



RULES FOR CLASSIFICATION OF **SHIPS**

SPECIAL SERVICE AND TYPE
ADDITIONAL CLASS

PART 5 CHAPTER 12

COMFORT CLASS

JANUARY 2003

*This booklet includes the relevant amendments and corrections
shown in the July 2008 version of Pt.0 Ch.1 Sec.3.*

CONTENTS	PAGE
Sec. 1 General Requirements	5
Sec. 2 Noise and Vibration.....	6
Sec. 3 Indoor Climate.....	11
App. A Guidelines for handling of excessive noise and vibration levels	15

DET NORSKE VERITAS

Veritasveien 1, NO-1322 Høvik, Norway Tel.: +47 67 57 99 00 Fax: +47 67 57 99 11

CHANGES IN THE RULES

General

This booklet is a reprint of the previous edition and apart from clarifications of text and the inclusion of amendments and corrections, published in the July 2002 edition of Pt.0 Ch.1 Sec.3, no other changes have been made.

This chapter is valid until superseded by a revised chapter. Supplements will not be issued except for an updated list of minor amendments and corrections presented in Pt.0 Ch.1 Sec.3. Pt.0 Ch.1 is normally revised in January and July each year.

Revised chapters will be forwarded to all subscribers to the rules. Buyers of reprints are advised to check the updated list of rule chapters printed in Pt.0 Ch.1 Sec.1 to ensure that the chapter is current.

Corrections and Clarifications

In addition to the above stated rule requirements, a number of corrections and clarifications have been made in the existing rule text.

Comments to the rules may be sent by e-mail to rules@dnv.com

For subscription orders or information about subscription terms, please use distribution@dnv.com

Comprehensive information about DNV and the Society's services is found at the Web site <http://www.dnv.com>

© Det Norske Veritas

Computer Typesetting (FM+SGML) by Det Norske Veritas

Printed in Norway

If any person suffers loss or damage which is proved to have been caused by any negligent act or omission of Det Norske Veritas, then Det Norske Veritas shall pay compensation to such person for his proved direct loss or damage. However, the compensation shall not exceed an amount equal to ten times the fee charged for the service in question, provided that the maximum compensation shall never exceed USD 2 million.

In this provision "Det Norske Veritas" shall mean the Foundation Det Norske Veritas as well as all its subsidiaries, directors, officers, employees, agents and any other acting on behalf of Det Norske Veritas.

CONTENTS

SEC. 1 GENERAL REQUIREMENTS	5	E. Test Conditions.....	9
A. Classification.....	5	E 100 General	9
A 100 Application.....	5	E 200 Noise	10
A 200 Grouping of environmental standards.....	5	E 300 Vibration	10
A 300 Class notations	5		
B. Definitions.....	5	SEC. 3 INDOOR CLIMATE	11
B 100 Definitions.....	5	A. General.....	11
C. Documentation	5	A 100 Rule applications.....	11
C 100 Noise and vibration	5	A 200 International standards	11
C 200 Indoor Climate	5	A 300 Terminology and units	11
		A 400 Abbreviations.....	11
SEC. 2 NOISE AND VIBRATION.....	6	B. Requirements for On Board Climate	11
A. General.....	6	B 100 General	11
A 100 Rule applications.....	6	B 200 Climate requirements	12
A 200 International standards	6	C. Certification and Testing	13
A 300 Definitions.....	6	C 100 General	13
A 400 Abbreviations	6	C 200 Measuring locations	13
B. Noise and Vibration Requirements	6	C 300 Testing.....	14
B 100 General	6	C 400 Reporting.....	14
B 200 Noise criteria.....	6	D. System Requirements.....	14
B 300 Sound insulation.....	7	D 100 General	14
B 400 Impact sound insulation	7	D 200 HVAC System Failure Mode Control.....	14
B 500 Vibration criteria	8	D 300 HVAC System Maintainability	14
C. Certification and Testing, Noise	8	D 400 Filter requirements.....	14
C 100 General	8	APP. A GUIDELINES FOR HANDLING OF	
C 200 Distribution of measuring positions in sleeping cabins	8	EXCESSIVE NOISE AND VIBRATION	
C 300 Distribution of measuring positions for public spaces.....	8	LEVELS	15
C 400 Measuring positions open deck recreation areas.....	8	A. Introduction.....	15
C 500 High speed and light craft	8	A 100 General	15
C 600 Reporting.....	8	B. Excessive Vibration Levels	15
D. Certification and Testing, Vibration	9	B 100 Deviations from vibration limits.....	15
D 100 General	9	C. Excessive Noise Levels	16
D 200 Measuring positions	9	C 100 Deviations from noise limits	16
D 300 Data acquisition	9	D. Scaling or Weighting of the Measurements in Cabins....	16
D 400 Reporting.....	9	D 100 General	16

