PART IV. STABILITY

1. GENERAL

1.1 APPLICATION

1.1.1 The requirements of the present Part of the Rules apply to decked ships[1]sailing in displacement condition. As to sailing ships navigating under sails the requirements of the present Part apply to them as far as it is reasonable and practicable.

Passenger ships of all types shall meet the certain requirements of "Code on Intact Stability for All Types of Ships Covered by IMO Instruments", adopted by IMO Resolution A.749 (18), as amended by IMO Resolution MSC.79(69).

Subject to the agreement with the Register it is possible to apply alternative assessment of the weather criterion with application of Guidelines adopted by MSC.1/Circ.1200.

The ships constructed on 1 July 2010 or after this date shall at least meet the requirements of Part A of the International Code on Intact Stability (IS Code), 2008.

If there are distinctions between requirements of these Rules and the stipulated Code for new passenger ships lengthed 24 m and more, it is necessary to apply the requirements of the Code subject to the agreement with the Register.

1.1.2 Unless expressly provided otherwise, the requirements of the present Part apply to ships in service as far as it is reasonable and practicable, but it is, however, compulsory for ships which undergo reconstruction, major repair, alteration or modification if their stability is impaired as a result.

Stability of ships under 24 m in length after reconstruction, major repair, alteration or modification shall comply either with the requirements of this Part or with the requirements applied to such ships before reconstruction, major repair, alteration or modification.

1.1.3 The requirements set forth in the present Part do not extend to the light-ship condition, except for the provisions given in 2.3.1.

1.1.4 Conformity of passenger ship with distinguishing marks **A**, **A-R1, A-R2**, **A-R2-RS**, **A-R2-S**, **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS**, **D-R3-S**, **D-R3-RS** in the class notation with provisions of Directive 2009/45/EC of the European Parliament and of the Council of 6 May 2009 on Safety Rules and Standards for Passenger Ships, entered into force on 15 July 2009 (amended by Commission Directive 2010/36/EU of 1 June 2010), hereinafter refereed as Directive 2009/45/EU, shall be assessed in accordance with requirements of 2.6.1 of General Regulation for Technical Supervision with application of these Rules and/or special requirements of these

[1] In Section 1 of the present Part the term "ship" also includes a floating crane, crane ship, dock, transport pontoon and berth connected ship, unless expressly provided otherwise.

Rules depending on the class notation mark of the ship, both for new and existing (see 2.6.1.1.4.2 or 2.6.1.1.4.3 of the General Regulations for Technical Supervision correspondingly) ships stipulated in certain items with or without reference to the class notation marks of a ship upon fulfilment of the following requirements:

- new ships with distinguishing marks **A**, **A-R1, A-R2**, **A-R2-RS**, **A-R2-S** - all applicable requirements of this Part taking into account references to the class notation of a ship, where there are particular requirements to stipulated marks in certain items:

- new ships with distinguishing marks **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS**, **D-R3-S**, **DR3-RS** built prior to 1 January 2011 and existing ships **B-R3-S**, **B-R3-RS** - 1.4.11.1, 1.4.11.3, 1.5.1.7, 1.5.2, 1.5.5;

- new ships with distinguishing marks **A**, **A-R1, A-R2**, **A-R2-RS**, **A-R2-S**, **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS**, **D-R3-S**, **D-R3-RS**

1.2 DEFINITIONS AND EXPLANATIONS

The definitions and explanations relating to the general terminology of the Rules are given in General Regulations for Supervision and in Part I "Classification” of the Rules for Classification and Construction of Ships[2].

For the purpose of the present Part of the Rules the following definitions and explanations have been adopted:

Amplitude of roll is an assumed rated amplitude of roll.

Bulk cargo is grain and non-grain cargo constituted by separate particles and loaded without packaging.

Homogeneous cargo is cargo having constant stowage rate.

Liquid cargoes are all liquids on board, including tanker cargo, the ship's liquid stores, ballast water, water in the anti-rolling tanks and in the swimming pool, etc.

Moulded depth is the vertical distance measured amidships from the top of plate keel or from the point where the inner surface of shell plating abuts upon the bar keel to the top of the beam of the uppermost continuous deck, i.e. of the deck below which the volume of the ship's hull is taken into account in stability calculations. In ships having a rounded gunwale, the moulded depth shall be measured to the point of intersection of the moulded lines of the uppermost continuous deck and side, the lines extending as though the gunwale were of angular design. If the uppermost continuous deck is stepped and the raised part of the deck extends over the point at which the moulded depth shall be determined, the moulded depth shall be measured to a line of reference extending from the lower part of the deck along a line parallel with the raised part.

Hydrostatic curves are curves of the ship's lines plan particulars.

Diagram of limiting moments is a diagram of limiting statical moments on the abscissa of which ship's displacement, deadweight or draught is plotted and on the ordinate, limiting values of the vertical statical moments of masses are plotted meeting the complex of various requirements of the present Part of the Rules for ship's stability.

[2] Hereinafter referred to as Part I “Classification”

L e n g t h o f s h i p is the length as defined in the Load Line Rules for Sea-Going Ships.

S t o r e s are fuel, fresh water, provision, oil, expendable supplies, etc.

G r a i n means wheat, maize (corn), oats, rye, barley, rice, sorghum, pulses, seeds and processed forms thereof whose behaviour is similar to that of grain in its natural state.

I n c l i n i n g g u i d e l i n e s are guidelines to determine ship's displacement and centre-of-gravity position as per heeling test.

G u i d e l i n e s f o r f r e e s u r f a c e s are the guidelines to determine influence of free surfaces of liquid cargoes on ship's stability.

2 0 0 8 I S C o d e is the International Code on Intact Stability, 2 0 0 8[3].

W e l l is an open space on the upper deck not longer than 30 per cent of the ship's length bounded by superstructure and a continuous bulwark provided with freeing ports.

H e e l i n g m o m e n t d u e t o w i n d p r e s s u r e is an assumed rated moment caused by wind pressure.

W e a t h e r c r i t e r i o n is a severe wind and rolling criterion.

A n g l e o f f l o o d i n g is the angle of heel at which the ship's interior spaces are flooded by water through openings considered to be open or openings which may be open as required by operation conditions of the ship in working position.

[3] 2008 IS Code consists of Preamble, Part A (Mandatory) and Part B (Recommendatory) adopted by IMO Resolution MSC.267(85).

A m i d s h i p s is at the middle of the ship's length.

S u p e r s t r u c t u r e is a decked structure on the uppermost continuous deck extending from side to side of the ship or with the side plating not being inboard of the shell plating more than 4 per cent of the breadth of the ship. A raised quarter deck is regarded as a superstructure.

O p e n i n g s c o n s i d e r e d t o b e o p e n are openings in the upper deck or hull sides, as well as in decks, sides and bulkheads of superstructures and deckhouses whose closures do not comply with the requirements of Section 7, Part III "Equipment, Arrangement and Outfit" as to their strength, watertightness and efficiency. Small openings such as those for passing wires or chains, tackle and anchors, and also holes of scuppers, discharge and sanitary pipes shall not be considered as open if they submerge at an angle of inclination more than 30°. If they submerge at an angle of 30° or less, these openings shall be assumed open if the Register considers this to be a source of significant flooding of the ship's internal spaces.

D e c k t i m b e r c a r g o is a timber cargo carried on open parts of the freeboard deck or superstructure. This term does not apply to the wood-pulp or similar cargo.

P a s s a g e is a navigation of a ship outside the prescribed area of navigation.

C a p s i z i n g m o m e n t is an assumed rated minimum heeling moment by which the ship is capsized.

V o y a g e is navigation of a ship belonging to the technical fleet with the prescribed area of navigation.

A r m o f w i n d a g e a r e a is a

center of resultant forces of wind pressure over the waterline area.

Windage area is the projected lateral area of the above-water portion of the ship (except for a floating crane or crane ship) on the centreline with the ship in the upright position.

Correction for free surfaces is a correction allowing for a decrease in the ship's stability due to the effect of free surfaces of liquid cargoes.

Deckhouse is a decked structure on the upper deck or superstructure deck with its side plating, on one side at least, being inboard of the shell plating by more than 4 per cent of the greatest breadth of the ship measured amidships to the outside of frames and having doors, windows and other similar openings in external bulkheads.

Sister ships are ships built at the same yard as per the same drawings.

Special facility is a system permanently installed in the ship for rapid estimation of her initial stability (e.g. heeling tanks with angle-of-inclination indicators) .

Light ship is a fully ready ship less deadweight. Water ballast is included to the deadweight.

Wind pressure is an assumed rated pressure of wind.

Universal diagram is a diagram of ship's stability with a non-uniform scale of abscissae proportional to the heeling angle sines, a set of cross-curves of stability for various displacements and a scale of metacentric heights (or heights of the ship's centre of gravity) along the axis of ordinates for construction of straight half-lines determining the weight stability.

Breadth of a ship is the maximum breadth measured on the summer load line from outside of frame to outside of frame in a ship with a metal shell and to the outer surface of the hull in a ship with the shell of any other material.

Various symbols used in the Part IV "Stability" are given in the Table at the end of this Part.

1.3 SCOPE OF SURVEY

1.3.1 General provisions related to the procedure for classification, supervision over construction and classification surveys, as well as requirements for the technical documentation submitted to the Register for review and approval are given in "General Regulations for the Classification and Other Activity" and in Part I "Classification".

1.3.2 For every ship subject to the requirements of the present Part, the Register shall carry out the following:

.1 prior to the commencement of ship's construction and conversion -

examination and approval of the technical documentation related to ship's stability;

.2 during the ship's construction, conversion and trials -

supervision over heeling test or light-weight check;

examination and approval of the Information on Stability;

consideration and approval of the Guidelines on the Safe Ballast Water Exchange at Sea;

.3 during special surveys for the purpose of class renewal and after repair or modernization -

inspections to check for changes in the light-ship condition to conclude whether the Information on Stability is still applicable;

determination of light-ship weight experimentally for passenger ships and fishing vessels and supervision over the heeling test and light-weight check.

1.4 GENERAL TECHNICAL REQUIREMENTS

1.4.1 All calculations shall be made by the methods generally accepted in naval architecture. When using a computer, the methods of computation and programme shall be approved by the Register.

1.4.2. Calculation of cross curves of stability

1.4.2.1 Cross-curves of stability shall be calculated for the waterline parallel to the design waterline.

For the ships operation with permanent considerable initial trim, cross-curves of stability shall be calculated considering this trim.

Cross-curves of stability shall be calculated with due regard to the accompanying trim.

In case of port-starboard asymmetry (including deck spaces), the most unfavourable righting lever curve shall be used.

1.4.2.2 When calculating the cross-curves of stability, full account may be taken of those tiers of superstructure which:

.1 meet the requirement of 7.5, Part III "Equipment, Arrangements and Outfit" for superstructure (counting from the freeboard deck); side scuttles considering efficiency of their closures shall comply with the requirements of 7.2.1.3–7.2.1.5 of the said Part;

.2 have an access for the crew from the above deck to the working spaces inside these superstructures, as well as to the engine room by other means during the whole period when the openings in the superstructures bulkheads are closed.

If a midship bridge or poop complies with the requirements of 7.5, Part III "Equipment, Arrangements and Outfit", but the doors in their bulkheads provide the only exists to the deck, and the upper edge of the sills of the superstructure doors in a fully loaded ship immerses at a heeling angle less than 60º, the effective height of superstructures shall be assumed to be half their actual height and the superstructure doors shall be assumed to be closed. If the upper edge of the door sills of a fully loaded ship immerses at a heeling angle equal to or over 60º, its effective height above the freeboard deck is taken to be its actual height.

