at one position on each deck.

208 The distribution of the measuring positions shall be approved prior to the tests. The measuring positions may, however, be subjected to alterations during the testing based on actual findings during the survey on board the ship.

D 300 Data acquisition

301 The measurements shall be analysed using FFT - techniques, and presented in the frequency domain (frequency spectra).

302 Analysis parameters:

- frequency range 1– 100 Hz
- at least 400 spectral-lines

- window function which gives an accurate estimate of the amplitude value of the single peaks in the frequency spectra (for instance Flat top window)
- the vibration recordings shall be averaged over a time period of approximately 1 min.

303 The results should preferably be presented as vibration velocities.

304 The velocity levels should preferably be given in peak single amplitude. If not, the units and conventions applied shall be clearly stated.

D 400 Reporting

401 The report shall contain the following information:

- ship and machinery particulars
- condition during the measurements such as power output, propeller/engine speed, draught, water depth under keel, wind and sea state
- sketch showing the location of the measuring positions and their direction of measurements
- tables of all significant components of the vibration levels and corresponding frequency. Alternatively the frequency spectra for the different locations may be presented, or the significant vibration components plotted in a graph
- instrumentation which has been used, including type of analyser, window function which has been applied, averaging time and resolution.

E. Test Conditions

E 100 General

101 The required conditions to be fulfilled during the tests are based on ISO 2923 for noise and ISO 4868 for vibration. Major items to be fulfilled are listed below. When the test conditions described in the ISO standards deviate from any requirements or procedure mentioned in these rules, the requirements in these rules take precedence.

102 Generally the power output on the propeller shaft(s) shall correspond to contractual normal seagoing condition, or at least 85% of maximum continuous power available on the propeller shaft(s). All other machinery shall be run under normal operating conditions during the tests. For propulsion plants with shaft-generators and boosters, the power to be used on the propeller shaft(s) shall be based on a normal operation of the ship and will be determined and approved for each individual case.

103 The test should be conducted in a depth of water not less than three times the draught of the ship for vessels which normally are operated in deep waters. For ships to be operated continuously in shallow waters, the tests shall be performed at relevant depth of water.

104 The tests should be conducted in a quiet sea (Sea state 3 or less).

105 The loading condition(s) of the ship shall be as close as possible to normal operating condition(s). For ships with larger variation than 25% in relevant displacements, the measurements shall be taken at two loading conditions close to the relevant heavy and light condition. The loading condition(s) to be used shall be approved by the Society prior to the testing.

106 The rudder angle should be restricted to about 0 degrees \pm 2 degrees (minimum rudder action is desired).

107 For offshore service vessels to be operated at DP, noise and vibration measurements shall be carried out with the side thrusters in operation. The operating condition shall correspond to contractual conditions or with at least 40% power on the thrusters.

108 For yachts the noise and vibration levels should be measured for a “normal” harbour condition. In this condition the power supply shall be provided by the yacht's auxiliary engine(s), the HVAC system shall be run at rated capacity and the power consumption shall be at least 85% of the normal service supply.

109 Any divergence from the above mentioned conditions shall be clearly stated in the report.

E 200 Noise

201 Air-conditioning supply and ventilation supply shall be run at normal full capacity during the tests.

202 The rooms shall be fully equipped with actual deck covering (carpets, vinyl, etc.), ceiling, curtains, furniture, etc.

203 Doors and windows shall be closed.

E 300 Vibration

301 The decks shall be fully equipped with regards to outfit weights.

SECTION 3 INDOOR CLIMATE

A. General

A 100 Rule applications

101 The rules outline standards, conventions, guidelines and specifications for the purpose of categorization of a vessel's on board climate in relation to the performance of the on board Heat, Ventilation, and Air Conditioning (HVAC) plant at the typical ambient climatic conditions to which the vessel will be subjected during its intended use. (see Sec.B, on restrictions).

102 The rules apply to passenger vessels with a dead-weight and/or length exceeding 100 tons or 50m and to combined cargo/passenger vessels and cargo vessels exceeding 300 tons deadweight.

103 The rules apply to the occupancy zone in designated locations specified in Table B1.

A 200 International standards

201 International standards have been used as foundation for the rules, but have not necessarily been adhered to. When setting the limits to the climate parameters, and determining the measuring procedure, due consideration has been given to technical and practical limitations inherent in the design and construction of different types of ship and localities.

202 The standards listed below have been used by the Society as basis when developing the rules. Unless a particular edition is referred to explicitly, the latest edition of each standard shall apply.