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 is to 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 fulfill 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 fulfill 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 fulfill 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 Section 2

C 200 Indoor Climate

201 Required documentation is described in Section 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 is to apply.

203 Noise:

- IMO Resolution A. 468 (XII), "Code on noise levels on-board 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 de-

fined 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 is to 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 are to 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 is to 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 are to 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)						
Locations	comfort rating number (crn)					
	50m and below			Above 50m		
	1	2	3	1	2	3
Passenger localities	65	70	75	60	65	68
Navigation bridge	60	60	65	60	60	65
Service areas / shops / kiosk	68	73	78	65	65	70

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

Table B5 Sound Insulation Indexes	
Positions	$L_p + RW'$ (dB)
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 are to 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

401 For the cabins in general, the normalized impact sound pressure level is not to exceed 50 dB. For cabin 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 cabins located below dance floors, stages and gymnasiums, a normalized impact sound pressure level is not to 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⁾			
Locations	comfort rating number (crn)		
	1	2	3
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⁾			
Locations	comfort rating number (crn)		
	1	2	3
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⁾			
Locations	comfort rating number (crn)		
	1	2	3
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⁾

Locations	comfort rating number (crn)					
	In harbour conditions			Transit conditions		
	1	2	3	1	2	3
Accommodation	0,5	1,0	2,0	1,0	2,0	3,0
Outdoor recreation 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 are to 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 is to be assessed separately.

C. Certification and Testing, Noise

C 100 General

101 The measurements are to 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 is to comply with the requirements given in ISO 2923.

103 A test program is to 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 are to 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 are to be approved by the Society prior to the noise survey.

106 If the specified criterion is exceeded, octave band analysis of the noise is to 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 are to 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 are to be evenly distributed amongst the cabins within in each of the aft-, mid- and foreship sections of the ship.

Table C1 Distribution and number of measuring positions for cabins

Measuring region	Minimum percentage of cabins in the region to be measured
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 is to be measured in all the public spaces on board. The measuring positions are to 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 is to 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 is to 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 is to 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 are to be taken in at least the following positions:

- at the aft seat row / seat position, near starboard side, near centerline 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 centerline 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 centerline 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 is to comply with the requirements in ISO 2923.

- 602** The positions of the noise measurements are to be plotted on general arrangement drawings of the ship.
- 603** The dB(A) levels are to 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 are to be reported.

D. Certification and Testing, Vibration

D 100 General

101 The measurements are to 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 is to be of an electronic type. The signal may be stored on tape, analyzed directly by means of a FFT-analyzer, or by means of PC-based equipment.

103 A test program is to 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 are to 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 are to 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 is to 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 is to be applied on each deck.

Table D1 Distribution and number of measuring positions for cabins	
Measuring region	Percentage of measuring positions to be placed in the region
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 ac-

cording 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 is to 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 are to be analyzed 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 are to 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 is to be clearly stated.

