

OFFSHORE STANDARD

DNVGL-OS-C301

Edition July 2015

Stability and watertight integrity

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FOREWORD

DNV GL offshore standards contain technical requirements, principles and acceptance criteria related to classification of offshore units.

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CHANGES – CURRENT

General

This document supersedes DNV-OS-C301, July 2014.

Text affected by the main changes in this edition is 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.

On 12 September 2013, DNV and GL merged to form DNV GL Group. On 25 November 2013 Det Norske Veritas AS became the 100% shareholder of Germanischer Lloyd SE, the parent company of the GL Group, and on 27 November 2013 Det Norske Veritas AS, company registration number 945 748 931, changed its name to DNV GL AS. For further information, see www.dnvgl.com. Any reference in this document to “Det Norske Veritas AS”, “Det Norske Veritas”, “DNV”, “GL”, “Germanischer Lloyd SE”, “GL Group” or any other legal entity name or trading name presently owned by the DNV GL Group shall therefore also be considered a reference to “DNV GL AS”.

Main changes July 2015

- General

The revision of this document is part of the DNV GL merger, updating the previous DNV standard into a DNV GL format including updated nomenclature and document reference numbering, e.g.:

- Main class identification **1A1** becomes **1A**.
- DNV replaced by DNV GL.
- DNV-RP-A201 to DNVGL-CG-0168. A complete listing with updated reference numbers can be found on DNV GL's homepage on internet.

To complete your understanding, observe that the entire DNV GL update process will be implemented sequentially. Hence, for some of the references, still the legacy DNV documents apply and are explicitly indicated as such, e.g.: Rules for Ships has become DNV Rules for Ships.

Editorial corrections

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

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CHAPTER 1 INTRODUCTION

SECTION 1 INTRODUCTION

1 General

1.1 Introduction

1.1.1 This offshore standard provides principles, technical requirements and guidance related to stability, watertight integrity, freeboard and weathertight closing appliances for mobile offshore units and floating offshore installations.

The types of units and installations that are covered by this standard include:

- ship shaped units
- column stabilised units
- self elevating units
- deep draught units.

Guidance note:

For novel designs, not recognised by the typical features of a known type of design, the stability requirements have to be considered separately and based on an evaluation of risks reflecting the unit's design, the intended operational aspects and the environmental conditions.

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1.1.2 The standard has been written for general worldwide application. Governmental regulations may include requirements in excess of the provisions by this standard depending on the size, type, location and intended service of the offshore unit or installation.

1.2 Objectives

The objectives of this standard are to:

- provide an internationally acceptable standard of safety by defining minimum requirements for stability, watertight integrity, freeboard and weathertight closing appliances
- serve as a contractual reference document between suppliers and purchasers
- serve as a guideline for designers, suppliers, purchasers and regulators
- specify procedures and requirements for units or installations subject to DNV GL certification and classification.

2 Normative references

2.1 General

2.1.1 The standards given in [2.2] include provisions which, through reference in the text, constitute provisions of this offshore standard. The latest issue of the references shall be used unless otherwise agreed.

2.1.2 Other recognised standards may be used provided it can be demonstrated that these meet or exceed the requirements of the standards given in [2.2].

2.1.3 Any deviations, exceptions and modifications to the design codes and standards shall be documented and agreed between the contractor, purchaser and verifier, as applicable.

2.2 Reference documents

2.2.1 Applicable DNV GL and DNV documents are given in [Table 1](#).

Table 1 DNV GL and DNV reference documents

<i>Reference</i>	<i>Title</i>
DNVGL-OS-B101	Metallic materials
DNVGL-OS-C101	Design of offshore steel structures, general - LRFD method
DNVGL-OS-C201	Structural design of offshore units - WSD method
DNVGL-OS-D101	Marine and machinery systems and equipment
DNV Rules for ships	DNV Rules for Classification of Ships
DNVGL-CG-0168	Plan approval documentation types – definitions
DNV-RP-C205	Environmental Conditions and Environmental Loads
DNV Classification Notes 20.1	Stability Documentation for Approval

2.2.2 Other reference documents are given in [Table 2](#).

Table 2 Normative references

<i>Reference</i>	<i>Title</i>
ICLL 1966	International Convention on Load Lines, 1966, amended by Protocol 1988
IMO MODU Code, 2009	Code for the Construction and Equipment of Mobile Offshore Drilling Units, 2009

3 Informative references

3.1 General

3.1.1 Informative references are not considered mandatory in the application of this offshore standard, but may be applied or used for background information.

3.1.2 Informative references are given in [Table 3](#).

Table 3 Informative references

<i>Reference</i>	<i>Title</i>
ISO 1751	Shipbuilding and marine structures - Ships' side scuttles
ISO 3903	Shipbuilding and marine structures - Ships' ordinary rectangular windows
ISO 1095	Shipbuilding and marine structures - Toughened safety glass panes for side scuttles
ISO 614	Shipbuilding and marine structures - Toughened safety glass panes for rectangular windows and side scuttles - Punch method of non-destructive testing
SOLAS 1974	The International Convention for the Safety of Life at Sea, 1974, as amended

4 Definitions

4.1 Verbal forms

Table 4 Definitions

<i>Term</i>	<i>Definition</i>
shall	verbal form used to indicate requirements strictly to be followed in order to conform to the document
should	verbal form used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required
may	verbal form used to indicate a course of action permissible within the limits of the document

4.2 Definitions

Table 5 Definitions

Term	Definition
column stabilised unit	a unit with the main deck connected to the underwater hull or footings by columns
damage penetration zone	defined as 1.5 m from the outer skin The damage penetration zone is limited to exposed portions only.
damage waterline	the final equilibrium waterline, including the wind heeling moment, after a damage
downflooding	any flooding of the interior of any part of the buoyant structure of a unit through openings which cannot be closed watertight or weathertight, as appropriate, in order to meet the intact or damage stability criteria, or which are required for operational reasons to be left open
dynamic angle	the angle of heel where the area requirement according to the stability requirements of Ch.2 Sec.1 is achieved
exposed portions	those portions of the structure that are exposed to collision from other units Guidance note: For a column stabilised unit, the exposed portions are the portions of the columns, pontoons and bracings which are located outboard of a line drawn through the centres of the periphery columns, see Figure 1. <div style="text-align: center;"> <p>d_0 = OPERATING DRAUGHT D_T = TRANSIT DRAUGHT</p> </div>
field move	the transit voyage which can be completed within 12 hours (transit time) or within the limits of favourable reliable weather forecasts, whichever is less However, for certain operating areas and seasons, a field move may exceed 12 hours if justified by independent reliable evidence. Guidance note: Weather may be considered favourable up to Beaufort condition 6, i.e. average wind speed of 24 knots. <div style="text-align: center;"> <p>---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---</p> </div>
first intercept	the angle of heel where the righting moment curve intercepts the heeling moment curve for the first time The first intercept is also known as the static angle of heel.
floating offshore installation	a buoyant construction engaged in offshore operations including drilling, production, storage or support functions, and which is designed and built for installation at a particular offshore location
freeboard	the distance measured vertically downwards amidship from the upper edge of the deck line to the upper edge in the related load line
lightweight	the unvariable weight of the unit; i.e. the basis for calculating the loading conditions Anchors and cables intended for mooring the unit at the field are to be excluded from the lightweight and included in the loading conditions as variable loads.

Table 5 Definitions (Continued)

<i>Term</i>	<i>Definition</i>
maximum allowable vertical centre of gravity	the maximum vertical centre of gravity (VCG) which complies with both intact and damage stability requirements at a given draught and service mode All loading conditions are to have a VCG below the maximum allowable value for the given draught and service mode. The free surface effect of each slack tank should be calculated about the axis at which the moment of inertia is the greatest.
mobile offshore unit	a buoyant construction engaged in offshore operations including drilling, production, storage or support functions, not intended for service at one particular offshore site and which can be relocated without major dismantling or modification
offshore installation	a collective term to cover any construction, buoyant or non-buoyant, designed and built for installation at a particular offshore location
position 1 and 2	in accordance with Regulation 13 of the International Convention on Load Line 1966 (ILLC 1966), adapted to mobile offshore units
safe draught	a draught which can be accepted under loading condition corresponding to damaged condition with respect to strength, and the requirement for minimum airgap is fulfilled
second intercept	the angle of heel where the righting moment curve intercepts the heeling moment curve for the second time
self elevating unit	a unit with movable legs capable of raising its hull above the surface of the sea
service modes	<ul style="list-style-type: none"> – operation condition, i.e. normal working condition – temporary conditions, i.e. transient conditions during change of draught to reach another service mode or installation mode – survival condition, i.e. in case of severe storms – transit condition.
ship shaped unit	a unit with a ship or barge type displacement hull of single or multiple hull construction intended for operation in the floating condition
variable load	the load that varies with the operation of the unit such as deck cargo, fuel, lubricating oil, ballast water, fresh water, feedwater in tanks, consumable stores and crew and their effects
watertight	capable of preventing the passage of water through the structure under a head of water for which the surrounding structure is designed
weathertight	water will not penetrate into the unit in any sea conditions

4.3 Abbreviations and symbols

Abbreviations used are given in [Table 6](#).