1.4.2.3 When calculating the cross-curves of stability, account may also be taken of those tiers of deckhouse which:

.1 meet the requirement of 7.5, Part III "Equipment, Arrangements and Outfit" for the first tier of deckhouse (counting from the freeboard deck); side scuttles considering efficiency of their closures shall comply with the requirements of 7.2.1.3–7.2.1.5 of the said Part;

.2 have an additional exit to the deck above.

Subject to the conditions mentioned above, account is taken of full height of the deckhouses. If the deckhouses meet the requirements of 7.5, Part III "Equipment, Arrangements and Outfit", but there is no additional exit to the deck above, such deckhouses shall not be taken into account in calculations of the cross-curves stability, however, any deck openings inside such deckhouses are assumed as closed, irrespective of whether they are fitted with closures of not.

The deckhouses whose closures do not comply with the requirements set forth in 7.5, Part III "Equipment, Arrangements and Outfit" shall not be considered in calculations of the cross-curves of stability.

Any deck openings inside them are regarded as closed only if their coamings and means of closing comply with the requirements of 7.3, 7.7 – 7.10, Part III "Equipment, Arrangements and Outfit".

Deckhouses on decks above the freeboard deck shall not be taken into account when calculating the cross-curves of stability.

1.4.2.4 In ships with hatch covers meeting the requirements of Section 7, Part III "Equipment, Arrangements and Outfit", the volumes of hatches may be taken into account.

1.4.2.5 The cross-curves of stability shall have a small-scaled scheme of superstructures and deckhouses to be taken into account, specifying the openings considered to be open.

The point shall be indicated in relation to which the cross-curves of stability are calculated.

1.4.3. Arrangement of compartments

A drawing of watertight compartments, being part of the technical documentation, shall contain data required to calculate the positions of centres of gravity for individual tanks filled with liquid cargoes and values of corrections for the effect of free surfaces of liquid cargoes on stability.

1.4.4 Deck plan

1.4.4.1 Deck plans, being part of the technical documentation, shall include all data required to determine the centres of gravity of deck cargoes.

1.4.4.2 The deck plans for passenger ships shall indicate the deck area on which passengers can walk freely and maximum permissible crowding of passengers on free areas of the deck with passengers moving to one side of the ships (refer to 3.1.2).

1.4.5 Arrangement of doors, companionways and side scuttles. Angle of flooding

1.4.5.1 The arrangement plan of doors and companionways shall include all doors and companionways to exposed decks, as well as ports and hatches in the shell plating with appropriate references to their design.

1.4.5.2 The arrangement plan of scuttles shall incorporate all side scuttles located below the uppermost continuous deck, as well as the side scuttles in the superstructures and deckhouses taken into account when calculating the cross-curves of stability.

1.4.5.3 A curve of angles of flooding for the lowest opening in the ships' side, deck and superstructure, assumed to be open, shall be appended to the calculations of cross-curves of stability for each ship.

Openings for ventilation of machinery spaces, openings for ventilation of passenger spaces and other openings, which shall be open to allow air inside the ship when navigating in rough weather, shall be assumed open even if fitted with weathertight covers.

1.4.6 Calculation of windage area of a ship (except for a floating crane and crane ship)

1.4.6.1 The windage area shall include the projections of all continuous surfaces of the ship's hull, superstructures and deckhouses on the centreline, as well as projections of masts, ventilators, boats, deck machinery, all tents that might be stretched in stormy weather and also the projections of side surfaces of deck cargoes, including timber cargo, if the ship design makes the carriage of it possible.

For ships having auxiliary sails, the projected lateral areas of rolled up sails shall be taken into account separately according to the ship's profile plan and shall be included in the total projected lateral area of the continuous surfaces.

It is recommended that projected lateral areas of discontinued surfaces of rails, spars (except for masts) and rigging of ships having no sails and those of various small objects be taken into account by increasing the total projected lateral area of continuous surfaces calculated for draught d_{min} by 5 per cent and the statical moment of this area by 10 per cent with respect to the base line.

The projected lateral areas of discontinued surfaces of ships subjected to icing is taken into account by increasing the projected lateral area and its statical moment of continuous surfaces calculated for draught d_{min}, under icing conditions by 10 and 20 per cent or 7.5 and 15 per cent, respectively, depending upon the rates of icing stated in 2.4. Meanwhile, the value of the projected lateral area of discontinued surfaces and the position of its centre of gravity with respect to the base plane are assumed to be constant for all loading conditions.

For container ships the projected lateral area shall be taken into account as a continuous surface having no regard to the clearances between containers.

1.4.6.2 Application of the said approximate methods for considering the projected lateral areas of discontinued surfaces and small objects is not obligatory. These components of windage area can be determined in a more precise way if deemed necessary by the designer.

In such a case when calculating the projected lateral area of, for example, spars and rigging with no sails, rails, crane trusses of lattice types, etc., the overall areas taken into account, shall be multiplied by filling factors whose values are taken as per the Table 1.4.6.2-1.

For spars, tackle and shrouds of ships with no sails, values of the filling factors shall be taken as per Table 1.4.6.2-2 subject to the ratio z_0/b_0,

where z_0 is the height of the point of shrouds fastening to the mast over the bulwark;

b_0 is the distance between the shrouds at bulwark.

Table 1.4.6.2-1

Filling factor	No icing	Icing
For rails covered with meshed wire	0.6	1.2
For rails not covered with meshed wire	0.2	0.8
For crane trusses of lattice type	0.5	1.0

The projections of the hull above the waterline, deckhouses and superstructures shall be taken into account with a flow coefficient 1.0. The projections of circular section structures located separately on the deck (funnels, ventilators, masts) shall be assumed to have a flow coefficient of 0.6. When calculating in details, the projected lateral areas of small objects, discontinues surfaces, spars, rigging, rails, shrouds, tackle, etc. shall be taken equal to 1.0.

If the projections of individual components of the windage area overlap one another fully or in part, the areas of only one of the overlapping projections shall be included in the calculation.

If the overlapping projections have different flow coefficients, those with higher coefficients shall be taken for the calculation.

1.4.6.3 The arm of windage area z_v to determine the heeling moment due to the wind pressure as per 2.1.4 shall be defined as a distance, in metres, between the centre of the windage area and the actual waterline plane for an upright ship in smooth water. The position of the centre of windage area shall be determined by a method generally applied to determine the coordinates of the centre of gravity for a plane figure.

1.4.6.4 The windage area and its statical moment shall be calculated for the ship's draught d_{min}.

These components for others draughts shall be determined by calculation. The use of linear interpolation is permissible if the second point is assumed at the draught corresponding to the summer load line.

Table 1.4.6.2-2 **Filling factors**

Filling factors	z_0/b_0											
	3	4	5	6	7	8	9	10	11	12	13	14
No icing	0.14	0.18	0.23	0.27	0.31	0.35	0.40	0.44	0.48	0.52	0.57	0.61
Icing	0.27	0.34	0.44	0.51	0.59	0.66	0.76	0.84	0.91	1.00	1.00	1.00

1.4.7 Calculation of the liquid cargo effect

1.4.7.1 Free surface effects that reduce ship's stability will exist whenever the filling level in a tank is less than 100 per cent of its capacity.

Where the total free surface effects of nominally full (i.e. 98 per cent or above) tank is small in relation to the initial metacentric height of the ship, the effects for such tanks may be ignored subject to the consent of the Register.

Free surface effects shall be considered whenever the filling level in a tank is less than 98 per cent (considering 1.4.7.7).

Free surface effects shall be considered as follows for the nominally full tank:

correction for initial metacentric height shall be considered as a part of division of an inertia moment of the free surface of cargo arising at 5° heeling by ship's displacement, while correction to the righting arms shall be determined using the actual heeling moment due to liquids flow.

1.4.7.2 The tanks to be considered at determining the correction for free surfaces may be referred to one of the two categories, namely:

tanks with permanent filling level (for example, cargo tank with liquid cargo, water ballast tank). Corrections for free surfaces shall be determined for actual filling level defined for each tank;

tanks with a variable filling level (for example, consumable liquids, such as fuel, oil, fresh water as well as liquid cargo and ballast at reception, consumption and transfer operation).

Except for the cases provided in 1.4.7.4, corrections for free surfaces shall have the maximum values specified within the lower and upper filling boundaries of each tank provided by the recommendations for ship's operation.

1.4.7.3 Tanks for every type of liquid cargo and ballast, in which as per the operational conditions may simultaneously be free surfaces, as well as anti-heeling tanks and tanks for roll stabilizing system regardless of the tanks categories shall be included in the number of tanks to be considered at calculation of the liquid cargo effect on stability. To consider the free surface effect, it is necessary to compile the design combination of single tanks or their combinations per each tank of liquid cargo.

It is necessary to select tanks, which have the maximum free surfaces effect, out of possible operational combinations of tanks per separate types of liquid cargoes and ballast, or single tanks. The received design combination of tanks applies to all loading conditions, except docking, irrespective of the actual availability of free surfaces, including the ship with full stores. Meanwhile, angles of heel, for which the maximum corrections are determined, shall be selected with respect to the stability criteria applied to the ship (considering the requirements for subdivision, damage trim and stability, if applicable).

1.4.7.4 For a ship engaged in liquids transfer operation, correction for free surfaces at any stage of the operation may be determined for the actual filling level of the tank at a given stage of transfer.

1.4.7.5 Corrections to the initial metacentric height and the righting lever curve shall be calculated separately as follows.

1.4.7.5.1 Corrections to the initial metacentric height Δm_h shall be determined as a product of liquid cargoes densities by intrinsic transverse moments of inertia of free surfaces in tanks calculated for a ship's position without heel in compliance with the categories of tanks specified in 1.4.7.2.

1.4.7.5.2 Corrections to the righting arms ΔM_θ with the consent of the Register may be defined by one of the two following methods:

.1 correction of calculation based on the actual heeling moment due to the liquid flow in tanks for each angle of ship's heel under consideration;

.2 correction calculation based on the intrinsic transverse moment of inertia of free surfaces in tanks for a ship's position without heel to be corrected for each angle of ship's heel θ under consideration by multiplying $\sin \theta$;

1.4.7.6 Information on Stability shall contain only a method used for calculation of corrections to the righting arms.

If instructions on manual assessment of stability for a non-typical loading case provide for an alternative method, the instructions shall include an example of correction for free surfaces calculation with explanation of reasons of different results of manual correction calculation and of calculation by the adopted method.

1.4.7.7 The tanks complying with the following condition may not be included in the calculation

$$\Delta M_{30} < 0.01\Delta_{min}; \quad (1.4.7.7\text{-}1)$$

for floating cranes, the tanks complying with the following condition may not be included in the calculation

$$\Delta M_{15} < 0.02\Delta_{min}; \quad (1.4.7.7\text{-}1)$$

where ΔM_{30}, ΔM_{15} are heeling moments due to liquid flow at angles of heel equal to 30° and 15°.

Aggregate correction ΔM_{15} for tanks not included in the calculation shall not exceed $0.05\Delta_{min}$.

Otherwise, appropriate corrections shall be considered in the calculation.

Usual residues of liquids in emptied tanks shall not be considered in the calculations provided that the total number of these residues shall not result in considerable increase of the free surfaces effect on ship's stability.

1.4.8 Loading condition

1.4.8.1 Stability shall be checked under all loading conditions specified in Sections 3 and 4 for various types of ships.