D 400 Reporting

401 The report is to 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 analyzer, 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) is to correspond to contractual normal seagoing condition, or at least 85% of maximum continuous power available on the propeller shaft(s). All other machinery is to 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) is to 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 are to 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 is to be as close as possible to normal operating condition(s). For ships with larger variation than 25% in relevant displacements, the measurements are to be taken at two loading conditions close to the relevant heavy and light condition. The loading condition(s) to be used is to be approved by the Society prior to the testing.

106 The rudder angle should be restricted to about 0 degrees ± 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 is to be provided by the yacht's auxiliary engine(s), the HVAC system is to be run at rated capacity and the power consumption is to be at least 85% of the normal service supply.

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

E 200 Noise

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

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

203 Doors and windows are to be closed.

E 300 Vibration

301 The decks are to 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 is to 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, Moderate thermal environments — Determination of PMV and PPD indices
- ISO 7726, Thermal environments — Instruments and methods for measuring physical quantities
- ISO 8862, Shipbuilding — Air-conditioning and ventilation of machinery control rooms on board ships — Design conditions and basis for calculations
- ISO 8864, Shipbuilding — Air-conditioning and ventilation of wheelhouse on board ships — Design conditions and basis for calculations
- WHO, Indoor air pollutants; Exposure and health effects. EURO reports and studies 78, 83
- WHO, Air Quality Guidelines for Europe series 23, 1987
- ASHRAE, Applications Handbook. American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc. Atlanta, 91
- ASHRAE, Comfort Standard 55-66
- ASHRAE, Ventilation for Acceptable Indoor Climate 62-1989
- SCANVAC, Classified Indoor Climate Systems — Guidelines and specifications, the Swedish Indoor Climate Institute
- NKB, 61E-June 1991, Definitions of terms relating to ventilated air

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, recorded during 15 minutes, expressed in °C. If the thermal environment in which the measurements are performed is in substantial thermal unbalance, the recording time is to be extended to 30 minutes.

304 Relative humidity: The quotient of the vapour content in the air and the saturation vapour content of that air expressed in percent.

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

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

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

308 Vertical gradient: Vertical air temperature difference.

309 Air operative temperature: A measure of the equivalent heat loss from a human body caused by convection and radiation as the actual temperature causes, expressed in °C. (It can be approximated by the globe temperature).

310 Air supply quantity: The quantity of fresh/outside air per person supplied to a space, expressed in litres/s. The total amount of supplied air to any given space may consist of a percentage recirculated return air in addition to the air supply quantity.

311 Concentration of CO₂: The volume quotient of CO₂ to air expressed in ppm.

312 Public spaces: A general term for larger spaces to which passengers and crew on board have access, excluding cabins.

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

A 400 Abbreviations

401 ISO: International Organization for Standardization

402 WHO: World Health Organization

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

404 SCANVAC: Scandinavian federation of heating, ventilation and sanitary engineering associations in Denmark, Iceland, Norway and Sweden.

405 NKB: Nordic Committee on Building-regulation

406 HVAC: Heat, 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 is to be verified through measurements. The rules may, however, also be used in conjunction with the specification, design and engineering of a vessel's HVAC plant.

103 All locations specified in tables B1 to B3 are to 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.

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	Cabin accommodation spaces
Type B	Public spaces excluding toilettes and corridors
Type C	Hospital areas
Type D	Navigation bridge/Wheel house, Engine control room, Office areas, Crew mess/Recreation rooms

202 The requirements to air properties and quality at different localities and comfort standard are shown in Table B2 and B3.