Table 6 Abbreviations

<i>Abbreviation</i>	<i>Full text</i>
CG	class guideline
CIBS	classification information breakdown structure
ILLC	International Convention on Load Lines
IMO	International Maritime Organization
ISO	International Organisation for Standardisation
LRFD	load resistance factor design
MODU	mobile offshore drilling unit
OS	offshore standard
RP	recommended practice
VCG	vertical centre of gravity
WSD	working stress design

5 Documentation

5.1 General

5.1.1 The documentation given in [Table 7](#) is required to be produced to document aspects covered by this standard:

Table 7 Documentation requirements

<i>Object</i>	<i>Documentation type</i>	<i>Additional description</i>	<i>For approval (AP) or For information (FI)</i>
Stability	B010 – Lines plan or offset tables		FI
	B020 – External watertight integrity plan or freeboard plan	Subject to approval for Column-stabilised and self-elevating units where beach lines according to Ch.2 Sec.2 [10.1] must be included.	AP/FI
	B030 – Internal watertight integrity plan		FI
	B040 – Stability analysis	Not applicable for Ship-shaped units. See also definition of B050 for more details.	AP
	B050 – Preliminary stability manual	Applicable for Ship-shaped units	AP
	B070 – Preliminary damage stability calculation	Applicable for Ship-shaped units. See also definition of B050 for more details.	AP
	B100 – Inclining test procedure		AP
	B110 – Inclining test report		AP
	B120 – Final stability manual	The final stability manual may be included in the operation manual.	AP
	B130 – Final damage stability calculation	Applicable for Ship-shaped units	AP
	B200 – Freeboard plan		AP

5.1.2 For general requirements to documentation, see DNVGL-CG-0168 Sec.1.

5.1.3 For a full definition of the documentation types, see DNVGL-CG-0168 Sec.2 and DNV Classification Note No. 20.1.

5.1.4 For documentation requirements related to certification and classification, see [Ch.3](#).

CHAPTER 2 TECHNICAL PROVISIONS

SECTION 1 STABILITY

1 General

1.1 Scope

1.1.1 This section gives requirements related to the following design parameters of mobile offshore units and floating offshore installations:

- 1) Buoyancy and floatability.
- 2) Wind exposed portions.
- 3) Draught range at various modes of service.
- 4) Watertight and weathertight closing of external openings.
- 5) Internal watertight integrity and watertight subdivision.
- 6) Lightweight and loading conditions.

1.1.2 The combination of the design parameters under [1.1.1] items 1 to 5 will determine the maximum allowable vertical centre of gravity (VCG) of the unit or installation at the applicable service draughts and modes.

1.1.3 The loading of the unit or installation at various service draughts and modes shall be within the limits of maximum allowable VCG-curves.

1.1.4 In order to determine VCG of the actual loading conditions, the lightweight and its centre of gravity must be known. This shall be obtained by an inclining test carried out in accordance with [3].

1.1.5 The requirements of this section are based on the IMO MODU Code, 2009.

1.1.6 Deep draught floating installations (e.g. SPARs) are not directly covered by the IMO MODU Code. Criteria identical to those of a column stabilised unit or installations have been adopted.

2 Determination of wind forces

2.1 Heeling moment curves

2.1.1 The curves of wind heeling moments shall be drawn for wind forces calculated by the following formula:

$$F = 0.5 C_s \cdot C_h \cdot P \cdot V^2 \cdot A$$

F = the wind force (Newton)

C_s = the shape coefficient depending on the shape of the structural member exposed to the wind (see Table 2)

C_h = the height coefficient depending on the height above sea level of the structural member exposed to wind (see Table 2)

P = the air mass density (1.222 kg/m³)

V = the wind velocity (metres per second)

A = the projected area of all exposed surfaces in either the upright or the heeled condition (square metres)

(See MODU Code 3.2.3)

2.1.2 Wind forces shall be considered from any direction relative to the unit and the value of the wind velocity shall be as follows:

- in general a minimum wind velocity of 36 m/s (70 knots) for offshore service shall be used for normal operating and transit conditions and a minimum wind velocity of 51.5 m/s (100 knots) shall be used for the severe storm conditions

- where a unit is to be limited in operation to sheltered locations (protected inland waters such as lakes, bays, swamps, rivers, etc.) consideration shall be given to a reduced wind velocity of not less than 25.8 m/s (50 knots) for normal operating conditions.

(See MODU Code 3.2.4)

2.1.3 In calculating the projected areas to the vertical plane, the area of surfaces exposed to wind due to heel or trim, such as under-deck surfaces, etc., shall be included using the appropriate shape factor. Open truss work may be approximated by taking 30% of the projected block area of both the front and back section, i.e. 60% of the projected area of one side.

(See MODU Code 3.2.5)

2.1.4 In calculating the wind heeling moments, the lever of the wind overturning force shall be taken vertically from the centre of pressure of all surfaces exposed to the wind to the centre of lateral resistance of the underwater body of the unit. The unit is to be assumed floating free of mooring restraint.

(See MODU Code 3.2.6)

Interpretation:

For units supported by dynamic positioning systems, the centre of the thruster force should be applied as the centre of lateral resistance.

In case the total maximum thruster force is less than the wind force, the total wind heeling moment may be taken as a combination of wind moment and thruster moment. The lever of the wind force should in this case be taken to the centre of the lateral resistance of the hull. The lever of the maximum thruster force is taken vertically from centre of the thruster force to the centre of the lateral resistance of the underwater hull.

----- end of Interpretation -----

Table 1 Values of the coefficient C_s

Shape	C_s
Spherical	0.4
Cylindrical	0.5
Large flat surface (hull, deckhouse, smooth under-deck areas)	1.0
Drilling derrick	1.25
Wires	1.2
Exposed beams and girders under deck	1.3
Small parts	1.4
Isolated shapes (crane, beam, etc.)	1.5
Clustered deckhouses or similar structures	1.1

Table 2 Values of the coefficient C_h

Height above sea level (metres)	C_h	Height above sea level (metres)	C_h
0 – 15.3	1.00	137.0 – 152.5	1.60
15.3 – 30.5	1.10	152.5 – 167.5	1.63
30.5 – 46.0	1.20	167.5 – 183.0	1.67
46.0 – 61.0	1.30	183.0 – 198.0	1.70
61.0 – 76.0	1.37	198.0 – 213.5	1.72
76.0 – 91.5	1.43	213.5 – 228.5	1.75
91.5 – 106.5	1.48	228.5 – 244.0	1.77
106.5 – 122.0	1.52	244.0 – 256.0	1.79
122.0 – 137.0	1.56	Above 256	1.80

2.1.5 The wind heeling moment curve shall be calculated for a sufficient number of heel angles to define the curve. For ship-shaped hulls the curve may be assumed to vary as the cosine function of vessel heel.

(See MODU Code 3.2.7)

2.1.6 Wind heeling moments derived from wind tunnel tests on a representative model of the unit may be considered as alternatives to the methods given in [2.1.1].

(See MODU Code 3.2.8)

3 Determination of lightweight

3.1 Inclining test

3.1.1 An inclining test shall be required for the first unit of a design, when the unit is as near to completion as possible, to determine accurately the light ship data (weight and position of centre of gravity).

(See MODU Code 3.1.1)

Interpretation:

For self-elevating units, lightweight Centre of Gravity should be specified for each relevant position of legs.

----- end of Interpretation -----

3.1.2 For successive units which are identical by design, the light ship data of the first unit of the series may be accepted in lieu of an inclining test, provided the difference in light ship displacement or position of centre of gravity due to weight changes for minor differences in machinery, outfitting or equipment, confirmed by the results of a deadweight survey, are less than 1% of the values of the light ship displacement and principal horizontal dimensions as determined for the first series.

Such dispensation cannot be granted for column stabilised units.

(See MODU Code 3.1.2)

4 Intact stability requirements

4.1 General

4.1.1 Each unit shall be capable of attaining a severe storm condition in a period of time consistent with the meteorological conditions. The procedures recommended and the approximate length of time required, considering both operating conditions and transit conditions, shall be contained in the stability manual. It shall be possible to achieve the severe storm condition without the removal or relocation of solid consumables or other variable load. However, it may be acceptable loading a unit past the point at which solid consumables would have to be removed or relocated to go to severe storm condition under the following conditions, provided the allowable VCG requirement is not exceeded:

- 1) In a geographic location where weather conditions annually or seasonally do not become sufficiently severe to require a unit to go to severe storm condition, or
- 2) Where a unit is required to support extra deck load for a short period of time that falls well within a period for which the weather forecast is favourable.

The geographic locations, weather conditions and loading conditions in which this is permitted shall be identified in the stability manual.

(See MODU Code 3.3.2)

Interpretation:

For column stabilised units where a change in draft is necessary to reach the severe storm condition; ballasting and de-ballasting curves should be worked out. Reference is made to DNV Classification Note

No. 20.1, May 2011 *Limit curves or maximum allowable VCG-curves, column-stabilised units* for additional information.

----- end of Interpretation -----

4.1.2 Alternative stability criteria may be acceptable, provided an equivalent level of safety is maintained and if it can demonstrate to afford adequate positive initial stability. In determining the acceptability of such criteria, the following will be considered and taken into account as appropriate:

- 1) Environmental conditions representing realistic winds (including gusts) and waves appropriate for world-wide service in various modes of operation;
- 2) Dynamic response of a unit. Analysis shall include the results of wind tunnel tests, wave tank model tests, and non-linear simulation, where appropriate. Any wind and wave spectra used shall cover sufficient frequency ranges to ensure that critical motion responses are obtained;
- 3) Potential for flooding taking into account dynamic responses in a seaway;
- 4) Susceptibility to capsizing considering the unit's restoration energy and the static inclination due to the mean wind speed and the maximum dynamic response;
- 5) An adequate safety margin to account for uncertainties.

(See MODU Code 3.3.3)

4.2 Ship shaped units or installations

4.2.1 For units or installations having a ship shaped hull form, the intact stability requirements of the DNV Rules for ships, Pt.3 Ch.3 Sec.9 D101, shall be met.

(See IS Code)

4.2.2 The area under the righting moment curve to the second intercept or downflooding angle, whichever is less, shall be not less than 40% in excess of the area under the wind heeling moment curve to the same limiting angle. See [Figure 1](#).