203 Standard - Guidelines

- ISO 7547, Shipbuilding – Air-conditioning and ventilation of accommodation spaces on board ships – Design conditions and basis of calculations
- ISO 7730, Ergonomics of the thermal environment - Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria
- ISO 7726, Thermal environments – Instruments and methods for measuring physical quantities
- ASHRAE, Applications Handbook. American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc. Atlanta, 91
- ANSI/ASHRAE, Standard 55-2004; Thermal Environmental Conditions for Human Occupancy
- ANSI/ASHRAE, Standard 62.1 - 2007, Ventilation for Acceptable Indoor Air Quality
- CIBSE Commissioning Code A: 1996 (2006); Air Distribution Systems (The Chartered Institute of Building Service Engineers).

A 300 Terminology and units

301 *Onboard climate:* A general term for the physical factors that influence human beings inside a vessel or installation at sea.

302 *Thermal comfort:* A comfortable thermal balance between man and the environment.

303 *Temperature:* The average temperature of a specific number of temperature measurements in a particular space, expressed in °C.

304 *Relative humidity:* Relative humidity is the actual amount of water vapour in the air compared to the saturation amount of water vapour in the air at the same temperature and pressure. The figure is usually expressed as percentage with saturated air having a relative humidity of 100%.

305 *Relative humidity range:* The range of which relative humidity must be within during all outdoor conditions the HVAC system is designed for.

306 *Air velocity:* The measured mean absolute velocity of a mass of air in motion.

307 *Ambient outside air temperature:* The actual air temperature measured out of direct sun exposure outside of the vessel, expressed in °C.

308 *Draught:* The unwanted local cooling of the body caused by air movement.

309 *Vertical gradient:* Vertical air temperature difference.

310 *Air temperature control span:* A measure of the temperature interval of which each designated space is able to satisfy.

311 *Fresh Air supply quantity:* The quantity of fresh/ outside air per person supplied to a space, expressed in litres/s.

312 *Air supply quantity:* The total amount of supplied air to any given space may consist of a percentage re-circulated return air in addition to the air supply quantity.

313 *Public spaces:* Communal indoor areas, e.g. restaurants, messes, theatres, cinemas, discos, reading rooms, game rooms, gymnasiums, hobby rooms etc. Corridors, washrooms and toilets are excluded.

314 *Cabins:* A general term for smaller spaces on board intended for accommodation only.

A 400 Abbreviations

401 *ISO:* International Organization for Standardization.

402 *ASHRAE:* American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc.

403 *CIBSE:* The Chartered Institution of Building Services Engineers.

404 *HVAC:* Heating, Ventilation and Air Conditioning.

B. Requirements for On Board Climate

B 100 General

101 With the specified climate comfort of a room, the majority of the passengers and crew can safely and comfortably perform an activity over a prolonged period of time, for which the room is intended for.

102 Compliance with the rules shall be verified through measurements and documentation.

103 All locations specified in Table B1 shall comply with the criteria in order to be assigned the additional class notation **COMF-C**.

104 The requirements for on board climate are divided into three groups depending on the level of comfort achieved, i.e. comfort rating number (**crn**) **1**, **2** and **3** where (**crn**) **1** represents the highest level of comfort, and (**crn**) **3** an acceptable level of comfort.

105 Only one (**crn**) number, **1**, **2** or **3** can apply to one vessel, except for ships carrying passengers, where it is allowed to differentiate between passenger and crew accommodation.

106 It shall be stated for which outside temperature and humidity range the vessel shall comply with the **Comf-C(crn)** notation. The outside temperature and humidity range for which the vessel meets the **Comf-C(crn)** will be given together with the notation. The class notation is only valid for temperature and humidity ranges within this given range.

B 200 Climate requirements

201 The standard applies to the designated accommodation spaces onboard classified as shown in Table B1.

Table B1 Classification of accommodation spaces	
Type A	Cabins
Type B	Hospital and Ward rooms
Type C	Wheel house, Control rooms, Office areas and public spaces intended for low physical activity such as Conference rooms, Libraries, Card rooms, Seating areas, etc.
Type D	Public spaces intended for high physical activity such as Show lounges, Dining areas, Atriums, Casinos, Shopping areas, Bars, Dance lounges, Discos, Gymnasiums, etc.

202 The requirements to air properties and quality at different localities and comfort standard are shown in Table B2.

203 Each designated space should be able to change from the lower to the higher temperature given in Table B2 within two hours. However for special areas, this temperature control span time criteria may be evaluated separately.

