DNV·GL

RULES FOR CLASSIFICATION

Ships

Edition October 2015
Amended January 2016

Part 6 Additional class notations

Chapter 8 Living and working conditions

DNV GL AS

FOREWORD

DNV GL rules for classification contain procedural and technical requirements related to obtaining and retaining a class certificate. The rules represent all requirements adopted by the Society as basis for classification.

Any comments may be sent by e-mail to *rules@dnvgl.com*

CHANGES – CURRENT

This is a new document.

The rules enter into force 1 January 2016.

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

Amendments January 2016

- Sec.1 Comfort class - COMF

— Sec.1 Table 4: Documentation requirement for specification of accommodation panels and cabin doors included.

Editorial corrections

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

CONTENTS

SECTION 1 COMFORT CLASS - COMF

1 General

1.1 Introduction

The additional class notation **COMF (V-crn, C-crn)** is applicable for all ship types. The class notation **COMF (V-crn, C-crn)** indicates that comfort conditions that may adversely influence human performance on board ships have been taken into consideration, and that the vessel satisfies acceptable levels of noise and vibration and indoor climate on board ships. The qualifier **V-crn** indicates to what level the requirements related to noise and vibration have been achieved, and **C-crn** indicates to what the requirements related to indoor climate have been achieved.

1.2 Scope

The additional class notation **COMF** includes requirements for noise levels, vibration levels and the performance of the on board HVAC system, for passenger ships, cargo ships, yachts and high-speed crafts. The areas included are cabins, public spaces, wheelhouse, radio rooms, offices, control rooms, hospital and recreation rooms.

Compliance with the rules shall be verified through measurements of defined environmental parameters. Possible influence of vibration on machinery, structure or other systems is considered in other relevant Society rules. The least strict noise level and sound insulation requirements (**crn = 3**) for cargo ships correspond to the requirements in IMO MSC 337(91) "Code on noise levels on board ships". In order to achieve the class notation , the vibration criteria's in this section shall also be satisfied.

1.3 Application

The additional class notation **COMF (V-crn, C-crn)** is applicable to ships which comply with all the requirements to noise, vibrations and indoor climate. Criteria for providing a comfort rating number (**crn**) are divided into three groups 1, 2, and 3 depending on the level of comfort achieved. **crn = 1** represents the highest comfort level and **crn = 3** represents an acceptable level of comfort.

1.4 Class notations

Ships constructed in accordance with the requirements as specified in Table 1 will be assigned the class notations as follows:

Table 1 Class notation and qualifiers

Class notation		*Qualifier*		*Requirements*
Name	*Description*	*Name*	*Description*	
COMF	Requirements related to comfort conditions that may adversely influence human performance.	**V**	Noise and vibration	[2]
		C	Indoor climate	[3]
		crn	For each of the qualifiers **V** and **C** a separate comfort rating number **crn** will be set up. **crn** will be set to 1, 2 or 3 depending on the level of comfort achieved. **crn = 1** represents the highest comfort level and **crn = 3** represents an acceptable level of comfort.	

1.5 Definitions and abbreviations

1.5.1 Definitions

The main parameters determining the comfort on board a ship are defined in Table 2 below. Further definitions of sound and vibration quantities and units are given in ISO 80000-8 and ISO 1683.

Table 2 Definitions

Air supply quantity	The total amount of supplied air to any given space which may consist of a percentage re-circulated return air in addition to the fresh air supply quantity.
Air temperature control span	The temperature interval which each designated space shall be able to satisfy.
Air velocity	The measured mean absolute velocity of a mass of air in motion.
Ambient outside air temperature	The actual air temperature measured out of direct sun exposure outside of the ship, expressed in °C.
Cabin	An accommodation room intended for sleeping or recreation only.
Cargo ship	Any ship, not specifically a passenger ship, yacht or high-speed craft, which is used commercially.
Draught	The depth of a ship's keel below the surface, [2]. Air flow which may cause unwanted local cooling of the body, [3].
Fresh Air supply quantity	The quantity of fresh/ outside air per person supplied to a space, expressed in litres/s or m^3/h.

Indoor climate	Indoor ambient temperature, temperature gradient, air velocity, humidity and carbon dioxide concentration used as descriptors for indoor climate.
Noise	Audible air pressure fluctuations generated by ship machinery, equipment or structure.
Noise level	A-weighted sound pressure level $L_{Aeq}(T)$, measured by a sound level meter in which the frequency response is weighted according to the A-weighting curve (ref. IEC 61672-1).
Open deck recreation/ *Outdoor passenger areas*	Any area accessible to passengers during normal operation of the vessel.
Public spaces	Communal indoor areas, e.g. restaurants, theatres, cinema, discos, shops, reading rooms, game rooms, gymnasiums, hobby rooms etc. Corridors, washrooms and toilets are excluded.
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. Usually expressed as percentage of saturated air having a relative humidity of 100%.
Relative humidity range	The range of which relative humidity must be within during all outdoor conditions the HVAC system is designed for.
Temperature	The average temperature of a specific number of temperature measurements in a particular space, expressed in °C.
Thermal comfort	A temperature range perceived as comfortable for most persons indoor.
Vertical gradient	Vertical air temperature difference.
Vibration	Structural motion in the frequency range 1 Hz to 80 Hz.
Vibration level	The overall frequency weighted r.m.s. value of vibration velocity measured in accordance with ISO 6954:2000.

1.5.2 Abbreviations

Table 3 Abbreviations

ASHRAE	American Society of Heating, Refrigerating and Air-conditioning Engineers Inc.
CIBSE	The Chartered Institution of Building Services Engineers
HVAC	Heating, ventilation and air conditioning
IEC	International Electrotechnical Commission
IMO	International Maritime Organization
ISO	International Organization for Standardization
WMO	World Meteorological Organization

1.6 Documentation requirements

1.6.1 Noise and vibration - qualifier V

Documentation shall be submitted as required by Table 4:

Table 4 Documentation requirements for qualifier V

Object	*Documentation type*	*Additional description*	*Info*
Noise and vibration	Z100-Specification	Including information on accommodation panels and cabin doors: — name and type, construction, door ventilation arrangement — insulation arrangement plan of accommodation area — laboratory test reports for sound insulation measurements including sound reduction indexes (Rw).	FI
	Z250 – Procedure	A detailed plan for the measurements prior to the execution, containing: — specification of measuring locations, — expected loading condition during the measurements and normal range of loading conditions for the vessel, — required operating conditions for the vessel during the measurements, i.e.: rotational speed, pitch and load of any propeller / thruster at the test condition. Rotational speed and load of any engine to be used during the test. Estimated vessel speed through water, — instrumentation to be used, including date of last calibration, — in case field measurements of sound insulation are to be performed: clear indication of sound insulation barriers to be tested, marked on arrangement plan; representative selection of constructions to be tested.	AP

Object	*Documentation type*	*Additional description*	*Info*
	Z266 – Measurement report	Including: — conditions during the measurements such as power output, propeller/engine speed, propeller pitch setting, draught, waterdepth under keel, wind and sea state, vessel speed through water, — the positions of the noise measurements shall be plotted on general arrangement plans, [2.2.2], — the dB(A) noise levels for each location shall be listed in tables and preferably plotted on general arrangement plans, — sound insulation and impact sound results if required, — general arrangement plans showing the location of the vibration measuring positions and their direction of measurements, [2.3.2], — tables of vibration levels for each location, — for locations with vibration levels exceeding the requirements, the frequency spectra shall be included in the report, — description of instrumentation which has been used, including date of calibration and calibration procedure, — description of any deviations from the required measurement procedures, — for informative purposes it is recommended that frequency spectra for the different locations are enclosed.	AP
Info: AP – For approval, FI: For information			

For general requirements to documentation, including definition of the Info codes, see Pt.1 Ch.3 Sec.2.
For a full definition of the documentation types, see Pt.1 Ch.3 Sec.3.

1.6.2 Indoor climate - qualifierC

Documentation shall be submitted as required by Table 5:

Table 5 Documentation requirements for qualifierC

Object	*Documentation type*	*Additional description*	*Info*
On board environment	S120 – Heat balance calculation		FI
	Z100 – Specification	HVAC plant Air filter data.	FI
	S013 – Ducting and instrumentation diagram (D&ID)		FI

Object	*Documentation type*	*Additional description*	*Info*
	Z253 - Test procedure for quay and sea trial	Including: — operating condition of the vessel during the testing, — required operating condition of the HVAC plant, — specification of measurement locations, — test responsible, — test instrumentation.	AP
On board environment	Z263 – Report from quay and sea trial	Including: — identity and description of the spaces, — details of type and make of instrumentation used, — instrument calibration data, — vessel and HVAC operating conditions, — outdoor climatic conditions, — measured climate parameters.	AP
	Z266 – Measurement report	Measured air quantities in accommodation spaces.	FI
Info: AP – For approval, FI: For information			

For general requirements to documentation, including definition of the Info codes, see Pt.1 Ch.3 Sec.2.
For a full definition of the documentation types, see Pt.1 Ch.3 Sec.3.

1.7 Normative references

International standards specifying criteria related to comfort aspects of noise, vibration and climate have been used as basis for the rules combined with current knowledge about achievable shipboard levels applying good engineering practice.

The normative references are cited at appropriate places in the text. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document including any amendments applies.