(See MODU Code 3.3.1.1)

4.2.3 The righting moment curve shall be positive over the entire range of angles from upright to the second intercept.

(See MODU Code 3.3.1.3)

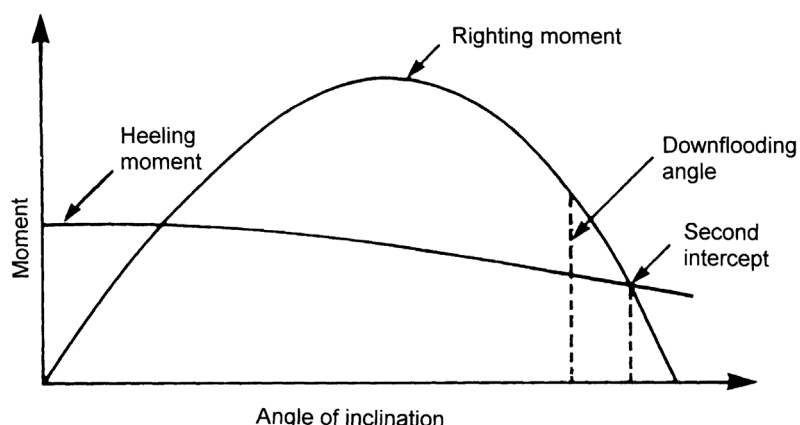


Figure 1 Righting moment and heeling moment curves

Guidance note 1:

In this context, the downflooding angle represents the angle of heel at which the first opening that cannot be closed watertight or weathertight gets immersed (so-called unprotected opening).

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Guidance note 2:

For units storing oil, the stability requirements of MARPOL should be considered, see IMO Res. MEPC 139 & 142.

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4.3 Column stabilised units

4.3.1 The area under the righting moment curve to the angle of downflooding shall be not less than 30% in excess of the area under the wind heeling moment curve to the same limiting angle.

(See MODU Code 3.3.1.2)

4.3.2 The righting moment curve shall be positive over the entire range of angles from upright to the second intercept.

(See MODU Code 3.3.1.3)

4.3.3 During temporary conditions the metacentric height (GM) shall be at least 0.3 m.

4.4 Self elevating units or installations

4.4.1 The area under the righting moment curve to the second intercept or downflooding angle, whichever is less, shall be not less than 40% in excess of the area under the wind heeling moment curve to the same limiting angle.

(See MODU Code 3.3.1.1)

4.4.2 The righting moment curve shall be positive over the entire range of angles from upright to the second intercept.

(See MODU Code 3.3.1.3)

4.5 Deep draught floating installations

4.5.1 The area under the righting moment curve to the second intercept or downflooding angle, whichever is less, shall be not less than 30% in excess of the area under the wind heeling moment curve to the same limiting angle.

(See MODU Code 3.3.1.2)

4.5.2 The righting moment curve shall be positive over the entire range of angles from upright to the second intercept.

(See MODU Code 3.3.1.3)

4.5.3 Current is to be included in calculation of overturning moment. Guidance on calculation of current can be found in DNV-RP-C205.

4.5.4 Intact inclination angle is limited to 6° and 12° for normal operating conditions and survival conditions, respectively.

4.6 Cylindrical surface units

4.6.1 The area under the righting moment curve to the angle of downflooding shall be not less than 30% in excess of the area under the wind heeling moment curve to the same limiting angle.

(See MODU Code 3.3.1.2)

4.6.2 The righting moment curve shall be positive over the entire range of angles from upright to the second intercept.

(See MODU Code 3.3.1.3)

Guidance note:

For units storing oil, the stability requirements of MARPOL may be applicable, see IMO Res. MEPC 139 & 142.

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5 Damage stability requirements

5.1 General

5.1.1 It shall be demonstrated that the unit or installation complies with the requirements of [5.2] to [5.5] by calculations, which take into consideration the proportions and design characteristics of the unit or installation and the arrangements and configuration of the damaged compartments. In making these calculations it shall be assumed that the unit or installation is in the worst anticipated service condition as regards stability and is floating free of mooring restraints.

(See MODU Code 3.4.5)

5.1.2 The ability to reduce angles of inclination by pumping out or ballasting compartments or application of mooring forces, etc., shall not be considered as justifying any relaxation of the requirements.

(See MODU Code 3.4.6)

5.1.3 The following permeability factors shall be assumed in the calculations:

Store rooms: 0.60

Engine room: 0.85

Tanks, void spaces etc: 0.95

(See SOLAS II-1 7-3)

Guidance note:

Other permeabilities may be accepted if documented by calculations.

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5.1.4 Alternative subdivision and damage stability criteria may be acceptable provided an equivalent level of safety is maintained. The alternative stability criteria, shall consider at least the following and take into account:

- 1) Extent of damage as set out in [5.6] and [5.7];
- 2) On column stabilised units, the flooding of any compartment as set out in [5.4.2];
- 3) The provision of an adequate margin against capsizing.

(See MODU Code 3.4.7)

5.2 Ship shaped units or installations

5.2.1 The unit shall have sufficient freeboard and be subdivided by means of watertight decks and bulkheads to provide sufficient buoyancy and stability to withstand in general the flooding of any one compartment in any operating or transit condition consistent with the damage assumptions set out in [5.6].

(See MODU Code 3.4.1)

5.2.2 The unit shall have sufficient reserve stability in a damaged condition to withstand the wind heeling moment based on a wind velocity of 25.8 m/s (50 knots) superimposed from any direction. In this condition the final waterline, after flooding, shall be below the lower edge of any downflooding opening.

Guidance note 1:

In this context, the downflooding opening is an opening that cannot be closed watertight (i.e. includes both weathertight and unprotected openings).

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Guidance note 2:

Additional requirements following different statutory certificates, if applicable, may come into force.

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5.3 Self elevating units or installations

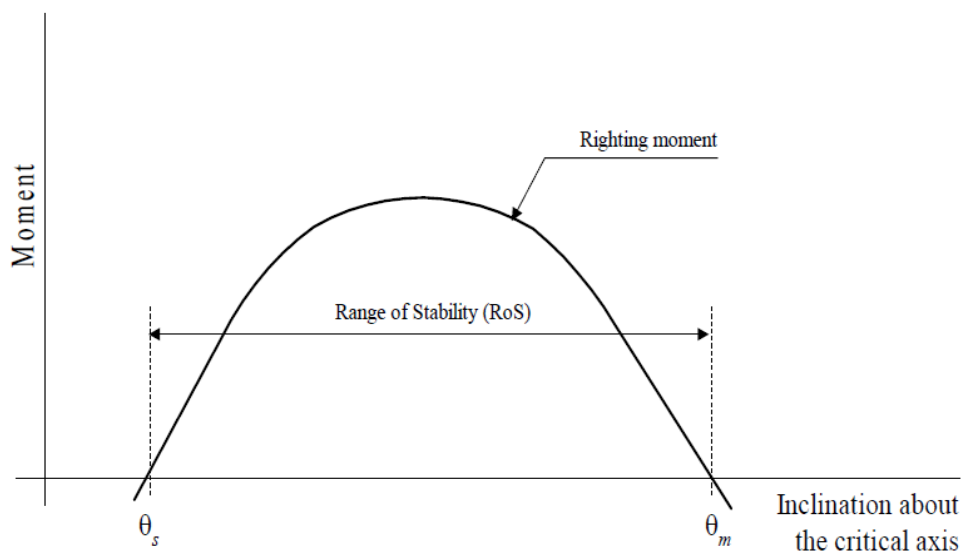


Figure 2 Residual Stability for self-elevating units

5.3.1 The unit shall have sufficient freeboard and be subdivided by means of watertight decks and bulkheads to provide sufficient buoyancy and stability to withstand:

- 1) in general the flooding of any compartment in any operating or transit condition consistent with the damage assumptions set out in [5.6]; and
- 2) flooding of any single compartment while meeting the following criterion (see Figure 2)

$$\text{RoS} \geq 7^\circ + (1.5\theta_s), \text{ (but at least } 10^\circ\text{)}$$

where:

$$\text{RoS} \geq 10^\circ$$

$$\text{RoS} = \text{range of stability, in degrees} = \theta_m - \theta_s$$

where:

θ_m = maximum angle of positive stability, in degrees

θ_s = static angle of inclination after damage, in degrees

The range of stability is determined without reference to the angle of downflooding.

(See MODU Code 3.4.1)

5.3.2 The unit shall have sufficient reserve stability in a damaged condition to withstand the wind heeling moment based on a wind velocity of 25.8 m/s (50 knots) superimposed from any direction. In this condition the final waterline, after flooding, shall be below the lower edge of any downflooding opening.

(See MODU Code 3.4.2)

5.4 Column stabilised units or installations and cylindrical surface units

5.4.1 The unit shall have sufficient freeboard and be subdivided by means of watertight decks and bulkheads to provide sufficient buoyancy and stability to withstand a wind heeling moment induced by a wind velocity of 25.8 m/s (50 knots) superimposed from any direction in any operating or transit condition, taking the following considerations into account:

- 1) The angle of inclination after the damage set out in [5.7] shall not be greater than 17° ;
- 2) Any opening (through which progressive flooding may occur) below the final waterline shall be made watertight, and openings within 4 m above the final waterline shall be made weathertight;
- 3) The righting moment curve, after the damage set out above, shall have, from the first intercept to the lesser of the extent of weathertight integrity required by 2) and the second intercept, a range of at least 7° . Within this range, the righting moment curve shall reach a value of at least twice the wind heeling moment curve, both being measured at the same angle. See Figure 3.