Table B2 Air properties and quality at different localities and comfort standard								
Designated space type	Comfort rating number	Minimum air temperature control span ¹⁾		Maximum air velocity	Minimum fresh air supply quantity per person ²⁾		Vertical air temperature difference	Relative humidity -RH ³⁾
	(crn)	10°C and below (outside)	45°C and above (outside)					
		Min./Max. limit (°C)	Min./Max. limit (°C)	m/s	litres/s	m ³ /hour	°C	%
A	1	18 - 24	22 - 28	0.25	10	36.0	2.0	30 – 60
	2	19.5 - 24	23.5 - 28	0.35	9	32.4	2.5	20 – 60
	3	21 - 24	25 - 28	0.40	8	28.8	3.0	< 65
B	1	18 - 24	22 - 28	0.15	12	43.2	2.0	30 – 60
	2	19.5 - 24	23.5 - 28	0.25	10	36.0	2.5	20 – 60
	3	21 - 24	25 - 28	0.35	8	28.8	3.0	< 65
C	1	20 - 24	23 - 28	0.20	10	36.0	2.0	30 – 60
	2	21 - 24	24 - 28	0.25	9	32.4	3.0	20 – 60
	3	22 - 24	25 - 28	0.35	8	28.8	3.5	< 65
D	1	20 - 24	23 - 28	0.25	10	36.0	2.0	30 – 60
	2	21 - 24	24 - 28	0.30	9	32.4	3.0	20 – 60
	3	22 - 24	25 - 28	0.40	8	28.8	3.5	< 65

1) For outside temperatures between 10°C and 45°C, the control span is to comply with the graphs shown in figs. 1 and 2

2) The number of persons to be considered for cabins is normally the number of beds. For special cabins this may be disregarded. The reason for the deviations is to be documented. The number of persons to be considered in public spaces is the same as the location is designed for.

3) Any relative humidity is to be within the range for all outdoor conditions the HVAC system is designed for. It is not necessary to meet the whole range during the specified design condition.