1.4.8.2 For the types of ships which are not covered by special provisions of Section 3, the loading conditions subject to a check shall be as follows:

.1 ship in fully loaded condition with full stores;

.2 ship in fully loaded condition with 10 per cent of stores;

.3 ship without cargo with full stores;

.4 ship without cargo with 10 per cent of stores.

1.4.8.3 If the loading conditions anticipated in normal service of a ship as for stability are less favourable than those given in 1.4.8.2 or specified in Section 3, stability shall also be checked for these conditions.

1.4.8.4 If there is solid ballast on board, its mass shall be included in the light-ship condition.

1.4.8.5 In all cases of loading which might occur in the ship's service, except those specified in 1.4.8.2.1 and expressly provided in Section 3, the weight of ballast water may be included in the deadweight of the ship where necessary.

1.4.9. Curves of stability

1.4.9.1 Stability curves calculated with due allowance for the corrections of free surfaces shall be plotted for all loading conditions under consideration.

1.4.9.2 If there are openings considered to be open in the ship's sides, upper deck or superstructures through which water can penetrate inside the hull, the stability curves are considered effective up to the angle of flooding. At the inclinations of the ship exceeding the angle of flooding, the ship may be regarded to have entirely lost her stability and the curves of stability at this angle are cutting short.

1.4.9.3 If the spread of water coming to a superstructure through openings considered to be open is limited only by this superstructure or a part thereof, such superstructure or its part shall be considered as non-existent at the angles of heel exceeding the angle of flooding. In this case, the righting lever curve becomes stepped and that of dynamically stability broken.

1.4.10 Design data related to stability checking and summary tables

1.4.10.1 For ships under inspection all design data related to stability checking (calculations of loading, initial stability, curves of stability, windage area, amplitudes of roll, heeling due to crowding of passengers on one side, heeling when turning, icing, etc,) shall be submitted to the Register for review.

1.4.10.2 For all design loading conditions, summary tables presenting the results of calculations of displacement, position of the centre of gravity, initial trim and stability, as well as summary tables of results of stability checking for the compliance with the present Part shall be drawn up.

1.4.11 Requirements for Information on Stability

1.4.11.1 To provide stability of ships in service, the Information on Stability approved by the Register and containing the following data shall be issued for each ship:

.1 particulars of ship;

.2 information on how the ship conforms to stability criteria and directions based on the Register requirements for stability to prevent the ship capsizing;

.3 designer recommendations concerning stability and other instructions for safe service:

.4 stability data for typical, predetermined loading conditions;

.5 advice and documents necessary to estimate trim and stability of the ship for any cases of full and partial loading which might occur in the ship's service.

The trim and stability of the ship shall be determined by calculation.

.6 instructions concerning the operation of cross-flooding arrangements.

The Information on Stability shall be drawn up in accordance with the provisions of Appendix 1 to the present Part.

1.4.11.2 Information on Stability shall be compiled as per the ship's inclining test data.

For ships where the inclining test may be substituted by the light-weight check in compliance with 1.5.2.1, the light-ship displacement and longitudinal centre of gravity derived from the light-weight check in conjunction with the light-ship vertical centre of gravity derived from the inclining test are to be used as per the Information.

For ships whose light-ship properties deviation is within the limits specified in 1.5.2.2, the light-ship displacement and longitudinal centre of gravity derived from the light-weight check in conjunction with the higher of either the lead ship's (previous sister ship's) vertical centre of gravity or the calculated value are to be used as per the Information.

For ships whose light-ship properties deviation is within the limits specified in 1.5.3, the light-ship displacement and longitudinal centre of gravity derived from the light-weight check in conjunction with the higher of either the light-ship vertical centre of gravity derived from the inclining test prior to conversion or the design vertical centre of gravity following the conversion are to be used as per the Information.

For ships where inclining test may be omitted in compliance with 1.5.7, the light-ship displacement and longitudinal centre of gravity derived from the light-weight check in conjunction with the light-ship vertical centre of gravity determined as per 1.5.7 are to be used as per the Information. It shall be stated in the Information that the ship has been subjected to light-weight check instead of inclining test, and the light-ship vertical centre of gravity has been calculated in compliance with 1.5.7.

1.4.11.3 Where bulk cargoes other than grain are carried, special Information on Stability and Strength during Transportation of Bulk Cargoes Other than Grain shall be available on board, which shall be drawn in accordance with 1.4.8.7, Part II "Hull".

1.4.12 Requirements for onboard stability instrument

Where the ship trim and stability is determined by using software, the latter shall be approved by the Register, the requirements for hardware are given in Appendix 2, Part II “Hull”.

Availability of the software approved by the Register on board to control the ship’s trim and stability shall not be considered as a ground for deleting any section of the Information on Stability.

The procedure for using software shall be specified in the user manual for the onboard stability instrument.

The manual shall be compiled in the user native language and translated into English. The manual shall contain a statement that the serviceability of the onboard stability instrument shall be checked by the crew prior to its use.

1.4.13 Requirements for the Ballast Water Management Plan

When ships in service call ports which require ballast water exchange at sea in advance, they shall have the Ballast Water Management Plan developed according to the Instruction for the Development of Ballast Water Management Plans.[4].

1.5 INCLINING TESTS AND LIGHT-WEIGHT CHECKS

1.5.1 The following ships are subject to inclining test:

.1 series-built ships as per 1.5.2;

.2 every ship of non-series construction;

.3 every ship after restoring repair;

.4 ships after major repair, alteration or modification as per 1.5.3;

.5 ships after installation of permanent solid ballast as per 1.5.4;

.6 ships whose stability is unknown or gives rise to doubts;

.7 passenger ships in service at intervals not exceeding five years if provided by 1.5.5;

.8 fishing vessels in service (of 30 m in length and less) at intervals not exceeding fifteen years and fishing vessels over 30 m in length if provided by 1.5.5;

1.5.2 The following ships shall be inclined out of the series of ships under construction at each shipyard:

.1 the first ship, then every fifth ship of the series (i.e. sixth, eleventh, etc.).

For other ships of the series upon consent of the Register (for each particular ship), the inclining test may be substituted by the light-weight check as per 1.5.14.

Depending on the seasonal conditions during the delivery of the ship and subject to special agreement with the Register, the inclining test of the next ship of the series may be permitted instead of the ship to be delivered. Starting from the twelfth ship of the series, the Register may require inclining of the smaller number of ships if it is demonstrated to the satisfaction of the Register that in the process of constructing the ships of the series stability of their mass and centre of gravity position is ensured within the limits stated in 1.5.2.2;

.2 a series-built ship where structural alterations compared with the first ship of the series as shown by the calculation result in:

.2.1 the changes of the light-ship

[4] Resolution A.868(20) “Guidelines for the Control and Management of Ships’ Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens”.

displacement for $L \leq 50$ exceeding 2 per cent, for $L \geq 160$ exceeding 1 per cent (for intermediate values L - the acceptable deviation is determined by linear interpolation); or

.2.2 deviation of the light-ship longitudinal centre of gravity exceeding 0.5 per cent of the subdivision length *LS* of the lead ship; or

.2.3 increase of the light-ship vertical centre of gravity exceeding simultaneously 4 cm (10 cm in the case of floating cranes and crane ships) and the value determined by the formulae (whichever is the less):

$$\delta z_g = 0.1 \frac{\Delta_1}{\Delta_0} l_{max}, \qquad (1.5.2.2.3\text{-}1)$$

$$\delta z_g = 0.05 \frac{\Delta_1}{\Delta_0} h, \qquad (1.5.2.2.3\text{-}2)$$

where Δ_0 is light-ship displacement, in t;

Δ_1 is the ship's displacement under the most unfavourable loading condition regarding the value of h or l_{max}, in t;

l_{max} is the maximum righting arm under the most unfavourable design loading condition regarding its value;

h is the corrected initial metacentric height under the most unfavourable design loading condition regarding its value;

or

.2.4 violation of the requirements of the present Part for design loading conditions with $z_g = 1.2\ z_{g2} - 0.2\ z_{g1}$,

where z_{g1} (z_{g2}) is a design light-ship vertical centre of gravity prior to (after) structural changes;

z_g is an assumed light-ship vertical centre of gravity.

Such ship shall be considered the first ship of a new series regarding stability, and the inclining test procedure of the subsequent ships shall comply with the requirements of 1.5.2.1.

1.5.3 After major repair, alteration or modification to be inclined are the ships in which structural changes as shown by calculation result in:

.1 change of load (total mass of load removed and added) by more than 6 per cent of the light-ship displacement; or

.2 change in the light-ship displacement by more than 2 per cent or 2 t, whichever is the greater; or

.3 deviation of the light-ship longitudinal centre of gravity exceeding 1 per cent of the ship's subdivision length; or

.4 increase in the light-ship vertical centre of gravity by more than the value obtained as per 1.5.2.2.3; or

.5 violation of the requirements of the present Part for design loading conditions as specified in 1.5.2.2.4.

If no inclining test is required upon results of the calculation, the light-weight check shall be carried out as per 1.5.14.

Irrespective of the calculations submitted, the Register may require inclining test of the ship to be performed proceeding from the technical condition of the ship as per 1.5.1.6.

1.5.4 After installation of the permanent solid ballast each ship shall be inclined.

Inclining test of the ship may be omitted if the Register is satisfied that when installing the ballast, efficient control is effected to ensure the design value of mass and centre of gravity position, or these value can be properly confirmed by calculation.

1.5.5 Light-weight check (experimental determination of the light-ship displacement and the longitudinal centre of gravity) shall be effected periodically for finding whether as per 1.5.1.7 and 1.5.1.8 the inclining test is required for:

.1 passenger ships;

.2 fishing vessels over 30 m in

length after 10 years in service from the date of build or last inclining test.

Light-weight check shall be carried out at intervals not more than five years.

If a change in the light-ship displacement by more than 2 per cent or in longitudinal centre of gravity by more than 1 per cent of the ship's subdivision length as compared to the approved Information on Stability is found out as a result of the light-weight check, then, the ship shall be inclined.

1.5.6 Where the inclining test results for the ship built show that the light-ship vertical centre of gravity exceeds design value to the extent that involves the violation of the requirements of the present Part, calculations with explanation of the reasons of such differences shall be attached to the Inclining Test Report.

Based on the investigation analysis of the documents submitted, or in case such documents are not available, the Register may require the repeated (check) inclining test of the ship to be performed. In this case, both Inclining Test Reports shall be submitted to the Register for review.

1.5.7 Except for the ships engaged on international voyages, at the shipowner's wish the Register may substitute the inclining test of a newly built ship by the light-weight check provided an increase of a light-ship vertical centre of gravity by 20 per cent as against the design value will not result in the violation of the requirements of the present Part.

If the light-weight check results show that the deviation of the light-ship displacement exceeds 2 per cent of the design value or the deviation of the light-ship longitudinal centre of gravity exceeds 1 per cent of the ship's subdivision length, the explanatory calculation of such difference shall be attached to the Light-Weight Check Report.

1.5.8 Ship's loading during the inclining test shall be as far as practicable close to the light-ship displacement. The mass of missing loads shall not be more than 2 per cent of the light-ship displacement, and the mass of surplus loads less inclining ballast and ballast as per 1.5.9 shall not be more than 4 per cent.

1.5.9 The metacentric height of the ship in the process of the inclining test shall be at least 0.20 m.

For this purpose the necessary ballast may be taken. When water ballast is taken, the tanks shall be carefully pressed up.