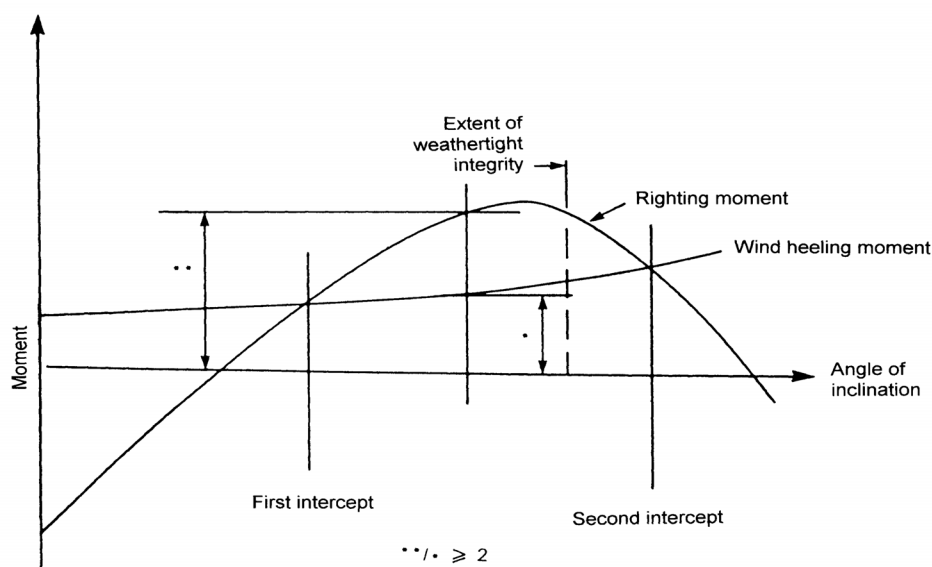


Figure 3 Righting moment and wind heeling moment curves

(See MODU Code 3.4.3)

5.4.2 The unit shall provide sufficient buoyancy and stability in any operating or transit condition to withstand the flooding of any watertight compartment wholly or partially below the waterline in question, which is a pump-room, a room containing machinery with a salt water cooling system or a compartment adjacent to the sea, taking the following considerations into account:

- 1) The angle of inclination after flooding shall not be greater than 25°;
- 2) Any opening below the final waterline shall be made watertight;
- 3) A range of positive stability shall be provided, beyond the calculated angle of inclination in these conditions, of at least 7°.

(See MODU Code 3.4.4)

Interpretation:

For the purpose of flooding and stability considerations "any watertight compartment" includes those compartments containing sea water piping systems.

----- end of Interpretation -----

5.5 Deep draught floating installations

The installation shall have sufficient freeboard and be subdivided by means of watertight decks and bulkheads to provide sufficient buoyancy and stability to withstand a wind heeling moment induced by a wind velocity of 25.8 m/s (50 knots) superimposed from any direction in any operating or transit condition, taking the following considerations into account:

- 1) The angle of inclination after the damage set out in [5.7] shall not be greater than 17°;
- 2) Any opening through which progressive flooding may occur below the final waterline shall be made watertight, and openings within 4 m above the final waterline shall be made weathertight;
- 3) The righting moment curve, after the damage set out above, shall have, from the first intercept to the lesser of the extent of weathertight integrity required by [5.4.1] 2) and the second intercept, a range of at least 7°. Within this range, the righting moment curve shall reach a value of at least twice the wind heeling moment curve, both being measured at the same angle. See Figure 3.

(See MODU Code 3.4.3)

5.6 Extent of damage – ship shaped, cylindrical and self-elevating units or installations

In assessing the damage stability of such units the following extent of damage is assumed to occur between effective watertight bulkheads:

- 1) Horizontal penetration: 1.5 m.
- 2) Vertical extent: from the base line upwards without limit.

The distance between effective watertight bulkheads or their nearest stepped portions which are positioned within the assumed extent of horizontal penetration shall be not less than 3.0 m; where there is a lesser distance one or more of the adjacent bulkheads shall be disregarded.

Where damage of a lesser extent than the above results in a more severe condition, such lesser extent shall be assumed.

Where a mat is fitted for self elevating units the above extent of damage shall be applied to both the platform and the mat but not simultaneously, unless deemed necessary due to their close proximity to each other.

All piping, ventilation systems, trunks, etc., within the extent of damage shall be assumed damaged. Positive means of closure shall be provided at watertight boundaries to preclude the progressive flooding of other spaces which are intended to be intact.

(See MODU Code 3.5)

5.7 Extent of damage – column stabilised units and deep draught floating installations

In assessing the damage stability of such units, the following extent of damage shall be assumed:

- 1) Only those columns, underwater hulls and braces on the periphery of the unit shall be assumed to be damaged, and the damage shall be assumed in the exposed portions of the columns, underwater hulls and braces.
- 2) Columns and braces shall be assumed flooded by damage having a vertical extent of 3.0 m occurring at any level between 5.0 m above and 3.0 m below the draughts specified in the stability manual. Where a watertight flat is located within this region, the damage shall be assumed to have occurred in both compartments above and below the watertight flat in question. Lesser distances above or below the draughts may be applied upon consideration, taking into account the actual operating conditions. However, the required damage region shall extend at least 1.5 m above and below the draught specified in the operating manual.
- 3) No vertical bulkhead shall be assumed damaged, except where bulkheads are spaced closer than a distance of one eighth of the column perimeter at the draught under consideration, measured at the periphery, in which case one or more of the bulkheads shall be disregarded.
- 4) Horizontal penetration of damage shall be assumed to be 1.5 m.
- 5) Underwater hull or footings shall be assumed damaged when operating in a transit condition in the same manner as indicated in 1), 2), 4) and either 3) or [5.6], having regard to their shape.
- 6) All piping, ventilation systems, trunks, etc., within the extent of damage shall be assumed damaged. Positive means of closure shall be provided at watertight boundaries to preclude the progressive flooding of other spaces that are intended to be intact.
- 7) All Deep Draught Units shall comply with the damage stability survival requirements in [5.5] assuming flooding of any single watertight compartment located at or below the waterline corresponding to the maximum draught.

(See MODU Code 3.5.10)

5.8 Chain lockers

5.8.1 Chain lockers, which are not provided with weathertight closing appliances, shall be provided with level alarm or sounding and bilge arrangement or drainage system in accordance with DNVGL-OS-D101. In this case the chain pipes will be regarded as downflooding points.

(See MODU Code 3.6.8)

5.8.2 When chain lockers without weathertight closing appliances are used as ballast tanks, downflooding through chain pipes can be disregarded at a given draught provided that chain lockers are:

- equipped as ballast tanks according to DNVGL-OS-D101
- kept full at the given draught. This shall be stated in the stability manual.

Conditions during the cleaning of chain lockers shall be considered as temporary conditions.

5.9 Machinery and machinery space openings

Openings necessary for continuous air supply for operation of machinery space and emergency generator room shall be located in a position where weathertight closing according to [Ch.2 Sec.2 \[10.1\]](#) and [\[10.2\]](#) is not required.

(See ICLL Annex I, Reg. 17)

5.10 Load line and draught marks

5.10.1 The unit or installation shall have load line marks according to the maximum permissible draught in the afloat condition.

5.10.2 The load line marks will be assigned on the basis of compliance with the requirements of this section as well as other applicable requirements.

5.10.3 Draught marks shall be located in positions, which will ensure accurate determination of draughts, trim and heel and where they are clearly visible to personnel operating the unit or installation. The reference line shall be defined in the stability manual.

5.11 Extent of watertight and weathertight closing of external openings

5.11.1 Watertight closing appliances are required for those external openings being submerged at least up to an angle of heel equal to the first intercept in intact or damage condition, whichever is greater.

5.11.2 Weathertight closing appliances are required for those external openings being submerged at least up to an angle of heel equal to the dynamic angle. This applies to any opening within 4.0 m above the final waterline as well.

Guidance note:

See DNVGL-OSS-201 for additional requirements for units intended for the Norwegian shelf, see also [Ch.2 Sec.2 \[10.1\]](#) and [\[10.2\]](#).

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5.12 Internal watertight integrity and subdivision

5.12.1 The internal subdivision shall be adequate to enable the unit or installation to comply with the damage stability requirements of this section.

5.12.2 Ducts or piping, which may cause progressive flooding in case of damage, shall generally not be used in the damage penetration zone.

5.13 Loading computers

Loading computers for stability calculation shall be considered as supplementary to the stability manual or the stability part of the operation manual.

Guidance note:

See the applicable Rules for Mobile Offshore Units [Ch.2 Sec.1 \[6.1.2\]](#) and Rules for Self-elevating drilling units Pt. 3 [Ch.2 Sec. 2](#) and DNV Rules for Ships Pt. 6 [Ch.9](#) for information regarding approval of loading computers.

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SECTION 2 WATERTIGHT INTEGRITY, FREEBOARD AND WEATHERTIGHT CLOSING APPLIANCES

1 General

1.1 Application

1.1.1 This section provides requirements with regards to arrangement and design of watertight integrity and freeboard for self elevating and column stabilised units and installations.

1.1.2 Watertight integrity, freeboard plan and weathertight closing appliances for ship shaped units or installations shall comply with the DNV Rules for ships Pt.3 Ch.1, Ch.3 Sec.6 and Sec.9 with the following additional requirements:

- a) Doors in unprotected fronts and sides shall be of steel.
- b) For doors located in exposed positions in sides and front bulkheads, the requirements to sill heights apply one deck higher than given by the DNV Rules for ships Pt.3 Ch.3 Sec.6 B.

1.1.3 Piping and electrical systems for operation of watertight closing appliances shall be in accordance with relevant requirements given in DNVGL-OS-D101 unless otherwise specified in this section.

2 Materials

2.1 Technical requirements

2.1.1 Materials for:

- rolled steel for structural applications and pressure vessels
- steel tubes, pipes and fittings
- steel forgings
- steel castings
- aluminium alloys

shall comply with the requirements given by DNVGL-OS-B101 unless otherwise stated in the relevant technical reference documents.

2.1.2 Stainless steel shall be with a maximum carbon content of 0.05%. The stainless steel material shall be of the white pickled and passivated condition.

2.1.3 Aluminium shall be of seawater resistant type.

2.2 Supplementary classification requirements

2.2.1 Certification requirements for materials are given in DNVGL-OS-B101, Ch.3.

2.2.2 Rolled, forged or cast elements of steel and aluminium for structural application shall be supplied with DNV GL material certificates in compliance with the requirements given in DNVGL-OS-B101.

3 Watertight integrity

3.1 General

3.1.1 The number of openings in watertight subdivisions shall be kept to a minimum compatible with the design and proper working of the unit or installation. Where penetrations of watertight decks and bulkheads are necessary for access, piping, ventilation, electrical cables etc., arrangements shall be made to maintain the watertight integrity of the enclosed compartments.