Temperature control span, designated space type A and B

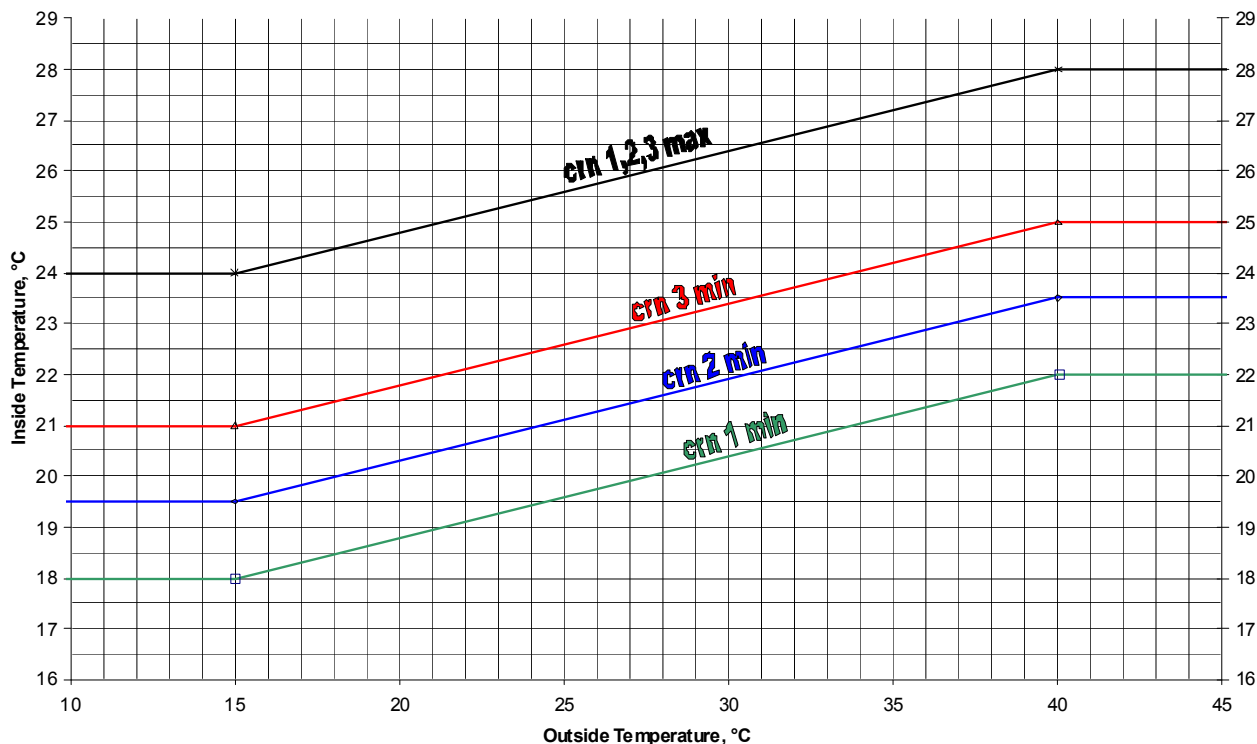


Fig. 1

Temperature control span, designated space type C and D.

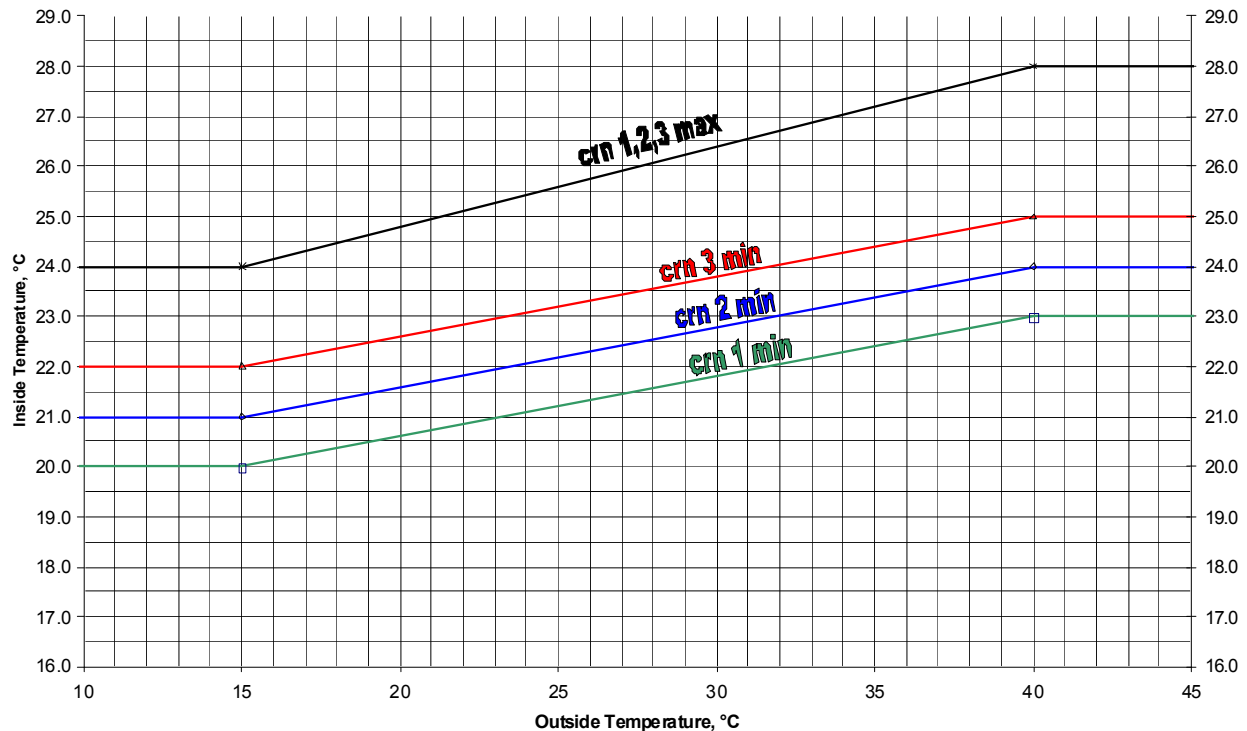


Fig. 2

204 For **(crn) 1**: Individual and automatic room temperature control (with thermostat) of designated spaces type A, B C and D are required.

205 For **(crn) 2** and **3**: Individual room temperature control of designated spaces type A, B, C and D is required.

206 For passenger ships the given comfort rating number applies to the passenger accommodation only. Unless specified, the crew accommodation shall comply with minimum rating **(crn) 3**.

C. Certification and Testing

C 100 General

101 An analysis of the basic HVAC design, calculation procedures and measurements on board, constitutes the basis for the compliance with the designated comfort rating number **(crn)**.