1.5.10 To determine angles of inclination during the inclining test, not less than three pendulums of at least 3 m in length shall be provided onboard.

For ships of under 30 m in length only tow pendulums of at least 2 m in length may be used.

One or more pendulums may be substituted by other measuring devices approved by the Register.

1.5.11 If the inclining test is well performed, the value of the metacentric height obtained may be used in calculations without deduction for probable error of the test.

Inclining test is considered to be satisfactory performed, provided:

.1 for each measurement the following condition is fulfilled:

$$|h_i - h_k| \le 2\sqrt{\frac{\Sigma(h_i - h_k)^2}{n-1}}, \quad (1.5.11.1)$$

where h_i is a metacentric height obtained by individual measurement;

$h_к = \Sigma h_i/n$ is a metacentric height obtained in inclining the ship;

n is a number if measurements.

Measurements not meeting the above condition are excluded when treating the results with appropriate change of the total number *n* and repeated calculation of the metacentric height $h_к$.

No more than one measurement is excluded from the calculation (greater number of measurements may be excluded only in well-grounded cases with the consent of the Register);

.2 probable error of the test

$$t_{\alpha n}\sqrt{\frac{\Sigma(h_i - h_k)^2}{n(n-1)}}$$

fulfils the condition

$$t_{\alpha n}\sqrt{\frac{\Sigma(h_i - h_k)^2}{n(n-1)}} \le 0.02(1 + h_k)$$

if $h_к \le 2$ m, (1.5.11.2-1)

$$t_{\alpha n}\sqrt{\frac{\Sigma(h_i - h_k)^2}{n(n-1)}} \le 0.04 h_k \quad \text{if } h_к > 2 \text{ m,}$$

(1.5.11.2-2)

Factor $t_{\alpha n}$ is taken from Table 1.5.11.

Table 1.5.11 **Factor** $t_{\alpha n}$

n	$t_{\alpha n}$	*n*	$t_{\alpha n}$
8	5.4	13	4.3
9	5.0	14	4.2
10	4.8	15	4.1
11	4.6	16	4.0
12	4.5		

.3 the following condition is fulfilled considering *h* and l_{max} under the most unfavourable design loading conditions:

$$t_{\alpha n}\sqrt{\frac{\Sigma(h_i - h_k)^2}{n(n-1)}}\,\frac{\Delta_0}{\Delta_1} \le \varepsilon\,, \quad (1.5.11.3)$$

where ε = 0.05 *h* or $0.10 l_{max}$,

whichever is less, but not less than 4 cm;

.4 total number of satisfactory measurements is not less than 8.

1.5.12 Where the requirements of 1.5.11 are not fulfilled, the value of the metacentric height less the probable error of the test obtained as per 1.5.11.2 may be taken for calculations with the consent of the Register.

1.5.13 The inclining test shall be performed in compliance with the Instructions on Inclining Test of the Shipping Register of Ukraine and shall be witnessed by a surveyor to the Register.

Other methods of inclining test may be permitted provided that it is demonstrated to the satisfaction of the Register that the accuracy of the inclining test results meets the present requirements.

1.5.14 The light-weight check means experimental determination of light-ship displacement and the coordinates of its centre of gravity in accordance with the Instructions on Inclining Test to be carried out in the presence of the Register attending Surveyor.

The light-weight check is carried out with the aim to:

.1 determine the necessity to conduct the inclining test as per 1.5.5;

.2 correct the Information on Stability for ships of the series and after conversion as specified in 1.4.11.2;

.3 determine the light-ship properties of the ship exempted from the inclining test as per 1.5.7.

1.6 DEPARTURES FROM THE RULES

1.6.1 If doubts arise as for stability of any ship when the requirements of the present Part are formally complied with, the Register may require checking of the ship's stability against additional criteria.

In case where the requirements set forth in the present Part are considered to be too severe, the Register may permit, on a well-grounded statement of design and service bodies, appropriate departures from these requirements for the ship in question.

1.6.2 When a ship navigating in a particular area does not comply with the requirements of the present Part, the Register may, in each particular case, either restrict the ship's area of navigation or introduce other limitations depending upon the ship's stability characteristics, service conditions and purpose the ship is intended for.

1.7 CONDITIONS OF SUFFICIENT STABILITY

1.7.1 Under the most unfavourable loading conditions regarding stability, the ship's stability, except for floating cranes, crane ships, pontoons, floating docks and berth-connected ships shall comply with the following requirements:

.1 the ship shall withstand, without capsizing, simultaneously the effect of dynamically applied wind pressure and rolling the parameters of which are determined as per Section 2;

.2 numerical values of the parameters of the righting lever curve for the ship on still water and the values of the corrected initial metacentric height shall not be below those specified in Section 2;

.3 the effect of consequences of probable icing upon stability shall be taken into account in compliance with Section 2:

.4 stability of a ship shall comply with additional requirements of Section 3.

1.7.2 Stability of floating cranes, crane ships, transport pontoons, floating docks and berth-connected ships shall comply with the requirements of Section 4.

1.7.3 For ships to which the requirements of Part V "Subdivision" are applicable, the intact stability shall be sufficient to meet these requirements in damaged condition.

1.7.4 Stability of ships which have distinguishing mark for ships carrying equipment for fire fighting aboard other ships in their class notation shall be considered to be sufficient in the course of fire fighting operations, if in case when all the monitors operate simultaneously with the maximum supply rate in the direction corresponding to the minimum stability of the ship, the static heeling angle does not exceed 5°.

To determine the heeling moment, the vertical distance between the monitor axis and midpoint of the mean draft is assumed to be the heeling lever. Where the ship is fitted with a thruster, the design heeling moment shall be increased by a value of the moment which occurs during operation of the thruster in relation to the midpoint of the ship's draft.

1.8 PASSAGE OF SHIPS FROM ONE PORT TO ANOTHER

1.8.1 When passing from one port to another, the ship's stability shall meet the requirements imposed upon the ships navigating in a region through which the passage is expected to be undertaken.

1.8.2 The Register may permit the passage of a ship which stability cannot be raised up to that required by 1.8.1 provided that the weather restrictions correspond to its stability.

2. GENERAL REQUIREMENTS FOR STABILITY

2.1 WEATHER CRITERION

2.1.1 The requirements for stability set forth in the present Part are differentiated depending upon the ship's area of navigation.

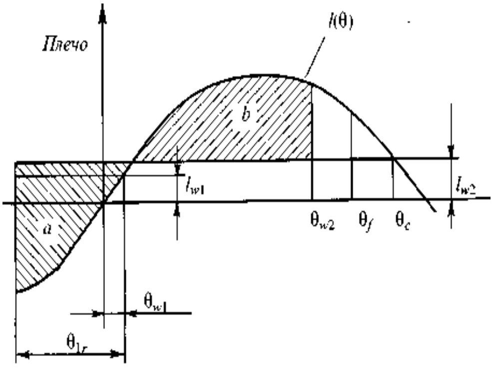
Definitions of restricted areas of navigation are given in 2.2.5, Part I "Classification".

Particular restrictions of navigation areas for each basin for ships with restricted areas of navigation **R3-RS**, **R3-S**, **B-R3-RS**, **B-R3-S**, **C-R3-RS**, **C-R3-S** shall be defined by the Register as for wind and sea conditions for a particular area as per 2.2.5.3, Part I "Classification".

2.1.2 Stability of ships of unrestricted service, including area **A**, and of restricted areas of navigation **R1**, **R2**, **R2-RS**, **R2-S**, **R3-RS**, **R3-S**, **A-R1**, **A-R2**, **A-R2-RS**, **A-R2-S**, **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS** shall be considered sufficient as to weather criterion *K* if the requirements of 2.1.2.5 are met under the assumed effect of wind and seas mentioned below, and:

.1 the ship is under effect of a wind of steady speed and direction perpendicular to the ship's centerline to which the lever of wind heeling moment l_{w1} corresponds (refer to Fig.2.1.2.1);

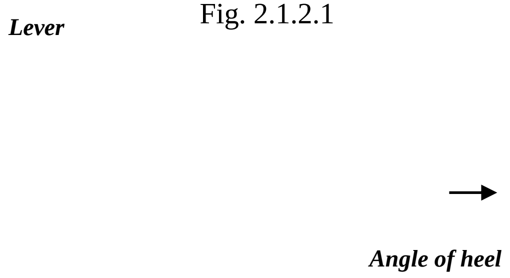
.2 by the static heeling angle θ_{w1}, resulting from steady wind and corresponding to the first point of intersection between the horizontal straight line l_{w1}, and the curve of righting levers $l(\theta)$, the ship heels to the weather side under the effect of waves to an angle equal to the roll amplitude θ_1 (refer to Fig.2.1.2.1);



.3 the ship is then subjected to a gust wind pressure which results in a gust wind heeling lever l_{w2};

.4 the areas a and b, are determined and compared which are shaded in Fig.2.1.2.1. The area b is formed by a righting lever curve $l(\theta)$, a horizontal straight line corresponding to the heeling lever l_{w2}, and the heeling angle $\theta_{w2} = 50°$, or the angle of flooding θ_f, or the heeling angle θ_c corresponding to the second point of intersection between the straight line l_{w2} and the righting lever curve, whichever angle is less. The area a is formed by the righting lever curve, straight line l_{w2} and heeling angle equal to θ_{w1} - θ_{1r};

Fig. 2.1.2.1



.5 the ship's stability is considered sufficient by the weather criterion $K = b / a$, provided the area b is equal to or greater than the area a, that is $K \geq 1$.

For meteorological ships, the weather criterion K is specially considered by the Register in each case; it is recommended this value shall be not less than 1.5.

2.1.3 The static heeling angle θ_{w1} due to steady wind shall not exceed 16° or an angle equal to 0.8 of the open deck edge emersion angle, whichever is less.

The requirements for the static heeling angle of timber carriers and container ships are given in 3.3 and 3.10.

2.1.4 Calculation of heeling lever due to wind pressure

2.1.4.1 The heeling lever l_{w1}, in m, shall be taken constant for all heeling angles and shall be determined by the formula

$$l_{w1} = \frac{p_v A z_v}{1000 g \Delta}, \qquad (2.1.4.1\text{-}1)$$

where p_v is a wind pressure, in Pa, to be determined as per Table 2.1.4.1 basing on the area of navigation;

z_v is an arm of windage area to be taken equal to the vertical distance between the windage area centre A and the centre of the underwater hull lateral area projected on the centerline or, approximately, the half of the ship draught;

A is a windage area, in m², to be determined as per 1.4.6;

Δ is a ship displacement, in t;

g = 9.81 m/s².

The heeling lever l_{w2} shall be determined by the formula

$$l_{w2} = 1.5\, l_{w1}. \qquad (2.1.4.1\text{-}2)$$

Table 2.1.4.1 **Wind pressure** p_v

Area of navigation	p_v, in Pa
Unrestricted (including area **A**)	504
Restricted **R1, A-R1,**	353
Restricted **R2**, **R2-S**, **R2-RS**, **R3-S**, **R3-RS**, **A-R2, A-R2-S**, **A-R2-RS**, **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS**	252

2.1.4.2 For fishing vessels having a length between 24 m and 45 m, the wind pressure value in formula (2.1.4.1-1) may be ascertained from Table 2.1.4.2 proceeding from the distance Z between the windage area centre and the waterline.