Table B2 Onboard Climate Classification - Climate Parameters (15 minutes mean values)							
Designated Type	Space	(crn) - comfort rating number	Air operative temperature		Air operative temperature control span		Vertical air operating temperature gradient (°C/m)
			Summer (°C)	Winter (°C)	Summer (°C)	Winter (°C)	
A	Cabins, accommodation spaces	1	22 (±1.0)	23 (±1.5)	22 - 28	23 - 25	2.5
		2	24 (±1.5)	22 (+2.0/ - 1.0)	24 - 28	22 - 24	3.5
		3	26 (±2.0)	22 (+2.5/ - 1.0)	26 - 28	22 - 24	4.0
B ₁	Public spaces intended for high physical activity and or spaces such as: <i>Dance lounges, Discos, Gymnasiums etc.</i>	1	22 (±1.5)	23 (+2.0/ - 1.5)	22 - 28	23 - 25	2.5
		2	24 (±2.0)	22 (+2.5/ - 2.0)	24 - 28	22 - 24	3.5
		3	26 (±2.5)	22 (+3.0/ - 2.0)	26 - 28	22 - 24	4.0
B ₂	Public spaces intended for medium physical activity and or spaces such as: <i>Show lounges, Dining rooms, Atriums, Casinos, Shopping areas, Bars</i>	1	22 (±1.0)	23 (±1.5)	22 - 28	23 - 25	2.5
		2	24 (±1.5)	22 (±2.0)	24 - 28	22 - 24	3.5
		3	26 (±2.0)	22 (+2.5/ - 2.0)	26 - 28	22 - 24	4.0
B ₃	Public spaces intended for low physical activity and or spaces such as: <i>Conference rooms, Libraries, Card rooms, Seating areas, etc.</i>	1	22 (±0.5)	23 (±1.0)	22 - 28	23 - 25	2.5
		2	24 (±1.0)	22 (±1.5)	24 - 28	22 - 24	3.0
		3	26 (±1.5)	22 (±2.0)	26 - 28	22 - 24	3.5
C	<i>Hospitals, Ward rooms</i>	1	22 (±1.0)	23 (±1.0)	22 - 28	23 - 25	2.5
		2	24 (±1.5)	22 (+2.0/ - 1.0)	24 - 28	22 - 24	3.0
		3	25 (±2.0)	22 (+2.5/ - 1.0)	25 - 28	22 - 24	3.5
D	<i>Offices, Wheelhouses, Engine control rooms, Messes, Recreation rooms</i>	1	22 (±1.5)	23 (±2.0)	22 - 28	23 - 25	2.5
		2	24 (±2.0)	22 (±2.5)	24 - 28	22 - 24	3.0
		3	25 (±2.5)	22 (±3.0)	25 - 28	22 - 24	3.0

Note: The air operative temperature and the vertical air operative gradient parameters are to be fulfilled at the same time at any given location in a designated space. This means that the vertical air operative temperature gradient is only allowed to vary with the specified number of °C/m as long as the requirements for the air operative temperature are met in the entire space.

Table B3 Onboard Climate Classification - Climate Parameters (15 minutes mean values)							
Designated Type	Space	(crn) - comfort rating number	Maximum air velocity (m/s)	Air Relative Humidity - RH		Air supply quantity. Minimum outside fresh air per person ¹⁾ (litres/s)	Maximum concentration of CO ₂ (ppmv)
				Summer (°C)	Winter (°C)		
A	Cabin, accommodation spaces	1	0.25	<50	>30	10	1000
		2	0.35	<55	>20	10	1000
		3	0.40	<60	-	7	1200
B ₁	Public spaces intended for high physical activity and or spaces such as: <i>Dance lounges, Discos, Gymnasiums etc.</i>	1	0.25	<60	>30	12	800
		2	0.30	<65	>20	10	1000
		3	0.40	<65	-	7	1200
B ₂	Public spaces intended for medium physical activity and or spaces such as: <i>Show lounges, Dining rooms, Atriums, Casinos, Shopping areas, Bars</i>	1	0.25	<60	>30	12	800
		2	0.30	<60	>20	10	1000
		3	0.40	<65	-	7	1200
B ₃	Public spaces intended for low physical activity and or spaces such as: <i>Conference rooms, Libraries, Card rooms, Seating areas etc.</i>	1	0.20	<55	>30	12	800
		2	0.25	<60	>20	10	1000
		3	0.35	<65	-	7	1200
C	<i>Hospitals, Ward rooms</i>	1	0.15	<50	>30	12	800
		2	0.25	<55	>30	10	1000
		3	0.35	<60	>20	7	1000
D	<i>Offices, Wheelhouses, Engine control rooms, Messes, Recreation rooms</i>	1	0.20	<55	>30	12	800
		2	0.25	<60	>20	10	1000
		3	0.25	<65	-	7	1200
1) 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.							