102 In general it may be difficult to achieve the variation in outdoor environment climate for which the HVAC is designed. Documentation showing the relation between outside temperature and the actual effect on cooling /heating unit has to be provided. This documentation may be given as a diagram showing required total cooling/heating effect as function of outside temperature and humidity. The scope of the test may therefore be reduced as long as it can be demonstrated that the capacity and general function of the HVAC plant can sustain a controlled climate on board according to the selected **(crn)**.

103 The following forms the basis for the approval and shall be submitted to the Society for documentation:

- design specification of HVAC plant
- plant layout diagrams
- calculations, standards and procedures
- documents issued during startup of HVAC units reporting air supply and exhaust quantity for all designated spaces
- heat transfer calculation for each room in accommodation.

104 Climate parameters subjected to verification through measurements are:

- vertical air temperature difference
- air temperature control span
- maximum air velocity.

105 Verification tests shall be performed onboard according to a specified program. Approval of this program shall be obtained from the society prior to the execution of measurements. This program shall at least include the following information:

- operating condition of the vessel during the test
- required operating condition of the HVAC plant
- specification of measurement location
- instrument to be used
- test responsible.

106 The measuring position in a location shall be selected such as to give a representative description of the on board climate or according to what is specified in 200 and 300.

107 Air relative Humidity is based on documentation and needs in general not to be verified through measurements.

108 Measurements shall be carried out by DNV or a 3rd party approved by the Society under supervision by a DNV representative onboard.

109 A summary of documentation to be submitted to the society is given in Table C1, with reference to Pt.0 Ch.3.

Table C1 Documentation requirements			
<i>Applicable system</i>	<i>Document type</i>	<i>Detailed description given in Pt.0 Ch.3 under item</i>	<i>Documentation submitted for information (FI) or approval (AP)</i>
Heating, ventilation and air conditioning	Heat balance calculations	S120	FI
Heating, ventilation and air conditioning	Specification	Z100	FI
Heating, ventilation and air conditioning	System Diagram	V011	FI
Heating, ventilation and air conditioning	Test procedure for quay and sea trial	Z140	AP
Heating, ventilation and air conditioning	Report from quay and sea trial	Z150	AP

C 200 Measuring locations

201 For ships with less than 100 cabins and the accommodation restricted to a separate section in the aft-ship, midship or in the fore-ship a full set of measurements applicable to climate parameters in the Table B2 shall be taken in the following minimum number of cabins (n = number of cabins):

- For $n < 10$ Measurements in all cabins
 For $10 \leq n \leq 40$ Measurements in min.10 cabins
 For $n \geq 41$ Measurements in min.25% of all cabins.

The cabins to be measured shall be evenly distributed amongst the cabins on each deck or in each respective fire zone. The positions should include start and end of duct line, if relevant.

202 For ships with more than 100 cabins distributed over a major portion of the ship, e.g. passenger ships, a full set of measurements shall be taken in minimum 10% of the cabins in each firezone containing cabins on each deck. The cabins to be measured shall be evenly distributed amongst the cabins on each deck or in each respective fire zone. The positions should include start and end of duct line.

203 The climate parameters (ref 104) shall be measured in a representative number of public spaces on board. The measuring positions shall be selected such as to give a representative description of the climate in the public spaces on board the ship.

204 The measurements position may be subjected to alterations during the testing based on the actual findings during the survey on board the ship.

C 300 Testing

301 The individual values of the climate parameters as stated in 302-305 shall be verified by measurements

during normal operation. HVAC plant shall be operated with constant output temperature during testing.

302 *Air supply quantity:* The air quantity supplied to a designated space shall be measured according to guidelines issued by the CIBSE Commissioning code, series A, air distribution systems, or any equivalent approved standard.

Documentation of measurements shall be submitted to the Society for approval.

303 *Air temperature control span:* The air temperature in a designated space shall be measured at the geometrical centre of the location. For larger spaces the temperature shall be measured in a representative number of positions in the occupancy zone.

In order to obtain the temperature span in each location, the measurements shall be carried out for the following two conditions with constant setting on central HVAC unit:

- minimum setting on local temperature regulation
- maximum setting on local temperature regulation.

The measurements shall be carried out at steady state conditions. The higher temperature criteria of the temperature control span should be measured within 2 hours after lower temperature measurement (ref B203).

304 *Vertical temperature gradient:* The vertical gradient in all designated spaces shall be measured in the following distances above the floor; 0.1 m, 1.0 m and 2.0 m in the geometrical center of the occupancy zone.