The rules contain references to the following publications:

1.7.1 Noise

- IEC 61672-1 *Electroacoustics - Sound level meters - Part 1: Specifications*,
- IMO MSC 337(91) *Code on noise levels on board ships*,
- ISO 80000-8, *Quantities and units,*
- ISO 1683. *Preferred reference values for acoustical and vibratory levels,*
- ISO 717-1:2013, *Acoustics – Rating of sound insulation in buildings and of building elements – Part 1: Airborne sound insulation,*
- ISO 717-2:2013, *Acoustics – Rating of sound insulation in buildings and of building elements – Part 2: Impact sound insulation,*
- ISO 140-4:1998, *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,*
- ISO 10140-2:2010, *Acoustics – Laboratory measurement of sound insulation of building elements – Part 2: Measurement of airborne sound insulation.*

1.7.2 Vibration

- ISO 6954:2000 *Mechanical vibration and shock – Guidelines for the overall evaluation of vibration in merchant ships,*
- ISO 2041:2009, *Mechanical vibration, shock and condition monitoring - Vocabulary,*
- ISO 2631-1:1997/Amd 1:2010, *Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration – Part 1: General requirements.*

1.7.3 Climate

- 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, *Ergonomics of the thermal environment – Instruments 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).*

2 Noise and vibration

2.1 Requirements

2.1.1 General

2.1.1.1 Compliance with the rules shall be verified through measurements.

Guidance note:

It may be advantageous to carry out calculations at an early project stage in order to ensure that necessary noise and vibration control measures are included.

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2.1.1.2 The required test conditions are given in [2.4].

2.1.1.3 The requirements for noise and vibration are set up for four types of ships; passenger ships, cargo ships, yachts and high-speed craft. The requirements for each type of ship are divided in groups for specified locations.

2.1.1.4 All locations specified in the tables below shall comply with the criteria in order to be assigned the notation **COMF** with qualifier **V**. Dispensations from certain requirements may in special circumstances be granted by the Society, if it is documented that compliance will not be possible despite relevant and reasonable technical reduction measures. If dispensation is granted it shall be ensured that no crew member is exposed to an $L_{ex}(24)$ exceeding 80 dB(A) or if wearing hearing protectors, not exceeding 105 dB(A). This will be considered by the Society in each particular case.

Guidance note:

Guidelines for handling of excessive noise and vibration levels are published by the Society.

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2.1.1.5 The highest comfort rating number achieved for noise or vibration will determine the overall rating for noise and vibration, e.g. a ship meeting **crn = 2** for vibration and **crn = 1** for noise will be denoted **crn = 2**.

2.1.1.6 For ships to be operated at DP (Dynamic Positioning) mode or if manoeuvring thrusters are intended for continuous operation for longer periods, the stated noise and vibration requirements shall be satisfied with the manoeuvring thrusters in operation.

For passenger ships the given comfort rating number applies to the passenger areas only. The crew areas shall as a minimum comply with **crn = 3** for cargo ships.

2.1.2 Noise criteria

2.1.2.1 The maximum allowed noise levels for different ships, localities and comfort standards are given in Table 6 to Table 10.

2.1.2.2 In Table 10 Yacht, the noise levels specified for the transit condition apply to smaller yachts not intended for overnight cruising. For yachts intended for overnight cruising, the rules for passenger ships shall apply for the transit condition.

Table 6 Passenger ships - passenger areas maximum 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	60
Open deck recreation [1)]	65	68	70
1) 5 dB(A) relaxation in sports areas, passage ways and near ventilation inlets and outlets			

Table 7 Cargo ships < 10 000 GT [1)] - maximum 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	58	60
Offices	60	60	65
Machinery control rooms	65	70	75
Open deck recreation	70	73	75
1) For working areas, navigation spaces, service spaces, machinery rooms and spaces not specified, the requirements of IMO MSC 337(91) Code on noise levels on board ships apply.			

Table 8 Cargo ships ≥10 000 GT [1)] - Maximum 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	53	55
Crew public spaces	55	58	60
Hospital	55	55	55
Offices	55	58	60
Machinery control rooms	65	70	75
Open deck recreation	70	73	75

Locations	*Comfort rating number (crn)*		
	1	*2*	*3*
1) For working areas, navigation spaces, service spaces, machinery rooms and spaces not specified, the requirements of IMO MSC 337(91) *Code on noise levels on board ships* apply.			

Table 9 High-speed Craft - Maximum Noise levels in dB(A)

Locations	*Comfort rating number (crn)*					
	100 m and below			*Above 100 m*		
	1	*2*	*3*	*1*	*2*	*3*
Passenger localities	70	72	75	60	65	68
Outdoor passenger areas	75	75	75	73	75	75
Navigation bridge	62	65	65	60	62	65
Service areas /shops/kiosk	70	73	75	65	68	70

Table 10 Yacht - Owner and Guest Areas Maximum 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

2.1.3 Sound insulation

2.1.3.1 The acoustic insulation between accommodation spaces shall at least satisfy the requirements for sound insulation given in Table 11 and Table 12.

2.1.3.2
Field measurements shall be performed according to ISO 140-4:1998. When the area tested is < 10 m^2, a minimum value of 10 m^2 shall be used for calculation of the R'_W index.

2.1.3.3 Laboratory tests of sound insulation properties of bulkhead and deck materials may be allowed in accordance with ISO 10140-2:2010.

Guidance note:

In general the requirements apply to field measured insulation indexes which shall be verified through field measurements. However, for some of the less strict requirements for constructions identical to previous constructions where ample field measurements exist in our files, we may allow verification based on laboratory data.

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Table 11 Sound Insulation Indexes R'_W (ISO 717-1:2013) for crew areas

Locations	*Comfort rating number (**crn**)*		
	1	***2***	***3***
Cabin to cabin (crew)	38	35	32
Cabin (crew) to corridor or cabin with communicating door	37	32	28
Cabin (crew) to mess rooms, recreation rooms, public spaces and entertainment areas	50	47	42
Note: Hospitals shall be subject to the same insulation requirements as crew cabins.			

Table 12 Sound Insulation Indexes R'_W (ISO 717-1:2013) for passenger areas

Locations	*Comfort rating number (**crn**)*		
	1	***2***	***3***
Cabin to cabin (passenger standard)	41	38	35
Cabin to cabin (passenger top grade)	46	43	40
Cabin (passenger standard) to corridor or cabin with communicating door	38	35	33
Cabin (passenger top grade) to corridor or cabin with communicating door	41	39	37
Passenger Cabin (standard) to mess rooms, recreation rooms, public spaces	51	48	45
Passenger (top grade) Cabin to mess rooms, recreation rooms, public spaces	56	53	50
Passenger cabin to entertainment area	65	62	60

2.1.3.4 The laboratory measured sound insulation (R_W)for the bulkheads and decks shall be at least 3 dB higher than the field measured (R'_W) values.

Guidance note:

Care should be exercised when mounting loudspeakers to the structure, so that noise transmission from the loudspeaker to the structure is avoided.

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2.1.4 Impact sound insulation, passenger ships

2.1.4.1 For passenger cabins the normalized impact sound pressure level (ISO 717-2:2013) shall not 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 57 dB.

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

2.1.5 Vibration criteria

2.1.5.1 The criteria to be met are given in Table 13 to Table 16.

2.1.5.2 The vibration limits are given in vibration velocity as frequency weighted overall r.m.s. values from 1 Hz to 80 Hz. The weighting curve to be applied is specified in ISO 6954:2000.

2.1.5.3 The specified vibration criteria apply to the maximum level, of vertical, longitudinal and transversal vibration which shall be assessed separately.

Table 13 Passenger ships, Passenger Areas, Frequency weighted r.m.s. maximum values in mm/s from 1 Hz to 80 Hz

Locations	*Comfort rating number (**crn**)*		
	1	***2***	***3***
Passenger top grade cabins	1.5	1.5	2.0
Passenger cabins, standard	1.5	2.0	3.0
Public Spaces	1.5	2.0	3.0
Open deck recreation	2.0	2.7	3.5

For passenger ships with comfort rating 1, no single frequency component within the frequency range 6.3 Hz to 12.5 Hz shall exceed 1 mm/s r.m.s. (weighted) for the indoor areas.

Guidance note:

[2.1.5.3] implies that if measured vibration levels are below 1.0 mm/s r.m.s., **crn = 1** is met. For vibration levels exceeding 1.0 mm/s r.m.s., the frequency spectra have to be examined in the frequency range 6.3 Hz to 12.5 Hz.

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Table 14 Cargo ships Frequency weighted r.m.s. maximum values in mm/s from 1 Hz to 80 Hz

Locations	*Comfort rating number (**crn**)*		
	1	***2***	***3***
Cabins	2.0	2.7	3.5
Mess/recreation rooms	2.0	2.7	3.5
Offices	2.0	2.7	3.5
Navigation Bridge	2.0	2.7	3.5
Control rooms	2.7	2.7	3.5
Work spaces	3.5	3.5	4.0

2.1.5.4 For cargo ships with **crn = 3**, except for work spaces, no single frequency component within the frequency range 1.0 Hz to 8.0 Hz shall exceed 2.7 mm/s r.m.s. (weighted).

Guidance note:

[2.1.5.4] implies that if measured vibration levels are below 2.7 mm/s r.m.s., **crn = 3**is met. For vibration levels exceeding 2.7 mm/s r.m.s., the frequency spectra have to be examined in the frequency range 1.0 Hz to 8.0 Hz.