203 For **(crn) 1**: Individual and automatic room temperature control of designated spaces type A, B, C, navigation bridge and engine control room, are required. For messes and recreation rooms, individual room temperature control is required.

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

205 For ships carrying passengers, crew cabins and crew spaces other than navigation bridge and engine control room may be excluded from the requirements specified for **(crn) 1** and **2**.

C. Certification and Testing

C 100 General

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

102 Final basic design specification, plant layout diagrams, calculations conventions, standards and procedures are to be submitted to the Society for approval. If available, sampled historical data on climatic variations in designated spaces for the ship in service are also to be submitted.

103 Verification tests are to be performed on board according to a test program. Approval of the test program is to be obtained from the Society prior to execution of the test.

104 In general it may be difficult to achieve variation of outdoor environment climate for which the HVAC is designed for. Likewise on-line measurements in spaces with on-going activities on board a ship in service, are associated with difficulties. 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)**.

105 The test program is at least to include the following information:

- date and planned duration of the test
- particulars of vessel and operating conditions during the test
- expected ambient environmental conditions during the test
- specification of measurement locations
- required operating conditions of the HVAC plant
- instrumentation to be used
- test sequence and basic test procedures
- surveying organization and name of the surveyor responsible for the test.

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

C 200 Measuring locations

201 For conventional cargo ships, research vessels, smaller passenger vessels, etc. with 10 — 100 cabins and with the accommodation restricted to a separate section in the aft-ship, midship or in the fore-ship area, a full set of measurements applicable to climate parameters in Table B2 and Table B3 is to be taken in N percent or more of the cabins, where $N = 1000/n$ and n = the number of cabins. The cabins to be measured are to be evenly distributed amongst the cabins in each respective fire zone. The corresponding percentage for $n < 10$ and $n > 100$ is 100 and 10%, respectively. The maximum air supply quantity is to be measured in 100 percent of the cabins according to the HVAC designers specification by way of a built in flow sensor or by an external flow measuring instrument.

202 For ships with a large number of cabins distributed over a major portion of the ship, e.g. passenger ships, a full set of measurements is to be taken in N percent or more of the cabins where $N = 500/n^{1/2}$ and n = the number of cabins. The cabins to be measured are to be evenly distributed amongst the cabins in each respective fire zone. The maximum air supply quantity is to be measured in 100 percent of the cabins according to the HVAC designers specification by way of a built in flow sensor or by an external flow measuring instrument.

203 The climate parameters are to be measured in all public spaces on board. The measuring positions are to be selected

such as to give a representative description of the climate in the public spaces on board the ship.

C 300 Testing

301 The individual values of the climate parameters listed below are to be verified by 15 minutes arithmetic mean values recorded during representative operating conditions, with occupied spaces and with on going activities, simulated or actual, for which the particular space is intended. If the environment in which the measurements are performed is in substantial unbalance, the recording time is to be extended to 30 minutes.

302 *Air supply quantity:* The air quantity supplied to a designated space is to be measured according to guidelines issued by the Swedish Indoor Climate Institute — Supply air terminals — or any equivalent approved standard at a relevant position adjacent to the air supply device (devices).

303 *Air operative temperature:* The ambient air operative temperature in a designated space is to be measured according to ISO 7726 at the geometrical center of type A, C and D designated spaces. For type B spaces the temperature is to be measured in at least 4 positions in the occupancy zone halfway between the geometrical center of the zone and its perimeters.