For larger spaces measurements shall be carried out in a representative number of positions in the occupancy zone.

305 *Air Velocity:* The mean air velocity is to be measured at the geometrical centre of the room. However the DNV representative may request alterations of the measurement position based on findings during the survey. Typical alteration may be to carry out the measurement at the position most commonly occupied in the location in question.

306 Minor deviations from the specified values in Table B2 may be acceptable in special cases. The Society decides whether to accept a deviation or not.

C 400 Reporting

401 The report shall contain the following information:

- main particulars of ship and machinery
- identity and description of the space (spaces)
- name of surveying engineer/organisation
- location, date and time of the measurements
- details of type and make of instrumentation used
- instrument calibration data
- vessel operating conditions
- outdoor climatic conditions
- climate parameter measurements according to Table B2.

D. System Requirements

D 100 General

101 In case of system failure, the HVAC system is, depending on the comfort rating number to be achieved, to have a redundancy in designated spaces given in 200.

102 In order to achieve the designated comfort rating number (**crn**), the maintainability of the system shall fulfil certain minimum requirements (see 300).

D 200 HVAC System Failure Mode Control

201 In case of system failure, a controlled climate in spaces designated A and B shall be restored after maximum 12 hours for comfort rating (**crn**) **1** and **2**. If different failures not related to each other occur simultaneously, the restoring time shall be increased by 12 hours.

The minimum required amount of spare parts to be available should be agreed between the owner and the supplier. The list should be available to DNV.

There is no redundancy requirement for comfort rating (**crn**) **3**.

202 A minimum level of ventilation in hospital and engine control room shall be provided during a system failure by means of separate forced ventilation. Regulation of the fans to be located in the respective rooms. This ventilation shall keep the temperature below 35 °C and above 15 °C.

D 300 HVAC System Maintainability

301 In order to guarantee a sustainable **(crn) 1, 2 and 3** climate a degree of system maintainability is required.

302 Ducts, central air handling units, air filters, dust collectors, heat exchangers, re-heaters and air terminals shall be possible to inspect, clean or replace at regular work intervals.

Inspection hatches/doors shall be installed for inspection and cleaning of ducts.

D 400 Filter requirements

401 Air filters in air handling units or fan-coil units supplying air to designated spaces shall have a minimum filtration efficiency* according to the following European or US standards:

<i>Space</i>	crn	<i>Filter</i>	<i>Performance - new filter*</i>
A, B, C, D	1	EU7/F7	90% of PM > 1 micron
A, B, C	2,3	EU7/F7	90% of PM > 1 micron
D	2,3	EU5/F45	
* Airborne particles are inherently difficult to measure accurately and it is difficult to isolate the source of the particles. The particles in the supply air which often dominate on board vessels can be reasonably checked by surveying the supply air filters instead of measuring the particulate concentration in the air.			

APPENDIX A

GUIDELINES FOR HANDLING OF EXCESSIVE NOISE AND VIBRATION LEVELS

A. Introduction

A 100 General

101 The general requirement is that all the locations on board shall comply with the relevant comfort class noise and vibration criteria. However, small deviations from the requirements may be accepted, depending on the type of location and how much the criteria are exceeded. This Appendix is meant to give guidelines concerning how to handle excessive noise and vibration levels.

B. Excessive Vibration Levels

B 100 Deviations from vibration limits

101 Locations with excessive vibration levels on board a ship shall not exceed the following maximum values in order to obtain a comfort class notation:

- 15% of all the sleeping cabins and public spaces
- 25% of the measurements on the open deck areas.

102 The distribution of excessive vibration levels in the cabins and public spaces shall additionally not exceed the distribution shown in Table B1. The limits in this table are based on a one-sided normal distribution of the excessive vibration levels with a standard deviation of 0.5 mm/s.

Table B1 Distribution of excessive vibration levels in cabins and public spaces			
<i>Range</i>	<i>Excessive vibration level (mm/s)</i>	<i>Limit for cabins/public spaces (maximum 15% of all cabins)</i>	
		<i>Normal</i>	<i>Maximum</i>
I	0.1 - 0.5	11%	(15%)
II	0.6 - 1.0	4%	(4%)

103 The distribution of excessive vibration levels in open deck areas shall additionally not exceed the distribution shown in Table B2. The limits in this table are based on a one-sided normal distribution of the excessive vibration levels with a standard deviation of 1.0 mm/s.