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Table 15 High-Speed Craft Frequency weighted r.m.s. maximum values in mm/s from 1 Hz to 80 Hz

Locations	*Comfort rating number (**crn**)*		
	1	***2***	***3***
Passenger localities	1.8	3.0	4.0
Navigation Bridge	1.8	3.0	4.0
Offices	1.8	3.0	4.0
Control Rooms	3.0	3.5	4.0

Table 16 Yacht Owner and Guest Areas Frequency weighted r.m.s. maximum values in mm/s from 1 Hz to 80 Hz

Locations	*Comfort rating number (**crn**)*					
	In harbour cond.			*Transit cond.*		
	1	**2**	**3**	**1**	**2**	**3**
Accommodation	0.5	1.0	2.0	0.8	1.5	2.5
Outdoor Recreation Areas	0.5	1.0	2.0	1.5	2.5	3.0
Navigation Bridge	-	-	-	1.0	2.0	3.0

2.2 Noise testing

2.2.1 General

2.2.1.1 The measurements shall be carried out according to the procedures described in IMO MSC 337(91)"*Code on noise levels on board ships*". If the procedure described in IMO MSC 337(91) deviates from any requirements or procedure mentioned in these rules, the requirements in these rules take precedence.

2.2.1.2 The instrumentation to be used for the measurements shall comply with the requirements given in IMO MSC 337(91)"*Code on noise levels on board ships*".

2.2.1.3 A test program shall be approved prior to the measurements. The test program shall at least include the information specified in Table 4.

2.2.1.4 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, stabilizers, thrusters and main/auxiliary engines, a higher density of measuring positions will be required in areas near noise sources.

2.2.1.5 If the specified criterion is exceeded, or contains subjectively annoying low frequency noise or obvious tonal components, 1/3 octave band analysis of the noise shall be performed.

2.2.1.6 Measurement of the C-weighted equivalent continuous sound level $L_{Ceq}(T)$ and the C-weighted peak sound level L_{Cpeak} shall be made in spaces where the $L_{Aeq}(T)$ exceeds 85 dB(A).

2.2.2 Distribution of measuring positions in sleeping cabins

2.2.2.1 For conventional cargo ships with less than 100 cabins noise measurements shall be taken in most cabins. For adjacent similar cabins, a reduction in the number of cabins where measurements are to be taken may be allowed.

2.2.2.2 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 typical lengthwise distribution of measuring positions is given in Table 17. The measuring positions shall be evenly distributed amongst the cabins within each of the aft-, mid- and fore ship sections of the ship.

2.2.2.3 The cabins shall be selected such that cabins in areas with high potential for elevated noise levels are included, e.g. cabins in proximity to machinery spaces, propellers, stabilizers and thrusters.

Table 17 Distribution and number of measuring positions for cabins

Measuring region	*Typical percentage of cabins in the region to be measured*
Aftship	40%
Midship	25%
Foreship	15%

2.2.3 Distribution of measuring positions for public spaces

2.2.3.1 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.

2.2.3.2 For larger spaces (public rooms, mess rooms, recreation areas, etc.) it may be necessary to distribute a number of measuring positions to get a representative description of the noise profile. No distance between measuring positions or between measuring positions and walls shall generally exceed 10 m.

2.2.4 Distribution of measuring positions on open deck recreation areas

2.2.4.1 Several measuring positions will normally be required to cover these areas. Measurements shall be taken in areas provided for recreation and in areas where high noise levels are suspected.

2.2.5 Distribution of measuring positions on board high speed craft

2.2.5.1 In the passenger saloons of high-speed craft, measurements shall as a minimum be taken in the following positions:

— at the aft seat row / seat position, near centreline and at ship sides, but at least 0.5 m from reflecting surfaces.
— for ships with length over all of 100 m and below, in positions near centreline and ship sides at distances not exceeding 5 m in longitudinal directions and at least 0.5 m from reflecting surfaces.
— for ships with length over all above 100 m, at distances not exceeding 5 m from the aft seat-position to a position beyond half the length over all of the ship, near centreline and ship sides, but at least 0.5 m from reflecting surfaces. Forward of the mid-ship position, at distances not exceeding 10 m in longitudinal direction.

2.2.5.2 The criteria given in Table 9, apply in each measuring location in the passenger saloon for high-speed craft.

2.2.6 Reporting

2.2.6.1 The report shall comply with the requirements in IMO MSC 337(91)"Code on noise levels on board ships" summarised in Table 4.

2.3 Vibration testing

2.3.1 General

2.3.1.1 The measurements shall be carried out according to the procedures described in ISO 6954:2000. When the procedure described in ISO 6954:2000 deviates from any requirements or procedure mentioned in these rules, the requirements in these rules take precedence.

2.3.1.2 A test program shall be approved prior to the measurements. The test program is at least to include the information specified in Table 4.

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

2.3.2 Measuring positions

2.3.2.1 Vibration measurements in cabins are normally to be taken at the floor in the centre of the room and shall reflect the vibration of the deck structure.

2.3.2.2 For larger spaces (public rooms, mess rooms, recreation areas, etc.) it may be necessary to distribute a number of measuring positions to get a representative description of the vibration profile.

2.3.2.3 On decks where the accommodation extends over a large proportion of the length of the ship, as for instance passenger ships, it is recommended that the measuring positions should be distributed according to the Table 18. The distribution shall be applied on each deck.

Table 18 Distribution of measuring positions

Measuring region	*Percentage of measuring positions to be placed in the region*
Aftship	60%
Midship	30%
Foreship	10%

2.3.2.4 Vibration levels in vertical, longitudinal and transverse directions are subject 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.

Guidance note:

For ships with the accommodation placed in a deck house, transversal vibration shall 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.

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2.3.2.5 If the requirements to maximum vibration levels in the transversal and/or longitudinal directions are satisfied on the highest deck levels, measurements on lower deck levels in the corresponding direction may be omitted.

2.3.2.6 For ships where the accommodation extends over a large portion of the length of the ship, as for instance for passenger ships, the transversal vibration shall be recorded at a minimum of three positions, evenly distributed along the ship. The longitudinal vibration shall be recorded at the bridge wings.

2.3.2.7 The distribution of the measuring positions shall be approved prior to the tests. Additional measuring positions may be added by the surveyor during the survey on board the ship

2.3.3 Data acquisition

2.3.3.1 The vibration levels shall be measured as one weighted overall velocity level according to the requirements in ISO 6954:2000.

2.3.3.2 Frequency spectra shall be presented for at least two measuring locations on each deck and in all cases where the measured vibration level exceeds the specified maximum level. Frequency spectra shall be presented for cargo ships with comfort rating **crn = 3** for locations with vibration levels exceeding 2.7 mm/s and for passenger ships with comfort rating **crn = 1** for locations with vibration levels exceeding 1.0 mm/s.

2.3.3.3 Frequency spectra for any other location shall be presented if requested by the Society.

2.3.3.4 For frequency spectra the following analysis parameters shall be applied:

— frequency range 1 to 80 Hz
— frequency resolution shall be maximum 0.25 Hz
— window function which gives an accurate estimate of the amplitudes in the frequency spectra (for instance Flat top window)
— the vibration recordings shall be averaged over a time period of approximately 1 min.

2.3.4 Reporting

2.3.4.1 The report shall at least contain the information specified in Table 4.

2.4 Test conditions

2.4.1 General

2.4.1.1 The required ship operating conditions for these tests are based on IMO MSC 337(91) for noise and ISO 6954:2000 for vibration. The operating conditions described in the referred documents shall be followed. When the test conditions described in the referred documents deviate from any requirements or procedure mentioned in these rules, the requirements in these rules take precedence. The main operating conditions with some additions are specified below.

2.4.1.2 Measurements shall be taken at normal operational condition of the vessel and no less than 80% of the maximum continuous power on the propeller shaft(s). All other machinery shall be run under normal operating conditions during the tests. For some ship types the power to be used on the propeller shaft(s) shall be based on normal operation of the ship and will be determined and approved for each individual case.

2.4.1.3 The test should be conducted in a depth of water not less than three times the draught of the ship for ships 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. If the water depth is less than five times the draught of the ship or if there are large reflecting surfaces in the vicinity of the test path this shall be described in the test report.

2.4.1.4 The tests should be conducted in a slight sea (WMO Sea state 3 or less).

2.4.1.5 The measurements are to be taken with the ship loaded or ballasted to a loading condition(s) as close as possible to the normal operating condition(s). For ships with larger variation than 25% in relevant displacements, measurements may be required at two loading conditions close to the relevant heavy and light conditions. If it is difficult to achieve two loading conditions during the sea trial, one loading condition may be accepted. The loading condition(s) to be used shall be approved by the Society prior to the testing.

2.4.1.6 The rudder angle for a transit operating condition shall be minimised and preferably be restricted to about 0 degrees ±2 degrees (minimum rudder action is desired).

2.4.1.7 For ships fitted with manoeuvring thruster(s) intended to be operated at DP or continuously for a long period of time, measurements of noise and vibration shall be taken with the manoeuvring thruster(s) operating on at least 40% power and the ship's speed shall be appropriate for thruster operation.

Guidance note:

For ships fitted with manoeuvring thruster(s) not to be operated at DP or continuously for a long period of time, measurements in adjacent locations affected by noise from the thruster(s) shall be taken with the manoeuvring thruster(s) operating on at least 40% power and the ship's speed shall be appropriate for thruster operation. The measured levels should be reported for reference only and do not need to comply with the noise limits.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

2.4.1.8 For ships equipped with stabilizers, the free sailing measurements shall be taken with the stabilizers engaged and active.

2.4.1.9 For yachts the noise and vibration levels shall 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 50% of the normal service supply.