3.1.2 Locations of openings where watertight integrity is required, are illustrated in [9].

3.1.3 The strength and arrangement of sliding doors and hatch covers and their frames as well as the capacity of the closing systems shall be sufficient to ensure efficient closing of doors and hatch covers when water with a head of 2.0 m is flowing through the opening, and at an inclination of 17° in any direction.

3.2 Internal openings

3.2.1 The means to ensure the watertight integrity of internal openings shall comply with the following:

- a) Doors and hatch covers which are used during the operation of the unit while afloat shall be remotely controlled from the central ballast control station and shall also be operable locally from each side. Open/shut indicators shall be provided at the control station.
- b) Doors or hatch covers in self-elevating units, or doors placed above the deepest load line draft in column-stabilized and surface units, which are normally closed while the unit is afloat may be of the quick acting type and shall be provided with an alarm system (e.g., light signals) showing personnel both locally and at the central ballast control station whether the doors or hatch covers in question are open or closed. A notice shall be affixed to each such door or hatch cover stating that it is not to be left open while the unit is afloat.
- c) Remotely operated doors shall meet SOLAS regulation II-1/13-1.2.

Guidance note:

Explanatory information on terms and definitions are provided in IACS UI SC156 "Doors in watertight bulkheads on passenger ships and cargo ships".

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3.2.2 The means to ensure the watertight integrity of internal openings which are intended only to provide access for inspection and are kept permanently closed during the operation of the unit, while afloat, shall have a notice affixed to each such closing appliance stating that it is to be kept closed while the unit is afloat; however, manholes fitted with close bolted covers need not be so marked.

3.2.3 Where valves are provided at watertight boundaries to maintain watertight integrity, these valves shall be capable of being operated from a control room. Valve position indicators shall be provided at the remote control station.

If the valves are remotely operated by means of mechanical devices, operation from a deck, which is above any final waterline after flooding will be accepted. Valve position indicators shall be provided at the remote control station.

3.3 External openings

3.3.1 Where watertight integrity is dependent on external openings, which are used during the operation of the unit or installation while afloat, they shall comply with a), b) and c).

- a) The lower edge of openings of air pipes (regardless of their closing appliances) shall be above the damage waterline.
- b) The lower edge of ventilator openings, doors and hatch covers with manually operated means of weathertight closures shall be above damage waterline, unless [3.3.3] applies.
- c) Openings such as manholes fitted with closely bolted covers, and side scuttles or windows of the non-opening type with inside hinged deadlights may be submerged.

3.3.2 The requirements of [3.3.1] b) apply where the watertight integrity is dependent on external openings, which are permanently closed during the operation of the unit or installation, while afloat.

3.3.3 External doors and hatch covers of limited size may be accepted between the damage waterline and freeboard deck provided they are watertight closeable locally and by remote operation of the closing appliances from the control room, with indicators showing whether the openings are closed or open.

3.4 Strength of watertight doors and hatch covers

3.4.1 Watertight doors and hatch covers for internal and external openings shall be designed with a strength equivalent to or better than required for the watertightness of the structure in which they are positioned.

3.4.2 Strength of watertight doors and hatches in general shall comply with structural requirements stated in DNVGL-OS-C101 Ch.2, Sec. 4 or DNVGL-OS-C201 Ch.2, Sec. 4 following the LRFD respectively the WSD design approach.

3.4.3 Provided flooding is a possible mode of failure based upon the damage assumptions as given in [Sec.1](#), for compartments on both sides of a watertight door or hatch cover, the watertight door or hatch cover shall be designed to withstand the design pressure from both sides.

3.4.4 The design pressure shall be taken as the waterhead corresponding to the vertical distance between the load point and the deepest waterline after damage.

3.4.5 *Plating*

The thickness of plating subjected to lateral pressure shall not be less than:

$$t = \frac{16.5 \cdot k_a \cdot s \cdot \sqrt{p_d}}{\sqrt{\sigma_f \cdot k_{pp}}} \quad (\text{mm})$$

k_a = correction factor for aspect ratio of plate field

$$= (1.1 \text{ minus } 0.25 \text{ s/l})^2$$

= maximum 1.0 for $s/l = 0.4$

= minimum 0.72 for $s/l = 1.0$

p_d = design pressure in kN/m^2 corresponding to the head of water to damage waterline

k_{pp} = fixation parameter for plates

k_{pp} = 1.0 for clamped edges

= 0.5 for simply supported edges

σ_f = minimum yield strength in N/mm^2

s = stiffener spacing in m, measured along the plating

l = stiffener span in m, measured along the top flange of the member

Guidance note:

The plating is normally assumed to be simply supported along the edges.

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3.4.6 The thickness of plating is in no case to be less than the minimum bulkhead thickness.

3.4.7 *Stiffeners on doors and hatch covers*

The section modulus of panel stiffeners shall not be less than:

$$Z = \frac{l^2 s p_d}{m \sigma_f k_s} \cdot 10^6 \quad (\text{mm}^3)$$

l = stiffener span in m. For doors with stiffeners in one direction only l shall be taken as the span length between cleat support points in door

m = bending moment factor

m = 8 if simply supported at both ends, or simply supported at one end and fixed at the other end

= 12 if fixed at both ends

k_s is dependent on support condition:

k_s = 1.0 if at least one end is clamped

= 0.9 if both ends are simply supported.

p_d = design pressure (kN/m^2) as given in [\[3.4.5\]](#)

The effective flange of the plate shall be included when calculating actual section modulus of the stiffeners.

3.4.8 Minimum stiffness of door and hatch cover edge stiffeners

Edge stiffeners of doors and hatch covers shall have a moment of inertia not less than:

$$I = 8p_e a^4 10^4 \text{ (mm}^4\text{)}$$

p_e = packing line pressure along edges in N/mm, minimum 5 N/mm
 = $p_d b$, whichever is greater

p_d = design pressure (kN/m²) as given in [3.4.5]

b = load breadth, normally taken as $h/3$ or $w/2$, whichever is less, where h and w are height and width of door or hatch in m.

a = distance between closing devices in m, to be measured along door or hatch edges

The effective flange of the plate shall be included when calculating the actual moment of inertia of the stiffeners.

3.4.9 Stiffness of door and hatch cover frames

The frames (coamings) shall have necessary stiffness to avoid large deflections resulting in leakage in the damage condition.

The frame shall be continuous on all four sides. The frame shall have a section moment of inertia on each side of not less than:

$$I = 3.2p_d b h^3 10^4 \text{ (mm}^4\text{)}$$

p_d = design pressure (kN/m²) as given in [3.4.5]

b = the shorter dimension of the opening in m

h = the longer dimension of the opening in m.

3.4.10 Securing devices shall be designed for the load acting also on the opposite side of where they are positioned. Allowable stresses in securing devices are as follows:

normal stress: $\sigma = 165 f_1 \text{ N/mm}^2$

shear stress: $\tau = 110 f_1 \text{ N/mm}^2$

equivalent stress: $\sigma_e = \sqrt{\sigma^2 + 3\tau^2} = 200 f_1$

The conversion factor f_1 shall be taken as:

$$f_1 = \frac{\sigma_f}{240}$$

σ_f = minimum yield strength in N/mm²

3.5 Frame and bulkhead interface

3.5.1 Door or hatch frames shall be installed, as appropriate by either bolting through air tight isolation gaskets, or by a continuous fillet weld all around. Frames shall be reinforced at hinges, locks and closing device positions. Detailing shall minimise galvanic corrosion

3.5.2 To reduce transmission of forces from bulkhead into the frame which may affect proper alignment and operation of a door or hatch, maximum plate buckling at perimeter of cut-out shall be 5 mm along a straightedge. Alternatively the cut-out maybe terminated at a welded angle profile, into which the frame may be welded or bolted.

Guidance note:

For frames located in high-stress areas it is recommended to arrange cut-out with corner radius more than 50 mm in order to reduce stress concentration and possible fatigue issues.

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3.5.3 The door (hatch) frame shall have no groove at the bottom in which dirt might lodge and prevent the door (hatch) from closing properly.

Guidance note:

The recess of the flush hatches located on main deck is prone to corrosion. Therefore, it is recommended that hatch covers are supplied with an operation and maintenance manual including:

- opening and closing instructions
- maintenance requirements for packing, securing devices and operating times
- cleaning instructions for the drainage system
- corrosion prevention instructions
- list of spare parts.

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3.6 Operation and control of watertight doors and hatch covers

3.6.1 Frequently used watertight doors or hatch covers shall be arranged for emergency remote closing according to the principles given in [3.2].

3.6.2 In addition to means for remote closing, it shall be possible to open and close the doors or hatch covers locally from both sides by use of e.g. a mechanical device or hydraulic system with stored energy. The stored energy may be a hydraulic accumulator connected to a centralised hydraulic system by a non-return valve. The capacity shall be sufficient for opening and closing the door or hatch cover three times. (See SOLAS Ch. II-1 Reg. 13)

3.6.3 The device for local operation shall be designed with a neutral spring return position in which the doors or hatch covers shall stop closing. The device shall be located easily accessible for the personnel passing the door or hatchway.

3.6.4 The movement of the local operating device shall be in the same direction as the movement of door or hatch cover.

3.6.5 The arrangement shall be such that the door or hatch cover will close automatically only if opened by local control after being closed from the central control station. The total closing time shall not be less than 30 s or more than 60 s.

3.6.6 Red lights shall be arranged for warning of personnel locally operating the doors or hatch covers that these have been remotely closed.

3.6.7 An audible local alarm shall sound when the doors or hatch covers are moving to closed position.

3.6.8 All watertight doors or hatch covers shall be provided with positive means of indication which will show at a central control station whether the doors or hatch covers are open or closed.

3.6.9 Any failure of the remote control system shall not cause opening of closed doors or hatch covers. Failure on one door or hatch cover shall not put any other door or hatch cover out of function.