2.1.4.3 The ships with the stability that do not comply as per the weather criterion with the requirements for the ships with restricted areas of navigation **R2**, **R2-S, R2-RS, A-R2, A-R2-S, A-R2-RS** may be allowed to operate as ships with restricted areas of navigation **R3-S**, **R3-RS**, **R3**, **R3-IN**, **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS**, **D-R3-S**, **D-R3-RS** with additional restrictions as provided by the Register considering peculiarities of the area of navigation and type of service.

The requirements for stability of floating cranes and crane ships are provided by 4.1.

Table 2.1.4.2 **Wind pressure** p_v

Z, in m	1	2	3	4	5	≥ 6
p_v, in Pa	316	386	429	460	485	504

2.1.5 Calculation of roll amplitude

2.1.5.1 The roll amplitude, in deg., for a round-bilged ship shall be determined by the formula

$$\theta_1 = 109\,k X_1 X_2 \sqrt{rS}\,, \quad (2.1.5.1)$$

where k is a factor taking into account the effects of bilge and/or bar keels and determined as per 2.1.5.2; k shall be taken equal to 1 where the keels are not mounted;

X_1 is a dimensionless factor to be taken from Table 2.1.5.1-1 proceeding from the breadth-to-draught ratio B/d;

X_2 is a dimensionless factor to be taken from Table 2.1.5.1-2 proceeding from the block coefficient C_B of the ship;

r is determined by the formula

$$r = 0.73 + 0.6(z_g - d)/d\,.$$

r shall not be taken greater than 1;

S is a dimensionless factor to be taken from Table 2.1.5.1-3 proceeding from the area of navigation and the roll period T to be determined by the formula

$$T = 2cB/\sqrt{h}\,,$$

where

$$c = 0{,}373 + 0{,}023\,B/d - 0{,}043\,L_{wl}/100$$

h is a metacentric height corrected for the effect of free surfaces of liquid cargoes;

L_{wl} is a length of ship on the waterline.

2.1.5.2 For ships with bilge keels or bar keels, or both, the factor k shall be taken from Table 2.1.5.2 proceeding from the $A_k/L_{wl}B$ ratio in which A_k denotes the total area, in m^2, of bilge keels or the lateral projected area of the bar keel, or the sum of both areas.

The bilge keels for ships having **Ice4** and more ice category mark in their class notation shall be ignored.

Table 2.1.5.1-1 **Factor** X_1

B/d	≤ 2.4	2.6	2.8	3.0	3.2	3.4	≥ 3.5
X_1	1.00	0.96	0.93	0.90	0.86	0.82	0.80

Table 2.1.5.1-2 **Factor** X_2

C_B	≤ 0.45	0.50	0.55	0.60	0.65	≥ 0.70
X_2	0.75	0.82	0.89	0.95	0.97	1.00

Table 2.1.5.1-3 **Factor** S

Area of navigation	T, in s									
	≤5	6	7	8	10	12	14	16	18	≥20
Unrestricted (including area **A**)	0.100	0.100	0.098	0.093	0.079	0.065	0.053	0.044	0.038	0.035
Restricted **R1**, **R2**, **R2-S**, **R2-RS**, **A-R2**, **A-R2-S**, **A-R2-RS**, **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS**	0.100	0.093	0.083	0.073	0.053	0.040	0.035	0.035	0.035	0.035

Table 2.1.5.2 **Factor** k

A_k / L_{wl}, %	0	1.0	1.5	2.0	2.5	3.0	3.5	≥ 4.0
k	1.00	0.98	0.95	0.88	0.79	0.74	0.72	0.70

2.1.5.3 When calculating the roll amplitude by Formula (2.1.5.1), coefficient k for sharp-bilged ships shall be equal to 0.7.

2.1.5.4 The roll amplitudes of ships equipped with anti-rolling devices shall be determined without regard for the operation of the latter.

2.1.5.5 As per the Tables 2.1.5.1-1–2.1.5.1-3, 2.1.5.2, the intermediate values shall be defined by linear interpolation. The calculated roll amplitude values shall be rounded to integer degrees.

2.1.5.6 The tables and formulas as per 2.1.5 used in calculation of roll amplitude are obtained from ships having the following parameters:

$B/d \leq 3.5$; $(z_g/d - 1)$ between 0.3 and 0.5; $T < 20$s.

For the ships with parameters outside of the above limits the roll amplitude may be determined with model experiments according to the procedure described in MSC.1/Circ.1200, and in each particular case shall be subject to a special consideration by the Register.

2.2 RIGHTING LEVER CURVE

2.2.1 The area under the righting lever curve shall not be less than 0.055 m·rad up to the heeling angle 30º and not less than 0.09 m·rad up to the heeling angle 40º, or up to the angle of flooding θf whichever is the less. Additionally, the area between the heeling angles of 30º and 40º, or, if $\theta f < 40°$, between 30° and θf shall not be less than 0.03 m·rad.

The maximum righting arm $l_{\max}$ shall not be less than 0.25 m for ships with $L \leq 80$ m and 0.2 m for ships with $L \geq 105$ m at the heeling angle $\theta_m \geq 30º$. For intermediate values of L, $l_{\max}$ shall be determined by linear interpolation.

Subject to the consent of the Register, the angle corresponding to the maximum of the righting lever curve may be reduced to 25º.

Where the righting lever curve has two maxima due to the influence of superstructures or deckhouses, the first maximum from the upright position shall occur at the angle of heel not less than 25º.

The limit of the positive metacentric stability (angle of vanishing stability) shall not be less than 60º. However, for the ships with restricted areas of navigation **R3-S, R3-RS, B-R3-S, B-R3-RS, C-R3-S, C-R3-RS** it can be decreased up to 50º provided that with every 1º of decrease the maximum righting arm shall be increased up to 0.01 m apart from the standard value.

2.2.2 Ships with ratio $B/D > 2$ are allowed to navigate having the angle corresponding to the maximum righting arm reduced as compared to that required under 2.2.1 by a value $\Delta\theta v$ determined by the formula (2.2.1) subject to B/D and weather criterion

$$K\Delta\theta\, v, = 40°[(B/D)-2](K-1)0.5 \qquad (2.2.2)$$

If $B/D > 2.5$ the ratio $B/D = 2.5$ shall be taken, if $K > 1.5$ the ratio K = 1.5 shall be taken.

The value $\Delta\theta v$ shall be rounded off to the nearest integer.

2.2.3 A ship shall comply with the aforesaid requirements when the correction for free surfaces is taken into account in righting lever curves as per the provisions of 1.4.7.

2.2.4 The angle of flooding shall not be less than 50°. For ships having a lesser angle the navigation may be permitted as for ships of restricted area of navigation depending upon the value of wind pressure endured when checking stability for compliance with the weather criterion.

2.2.5 The requirements for the righting lever curve of floating cranes and crane ships are given in 4.1.

2.3 METACENTRIC HEIGHT HEIGHT

2.3.1 For all ships under all loading conditions, except for the light-ship condition, the value of corrected initial metacentric height shall be not less than 0.15 m.

The minimum corrected initial metacentric height may have other value in cases specified in Section 3.

For all ships, except for fishing vessels, whale factory ships, fish factory ships and other ships used for processing the living resources of the sea and not engaged in catching the same, negative initial metacentric height for a light ship is subject to special consideration by the Register in each case.

2.3.2 Initial stability of well-deck ships shall be checked for the case of water penetration into the well.

Amount of water in the well and its free surface shall correspond to the water level up to the lower edge of the freeing ports for a ship in upright position allowing for the deck camber.

If a ship has two or more wells, stability shall be checked for the case of flooding of the largest one.

2.4 ALLOWANCE FOR ICING

2.4.1 For the ships intended for winter navigation within seasonal zones set up by the Load Line Rules for Sea-Going Ships, except for the basic loading variants, stability with due regard for icing, as specified in this Chapter, shall be checked in addition to the main loading conditions.

When calculating icing, account shall be taken of increase in displacement, height of the centre of gravity and windage area due to icing. The stability calculation under icing shall be carried out for the worst loading condition as to stability.

When checking stability under icing, the mass of the ice is considered as an overload and is not included in the ship's deadweight.

When verifying the stability of floating cranes and crane ships, the allowance for icing shall be made as per 4.1, and of timber carriers – as per 3.3.7.

2.4.2 When determining the heeling and capsizing moments for ships navigating in winter seasonal zones to the north of latitude 66º 30' N and to the south of latitude 60º 00' S, and also in winter in the Bering Sea, the Sea of Okhotsk and in the Tatarski Strait, the assumed rates of icing shall be as specified in 2.4.3 and 2.4.4.

2.4.3 The mass of ice per square metre of the total area of horizontal projection of exposed weather decks shall be assumed to be 30 kg.

The total horizontal projection of decks shall include horizontal projection of all exposed decks and gangways, irrespective of the availability of awnings. The vertical moment due to this loading is determined for heights of the centre of gravity of the corresponding areas of decks and gangways.

The deck machinery, arrangements, hatch covers, etc. are included in the projection of decks and are not taken into account separately.

For ships with framing fitted above open deck sections, allowance shall be made for an additional mass of ice having the thickness equal to the main framing height.

2.4.4 The mass of ice per square metre of the windage area shall be assumed to be 15 kg. The windage area and height of the centre of gravity shall be determined for a draught d_{min} as per 1.4.6, but without the allowance for icing.

2.4.5 In other areas of the winter seasonal zone, the rates of icing for winter time shall be assumed to be equal to half those specified in 2.4.3 and 2.4.4, except for the areas when icing may not be taken into account as agreed with the Register.

2.4.6 The mass of ice and vertical moment calculated as per 2.4.3 to 2.4.5 cover all loading conditions when drawing up the Information.

2.4.7 For the righting lever curves plotted with the allowance for icing the maximum righting arm for ships of restricted area of navigation shall be at least 0.2 m at an angle of heeling 25º.

For ships with the ratio $B/D > 2$ an additional decrease of an angle is allowed for rolling up the curve θ_v by the value equal to half of the values calculated by the formula (2.2.2.1).

2.4.8 For ships navigating in winter in the regions of the Black and Azov Seas northwards of the parallel of latitude 44º 00' N, as well as in the region of the Caspian Sea northwards of the parallel 42º 00' N, icing shall be taken into account as per 2.4.5.

3. ADDITIONAL REQUIREMENTS FOR STABILITY[5]

3.1 PASSENGER SHIPS

3.1.1 Stability of passenger ships shall be checked for the following conditions:

.1 ship in the fully loaded condition with full number of class and unberthed passengers and their effects and full stores without liquid ballast;

.2 ship in the fully loaded condition with full number of class and unberthed passengers and their effects, but with 10 per cent of stores;

.3 ship without cargo, but with full number of class and unberthed passengers and their effects and with full stores;

.4 ship in the same loading condition as in 3.1.1.3, but with 10 per cent of stores;

.5 ship without cargo and passengers, but with full stores;

.6 ship in the same loading condition as in 3.1.1.5, but with 10 per cent of stores;

.7 ship in the same loading condition as in 3.1.1.2, but with 50 per cent of stores.

When checking stability for the compliance with the weather criterion, class passengers shall be assumed to be in

[5] Additional requirements for stability of ships under 24 m in length are given in 3.9.

their accommodation and unberthed passengers on their decks. The stowage of cargo in holds, 'tween decks and on decks is assumed as for normal service condition of the ship. Stability with an allowance for icing shall be checked with no passengers on exposed decks.

3.1.2 Stability of passenger ships shall be such that in the eventual case of crowding of passengers to one side of the upper deck accessible for passengers, as near the bulkwark as possible, the angle of static heel does not exceed 10º.