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

2.4.2 Noise

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

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

2.4.2.3 Doors and windows shall be closed.

2.4.3 Vibration

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

3 Indoor climate

3.1 General

3.1.1 Rule applications

3.1.1.1 The rules outline standards, conventions, guidelines and specifications for the purpose of categorization of a ship'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 ship will be subjected to during its intended use. See [3.2] on restrictions.

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

3.1.1.3 The rules apply to the occupancy zone in designated locations specified in Table 19.

3.1.1.4 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.

3.2 Requirements for on board climate

3.2.1 General

3.2.1.1 With the specified climate comfort of a room, the majority of the passengers and crew can safely and comfortably perform normal activity over a prolonged period of time.

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

3.2.1.3 All locations specified in Table 20 shall comply with the criteria in order to be assigned the additional class notation **COMF** with qualifier **C**.

3.2.1.4 It shall be stated for which outside temperature and humidity range the ship shall comply withqualifier **C**. The outside temperature and humidity range for which the ship 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.

3.2.2 Climate requirements

3.2.2.1 The standard applies to the designated accommodation spaces on board, classified as shown in Table 19.

Table 19 Classification of accommodation spaces

Type A	Cabins
Type B	Hospital and ward rooms
Type C	Wheelhouse, 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.

3.2.2.2 The requirements to air properties and quality at different localities and comfort standard are shown in Table 20.

3.2.2.3 Each designated space should be able to change from the lower to the higher temperature given in Table 20 within two hours. However for special areas, this temperature control span time criteria may be evaluated separately.

Table 20 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* [4]	*Relative humidity -RH* [3]
	crn	*15°C and below (outside)*	*40°C and above (outside)*					
		Min./Max. limit (°C)	*Min./Max. limit (°C)*	*m/s*	*litres/s*	*m^3/ hour*	*°C*	*%*
A	**1**	18 to 24	22 to 28	0.25	10	36.0	2.0	30 to 60
	2	19.5 to 24	23.5 to 28	0.35	9	32.4	2.5	20 to 60
	3	21 to 24	25 to 28	0.40	8	28.8	3.0	< 65
B	**1**	18 to 24	22 to 28	0.15	12	43.2	2.0	30 to 60
	2	19.5 to 24	23.5 to 28	0.25	10	36.0	2.5	20 to 60
	3	21 to 24	25 to 28	0.35	8	28.8	3.0	< 65
C	**1**	20 to 24	23 to 28	0.20	10	36.0	2.0	30 to 60
	2	21 to 24	24 to 28	0.25	9	32.4	3.0	20 to 60
	3	22 to 24	25 to 28	0.35	8	28.8	3.5	< 65
D	**1**	20 to 24	23 to 28	0.25	10	36.0	2.0	30 to 60
	2	21 to 24	24 to 28	0.30	9	32.4	3.0	20 to 60
	3	22 to 24	25 to 28	0.40	8	28.8	3.5	< 65

1) For outside temperatures between 15°C and 40°C, the control span is to comply with the graphs shown in Figure 1 and Figure 2.

2) Unless otherwise specified by owner and yard, the number of persons in each designated space will be counted according to ISO7547.

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.

4) Vertical air temperature difference is normally tested for the low temperature condition only.

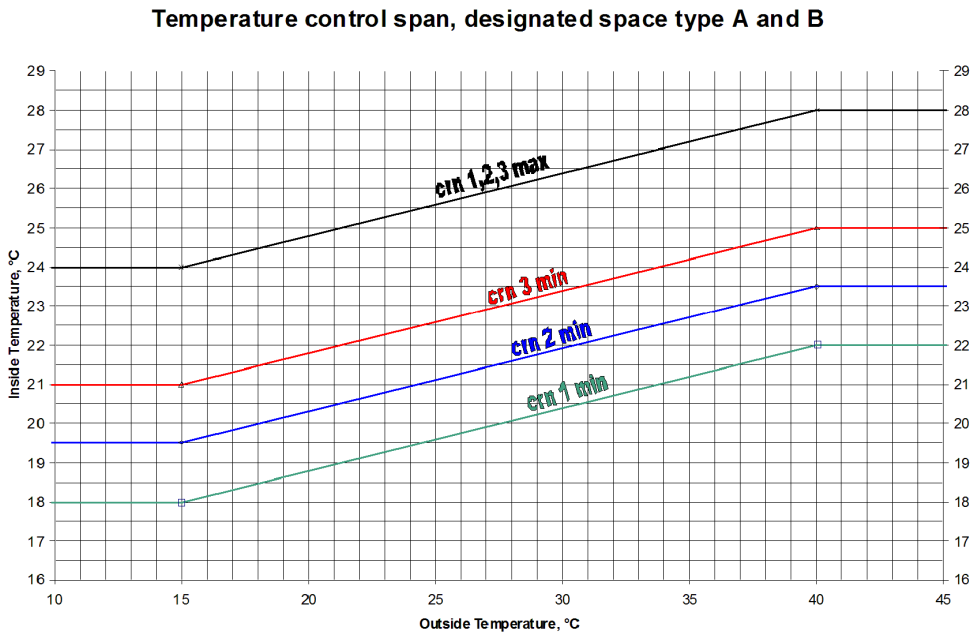

Figure 1 Temperature control span, designated space type A and B

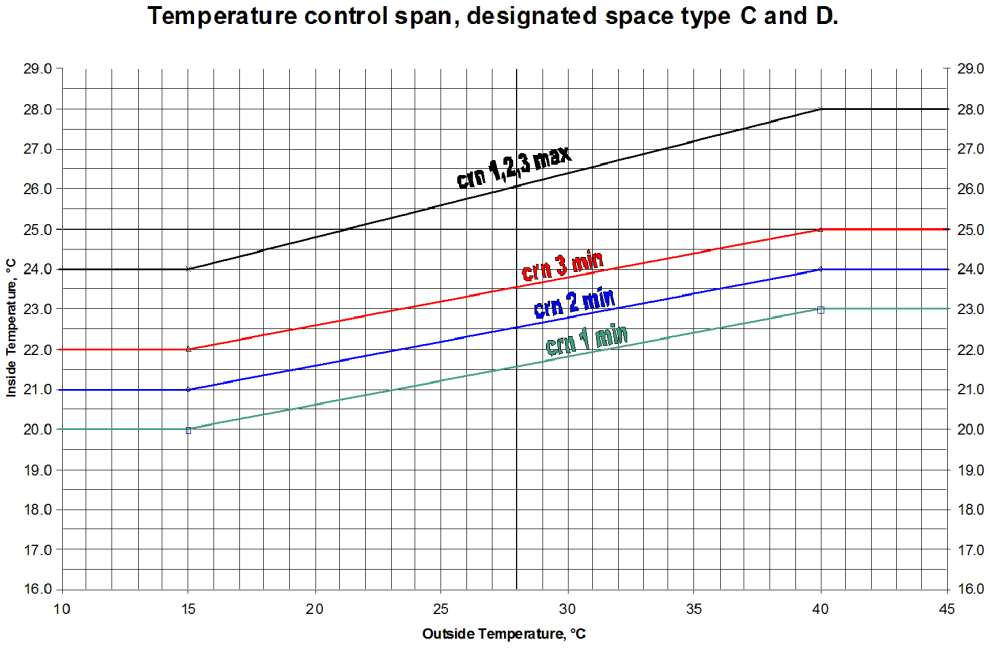

Figure 2 Temperature control span, designated space type C and D

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

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

3.2.2.6 For passenger ships the given comfort rating number applies to the passenger areas only. Unless specified, the crew areas shall comply with minimum rating **crn = 3**.

3.3 Certification and testing

3.3.1 General

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

3.3.1.2 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 shall 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**.

3.3.1.3 Climate parameters subjected to verification through measurements are:

— vertical air temperature difference,
— air temperature control span,
— maximum air velocity.

3.3.1.4 Verification tests shall be performed on board 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 information specified in Table 5.

3.3.1.5 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 [3.2] and [3.3].

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

3.3.1.7 Measurements shall be carried out by the Society or a 3rd party approved by the Society under supervision by a surveyor on board.

3.3.1.8 A summary of documentation to be submitted to the Society is given in Table 5, with reference to Pt.1 Ch.3.

3.3.2 Measuring locations

3.3.2.1 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 Table 20 shall be taken in the following minimum number of cabins (n = number of cabins):

— For n < 10 Measurements in all cabins
— For 10 ≤ n ≤ 40 Measurements in min.10 cabins
— For n ≥ 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.

3.3.2.2 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 fire zone 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.

3.3.2.3 The climate parameters 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.

3.3.2.4 The measurement positions may be subjected to alterations during the testing based on the actual findings during the survey on board the ship.

3.3.3 Testing

3.3.3.1 The individual values of the climate parameters as stated in [3.3.3.2] to [3.3.3.5] shall be verified by measurements during normal operation. HVAC plant shall be operated with constant output temperature during testing.

3.3.3.2 *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.

3.3.3.3 *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 (see [3.2.2.3]).

3.3.3.4 *Vertical air temperature difference*

The vertical temperature difference in all designated spaces shall be measured in the geometric centre of the occupancy zone at the following distances above the floor: 0.2 m, 1.0 m and 1.8 m. For larger spaces measurements shall be taken in representative positions. The positions shall reflect the temperature at ankle, abdomen and head level.

3.3.3.5 *Air Velocity*

The mean air velocity is to be measured at the geometric centre of the room. However the surveyor may request alterations of the measurement position based on findings during the survey. Typical alteration may be to carry out the measurement at the most commonly occupied position in the room in question.