304 *Air operative temperature gradient:* The vertical gradient in type A, C and D designated spaces is to be measured in the geometrical center of the space and $\pm 0.5\text{m}$ with the same instrumentation as is used for air operative temperature. For type B spaces the vertical gradient is to be measured in the occupancy zone at least 4 positions horizontally halfway between the geometrical center of the zone and vertically $\pm 0.5\text{m}$ from the zone center.

305 *Air relative humidity:* The air relative humidity in any designated space is to be measured at an arbitrary position in the space according to ISO 7726.

306 *Air velocity:* The mean air velocity relative to an occupant in type A, C and D type designated spaces is to be measured according to ISO 7726 in at least 4 positions in the occupancy zone similarly to what is specified for air operative temperature.

307 *CO₂ concentration:* According to any approved national or international standard.

308 Minor deviations from the specified values in Table B2 and Table B3 may be acceptable in special cases. It may require that repeat measurements be taken in order to establish a higher level of certainty of the magnitude of the deviations before approval can be obtained. The Society decides whether to accept a deviation or not.

C 400 Reporting

401 The report is to contain the following information:

- ship and machinery particulars
- 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 Tables B2 and B3.

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 is to fulfill 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 C is to be restored after maximum 12, and 24 hours for comfort ratings (**crn**) 1 and 2, respectively. If different failures not related to each other occur simultaneously, the restoring time is to be increased by 12 hours. There is no redundancy requirements for comfort rating (**crn**) 3.

202 For (**crn**) 1: During a systems failure the HVAC system must not cause excessive pressure differentials so as to create undue draught in designated spaces. A systems failure must not impair the segregation of air supply and exhaust, if any, between smoking and non smoking areas.

203 Compliance with 202 is to be demonstrated by appropriate tests and or by design verification.

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 For (**crn**) 1: Every integral part of the HVAC system intended for air transportation is to be possible to inspect and clean at regular intervals with a moderate effort and minimum system down time.

303 For (**crn**) 2: Central air handling units, air filters, dust collectors, humidifiers, heat exchangers, re-heaters and air terminals is to be possible to inspect, clean or replace at regular intervals with a moderate effort and minimum system down time.

304 For (**crn**) 3: No particular requirements.

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:

Space	crn	Filter	Performance - new filter
A	1	EU6/F60	90% of PM > 3 - 4 micron 90% of PM > 7 - 9 micron
	2	EU5/F45	
	3	EU3/G80	
B	1	EU5/F45	
	2	EU5/F45	
	3	EU3/G80	
C	1	EU7/F85	90% of PM > 1 micron
	2	EU7/F85	
	3	EU7/F85	
D	1	EU6/F60	
	2	EU5/F45	
	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			
Range	Excessive vibration level (mm/s)	Limit for cabins/public spaces (maximum 15% of all cabins)	
		Normal	Maximum
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			
Range	Excessive vibration level (mm/s)	Limit for open deck areas (maximum 25% of all positions)	
		Normal	Maximum
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 exceedings 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.