3.1.3 The angle of heel on account of turning shall not exceed 10º.

In addition, the angle of heel from joint force of heeling moments M_{h1} (on account of crowding of passengers to one side of the promenade decks) and M_{h2} (normally at their disposal on turning) shall not exceed 12º.

For ships of domestic sea (coastal) navigation with the length of 24 m and above:

all new ships and existing ships of restricted areas of navigation **A-R1, A-R2, A-R2-S, A-R2-RS**, **B-R3-S**, **B-R3-RS**, the heeling moment on account of turning shall not heel the ship to an angle more than 10º.

3.1.4 The heeling moment on turning circle, in kN·m, shall be determined by the formula

$$M_R = \frac{0,2\Delta\, v_0^2}{L_{wl}}\left(z_g - \frac{d}{2}\right), \quad (3.1.4)$$

where v_0 is a ship's service speed, in m/s

Δ is a displacement, in t

L_{wl} is a length of ship on the waterline

3.1.5 When calculating ship's stability on turning and for heeling caused by crowding of passengers to one side, no account shall be taken of wind and rolling effects.

3.1.6 When determining admissible distribution of passengers crowding to one side on their promenade decks, it shall be assumed that the ship's normal operating conditions are duly observed with an allowance for the position of the equipment and arrangements and the regulations concerning the access of passengers to a particular deck area.

3.1.7 When determining the area where crowding of passengers may be permitted, the passages between benches shall be included in the calculation with factor 0.5. The area of narrow external passages between the deckhouse and the bulkwark or railing up to 0.7 m wide shall be included with factor 0.5.

3.1.8 To determine the angle of heel caused by crowding of passenger to one side, the mass of each passenger shall be assumed to be 75 kg. The assumed density of distribution of passengers is 4 persons per square metre of the free area of the deck; the height of the centre of gravity for standing passengers shall be equal to 1.0 m above the deck level and that for sitting passengers 0.3 m above the seats.

3.1.9 All calculations of the static heeling angle caused by passengers crowding to one side and by turning shall be carried out taking no account of icing, but with a correction for free surfaces of liquid cargoes as specified in 1.4.7.

3.2 DRY CARGO SHIPS

3.2.1 Stability of dry cargo ships shall be checked for the following loading conditions:

.1 ship having a draught to the summer load line with homogeneous cargo filling cargo folds, 'tween decks, coaming spaces and trunks of cargo hatches with full stores, but without liquid ballast;

.2 ship in the same condition as in 3.2.1.1, but with 10 per cent of stores and, where necessary, with liquid ballast;

.3 ship without cargo, but with full stores;

.4 ship in the same condition as in 3.2.1.3, but with 10 per cent of stores.

3.2.2 Where cargo holds of a ship in the loading conditions specified in 3.2.1.3 and 3.2.1.4 are used to additionally take liquid ballast, ship's stability with liquid ballast in these holds shall be checked. The effect of free surfaces in ship's store tanks is taken into account as per the provisions of 1.4.7 and that in holds with liquid ballast in compliance with their actual filling.

3.2.3 Where ships are normally engaged in carrying deck cargoes, their stability shall be checked for the following additional conditions:

.1 ship having a draught to the summer load line (considering 3.2.1.1) with holds and 'tween decks filled by homogeneous cargo, with deck cargo, full stores and liquid ballast, if necessary;

.2 ship in the same loading condition as in 3.2.3.1, but with 10 per cent of stores.

3.2.4 The corrected initial metacentric height of ro-ro ships in the loaded condition with icing disregarded shall not be less than 0.2 m.

3.2.5 If during the stability verification it is found out that the value of one of the parameters $\sqrt{h}/B$ and B/d at least exceeds 0.08 and 2.5, respectively, the ship's stability shall be checked additionally on the basis of the acceleration criterion as per 3.12.3. In doing so, if the calculated acceleration value a_{calc} (in fractions of g) is in excess of the maximum permissible one, the possibility of operating the ship under the appropriate loading conditions shall be specially considered by the Register. Particular loading conditions under which the ship is permitted to proceed to sea with $a_{calc} > 0.30$ shall be specified in the Information on Stability.

In the case of a ship in the ballast condition no check of the acceleration criterion may be effected.

3.2.6 In transporting non-cohesive bulk cargoes like grain having an angle of repose less than or equal to 30° as specified in the Code of Safe Practice for Solid Bulk Cargoes the stability shall comply with the provisions of the Rules for the Carriage of Grain and the requirements of Maritime Administration (if any).

3.2.7 Bulk carriers of less than $L <$ 150 m in length shall be fitted with the onboard stability instrument complying with the requirements of 1.4.12.

3.3 TIMBER CARRIERS

3.3.1 Stability of timber carriers shall be checked for the following loading conditions:

.1 ship carrying timber cargo with a prescribed stowage rate (if stowage rate of timber cargo is not specified, the calculation of stability shall be made assuming $\mu = 2.32$ m^3/t) in holds and on deck and having a draught to the summer timber load line without ballast (considering 3.2.1.1) with full stores;

.2 ship in the same condition as in 3.3.1.1, but with 10 per cent of stores and, where necessary, with liquid ballast;

.3 ship with timber cargo having the greatest stowage rate specified, in holds and on deck, with full stores, without ballast;

.4 ship in the same loading condition as in 3.3.1.3, but with 10 per cent of stores and, where necessary, with liquid ballast;

.5 ship without cargo, but with full stores;

.6 ship in the same loading condition as in 3.3.1.5, but with 10 per cent of stores.

3.3.2 The stowage of timber cargo in timber carriers shall comply with the requirements of the Load Line Rules for Sea-Going Ships as well as with the provisions of the Information on Stability or special instructions.

3.3.3 When calculating the cross-curves of stability for timber carriers, the volume of timber cargo on deck may be included in the calculation with full breadth and height and permeability of 0.25 corresponding to the stowed timber.

3.3.4 Information on Stability shall include data to enable the master to estimate the ship's stability when carrying timber cargo on deck the permeability of which differs substantially from 0.25. Where the approximate permeability is not known, at least, three values shall be taken, namely: 0.25, 0.4 and 0.6.

The latter two values specify the permeability range for the stowed round timber where the larger log diameter corresponds to the higher permeability.

3.3.5 The corrected initial metacentric height of timber carriers shall not be less than 0.1 m all through the voyage with loading conditions as mentioned under 3.3.1.1 to 3.3.1.4, and not less than 0.15 m with loading conditions as mentioned in 3.3.1.5 and 3.3.1.6.

Subject to the loading conditions as per 3.3.1.1 to 3.3.1.4, the righting lever curve of timber carriers shall be in compliance with the following specific requirements:

the area under the righting lever curve shall not be less than 0.08 m·rad to the heeling angle of 40º or up to the angle of flooding θf whichever is the less;

the maximum righting arm shall not be less than 0.25 m.

The static heeling angle due to steady wind shall not exceed 16º; criterion of the deck edge immersion angle is not applicable to timber carriers.

3.3.6 Stability calculations for a ship carrying deck timber cargo for the most unfavourable loading condition out of those specified in 3.3.1.1 to 3.3.1.4 shall be performed with regard to possible increase in mass of deck timber cargo due to absorption of water.

Where no appropriate data on the extent of water absorption by different kinds of wood are available, it is necessary to increase a mass of deck cargo by 10 per cent in the calculations. This addition in mass shall be considered as an overload and shall not be included in the ship's deadweight.

3.3.7 For ships carrying deck timber cargo intended for operation in the areas where icing is required to be considered, as well as navigating in winter within winter seasonable zones stability calculations shall be carried out with regard to possible icing.

When calculating icing the upper surface of the deck timber cargo shall be considered as if it were the deck, while its side surfaces above the bulwark shall be considered as if they were part of the design windage area. Icing rate for these surfaces shall be three times that specified in 2.4.

3.3.8 If a timber carrier is used for the carriage of other kinds of cargo, its stability shall be checked in compliance with the provisions of Section 2 and Chapter 3.2. Cross-curves of stability shall be calculated taking no account of deck timber cargo.

3.3.9 The requirements of this Chapter apply to other types of ships when they are used for the carriage of deck timber cargo.

In case the stowage of deck timber cargo does not comply with 3.3.2 with respect to fulfilment of the requirements of the Load Line Rules for Sea-Going Ships, the buoyancy of timber deck cargo shall not be taken into consideration in the calculations of stability, while the ship stability shall comply with the requirements of 2.1 to 2.3.

3.3.10 Double bottom tanks of timber carriers where fitted within midship half-length of the ship shall have adequate watertight longitudinal subdivision.

3.4 TANKERS

3.4.1 Stability of tankers carrying liquid cargoes shall be checked for the following loading conditions:

.1 ship having draught up to summer load line, fully loaded, with full stores and without liquid ballast:

.2 ship fully loaded, but with 10 per cent of stores;

.3 ship without cargo with full stores;

.4 ship in the same loading condition as in 3.4.1.3, but with 10 per cent of stores.

Account of the free surfaces effect in ship's stores tanks shall be taken as specified in 1.4.7 and in cargo tanks according to the extent of their actual filling.

Where coamings are fitted on the open parts of the tanker's decks for prevention of cargo spillage forming an enclosed space (well), such space shall be considered as filled with sea water and it shall be taken into account in calculation of correction to the initial metacentric height.

3.4.2 For refuelling tankers, stability shall be checked for additional loading condition: a ship with 75 per cent of cargoes and free surfaces in tanks for each kind of cargo, and 50 per cent of stores without liquid ballast.

3.4.3 The requirements of 3.4.2 apply to oil recovery ships as well.

3.4.4 Stability of tankers having cargo tanks or ballast tanks breadths more than 60 per cent of the ship's breadth shall comply with the following additional requirements during cargo loading/unloading operations, including the intermediate stages thereof.

3.4.4.1 When the cargo loading/unloading operations are performed in port the corrected initial metacentric height shall be not less than 0.15 м and the extent of positive intact stability shall be not less 20º.

3.4.4.2 When the cargo loading/unloading operations are performed at sea and on roadstead all requirements of this Part of the Rules shall be met.

3.4.4.3 When determining correction for the effect of free surfaces of liquids an allowance shall be simultaneously made for maximum free surface effects in all cargo, ballast and consumable tanks.

3.4.4.4 If the requirements of 3.4.4.1 and 3.4.4.2 are not met due to application of the requirements of 3.4.4.3, instructions covering the operational restrictions to satisfy the said requirements may be included into the Information on Stability subject to the consent of the Register.

3.4.4.5 Instructions given in 3.4.4.4 shall be made considering the following:

they shall be in a language understood by the crew member in charge of loading/unloading operations and shall be translated into English;

they shall not require more complicated mathematical calculations than those provided in the other sections of the Information on Stability;

they shall indicate the list of cargo and ballast tanks which may simultaneously have free surfaces at any stage of loading/unloading operations;

they shall include typical versions of loading/unloading operations to satisfy the stability requirements under any load condition provided by the Information on Stability. The versions shall contain lists of cargo and ballast tanks which may simultaneously have free surfaces during various stages of loading/unloading operations;

they shall provide instructions required for independent pre-planning loading/unloading operations, including:

maximum heights of the ship's centre of gravity in graphical and/or tabular form which enables control of compliance with the requirements of 3.4.4.1 and 3.4.4.2,

the method of expeditious assessment of effect produced on the stability by the number of tanks which simultaneously have free surfaces at any stage of loading/unloading operations;

description of means available on board for control and monitoring loading/unloading operations from the viewpoint of the effects on stability;

the method used to monitor loading/unloading operations and to give early warning of possible impeding the stability criteria;

description of means available to suspend loading/unloading operations if the stability criteria are under the threat of being impeded;

information on the possibility and procedure of using shipboard computer and various automated systems to monitor loading/unloading operations (including systems of monitoring tank filling, shipboard computer software by which calculations of trim and stability are performed, etc.);

they shall provide for correction actions to be taken in case of unexpected technical difficulties which can emerge in the course of loading/unloading operations and in case of emergency.