3.3.3.6 Minor deviations from the specified values in Table 20 may be acceptable in special cases. The Society decides whether to accept a deviation or not.

3.3.4 Reporting

3.3.4.1 The report shall contain the information specified in Table 5.

3.4 System requirements

3.4.1 General

3.4.1.1 In case of system failure, the HVAC system shall, depending on the comfort rating number to be achieved, have a redundancy in designated spaces given in [3.4.2].

3.4.1.2 In order to achieve the designated comfort rating number (**crn**), the maintainability of the system shall fulfil certain minimum requirements (see [3.4.3]).

3.4.2 HVAC system failure mode control

3.4.2.1 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 **crn = 2**. If different failures, not related to each other, occur simultaneously, the required restoring time shall be increased by 12 hours.

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

3.4.2.3 There is no redundancy requirement for comfort rating **crn = 1**, except for paragraph [3.4.2.4] below.

3.4.2.4 A minimum level of ventilation in hospitals and machinery control rooms shall be provided during a system failure by means of separate forced ventilation. Regulation of the fans shall be located in the respective rooms. This ventilation shall keep the temperature below 35ºC and above 15ºC.

3.4.3 HVAC system maintainability

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

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

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

3.4.4 Filter requirements

3.4.4.1 Air filters in air handling units or fan-coil units supplying air to designated spaces shall have a minimum filtration efficiency* in accordance with the European or US standards in Table 21.

Table 21 Filter requirements

Space	***crn***	*Filter*	*Performance - new filter**
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 ships, can be reasonably checked by surveying the supply air filters instead of measuring the particulate concentration in the air.			

SECTION 2 VIBRATION CLASS - VIBR

1 General

1.1 Introduction

Vibrations on a vessel may impair the proper functioning of essential machinery and equipment, and it may cause fatigue damage to important structural elements of the vessel. The additional class notation **VIBR** indicates that vibrations to machinery, components and equipment, as well as to the structure in compartments where machinery, components and equipment are situated close to the propeller(s) have been measured and evaluated, to avoid excessive shipboard vibrations.

1.2 Scope

The scope of the additional class notation **VIBR** is to reduce the risk of failure in machinery, components and structures on board ships, caused by excessive vibration. This will be achieved through a proactive, systematic risk based plan for survey and measurement of main components on board. The requirements for the additional class notation **VIBR** are additional to the requirements in the main class rules Pt.4 Ch.3 and Pt.4 Ch.4. Compliance with the rules in this section shall be verified through survey and measurements in predefined positions.

1.3 Application

The additional class notation **VIBR** is applicable to machinery, components and equipment. It is also applicable to the structure in compartments where machinery, components and equipment are situated close to the propeller(s).

The rules apply to the machinery components and structure as specified and described in [2]. An evaluation of the particular vessel is carried out prior to the measurements in order to reveal critical positions and complete the list for the particular vessel. The list with positions to be measured, including the corresponding vibration limits, is hereafter called the protocol. Vessels that fulfil the requirements for vibration class notation may be assigned the additional class notation **VIBR**. The notation is applicable for both new buildings and ships in operation. The following procedure shall be followed in order to attain the **VIBR** notation:

— generation of the protocol,
— carry out measurements on board according to the pre-defined protocol.

When all measured positions are within the specified limits, the **VIBR** notation can be assigned.

For similar vessels the same protocol may be used. However, separate measurements shall be carried out for each vessel.

If major modifications to the vessel, which may influence the vibration conditions on board, are carried out, new measurements may have to be taken in order to maintain the notation. This will be decided by the Society

Excessive vibration levels will normally not be accepted. However, a risk based assessment of the actual position and level will be carried out and a possible dispensation evaluated. This may require that more extensive and frequent measurements have to be carried out or some sort of monitoring has to be installed.

The vibration class notation shall not apply as the basis for class survey of items in the machinery inventory list as described in Pt.7 Ch.1 Sec.4 [5].

Machinery CM ([3] - Machinery and systems) is the survey arrangement for machinery items in the inventory list class based on condition monitoring.

The influence of vibration from a comfort point of view is not included in this notation. The additional class notation **COMF (V, crn)**, see Sec.1, describes comfort limitations for noise, vibration and indoor climate, on board ships.

1.4 Definitions

1.4.1 General

1.4.1.1 Basic vibration quantities and units are defined in ISO 2041.

1.4.1.2 *Vibration level:* The specified vibration level is to be measured as r.m.s. velocity (mm/s), unless r.m.s. displacement (mm) or r.m.s. acceleration (mm/s^2) is specified.

1.4.1.3 *Resonance:* Coincidence between excitation frequency and natural frequency of the actual component or structural position.

1.4.1.4 *Structural vibration:* Vibration level measured on the vessel structure.

1.4.1.5 *Machinery vibration:* Vibration level measured on machinery, components, equipment, pipes, etc.

1.4.1.6 *Protocol:* A document containing positions, requirements, test conditions and measured results. The protocol is specifically generated for each vessel.

1.4.1.7 *Risk*, the combination of the frequency of occurrence and the severity of the consequence.

1.4.1.8 *Hazard*, a potential to threaten human life, health, property or environment.

1.5 Documentation

1.5.1 Documentation shall be submitted as required by Table 1.

Table 1 Documentation requirements

Object	*Documentation type*	*Additional description*	*Info*
Vibration	G150 – Vibration measurement protocol		AP
Info: AP – For approval, FI: For information			

1.5.2 For general requirements to documentation, including definition of the info codes, see Pt.1 Ch.3 Sec.2.

1.5.3
For a full definition of the documentation types, see Pt.1 Ch.3 Sec.3.

1.6 References

1.6.1 International standards have been used as the foundation for these rules, but have not necessarily been explicitly followed. When setting the vibration limits and determining the measuring positions, due consideration has been given to technical and practical limitations inherent in the design and construction of different types of ship and localities. Unless a particular edition is referred to explicitly, the latest edition of each standard shall apply.

1.6.2 Where requirements described in the ISO standards deviate from these rules, the requirements in the rules shall take precedence.

1.6.3 Vibration standards:

— 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 10816-1, "Mechanical vibration-Evaluation of machine vibration by measurements on non-rotating parts, Part 1: General guidelines".

2 Vibration criteria

2.1 General

2.1.1 Requirements

2.1.1.1 Compliance with the rules shall be verified through measurements. It may, however, be advantageous to carry out a vibration assessment at an early project stage.

2.1.1.2 In order to be assigned the class notation **VIBR**, the requirements in 1.2.1.7 shall be met. However, in special cases small deviations from the requirements may be accepted depending upon position and measured level. This will be decided by the Society in each particular case.

2.1.1.3 The vibration limits specified for structure aim at avoiding vibration induced fatigue cracks. For structure, used as foundation for equipment, the same limit as for the equipment shall be used. This is also applicable for mast mounted equipment, i.e. the limit specified for a radar to be mounted on a mast will be applied as the limit for the mast.

2.1.1.4 The vibration limits are in general given as r.m.s. vibration velocity. For some components restriction to maximum allowable r.m.s. displacement in the low frequency range and r.m.s. acceleration in the high frequency range are also specified.

2.2 Structural vibration

2.2.1 Scope

2.2.1.1 Structural vibration should be limited in order to ensure structural integrity.

2.2.1.2 Structural vibration is a indicator of the risk of fatigue cracks in the structure. The level of vibration causing cracks will depend upon stress concentration factors, environment (corrosive medium) and workmanship of local details.

2.2.1.3 The class notation is applicable to structure in compartments where machinery, components and equipment is situated as well as structure close to the propeller(s). The structure in cargo areas is not included.

2.2.2 Criteria

2.2.2.1 For structural vibration, the criteria specified in Table 2 and Table 3 are not to be exceeded. Vibration levels below the criteria gives low risk for fatigue cracks.

Table 2 Steel

Velocity
4 – 200 Hz
45 mm/s

Table 3 Aluminium

Velocity
4 – 200 Hz
15 mm/s

2.2.2.2 For further evaluation, structural vibration may be assessed by dynamic strain measurements in conjunction with relevant material fatigue data.

2.2.2.3 For structural details with known global stresses, the standard vibration limits may be changed.

2.3 Vibration in machinery and components

2.3.1 Scope

2.3.1.1 Machinery vibration levels will be indicators of sound mounting, balancing and alignment for new installations as well as indicators of working performance for machinery in operation.

2.3.1.2 The criteria shall apply to all permissible operating speeds and loads at stable running conditions. Possible restricted operating ranges shall be clearly defined.

2.3.2 Criteria

2.3.2.1 The criteria shown in Table 4 to Table 17 are not to be exceeded for the relevant machinery. The criteria shall apply for internally and externally excited vibration unless otherwise noted.

Table 4 Shaft line bearings

Velocity
1 – 200 Hz
5 mm/s
To be measured horizontally or vertically with the shaft centre. Shaft line vibration is specified in Pt.4 Ch.4 Sec.1. Frequency spectra to be presented to identify low frequency components.

Table 5 Diesel engines < 200 rpm

	1 – 200 Hz	
	Displacement	Velocity
Vertical	1 mm	10 mm/s
Longitudinal	1 mm	10 mm/s

Transverse	1.5 mm	25 mm/s
To be measured at the top of the A – frame at engine ends. Frequency spectra to be presented to identify low frequency components.		

Table 6 Diesel engines > 200 rpm

Velocity	
4 – 200 Hz	
Firmly mounted	Resiliently mounted
15 mm/s	25 mm/s
To be measured on the engine block top and bottom. 20% overshoot of the above criteria allowed for non-continuous running in the operating speed range.	