Table B2 Distribution of excessive vibration levels in open deck areas			
<i>Range</i>	<i>Excessive vibration level (mm/s)</i>	<i>Limit for open deck areas (maximum 25% of all positions)</i>	
		<i>Normal</i>	<i>Maximum</i>
I	0.1 - 0.5	11%	(25%)
II	0.6 - 1.0	7%	(14%)
III	1.1 - 1.5	4%	(7%)
IV	1.6 - 2.0	3%	(3%)

104 The number of locations within the lower allowable exceedance values may be increased at the expense of the number of locations within the higher vibration level ranges, but such that all the locations with excessive vibration levels shall not exceed the total maximum (15% of cabins/public rooms, and 25% of open deck areas). The increased limits are shown inside the parentheses in Table B1 and B2.

105 The following example may illustrate the permissible deviations from the normal distribution. One of nine measuring positions in the open deck areas has an exceeding value of 1.0 mm/s of the criteria, while the other positions are within the criteria, i.e. 11% exceeding values in group II. This is regarded as acceptable (see Table B2).

Table B1 and B2 are illustrated in Fig. 1 and 2.

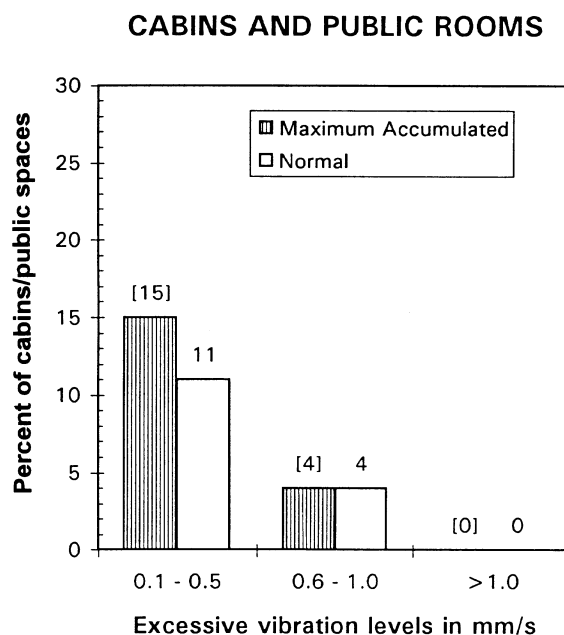


Fig. 1
Excessive vibration levels in mm/s for cabins and public spaces

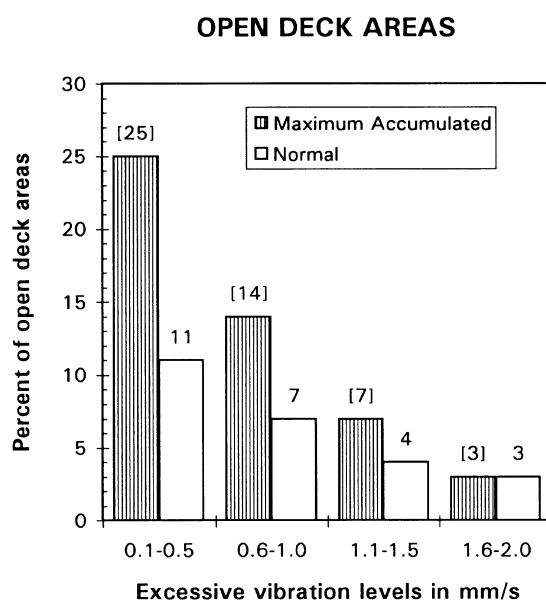


Fig. 2
Excessive vibration levels in mm/s in open deck areas

C. Excessive Noise Levels

C 100 Deviations from noise limits

101 Locations with excessive noise levels on board a ship shall not exceed the following maximum values on board in order to obtain a comfort class notation:

- 15% of all the sleeping cabins
- 30% of all the public spaces (recreation rooms, restaurants, cinemas, open deck recreation areas, etc.)

Table C1 Distribution of excessive noise levels in cabins and public spaces

Range	Excessive noise level	Limit for cabins (maximum 15% of all cabins)		Limit for public spaces (maximum 30% of all public spaces)	
		Normal	Maximum	Normal	Maximum
I	1 - 3 dB(A)	14%	(15%)	23%	(30%)
II	4 - 6 dB(A)	1%	(1%)	6%	(7%)
III	7 - 10 dB(A)	None	None	1%	(1%)
IV	>10 dB(A)	None	None	None	None

102 The distribution of excessive noise levels shall additionally not exceed the distribution shown in Table C1. The limits in this table are based on a one-sided normal distribution of the excessive noise levels.