3.4.4.6 Provisions of the instructions formulated as per 3.4.4.5 shall be specified in the Information on Stability and also in the computer software available on board by which trim and stability calculations are performed. A copy of the instructions shall be kept at the loading/unloading control station.

3.4.5 The requirements below are applied to oil tankers of deadweight 5000 t and more.

The requirements of 3.4.4 shall not apply to the ships mentioned above.

3.4.5.1 Each oil tanker shall comply with the requirements set forth in 3.4.5.1.1 and 3.4.5.1.2 (considering instructions given in 3.4.5.1.3 and 3.4.5.1.4) for any operation draught under the worst possible loading and ballasting conditions (in compliance with good operation practice) including intermediate stages of operations with liquids. Under all conditions it is considered that there is a free surface of liquid in ballast tanks.

3.4.5.1.1 At port the corrected initial metacentric height shall be not less than 0.15 m.

3.4.5.1.2 At sea:

.1 corrected initial metacentric height shall be not less than 0.15 m.

.2 the righting lever curve shall comply with the requirements of 2.2.1.

3.4.5.1.3 While calculating stability, each cargo tank is considered to be filled up to the level at which the sum of the cargo volume moment in relation to the main plain and the inertia moment of free surface at the heel of 0º reaches its maximum. The density of cargo shall correspond to the available cargo deadweight at the displacement at which the transverse metacentre over the main plain reaches its minimum at 100 per cent of stores and 1 per cent of the total water ballast capacity.

In calculations shall be accepted the maximum value of inertia moment of liquid free surface in ballast tanks.

In calculations of the initial metacentric height, the correction for free surface of liquids shall be based on the respective inertia moments of the free surfaces at upright ship position. The righting arms may be corrected on the basis of actual corrections for free surface effect for each angle of heeling.

3.4.5.1.4 As an alternative to the loading condition specified in 3.4.5.1.3, stability is permitted to be checked at all possible combinations of cargo and ballast tank loading. In doing so, the following shall be suggested:

when making calculations, the mass, centre of gravity co-ordinates and heeling moments due to liquid overflow shall correspond to the real contents of all tanks;

the calculations shall be made considering the following assumptions:

the draughts shall be varied between the light-ship draught and scantling draught specified;

consideration shall be taken to the ship loading conditions with consumables including but not limited to fuel oil, diesel oil and fresh water corresponding to 97 per cent, 50 per cent and 10 per cent content;

for each draught, distribution and amount of the ship's consumables, the available deadweight shall comprise ballast water and cargo such that all combinations between the maximum ballast and minimum cargo and vice versa are covered. In all cases, the number of ballast and cargo tanks loaded shall be chosen to reflect the worst combination for free surfaces from the stability standpoint. Operational limits on the number and list of tanks, simultaneously having free surfaces, or their exclusion are not permitted. All ballast tanks shall have at least 1 per cent content;

consideration shall be given to cargo densities between the lowest and highest values intended to be carried;

when checking all the combinations of the ship's loading, the interval of the parametric variation shall be such that the worst conditions from the stability standpoint shall be checked.

A minimum of twenty intervals for the range of cargo and ballast content, between 1 per cent and 99 per cent of the total capacity, shall be examined. More closely spaced intervals near critical parts of the range may be necessary.

3.4.5.2 Fulfilment of the requirements given in 3.4.5.1 shall be ensured by design measures. For combinations carriers additional simple operation instructions may be allowed.

These instructions shall:

.1 be approved by the Register;

.2 contain the list of cargo and ballast tanks which may have free surfaces during any operations with liquids and in the range of possible densities of cargo, still the above mentioned stability criteria are met;

.3 be easily understandable for the officer responsible for operations with liquids;

.4 provide possibility of planning the sequence of operations with cargo and ballast;

.5 enable to compare real stability figures with the required criteria presented in graphics and tables;

.6 do not require comprehensive mathematical calculations from the officer responsible for operations with liquids;

.7 contain instructions in respect of corrective actions to be fulfilled by the office responsible for the operations with liquids in case of deviations from recommended figures and in case of accidents;

.8 be highlighted in Information on Stability and hang out in the cargo operations control station and put into the ship software performing stability calculations.

3.5 FISHING VESSELS

3.5.1 Stability of fishing vessels shall be checked in service for the following loading conditions:

.1 departure for fishing grounds with full stores;

.2 arrival at a port from fishing grounds with full catch in holds and on deck, if provision is made for the deck cargo in the design and with 10 per cent of stores;

.3 arrival at a port from fishing grounds with 20 per cent of catch in holds and on deck (if provision is made in the design for stowage of cargo on deck), 70 per cent of ice and salt rating and 10 per cent of stores;

.4 departure from fishing grounds with full catch and amount of stores ensuring the ship's draught up to the load line.

3.5.2 The amount of full catch is determined depending on the ship's type, capacity of cargo spaces and stability characteristics. It shall correspond to the load line position approved by the Register and shall be specified in stability calculations as well as in the Information.

3.5.3 For net fishing vessels, allowance shall be made for wet fishing nets on deck in the second, third and fourth loading conditions.

3.5.4 Stability of a ship, while being on fishing grounds, shall be checked for compliance with the weather criterion for the following loading conditions: a vessel engaged in fishing, with the holds open, catch and wet nets stowed on deck, 25 per cent of stores and full amount of ice and salt. For vessels where nets and catch are hauled in with the help of cargo booms, account shall also be taken of cargo which is hoisted, with the cargo weight equal to the boom safe working load. The amount of catch allowed to be stowed on deck shall be specified both in the vessel's design and the Information.

3.5.5 The ship's amplitude of roll in the loading condition specified in 3.5.4 is assumed to be 10º, and the angle of heel at which the coaming of a cargo hatch immerse is regarded as the angle of the ship's flooding through openings considered open. Wind pressure in this loading condition for vessels of unrestricted service is assumed as that for ships of restricted area of navigation **R1**, the wind pressure for vessels of restricted area of navigation **R1** as that for ships of restricted area of navigation **R2**, the wind pressure for vessels of restricted area of navigation **R2** as that for these ships reduced by 30 per cent.

For ships having a length between 24 m and 45 m, the initial wind pressure shall be taken from Table 2.1.4.1.

3.5.6 The righting lever curve for ships in the loading condition of 3.5.4 limited by the angle of flooding cutting it short as agreed with the Register need not comply with the requirements set forth in 2.2.1.

For ships, for which the righting lever curve requirements cannot be met in case when relevant fish holds partially or fully flooded, the heeling angle at which progressive flooding of fish holds may occur through hatches remaining open during fishing operations shall not be less than 20º.

3.5.7 The corrected initial metacentric height under the light ship loading condition shall not be less than 0.05 m or 0.003 of the ship's breadth, whichever is the greater.

For single-deck ships the corrected initial metacentric height shall not be less than 0.35 m. However, in case of ships with continuous superstructures and those which length exceeds 70 m, the corrected initial metacentric height may be reduced to 0.15 m.

3.5.8 Under all loading conditions, the ships stability shall comply with 3.1.2 to 3.1.5, 3.1.7 to 3.1.9, where the ships are used for processing of fish and other living resources of the sea and have a crew on board of more than 12 persons engaged in catching and processing only. As for the said requirements the crew members in question are regarded as passengers.

3.5.9 In case of icing the parameters of the righting lever curve shall comply with 2.2.

3.5.10 The catch shall be duly secured in order to prevent its shifting which may cause the dangerous heel or trim of the ship. The detachable bulkheads of fish holds, if fitted, shall be of approved type.

3.5.11 Stability of sea fishing vessels of less than 24 m in length shall be checked considering requirements of 3.9 of this Part of the Rules.

3.6 SPECIAL PURPOSE SHIPS

3.6.1 The stability of whale factory ships, fish factory ships and other ships used for processing of sea living resources and not engaged in catching the same shall be checked for the following loading conditions:

.1 ship with special personnel, full stores, and full cargo of tare and salt on board;

.2 ship with special personnel, 10 per cent of stores, and full cargo of its production on board;

.3 ship in the same loading condition as in 3.6.1.2, but with 20 per cent of production and 80 per cent of tare and salt on board;

.4 ship in the same loading condition as in 3.6.1.1, but with 25 per cent of stores and cargo being processed on board.

3.6.2 The stability of research, expeditionary, hydrographic, training and similar ships shall be checked for the loading conditions as follows:

.1 ship with special personnel and full stores on board;

.2 ship in the same loading condition as in 3.6.2.1, but with 50 per cent of stores on board;

.3 ship in the same loading condition as in 3.6.2.1, but with 10 per cent of stores on board;

.4 ship in the same loading conditions as in 3.6.2.1, 3.6.2.2 and 3.6.2.3, but with full cargo on board if the carriage of the latter is envisaged.

3.6.3 The stability of special purpose ships shall comply with the requirements of 3.1.2 to 3.1.5, 3.1.7 to 3.1.9. As for the said requirements special personnel shall be regarded as passengers.

3.6.4 For special purpose ships that are similar to supply vessels, as agreed with the Register, the requirements for the righting lever curve may be reduced as provided by 3.11.5.

3.6.5 For whale factory ships, fish factory ships and other ships used for processing of sea living resources, the requirements of 3.5.7 for initial metacentric height apply.

3.6.6 For whale factory ships, fish factory ships and other ships used for processing of sea living resources, the requirements of 3.5.9 for the righting lever curve in the case of icing apply.

3.7 TUGS

3.7.1 General

3.7.1.1 Stability of tugs shall be checked for the following loading conditions:

.1 ship with full stores;

.2 ship with 10 per cent of stores;

and for tugs provided with cargo holds, additionally:

.3 ship with full cargo in holds and full stores;

.4 ship with full cargo in holds and 10 per cent of stores.

3.7.1.2 In addition to comply with the requirements of Section 2, the tugs shall have sufficient dynamic stability to withstand the heeling effect of an assumed transverse jerk of the tow line under the same loading conditions, that is the angle of dynamic heeling θ_{d1} due to assumed jerk of the tow line shall not exceed the limits given below.

3.7.2 Tugs for inner and outer roads

3.7.2.1 The angle of dynamic heel for tugs shall not be greater than the angle of flooding or capsizing, whichever is less.

To meet this requirement, the following condition shall be met:

$$K_1 = \sqrt{l_{d\,\mathrm{cap}} / l_{d\ heel}} \geq 1.00, \qquad (3.7.2.1)$$

where l_{dcap} is an arm of dynamical stability defined as an ordinate of the dynamic stability curve for a tug at the angle of heel equal to the angle of flooding (refer to 3.7.2.3) or capsizing angle θ'_{cap} determined disregarding roll, whichever is less, in m;

l_{dheel} is a dynamic heeling arm characterizing the assumed jerk effect of the tow line, in m.