Table 7 Turbochargers

4 – 200 Hz		
Total combined power from cylinder group serving one turbocharger	Velocity	Acceleration
Below 5 MW	45 mm/s	2.5 g
5 - 10 MW	50 mm/s	2.0 g
Above 10 MW	55 mm/s	1.5 g
To be measured at the top of compressor casing. 20% overshoot of the above criteria allowed for non-continuous running in the operating speed range.		

Table 8 Diesel driven generators and electrical motors on thrusters

Velocity
4 – 200 Hz
18 mm/s
To be measured in any direction on the bearings. Applies to both fixed and resilient mounted. 1st order vibration above 7 mm/s r.m.s. should be investigated.

Table 9 Turbines

Velocity
4 – 1000 Hz
7 mm/s
To be measured in any direction on the bearings. Applies to both fixed and resilient mounted.

Table 10 Turbine driven generators

Velocity
4 – 1000 Hz
7 mm/s
To be measured in any direction on the bearings. Applies to both fixed and resilient mounted.

Table 11 Gears

Velocity
4 – 1000 Hz
7 mm/s
To be measured in any direction on the foundation and on the input shaft bearing

Table 12 Electric motors, separators, motor driven hydraulic pumps, fans not installed on reciprocating engines

	Velocity
	4.0 – 200 Hz [1)]
Internal excited	7 mm/s [2)]
External excited	12 mm/s [2)]
To be measured in any direction on the bearings. 1) The upper frequency limit shall be at least 200 Hz and above 2 x rpm 2) For vertically mounted motors the vibration level may be increased by 50% for the top of the motor.	

Table 13 Compressors (screw or centrifugal)

	Velocity
	4 – 200 Hz [1)]
Elastically mounted	10 mm/s
Fixed mounted	7 mm/s
To be measured in any direction on the bearings. 1) The upper frequency limit shall be at least 200 Hz and above 2x rpm	

Table 14 Reciprocating compressors and reciprocating pumps

Velocity
4 – 200 Hz
30 mm/s
To be measured in any direction on the bearings. Applies for both resilient and fixed mounted.

Table 15 Boilers

Velocity
4 – 200 Hz
45 mm/s
To be measured on stiff parts, e.g. lugs, flanges etc.

Table 16 Pipes

Velocity
4 – 200 Hz
45 mm/s

Table 17 Electronic instruments and equipment

	Velocity
	4 – 200 Hz
Mounted on bulkheads	12 mm/s
Mounted on masts	20 mm/s
Mounted on machinery	25 mm/s

3 Measurements

3.1 General

3.1.1 Scope

3.1.1.1 Vibration of structure and components shall be measured in order to ensure that the actual vibration levels onboard do not exceed the limits as defined in [2], before the **VIBR** notation can be assigned.

3.1.2 Requirements

3.1.2.1 The criteria for all relevant machinery are defined in [2]. With regard to the actual measurement positions at each component, reference is made to ISO 10816-1.

3.1.2.2 The items to be fulfilled shall be listed in the protocol.

Guidance note:

An example of the protocol is shown in Table 18.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

3.1.2.3 Information about running machinery and the actual operational conditions, i.e. power, rpm, etc. has to be noted in the protocol before the measurements can start.

3.1.2.4 The measurements shall be carried out at a pre-defined steady state operating condition representative for future in-service operation (see also [3.2.1].2 and [3.3.1].4).

3.1.2.5 r.m.s. value corresponding to the defined frequency range shall be measured.

3.1.2.6 The measured vibration levels shall be analysed applying FFT technique. For positions where the measured level exceeds the level tabulated in the protocol, frequency spectra shall be included.

Guidance note:

Machinery may exhibit stochastic vibration which will not be correctly represented in an FFT analyses. This will be most pronounced for elastically mounted machinery/equipment and mainly for the low frequency content of the vibration. The criteria are therefore mainly related to frequencies above 4 Hz where stochastic vibration is of minor importance.

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3.1.2.7 For positions not predefined in the protocol, which are found during the survey to have high vibration levels, shall be included in the measurements.

Guidance note:

Typical examples are pipes vital for the operation of the vessel. It is difficult to predefine all position to be measured, because the clamping carried out during installation will determine the effective length of the different sections and consequently the natural frequency. In these cases, it is up to the surveyor to inspect the pipes and sense if any magnification of the vibration is present due to resonance.

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3.2 Test procedure

3.2.1 Measurements

3.2.1.1 The protocol shall be approved by the Society prior to measurements being taken.

Guidance note:

The selection of components and positions to be measured includes a risk evaluation of the different components. The basis for the requirements is the vibration limits as defined in [2]. The result of this work is the protocol, as shown as an example in Table 18, to be filled in during the measurements onboard.

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3.2.1.2 The measurements shall be carried out by a qualified vibration expert under supervision of a surveyor.

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

3.2.1.4 Analysis parameters:

- frequency range 1−200 Hz (unless noted for special components)
- at least 400 spectral-lines
- window function which gives an accurate estimate of the amplitude value of the single components in the frequency spectra (for instance flat top window)
- the vibration recordings shall be averaged over a time period necessary to achieve a stable reading, minimum 30 s.

3.2.1.5 The velocity levels shall be presented as r.m.s. values. For measured levels close to or exceeding the limits, plot showing the vibration spectra for the actual positions shall be included.

3.2.1.6 Calibration of instruments shall be carried out minimum every second year or according to standards.

3.2.2 Protocol

3.2.2.1 Table 18 shows an example of the Vibration Measurement Protocol.

Table 18 Vibration Measurement Protocol for: (insert name of vessel)

System	*Position*	*Checked*	*Limit [mm/s]*	*Measured [mm/s]*	*Max. Ampl./Freq.* mm/s / [Hz]*	*Comment*

* Only to be given when the vibration criterion is exceeded.

System	is the main machinery group
Position	is the actual measuring position
Checked	some position may only be checked without further measurements
Limit	is the predefined limit for the actual position
Measured	is the r.m.s. vibration level measured at the actual position
Max. Ampl./Freq.	is the maximum vibration component and the corresponding frequency
Frequency	is the frequency corresponding to a specific vibration component

3.2.2.2 Other components may be added to the protocol by the vibration expert or the Society as found appropriate. This will normally be based on the walk-through survey.

3.3 Test conditions

3.3.1 General

3.3.1.1 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), unless stated differently in the protocol. All other machinery shall be run under normal operating conditions during the tests. However, if other operational conditions are termed as critical, these conditions will be included in the protocol and the measurements.

3.3.1.2 For engines and components operated at different RPM, a run-up may be required.

3.3.1.3 For ships normally operated in deep waters, the test should be conducted in a depth of water not less than four times the draught of the ship. For ships to be operated continuously in shallow waters, the tests shall be performed at the relevant depth of water.

3.3.1.4 The tests should be conducted in a sea state that does not significantly influence the measurement results.

3.3.1.5 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 normally be taken at two loading conditions close to the relevant heavy and light condition. Where this is not possible from a

practical point of view, a light and heavy ballast condition are to be applied. The loading condition(s) used shall be approved by the Society, prior to testing.

3.3.1.6 The ship should sail on a straight course with minimum rudder deflection.

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

3.3.1.8 Special equipment and components, which are operated for limited periods, shall be included.

3.3.1.9 Information about running machinery and the actual ship operating conditions shall be noted in the protocol.

3.4 Reporting

3.4.1 General

3.4.1.1 Prior to the measurements a plan with the following information shall be issued:

— specification of measuring positions and corresponding limits, the protocol
— required loading conditions
— required operating conditions for machinery
— instrumentation to be used.

3.4.1.2 After the measurements have been carried out, a report shall be issued. The report shall contain the following information:

— ship and machinery particulars
— condition during the measurements such as power output, propeller and or engine speed, draught, water depth, wind and sea state
— sketches or pictures showing the location of the measuring positions and their direction of measurements
— tables of the measured vibration levels as defined in the protocol. The required frequency spectra for the different positions shall be included
— instrumentation that has been used, including type of analyzer, window function that has been applied, averaging time and resolution
— description of possible excessive vibration levels.

SECTION 3 SAFE WORKING CONDITIONS IN CONTAINER SECURING OPERATIONS - SAFELASH

1 General

1.1 Introduction

The additional class notation **SAFELASH** applies to vessels involved with transportation of containers. The objective of the additional class notation **SAFELASH** is to provide people safe working conditions in particular safe access and safe places of work, when they are engaged in container securing operations on deck.

1.2 Scope

The scope of the additional class notation **SAFELASH** is to ensure safer working conditions in container securing operations. This section describes requirements covering aspects within design and arrangement of working areas, container top working, fencing and fall protection, marking of obstacles and openings, design of walkways, ladders, steps and other means of access, design and arrangement of power supplies for reefer containers and illumination of working areas and transit areas.

1.3 Application

Ships complying with the requirements given in this section will be assigned the additional class notation **SAFELASH**. The additional class notation **SAFELASH** is applicable to ships designed for carrying containers on deck with either notation Container ship or Container. The additional class notation **SAFELASH** may be applied to other ships upon request.

The additional class notation **SAFELASH** intends to ensure the compliance with Code of Safe Practice for Cargo Stowage and Securing (CSS Code) Annex 14 adopted by MSC.1/Circ.1352 and related IACS UI SC265, considering design aspects to be implemented at the new building stage. The application of this class notation visualizes compliance with CSS Code Annex 14 to all relevant parties including flag administrations and port state authorities.