3.6.10 Power supply shall be a separate independent source with stored energy for each door or hatch cover or a common redundant system with two independent sources capable of closing at least 50% of all doors or hatch covers in not more than 60 s.

3.6.11 The electrical power required for operation, control and monitoring shall be supplied from the emergency switchboard either directly or by a dedicated distribution board situated above the area that may be flooded in a damage condition.

3.6.12 The power sources for operation, control and monitoring shall be monitored by alarm.

4 Weathertight closing appliances

4.1 General

This sub-section gives requirements for the arrangement of weathertight openings and their closing appliances. The closing appliances shall in general have a strength at least corresponding to the required strength of the part of the hull in which they are fitted.

For side scuttles and windows, however, the pressure head shall not be taken less than 2.5 m water column.

Guidance note:

Some requirements are also governed by the regulations in the "International Convention of Load Lines 1966":

- doors in reg.12
- definition of positions in reg.13
- hatchways in reg.14 to reg.16
- machinery space openings in reg.17
- miscellaneous openings in reg.18
- ventilators in reg.19
- air pipes in reg.20
- scuppers, inlets and discharges in reg.22
- side scuttles in reg.23
- freeing ports in reg.24
- special requirements in reg.25 to reg.27.

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Regarding location of openings where weathertight integrity is required, see [10].

4.2 Weathertight doors

4.2.1 Weathertight doors shall be of steel or equivalent material.

The doors shall be designed and documented for a strength equivalent to or better than that required for the weathertightness of the structure in which they are positioned.

Doors should generally open outwards to provide additional security against impact of the sea.

4.2.2 Sill heights

Openings as mentioned in [4.2.1] shall in general have a sill height of not less than 380 mm.

The following openings in position 1 shall have sill heights not less than 600 mm:

- companionways
- openings in superstructures and in bulkheads at ends and sides of deckhouses where access is not provided from the deck above
- openings in engine casings.

4.3 Weathertight hatch coamings and covers

4.3.1 The minimum height of coamings for hatch covers with weathertight covers shall normally not be less than:

- 600 mm in position 1
- 450 mm in position 2.

Guidance note:

In accordance with Regulation 13 of the International Convention on Load Line 1966 (ICLL 1966):

Position 1 - Upon exposed freeboard and raised quarter decks, and upon exposed superstructure decks situated forward of a point located a quarter of the ship's length from the forward perpendicular.

Position 2 - Upon exposed superstructure decks situated abaft a quarter of the ship's length from the forward perpendicular.

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4.3.2 Manholes and small scuttles with coaming height less than given in [4.3.1] and flush scuttles may be allowed when they are closed by watertight covers. Unless secured by closely spaced bolts, the covers shall be permanently attached.

4.3.3 Coamings with height less than given in [4.3.1] may be accepted for column stabilised units or installations upon special consideration.

4.3.4 Hatch covers shall be mechanically lockable in the open position.

4.3.5 Materials for steel hatch covers shall satisfy the requirements given for structural materials.

Other material than steel may be used, provided the strength and stiffness of the covers are equivalent to the strength and stiffness of steel covers.

4.3.6 The design sea pressure on weathertight deck hatch covers is given in the section for design loads in the offshore standard relevant for type of unit or installation considered.

4.3.7 The plating thickness depending on lateral pressure is given in DNVGL-OS-C201. The thickness of the top plating shall not be less than 6 mm.

4.3.8 The section modulus requirement of stiffeners is given in DNVGL-OS-C201. The requirements for section modulus and moment of inertia of hatch girders are given in DNVGL-OS-C201.

4.4 Gaskets and closing devices

4.4.1 The requirements in [4.4.2] to [4.4.10] apply to steel hatch covers on weather decks with ordinary gasket arrangement between hatch cover and coaming and gaskets arranged for vertical gasket pressure in joints between hatch cover elements.

Other gasket arrangements shall be specially considered.

4.4.2 The gasket material shall be of satisfactory air- and seawater-, and if necessary, oil-resistant quality, effectively secured along the edges of the hatch cover.

The hatchway coamings or steel parts on adjacent covers in contact with the gaskets shall be well rounded where necessary.

Where necessitated by the type and design of the unit or installation, mass forces from heavy covers or cargo stowed on the hatch covers as well as forces due to sea pressure should be transferred to the coaming or the deck by direct contact, obtained by suitable devices, while sealing is achieved by means of relatively soft gaskets.

4.4.3 The gaskets and securing arrangements shall either be designed for the expected relative movement between cover and coaming, or special devices shall be fitted to restrict such movement.

4.4.4 Panel hatch covers on weather decks shall be secured by bolts, wedges or similar arrangement, suitably spaced alongside the coamings and between the hatch cover sections.

4.4.5 Where hydraulic cleating is applied, the system shall remain mechanically locked in closed position in the event of failure of the hydraulic system or power supply.

4.4.6 Spare securing elements shall be kept on board; the number depending on the total number fitted, as well as type of element, special material used, etc.

4.4.7 Ordinary gasketed hatch covers shall be secured to the coaming by a net bolt area for each bolt not less than:

$$A = 1.4 a \text{ (cm}^2\text{)}$$

a = spacing of bolts in m.

The bolt diameter shall not be less than 16 mm.

4.4.8 The bolt diameter shall not be less than 22 mm for hatchways exceeding 5 m² in area.

4.4.9 Between cover elements the gasket line pressure shall be maintained by a bolt area as given in [4.4.6]

4.4.10 For gasket line pressures exceeding 5 N/mm, the net bolt area shall be increased accordingly. The gasket line pressure shall be specified.

4.4.11 Hatch covers on exposed decks with reduced coaming height shall be especially considered.

4.5 Drainage arrangement

4.5.1 On weather deck hatch covers drainage shall be arranged inside the line of gasket by means of a gutter bar or vertical extension of the hatch side and end of coaming.

4.5.2 Drain openings shall be arranged at the end of drain channels and shall be provided with effective means for preventing ingress of water from outside, such as non-return valves or equivalent.

4.5.3 Cross-joints of multi-panel covers shall be arranged with drainage of water from the space above gasket and a drainage channel below the gasket.

4.5.4 If a continuous outer steel contact between cover and hull structure is arranged, drainage from the space between the steel contact and the gasket is also to be provided for.

4.6 Buckling check

Hatch cover top or bottom plating acting as compression flanges in hatch cover main stiffening members (girders) shall be effectively stiffened against buckling.

In the middle half part of simply supported span the critical buckling stress is normally not to be less than:

— for hatchways in position 1 or 2:

$$\sigma_c = \frac{0.58\sigma_f Z_R}{\eta Z_A} \text{ (N/mm}^2\text{)},$$

η = stability factor (usage factor)

= 0.77 for sea loads and wave induced liquid loads

= 0.87 for other loads

Z_R = Z according to [3.4.7]

Z_A = actual section modulus in plate flange.

The critical buckling stress may be taken as:

$$\sigma_c = \sigma_{e1} \text{ when } \sigma_{e1} \leq \frac{\sigma_f}{2}$$

or

$$\sigma_c = \sigma_f \left(1 - \frac{\sigma_f}{4\sigma_{e1}}\right) \text{ when } \sigma_{e1} > \frac{\sigma_f}{2} \text{ (N/mm}^2\text{)}$$

k = 4 for plating with local stiffeners parallel to main stiffening members

= $c \left[1 + \left(\frac{s}{l}\right)^2\right]^2$ for plating with local stiffeners perpendicular to main stiffening members

c = 1.21 when local stiffeners are angles or T-sections

= 1.10 when local stiffeners are bulb flats

= 1.05 when local stiffeners are flat bars.

5 Freeboard

5.1 General

5.1.1 The requirements of the ICLL 1966 with respect to weathertightness and watertightness of decks, superstructures, deckhouses, doors, hatchway covers, other openings, ventilators, air pipes, scuppers, inlets and discharges, etc. are taken as a basis for all units or installations in the afloat condition.

5.1.2 The requirements for hatchways, doors and ventilators are depending upon the position as defined in the ICLL 1966, Reg. 13.

5.1.3 The minimum freeboard of units or installations, which cannot be computed by the normal methods laid down by the ICLL 1966, shall be determined on the basis of meeting the applicable intact stability,

damage stability and structural requirements for transit and operational conditions while afloat. The freeboard shall not be less than that calculated in accordance with the ICLL 1966, where applicable.

5.2 Self elevating units or installations

5.2.1 Load lines for self elevating units are calculated under the terms of the ICLL 1966. When floating or when in transit from one operational area to another, the units shall be subject to all the conditions of assignment of the ICLL 1966 unless specifically excepted. The regulations of relevant national authorities shall also be observed.

5.2.2 Self elevating units or installations shall not be subject to the terms of the ICLL 1966 while they are supported by the seabed or are in the process of lowering or raising their legs.

5.2.3 In general, heights of hatch and ventilator coamings, air pipes, door sills, etc. in exposed positions and their means of closing are determined by consideration of both intact and damage stability requirements.

5.2.4 Side scuttles below freeboard deck shall be of the non-opening type with inside hinged deadlight.

5.3 Column stabilised units or installations

5.3.1 Load lines for column stabilised units or installations shall be based on:

- the strength of the structure
- the air gap between waterline and deck structure
- the intact and damage stability requirements.

5.3.2 The conditions of assignment shall be based on the requirements of the ICLL 1966. The regulations of relevant national authorities shall also be observed.

5.3.3 In general, heights of hatch and ventilator coamings, air pipes, door sills, etc., in exposed positions and their means of closing are determined by consideration of both intact and damage stability requirements.

5.3.4 The freeboard deck (reference deck) is defined as the lowest continuous deck exposed to weather and sea, which has permanent means of closing and below which all openings are watertight closed at sea.

5.3.5 Side scuttles and windows, including those of non-opening type, or other similar openings, shall not be fitted below the freeboard deck.