103 The distribution of excessive noise levels for cabins (passenger and crew cabins) is stricter than for public spaces. The limits for cabins and public spaces are based on a normal distribution where the mean value is zero (i.e. no deviation from the noise limit), and with a standard deviation of 2 dB(A) for cabins and 3 dB(A) for public spaces.

104 The number of locations within the two lowest noise level ranges may be increased on the expense of the number of locations within the higher noise level ranges, but such that all the locations with excessive noise levels shall not exceed the total maximum (15% of cabins, and 30% of public spaces). The increased limits are shown inside the parentheses in Table C1.

105 The following example may illustrate the permissible deviations from the normal distribution. 25% of the public spaces have noise levels in excess of the relevant comfort class noise limits, but none of the public spaces have higher noise levels than 3 dB(A) in excess of the limits. Then the limit within parentheses in range I for public spaces apply, i.e. up to 30% of the total public spaces may have excessive noise levels in the range 1–3 dB(A) higher than the given limit, and consequently the public spaces will comply with the comfort noise criteria in question.

Table C1 is illustrated in Fig. 3 and 4.

D. Scaling or Weighting of the Measurements in Cabins

D 100 General

101 Since the number of measuring positions is not evenly distributed over the ship, it will be necessary to scale the results, before a comparison with the comfort class noise and vibration criteria can be carried out.

102 The scaling procedures will apply for each deck level and for the three parts of the ship (i.e. aftship, midship and foreship as defined in the rules). The scaling applies to noise and vibration separately. If n cabins are measured in a region with a total of N cabins, the number of cabins with excessive noise or vibration levels shall be multiplied by a scaling factor defined by:

scaling factor = N/n .

103 This scaling factor shall be multiplied with the number of excessive noise or vibration levels in each of the ranges I–II / I–IV (see Tables B1 and B2) for vibration, and I–II / I–III for noise (see Table C1), for the different parts of each deck level. The resulting number (rounded off to the nearest integer) will then be an estimate of the total number of cabins with excessive noise or vibration levels in this part of the ship.

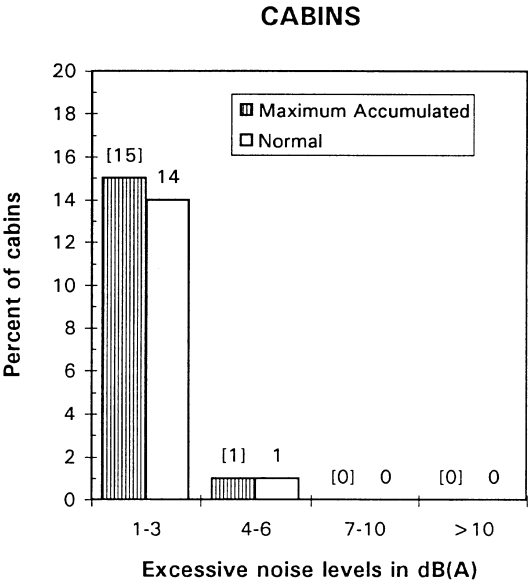


Fig. 3
Excessive noise levels in dB(A) in cabins

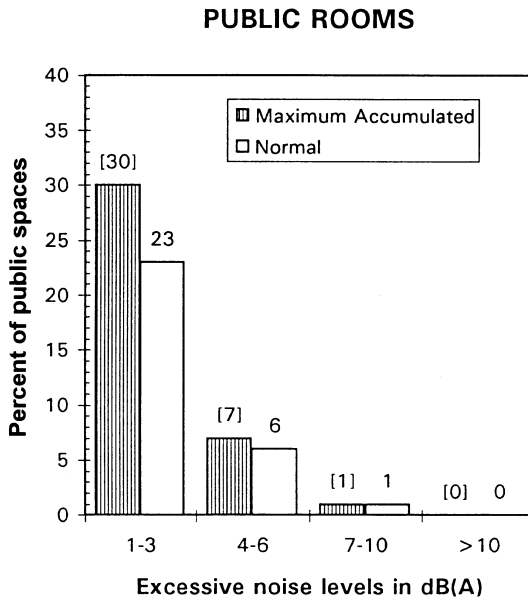


Fig. 4
Excessive noise levels in dB(A) in public spaces