1.4 Definitions

1.4.1 Definitions used specially in this section are given in Table 1.

Table 1 Definitions

Lashing positions / working area	Any positions or spaces used for operating container securing devices, e.g. in between container stows on hatch covers; lashing bridges and platforms.
Transit area	Passage ways, stairs, decks and other areas used for moving about the ship.
Fencing	A generic term for guardrails, safety rails, safety barriers and similar structures that provide protection against the falls of people.
Ladder stringers	The uprights or sides of a ladder.
Rungs	The bars that form the steps of a ladder.

2 Documentation

2.1 Documentation requirements

2.1.1 Documentation shall be submitted as required by Table 2.

Table 2 Documentation requirements

Object	*Documentation type*	*Additional description*	*Info*
Protection of the crew	H220 – Cargo safe access plan		AP
Lighting arrangement	E190 – Lighting description	Showing container working areas and transit areas, including light intensity levels.	AP
Electrical power systems	Z030 – Arrangement plan	Including location and details of reefer container power outlets and adjacent working areas.	AP
AP = For approval			

2.1.2 For general requirements to documentation, including definition of the Info codes, see Pt.1 Ch.3 Sec.2.

2.1.3 For a full definition of the documentation types, see Pt.1 Ch.3 Sec.3.

3 Design requirements

3.1 General

3.1.1 The cargo safe access plan shall be developed at the design stage to ensure that securing operations can be carried out safely for all intended container stowage configurations.

Guidance note:

Typically the cargo safe access plan should be developed based on a risk assessment including following hazards:

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— slips, trips and falls,
— falls from height,
— injuries while manually handling container securing equipment,
— being struck by falling securing equipment or other objects,
— injuries resulting from container loading and unloading operations,
— adjacent electrical risks (e.g., reefer container connections),
— adequate access to all areas necessary to safely perform container securing operations,
— ergonomics (e.g., size and weight of equipment) of lashing equipment,
— implications of lashing high cube (9’6”) containers and mixed stows of 40’ and 45’ containers.

3.2 Transit area

3.2.1 The clearance for transit areas shall be at least 600 mm wide and 2.0 m high. See Table 3, Dimensions B, J and F1.

Table 3 Transit area and working area dimensions

Dimension [1)]	*Description*	*Requirement (mm) / Ref.*
A	Width of work area between container stacks	750 minimum / [3.3.4]
B	Distance between lashing plates on deck or on hatch covers	600 minimum / [3.2.1]
C1	Distance from lashing bridge fencing to container stack	1100 maximum [2)] / [3.3.3]
C2	Distance from lashing plate to container stack (lashing bridge)	220 minimum / [3.3.3]
C3	Distance from lashing plate to container stack (elsewhere)	130 minimum / [3.3.3]
F	Width of lashing bridge between top rails of fencing	750 minimum / [3.3.4]
F1	Width of lashing bridge between storage racks, lashing cleats and any other obstruction	600 minimum / [3.2.1] & [3.3.4]
GL	Width of working platform for outboard lashing – fore/aft	750 minimum / [3.3.4]
GT	Width of working platform for outboard lashing – transverse	750 minimum / [3.3.4]
I	Width of work platform at end of hatch cover or adjacent to superstructure	750 minimum / [3.3.4]
J	Distance between fencings or from fencing to superstructure	600 minimum / [3.2.1]

Notes:

B = Measured between the centres of the lashing plates.

$C1$ = Measured from inside of fencing.

$C2, C3$ = Measured from centre of lashing plate to end of container.

F = Measured to inside of fencing.

GL = Measured from end of container to inside of fencing.

GT = Measured to inside of fencing.

I = Measured to inside of fencing.

J = Measured to inside of fencing.

1) See Figure 1, Figure 2, Figure 3 and Figure 4 for illustrations.

2) May be increased to 1300mm. See [3.3.3].

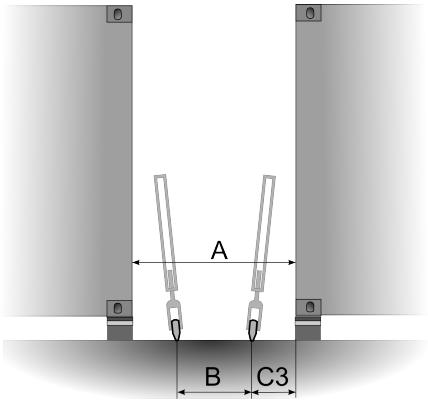

Figure 1 Work area between container stacks

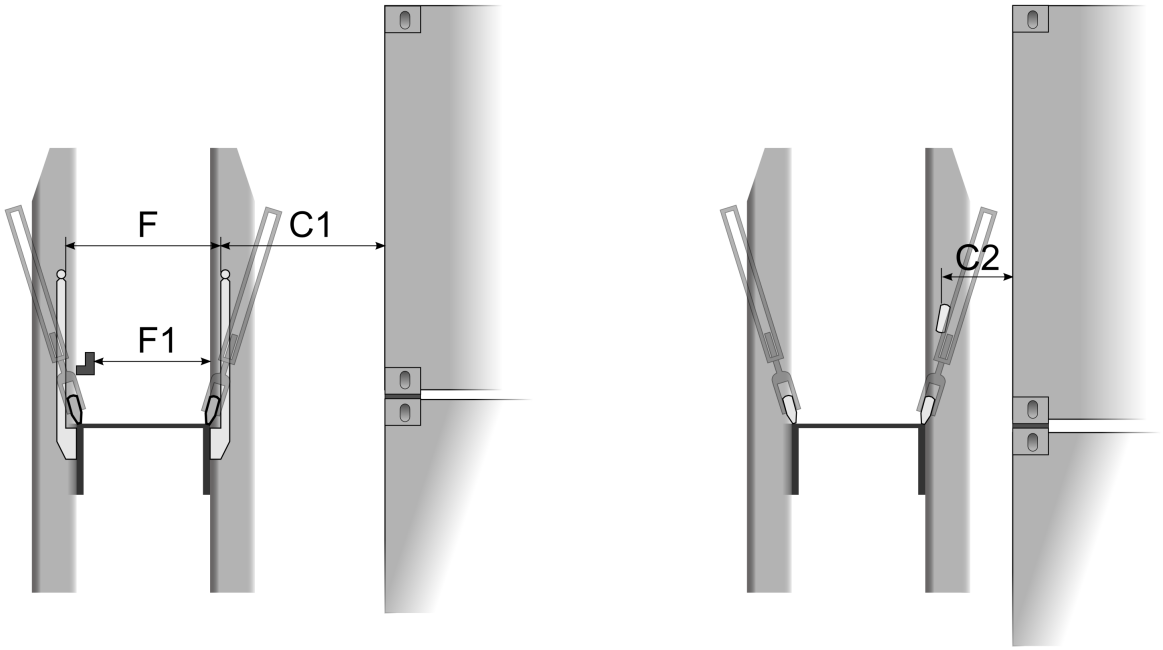

Figure 2 Lashing bridges

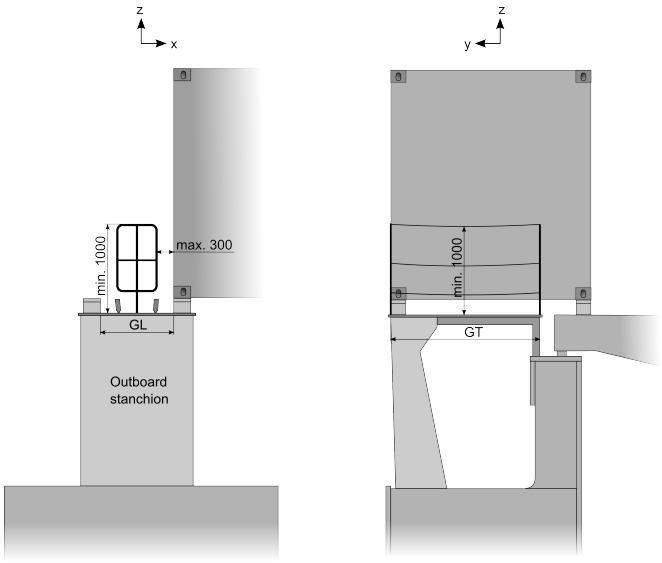

Figure 3 Lashing platforms on outboard stanchions

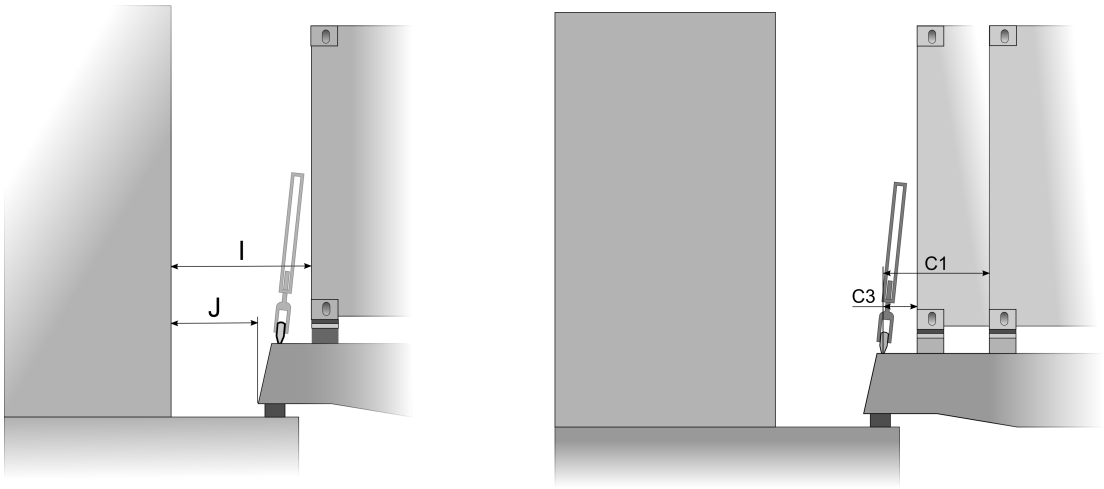

Figure 4 Work area between hatch covers

3.2.2 Transit area shall have anti-slip surfaces.

3.2.3 Walkways on deck shall be delineated by painted lines or otherwise marked by pictorial signs.

3.2.4 All protrusions in access ways in transit area, such as cleats, ribs and brackets that may constitute a trip hazard, shall be highlighted in a contrasting colour.