5.3.6 For the first tier on the freeboard deck, the requirements as for position 2 in the ICLL 1966 apply with respect to openings, sill heights, coaming heights and weathertight closing appliances. Windows and side scuttles on first tier protecting openings leading below or volumes considered buoyant in the stability calculations are to be fitted with inside hinged deadlights. For units with a positive air gap; inside hinged deadlights for windows and side scuttles may be omitted.

For the second tier, weathertight closing appliances are required, but sill or coaming heights may be omitted.

For third tier and above, load line requirements will not apply.

In addition to load line requirements watertight or weathertight closing appliances may be required as deemed necessary by stability requirements, ref. [Ch.2 Sec.1 \[5.11\]](#) and [Pt. Ch.2 Sec.2 \[10.1\]](#).

5.3.7 Deckhouses and wells on the first and second tiers, which are not weathertight closed as described in [\[5.3.6\]](#), shall be provided with satisfactory drainage. The total drainage cross sectional area shall not be less than 0.30% of the deck area for the deckhouse or well. The drainage shall be arranged so that it will prevent accumulation of water in any part of the space.

6 Ventilators and air pipes

6.1 General

6.1.1 Ventilators to spaces below freeboard deck or to deckhouses closed weathertight shall have a coaming height of at least:

- 900 mm in position 1
- 760 mm in position 2.

6.1.2 The thickness of ventilator coamings, air pipes, and exhaust pipes shall not be less than given in the Table 1 and Table 2.

Table 1 Thickness for self elevating units

<i>External diameter mm</i>	<i>Wall thickness mm</i>
≤ 80	6
≥ 165	8.5

Table 2 Thickness for column stabilised units or installations

<i>External diameter mm</i>	<i>Wall thickness Above freeboard deck mm</i>
≤ 80	5
≥ 165	7.0

For intermediate external diameters the wall thickness shall be obtained by linear interpolation. Coamings with height exceeding 900 mm shall be supported by stays or equivalent arrangements.

6.1.3 The deck plating in way of deck openings for ventilator coamings shall be of sufficient thickness and efficiently stiffened.

6.1.4 The openings shall be provided with permanently attached weathertight efficient means of closing.

6.1.5 Ventilators with coaming height of more than 4.5 m in position 1, or more than 2.3 m in position 2, need not be fitted with closing arrangement.

6.1.6 Stability requirements may necessitate closing appliances.

Guidance note:

Special closing arrangement may be required by national maritime administrations.

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6.1.7 The height of air pipes, measured from the deck to the point where water may have access below, shall not be less than 760 mm on freeboard deck and 450 mm on superstructure deck.

6.1.8 Where air pipes of heights as required in [6.1.6] will cause difficulties in operation of the unit or installation, a lower height may be accepted, provided that relevant regulatory bodies are satisfied that the closing arrangement and other circumstances justify a lower height.

6.1.9 Openings of air pipes shall be provided with permanently attached efficient means of closing. The closing appliances shall be so constructed that damage to the tanks by overpumping or occasionally possible vacuum by discharging is prevented.

6.1.10 All air pipes shall be well protected.

7 Inlets, discharges and scuppers

7.1 Sea inlets and discharges in closed systems

7.1.1 Valves for sea inlets and discharges shall be arranged for direct manual operation by means of a mechanical device or permanently installed hand pump. Any valve serving a sea inlet or a discharge below the load waterline shall be remotely operated from above the damage waterline.

Discharges between load waterline and damage waterline may be fitted with one locally closable non-return valve. The valves shall be fitted as close to the inlet or discharge as possible.

The controls shall be readily accessible and are to be provided with indicators showing whether the valves are open or closed. All connections to sea shall be marked:

SEA DIRECT.

7.1.2 The wall thickness of the pipes shall be as required in [7.2.4] and DNVGL-OS-D101.

7.2 Discharges

7.2.1 Discharges leading through the shell either from spaces below the freeboard deck or from spaces required to be watertight above the freeboard deck, shall be fitted with one automatic non-return valve at the outboard end with positive means of closing located at a suitable position above the damage waterline.

7.2.2 If a septic tank is arranged in the system, a discharge with inboard opening located lower than the uppermost load line may be accepted when a loop of the pipe is arranged, extended not less than 0.02 L above the summer load waterline, where L is the length of the unit or installation.

7.2.3 Discharges from spaces above the freeboard deck shall be of steel or material especially resistant to corrosion.

7.2.4 The wall thickness of steel piping between the hull plating and a closable or non-return valve below freeboard deck shall not be less than given in the Table 3.

Table 3 Wall thickness of steel piping

<i>External diameter mm</i>	<i>Wall thickness mm</i>
≤ 80	7.0
= 180	10.0
≥ 220	12.5

For intermediate external diameters the wall thickness shall be obtained by linear interpolation.

7.2.5 General requirements for pipes are given in DNVGL-OS-D101.

7.2.6 Adequate arrangement shall be provided to protect valves or pipes from being damaged.

7.2.7 The piping shall be of steel or equivalent material. Valves and shell fittings shall be of steel, bronze or other ductile material. Valves of ordinary cast iron are not acceptable.

7.2.8 Where plastic piping is used, the connection between plastic and steel shall be considered as the inboard opening.

7.3 Scuppers

7.3.1 A sufficient number of scuppers, arranged to provide effective drainage, shall be fitted to all decks.

7.3.2 Scuppers on weather portions of decks and scuppers leading from superstructures or deckhouses not provided with weathertight closing appliances shall be led overboard.

7.3.3 Scuppers through the deck or shell shall comply with requirements for material and thickness as given for discharges.

7.3.4 Scupper pipes shall be well stayed to prevent any vibrations. However, sufficient possibility for expansion of the pipes shall be provided where necessary.

7.3.5 Scuppers from spaces below the freeboard deck or spaces within closed superstructures, may be led to bilges.

7.3.6 Scuppers leading overboard from spaces mentioned in [7.3.5] shall comply with the requirements given for discharges. Scuppers and drains from compartments of exposed superstructure decks led through the unit or installation's side below the freeboard deck and not having closable valves, shall have additional wall thickness as required in [7.2.4].

8 Side scuttles and windows

8.1 General

8.1.1 Acceptable standards for side scuttles and windows are ISO 1751:1993 and ISO 3903:1993 with glass according to ISO 21005:2004 and testing according to ISO 614:1989. National standards equivalent to the ISO standards are also acceptable.

8.1.2 Side scuttles and windows in the first tier and second tier with direct access below the freeboard deck, shall have hinged inside deadlights arranged so that they can be effectively closed and secured watertight.

8.1.3 Deadlights as required in [8.1.2] may be hinged on the outside, provided there is easy access for closing.

8.1.4 No side scuttle shall be fitted in a position with its sill below a line drawn parallel to the freeboard deck. The lowest point shall be minimum 0.025 B above the summer load waterline, or 500 mm, whichever is the greater distance. B is the breadth of the unit or installation.

9 Testing of doors and hatch covers

9.1 Pressure testing of watertight doors and hatch covers

9.1.1 Before installation (i.e. normally at the manufacturer) the watertight doors or hatch covers shall be hydraulically tested with exposure to the side most prone to leakage.

9.1.2 The test pressure shall correspond to the pressure height p_d (see [3.4.5]) + 50 kN/m² (5 m water), and the acceptance criteria shall be:

- no leakage for doors or hatch covers with gaskets
- maximum water leakage 1 litre per minute for doors or hatch covers with metallic sealing.

9.2 Hose testing of watertight and weathertight doors and hatch covers

After installation onboard all (every single) watertight and weathertight doors or hatch covers shall be hose tested. The water pressure shall be at least 0.2 N/mm² (2 bar), and the nozzle shall be held at a distance of maximum 1.5 m from the door or hatch cover. No leakage shall be accepted.

As an alternative to hose testing, chalk testing may be applied under special circumstances upon acceptance by all parties involved.

9.3 Function testing of watertight doors and hatch covers

After installation onboard the operation, control and alarm functions for all watertight doors and hatch covers shall be tested.

The following shall be verified:

- a) It shall be possible to close all doors or hatch covers in one group simultaneously within 60 s from the control room.
- b) It shall be possible to open and close the doors or hatch covers three times by means of a local device and stored energy.
- c) It shall be possible for a person to pass through the doorway or hatchway and at the same time hold both handles in the "open position".
- d) It shall be possible to open the door or hatch cover locally from both sides, after being closed centrally, and the door or hatch cover shall close automatically after such opening.
- e) The door or hatch cover shall be mechanically locked in closed position.
- f) The light and sound signals shall give warning when the door or hatch cover is closed centrally.
- g) The remote position indicator for doors or hatch covers shall function properly.
- h) The alarms for the following conditions shall function properly:
 - start of standby pump

- loss of power to control, alarm and indicating system
- low pressure (below lowest permissible).

10 Closing arrangements for doors and hatch covers

10.1 Description of waterlines (beach lines)

The following waterlines are required for Column-stabilised and Self-elevating units in order to indicate the extent of the watertight and weathertight integrity:

- *Waterline A (watertight for Column-stabilised units)*; waterline showing equilibrium position at first intercept between righting and wind heeling moment curves in damage condition for damage cases according to [Sec.1 \[5.4.1\]](#), and waterline showing equilibrium position at first intercept (excluding wind) in damage condition for damage cases according to [Sec.1 \[5.4.2\]](#), whichever is the most severe (envelope curve).
- *Waterline A (watertight for Self-elevating units)*; waterline showing equilibrium position at first intercept between righting and wind heeling moment curves in damage condition.
- *Waterline B (weathertight for column-stabilised units)*; waterline according to area requirement of righting and wind heeling moment curves ([Sec.1 \[4.3.1\]](#)), the 7° range criterion ([Sec.1 \[5.4.1\] 3](#) and [\[5.4.2\] 3](#)), and the 4 meters criterion ([Sec.1 \[5.4.1\] 2](#)), whichever is the most severe (envelope curve).
- *Waterline B (weathertight for Self-elevating units)*; waterline according to area requirement of righting and wind heeling moment curves ([Sec.1 \[4.4.1\]](#)).