CABINS AND PUBLIC ROOMS

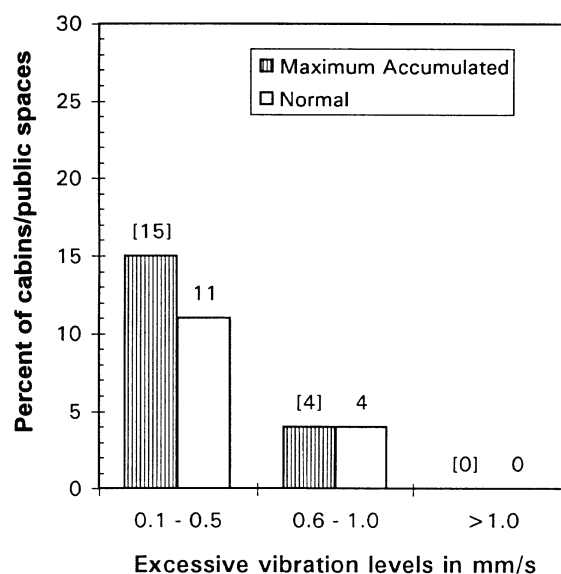


Fig. 1
Excessive vibration levels in mm/s for cabins and public spaces

OPEN DECK AREAS

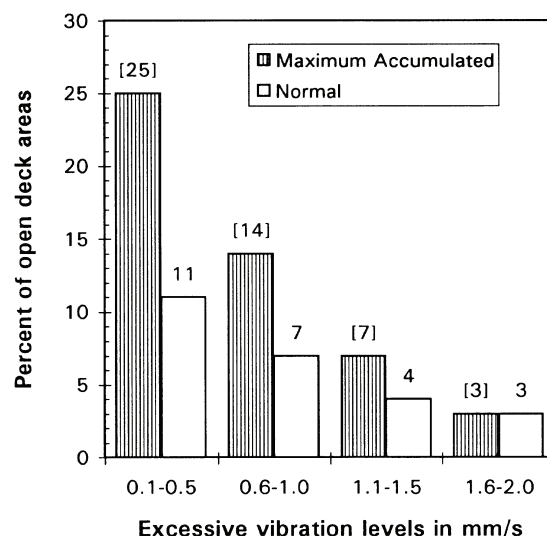


Fig. 2
Excessive vibration levels in mm/s in open deck areas

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.)

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 is to 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.

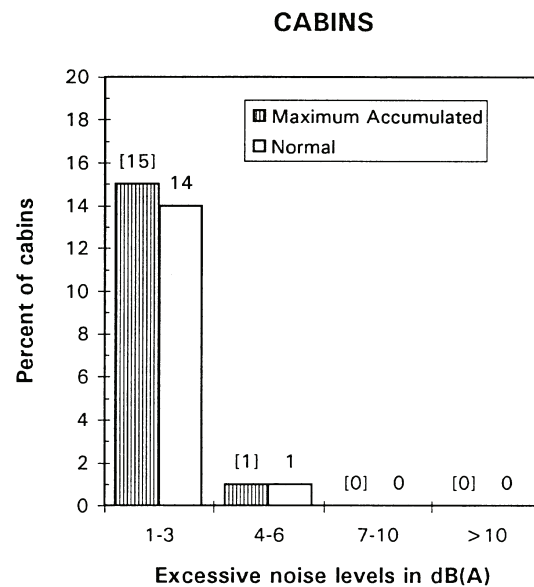


Fig. 3
Excessive noise levels in dB(A) in cabins

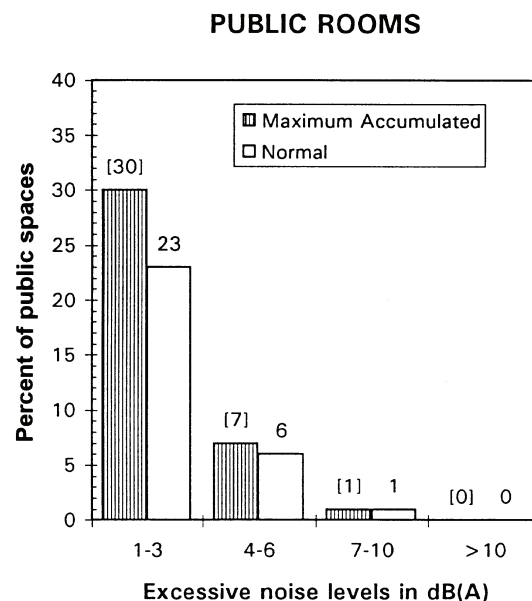


Fig. 4
Excessive noise levels in dB(A) in public spaces