Guidance note:

As far as practicable, access ladders and walkways should be free of permanent obstructions and designed so that workers do not have to climb over piping.

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3.3 Working area

3.3.1 Working areas shall be designed to eliminate the use of three-tier-high lashing bars and shall be located in close proximity to securing equipment storage areas.

3.3.2 Working areas shall be designed to provide a clear space which is unencumbered by obstructions such as deck piping, storage bins and guides to reposition hatch covers.

3.3.3 The horizontal distance from the lashing securing points to the containers shall not exceed 1100 mm, and not be less than 220 mm for lashing bridges and 130 mm for other positions. See Table 3, Dimensions C1, C2 and C3.

For container bays with foundations designed for 40’ and 45’ container stowage, the dimension C1 may be increased to 1300mm when measured to 40’ containers.

3.3.4 The width of working areas shall not be less than 750 mm. In addition, the width of permanent lashing bridges shall not be less than 750mm between top rails of fencing and shall provide a minimum clear distance of 600 mm between stowage racks, lashing cleats and other obstructions. See Table 3, Dimensions A, GL, GT, I, F and F1.

3.3.5 Platforms shall be provided on the end of hatches and outboard lashing positions.

Guidance note:

Platforms on the end of hatches and outboard lashing positions should be at the same level as the top of the hatch covers. The gap between such platforms and adjacent hatch covers should not exceed 90mm.

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3.3.6 Working areas which contain removable sections shall be capable of being temporarily secured.

3.3.7 Working on the top of containers shall be avoided, e.g. through use of semi-automatic or fully automatic twistlocks.

3.3.8 Toe boards of 150 mm in height shall be provided around the sides of elevated working areas, to prevent securing equipment from falling and injuring people. In cases where toe board obstructs the stowage of containers, the height of toe board may be reduced to 100 mm.

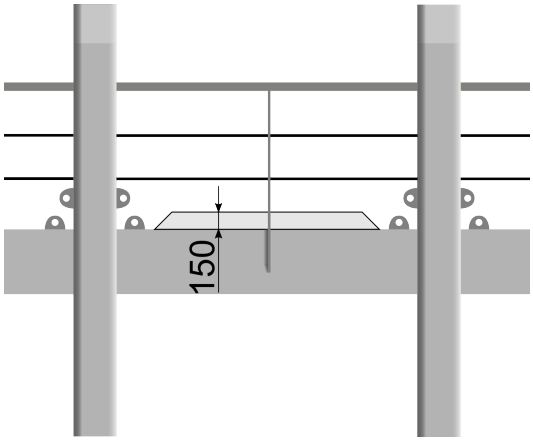

Figure 5 Toe boards

3.4 Fencing design

3.4.1 Lashing bridges, platforms and other working area from which persons may fall 2.0 m or more shall be provided with fencing satisfying the requirements given in [3.4.4].

3.4.2 Where openings in safety barriers are necessary to allow for container crane movements, removable fencing shall be provided.

3.4.3 Athwartships cargo securing walkways shall be protected by fencing satisfying the requirements given in [3.4.4], if the edges of walkways are not protected when the hatch cover is removed.

3.4.4 Fencing shall have a minimum of three courses. The height of the uppermost course shall be at least 1.0 m, measured from the base. The opening below the lowest course shall not exceed 230 mm. The other courses shall not be more than 380 mm apart.

A horizontal unfenced gap of fencing shall not be greater than 300 mm.

Guidance note:

At positions where movable fencings are arranged due to stowage of containers, e.g., lashing platform above outboard stanchions at 20' container gap end, see Figure 3 for illustration, an alternative arrangement of the lower two courses may be accepted by the Society on a case-by-case basis, taking position of container securing device into consideration.

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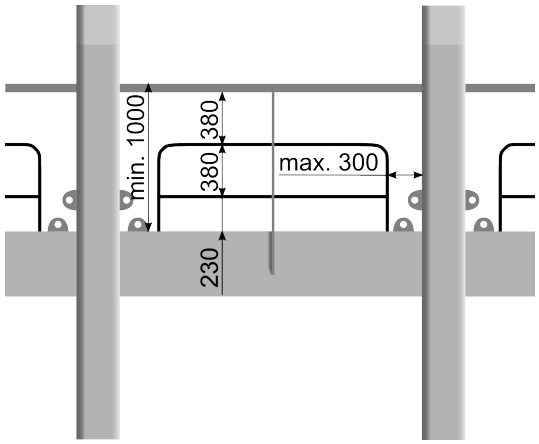

Figure 6 Fencing

3.5 Access openings

3.5.1 Access openings in working area with a potential fall of 2.0 m or more shall be either protected by fencing in accordance with [3.4.4] or possible to be closed by access covers.

3.5.2 Access openings in transit area with a potential fall of 2.0 m or more shall be avoided, unless they are protected by fencing in accordance with [3.4.4].

3.5.3 Access openings in working area and transit area shall be painted in contrasting colour around the rim of the openings.

3.5.4 Access openings at different levels of lashing bridges shall not be located directly below one another.

3.6 Ladders

3.6.1 Where a fixed ladder gives access to the outside boundary of a working area, the stringers shall be connected at their extremities to the guardrails of the working area, irrespective of whether the ladder is sloping or vertical. The stringers of shall also be opened above the working area level to give a minimum clear width of 700 mm to enable a person to pass through the stringers

3.6.2 Where a fixed ladder gives access to a working area through an opening in the working area, handholds extending at least 1.0 m above the working area shall be provided, to ensure safe access through the opening.

3.6.3 Fixed ladders shall not slope more than 25° from vertical. Where the slope of a ladder exceeds 15° from vertical, the ladder shall be provided with handrails positioned not less than 540 mm from the stringers, measured horizontally.

3.6.4 Fixed ladders shall provide a foothold at least 150mm deep.

3.6.5 Fixed ladders with a vertical height exceeding 3.0 m, and any fixed ladders from which a person may fall into the cargo hold, shall be fitted with a safety cage satisfying the requirements given in [3.6.6] to [3.6.7].

3.6.6 The distance between the rungs and the back of the safety cage shall be minimum 750 mm. Safety cage hoops shall be uniformly spaced at intervals not exceeding 900 mm and be connected by vertical bars inside the hoop uniformly spaced around the circumference of the hoops.

3.6.7 The stringers shall be extended at least 1.0 m above the working area, and the ends of the stringers shall be given lateral support. The top step or rung shall be at the same level of the working area unless rungs or steps are fitted up to the end of the stringers.

3.7 Container securing equipment arrangement

3.7.1 The lashing rod's length in conjunction with the length and design of the turnbuckle shall be such that the need of extension is eliminated when lashing high cube (9'6") containers.

In the container securing arrangement document, typical lashing patterns for 9'6" containers shall be shown, if such containers are stowed on board.

Guidance note:

Positively locked extensions, i.e., extensions positively locked to lashing rods before attached to containers, may be accepted.

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3.7.2 During tightening or loosening motions on turnbuckles, the risk for hand injury shall be minimised, e.g., by keeping sufficient distance between turnbuckles.

Guidance note:

During tightening or loosening motions, the distance between turnbuckles is typically not less than 45mm.

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3.7.3 Storage bins shall be provided for container securing equipment.

3.8 Power supply

3.8.1 Reefer power outlets shall provide a watertight electrical connection.

3.8.2 Reefers shall be fitted with heavy-duty, interlocked and circuit-breaker protected electrical power outlets. This is in order to ensure that the outlet cannot be switched on until a plug is fully engaged and the actuator rod is pushed to the "on" position. Pulling the actuator rod to the "off" position shall manually de-energise the circuit.

3.8.3 Reefer power outlets shall de-energise automatically if the plug is accidentally withdrawn while in the "on" position. Furthermore, the interlock mechanism shall break the circuit while the pin and sleeve contacts are still engaged.

3.8.4 Reefer power outlets shall be positioned and designed so as not to require the operator to stand directly in front of the socket when switching takes place.

3.8.5 The positioning of reefer power outlets shall allow for flexible cabling to be laid out without causing a tripping hazard.

3.9 Lighting

3.9.1 Working areas and transit areas shall be provided with lighting.

3.9.2 The lighting shall be designed as a permanent installation adequately guarded against breakage.

Guidance note:

Temporary lighting may be accepted by the Society on a case-by-case basis at locations where permanent lighting is not practical.

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3.9.3 Light intensity levels shall not be less than 10 lux for transit area and 50 lux for working area.

DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16 000 professionals are dedicated to helping our customers make the world safer, smarter and greener.

SAFER, SMARTER, GREENER