These lines should preferably be presented on the freeboard plan.

Guidance note:

The beach lines required above can be omitted if all relevant openings are included in the stability calculations with the correct positions.

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10.2 Description of location of openings

The location of openings in relation to the waterlines are defined as (see [Figure 1](#)):

- I* Internal openings in watertight bulkheads, i.e. internal bulkheads assumed watertight in stability calculations.
- II* External openings below deepest draught according to ICLL 1966.
- III* External openings between deepest draught and freeboard deck.
- IV* External openings above freeboard deck, submerged before equilibrium position at first intercept (line A) between righting and wind heeling moment curves in damage condition.
- V* External openings:
 - 1) on first and second tier
 - 2) submerged between equilibrium position at first intercept (line A) and waterline B.
- VI* External openings:
 - 1) on and above third tier
 - 2) above waterline B.

10.3 Operation, indication and locking

The requirements for operation, indication and locking of doors and hatch covers are given in [Table 4](#), in relation to the locations defined in [\[10.2\]](#).

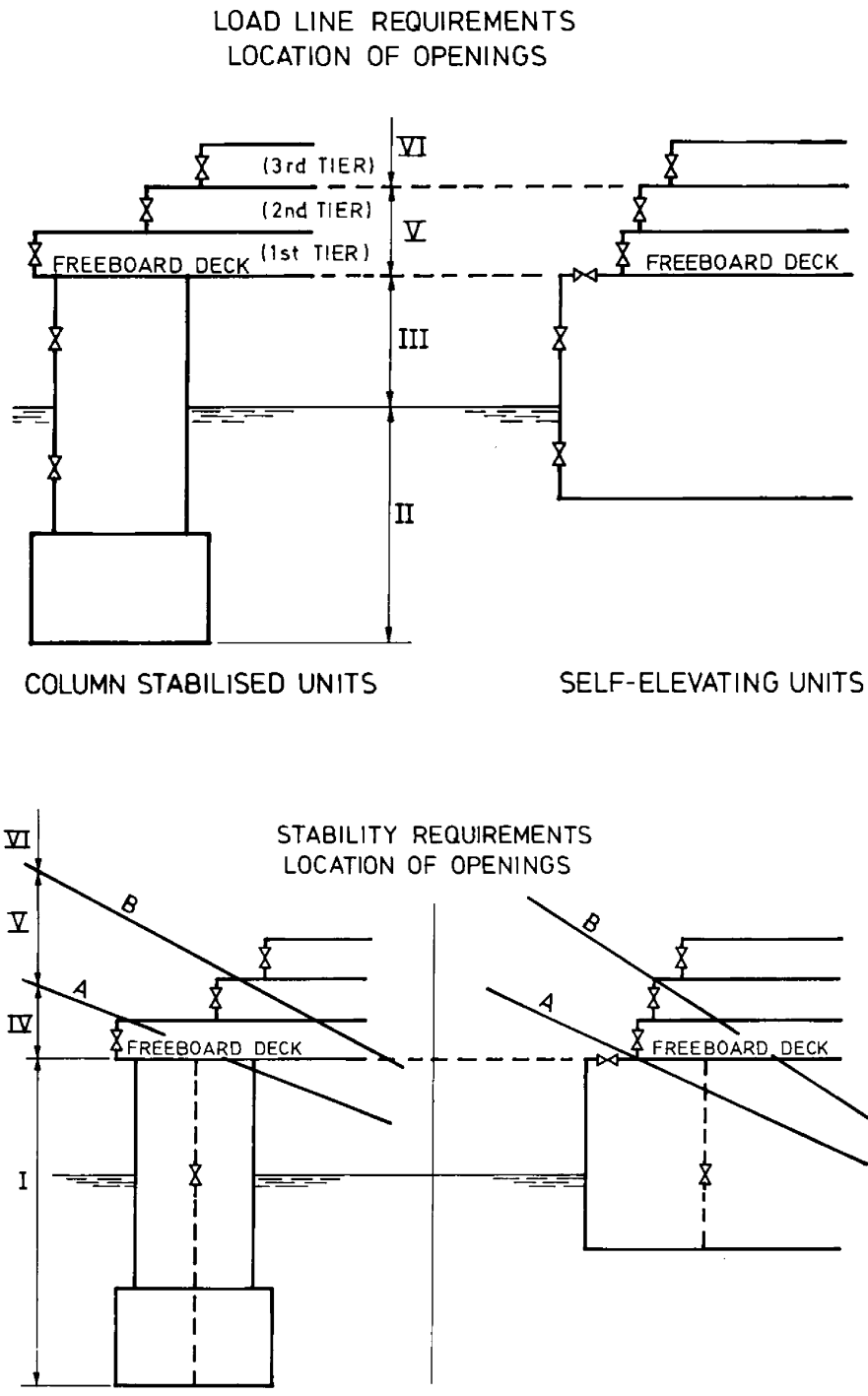


Figure 1 Location of openings

Table 4 Requirements regarding operation, indication and locking of doors and hatch cover

Location	Frequency of use	Type of door or hatch cover	Remote control	Remote Indication	Audible or visual alarm	Notice ⁴⁾	Watertight/ Weathertight	Internal/ External	Comment	Regulation	Mechanical locking in closed position ³⁾
I	Used	POS	Y	Y	Y	Y	WA	INT	Note 1)	MODU Code 3.6.5	X
	Norm. Closed	S,H	N	Y	Y	Y	WA	INT	Note 1), 2) and 4)	MODU Code 3.6.5	X
	Perm. Closed	S, H	N	N	N	Y	WA	INT	Note 1), 4) and 5)	MODU Code 3.6.5	X
II	Perm. Closed	Bolted	N	N	N	N	WA	EXT		ICLL	X
III	Perm. Closed	Bolted	N	N	N	N	WA	EXT		ICLL	X
IV	Perm. Closed	Bolted	N	N	N	N	WA	EXT		MODU Code 3.6.7	
V	Norm. Closed	H	N	N	N	Y	WE	EXT	Note 1) and 4)	ICLL & MODU Code 3.3 and 3.4	
VI	Norm. Closed	H	N	N	N	Y	WE	EXT	Note 1) and 4)	MODU Code 3.7.22	
<p>Y: YES, N: NO, WA: Watertight, WE: Weathertight, INT: Internal, EXT: External</p> <p>¹⁾ POS: Power Operated Sliding, S: Sliding, H: Hinged, Sliding door: moving along and supported by trackway grooves, with built-in «mechanical» locking due to the tapered form and friction, and a positive force is required to re-open the door.</p> <p>²⁾ This option is only allowed for self elevating units and above deepest load line draught for other units. The door or hatch cover shall then be of the quick acting type.</p> <p>³⁾ Mechanical locking: by means of wedges, bars or similar devices, which are self-locking.</p> <p>⁴⁾ The door or hatch cover shall be fitted with a notice board stating that the door or hatch cover is to be kept closed while the unit or installation is afloat at sea. Bolted manhole covers need not be so marked.</p> <p>⁵⁾ Internal openings intended only to provide access for inspection.</p>											

CHAPTER 3 CERTIFICATION AND CLASSIFICATION

SECTION 1 GENERAL

1 Introduction

1.1 Application

1.1.1 As well as representing DNV GL's recommendations on safe engineering practice for general use by the offshore industry, the offshore standards also provide the technical basis for DNV GL classification, certification and verification services.

1.1.2 A complete description of principles, procedures, applicable class notations and technical basis for offshore classification is given by the DNV GL rules for classification of offshore units as listed in the table [Table 1](#).

Table 1 DNV GL rules for classification - Offshore units

No.	Title
DNVGL-RU-OU-0101	Offshore drilling and support units
DNVGL-RU-OU-0102	Floating production, storage and loading units
DNVGL-RU-OU-0103	Floating LNG/LPG production, storage and loading units
DNVGL-RU-OU-0104	Self-elevating units

2 Design review

2.1 Documentation requirements

Documentation for classification shall be in accordance with the NPS DocReq (DNV GL Nauticus Production System for documentation requirements) and DNVGL-CG-0168.

2.2 Specific classification requirements

The computation of freeboard (see [Ch.2 Sec.2 \[5\]](#)) is not subject to classification. However, the requirements, including those relating to certification, of the International Convention on Load Lines 1966 (ILLC 1966) apply to all units and installations.

3 Certification of materials and components

3.1 General

3.1.1 The product certification is a conformity assessment normally including both design and production assessment.

The production assessment includes inspection and testing during production and/or of the final product.

3.1.2 Components shall be certified consistent with its functions and importance for safety. The principles of categorisation of component certification are given in the relevant rules, see [Table 1](#).

3.1.3 Product certification shall be documented by the following types of documents:

a) DNV GL Product Certificate (VL):

A document signed by a DNV GL surveyor stating:

- conformity with rules and standard requirements
- that tests are carried out on the certified product itself
- that tests are made on samples taken from the certified product itself
- that tests are performed in presence of the surveyor or in accordance with special agreements.

b) Works Certificate (W):

A document signed by the manufacturer stating:

- conformity with rules and standard requirements
- that tests are carried out on the certified product itself
- that tests are made on samples taken from the certified product itself
- that tests are witnessed and signed by a qualified department of the manufacturers.

c) Test Report (TR):

A document signed by the manufacturer stating:

- conformity with rules and standard requirements
- that tests are carried out on samples from the current production.

3.2 Certification requirements under this standard

Certification requirements for components are given in [Table 2](#).

Table 2 Certification of components

<i>Item</i>	<i>Certificate</i>
Watertight doors and hatch covers	VL
Weathertight doors and hatch covers	W*
Side scuttles and windows	W
Automatic closing devices for air pipes	VL
Valves for sea inlet or discharge	VL
Hydraulic system for watertight closing appliances	VL
Accumulator, hand pumps	VL
Control and monitoring systems for watertight closing appliances	VL

* In addition to the Work Certificate a design approval performed by DNV GL is required.



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.