3.7.2.2 The dynamic heeling arm l_{dheel}, in m, shall be determined by the formula

$$l_{dheel} = l'_v \left(1 + 2\frac{d}{B}\right) \frac{b^2}{(1+c^2)\,(1+c^2+b^2)}$$

(3.7.2.2-1)

where l'_v is the height of the velocity hydraulic pressure head, in m. The values of l'_v are obtained from Table 3.7.2.2 depending on the power N_e of the ship's main engines;

$$c = 4.55 x_H / L; \qquad (3.7.2.2\text{-}2)$$

$$b = \frac{(z_H / B) - a}{e}; \qquad (3.7.2.2\text{-}3)$$

where a and e are determined by the formulae:

$$a = \frac{0.2 + 0.3(2d/B)^2 + \dfrac{Z_g}{B}}{1 + 2\dfrac{d}{B}}; \quad (3.7.2.2\text{-}4)$$

$$e = 0.145 + 0.2\frac{Z_g}{B} + 0.06\frac{B}{2d} \quad (3.7.2.2\text{-}5)$$

Table 3.7.2.2 **Height of velocity hydraulic pressure head** l'_v

N_e, in kW	l'_v, in m	N_e, in kW	l'_v, in m
0 – 150	0.0862	900	0.147
300	0.0903	1050	0.180
450	0.096	1200	0.220
600	0.104	1350	0.268
750	0.122	1500 and over	0.319

3.7.2.3 When checking stability of tugs for the tow line jerk effect, the angle of flooding shall be determined assuming that all doors leading to engine and boiler casings and to the upper deck superstructures, as well as the doors of all companionways to the spaces below the upper deck, irrespective of their design, are open.

3.7.2.4 When checking stability of tugs for the tow line jerk effect, no account shall be taken of icing and free surfaces of liquid cargoes.

3.7.2.5 If special appliances are available for shifting the tow hook downwards of abaft, with the tow line athwartships, the assumption of x_H and z_H, differing from values given above is subject to special consideration by the Register in each particular case.

3.7.3 Tugs for ocean towage

3.7.3.1 The angle of heel for tugs due to the tow line jerk under rolling shall not exceed the angle corresponding to the maximum of the righting lever curve or the angle of flooding, whichever is less.

To meet this condition, the following requirement shall be met:

$$K_2 = \sqrt{l_{d\,\max} / l_{d\,\text{heel}}} - \Delta K \geq 1.0, \qquad (3.7.3.1\text{-}1)$$

where $l_{d\,\max}$ is an ordinate of the dynamical stability curve at an angle of heel corresponding to the maximum of the righting lever curve of the angle of flooding, whichever is less, in m;

$l_{d\,\text{heel}}$ is a dynamic heeling arm determined as per 3.7.2.2., in m. l'_v is assumed to be 0.20 m;

ΔK is a component of K_2 used to allow for the effect of rolling on resultant angle of heel and determined by the formula

$$\Delta K = 0{,}03\theta_{2r}\left[\frac{1+c^2}{b} - \frac{1}{e}\left(a - \frac{Z_g}{B}\right)\right] \times$$

$$\times \sqrt{\frac{h_0}{1 + 2\dfrac{d}{B}}}, \qquad (3.7.3.1\text{-}2)$$

where θ_{2r} is to be determined as per 2.1.5, in deg.;

c, b, a, e are to be determined as per 3.7.2.2.

The requirements of 3.7.2.3 are not apply to tugs for ocean towage.

3.7.3.2 When checking stability of tugs:

.1 3.7.2.5 is valid;

.2 for righting lever curves with two maxima or an extended horizontal region, the value of the angle at the first maximum or that corresponding to the middle of the horizontal region shall be taken as the angle of maximum specified in 3.7.3.1;

.3 stability for the tow line jerk effect shall be checked taking no account of the free surfaces of liquid cargoes.

3.7.3.3 When checking stability of tugs for compliance with the requirements of Section 2 and this Chapter, the icing rates are assumed to be as follows:

.1 for tags specially designed for salvage operations, twice as much those given in 2.4;

.2 for other tugs, as per 2.4.

3.7.3.4 Where a tug for ocean towage may be used for inner and outer road operations as well, compliance of such a tug with 3.7.2 is subject to special consideration by the Register.

3.7.4 Escort tugs

3.7.4.1 Stability for escort tugs apart from 3.7.1 to 3.7.3 shall comply with the following requirements.

3.7.4.2 The ratio of reduction moment at the region of righting lever curve from the angle of heel, caused by the maximum restraining force F_s (refer to Fig.9.1.2.1, Part III "Equipment, Arrangements and Outfit") to the angle of heel 20°, to the heeling moment from the same force at the same region of angles of heel shall not be less than 1.25.

3.7.4.3 The ratio of reduction moment at the region of righting lever curve from 0° of heel to the angle of flooding or angle of heel 40°, whichever is less, to the heeling moment caused by the maximum restraining force F_s (refer to Fig. 9.1.2.1, Part III "Equipment, Arrangements and Outfit") at the same region of angles of heel shall not be less than 1.4.

3.7.4.4 The angle of heel for escort tug suffered by the maximum heeling moment due to the tow line jerk under rolling shall not exceed an angle of maximum of the righting lever curve θ_{max} or the angle of flooding θ_f, whichever is less.

To meet this condition, the following requirement shall be met (refer to Fig. 3.7.4.3)

$$K_3 = \sqrt{\frac{b+c}{a+c}} \geq 1{,}0 \quad (3.7.4.3)$$

where a is a region limited by a reduction righting lever curve $l(\theta)$, horizontal line corresponding to the heeling arm $(l + l_h)$, and angle of heel to be equal to $\theta_1 - \theta_{2r}$;

b is a region limited above by a reduction righting lever curve $l(\theta)$, and limited below by a horizontal line corresponding to the heeling arm $(l + l_h)$, to the right – by the angle of maximum of the righting lever curve θ_{max} or angle of flooding θ_f, whichever is less;

c is a region limited from the left by a reduction righting lever curve $l(\theta)$, above - by a horizontal line corresponding to the heeling arm $(l + l_h)$, from the right - by an angle of maximum of the righting lever curve θ_{max} or angle of flooding θ_f, whichever is less.

When defining the angle of flooding θ_f, it is necessary to follow the guidelines for determination of the angle of flooding given in 1.2.

The heeling arm l_h, in m, characterizing effect of the assumed tow line jerk shall be defined by the formula

$$l_h = 0,2\left(1+2\frac{d}{B}\right)\frac{b^2}{(1+c^2)\,(1+c^2+b^2)}\times$$

$$\times\frac{57,5}{(\theta_{2r}-\theta_0+\theta_{lim})},\quad (3.7.4.3)$$

where *d, B* are draught and width of a tug, respectively;

c,b shall be calculated under 3.7.2.2;

θ_{lim} = θ_{max} or θ_f, whichever is less;

3.7.4.5 The angle of dynamic heel for escort tug that may appear during escort operations in case of a random breakdown of the main propulsion engine shall not exceed the angle of maximum of the righting lever curve θ_{max} or angle of flooding θ_f, whichever is less.

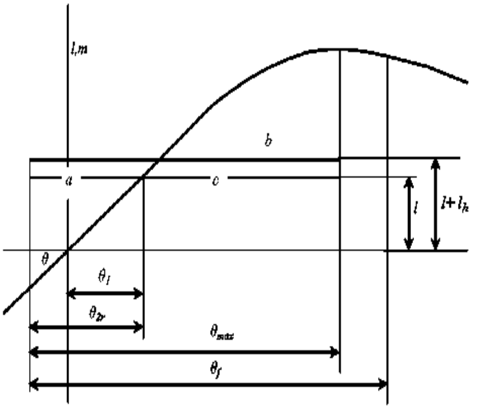


Fig. 3.7.4.3

3.7.4.6 At the stage of design, the value of the maximum reduction force F_s and angle of heel from its force may be determined by the results of the model tests or calculation method. After completion of the tug construction the value of the maximum reduction force F_s and the maximum possible angle of heel shall be clarified basing on the results of the actual tests.

3.8 VESSELS OF DREDGING FLEET

3.8.1 Working conditions

Working conditions means operation of a vessel according to its purpose with the prescribed operational zones:

.1 Zone 1 - coastal zone up to 20 miles from the coast;

.2 Zone 2 - zone including the prescribed area of navigation of a vessel.

3.8.2 Loading conditions

Subject to the type of a vessel of dredging fleet and its dredging gear the following conditions of loading shall be considered.

3.8.2.1 For vessels of dredging fleet of all types during voyages:

.1 vessel with full stores, without spoil, dredging gear being secured for sea;

.2 vessel in the same loading condition as in 3.8.2.1.1, but with 10 per cent of stores.

3.8.2.2 In operating conditions for hopper dredgers and hopper barges:

.1 vessel with full stores, with spoil, dredging gear being secured for sea;

.2 vessel in the same loading condition as in 3.8.2.2.1, but with 10 per cent of stores.

For hopper dredgers equipped with grab cranes additional loading conditions such as with grab cranes operating from one side and crane boom being in the athwartship plane, with spoil in the grab, with maximum loading moment and also with the highest position of the boom with due regard to initial heel shall be considered. These conditions shall be considered for a vessel with 10 per cent of stores and full stores, both with spoil and without it.

N o t e s: 1. The mass of spoil in the grab is taken to be 1.6*V* t, where *V* is the volume of the grab, in m^3.

2. The quantity of spoil in the hopper and the position of the centre of gravity shall be determined assuming that the hopper is filled with homogeneous spoil up to the level of the upper discharge holes or the upper coaming edge, if the discharge holes are not provided, with the vessel having a draught up to the load line permitted when dredging.

3.8.2.3 In operating conditions for dredgers equipped with bucket ladder:

.1 vessel with full stores, with spoil in buckets, ladder being secured for sea;

.2 vessel in the same loading condition as in 3.8.2.3.1, but with 10 per cent of stores.

Note. Spoil is taken into the buckets of the upper part of the ladder (from upper to lower drum). The mass of spoil in each bucket is taken to be 2*V* t, where *V* is the full volume of the bucket, in m^3.

3.8.2.4 In operating conditions for dredgers, other than those equipped with bucket ladder:

.1 vessel with full stores, with dredging gear in the highest position in normal operation;

.2 vessel in the same loading condition as in 3.8.2.4.1, but with 10 per cent of stores.

For dredgers equipped with grab cranes the additional loading conditions shall be considered as per 3.8.2.2.

Notes: 1. Spoil pipeline within the vessel is assumed to be filled with spoil having density equal to 1.3 t/m^3.

2. The mass of spoil in the grab (bucket) is assumed to be 1.6*V* t, where *V* is the volume of the grab (bucket), in m^3.

3.8.3 Calculation of cross-curves of stability and inclining test

3.8.3.1 When calculating cross-curves of stability for vessels of dredging fleet, the manholes of air spaces may be considered closed irrespective of the coaming height if they are fitted with covers conforming to 7.9, Part III "Equipment, Arrangements and Outfit".

3.8.3.2 Hopper barges, dredgers and other vessels in which the watertight integrity of their hoppers cannot be achieved due to the structural peculiarities may be inclined with water in the hoppers which communicates easily with sea water.

3.8.4 Checking of stability in working conditions and during voyages

3.8.4.1 Stability of vessels of dredging fleet during voyages shall be calculated having regard to the area of navigation prescribed to the vessel in question. To be stated both in the specification and in the Information on Stability are the conditions of voyages, if any (ballast water available, extent to which the dredging gear is dismantled, the position of the ladder, the possibility of spoil transportation in the hopper beyond the limits of 20-mile coastal zone, etc.). The dredgers equipped with a ladder may undertake voyages in the unrestricted area of navigation only with the bucket chain dismantled.

3.8.4.2 When calculating stability of vessels of dredging fleet under working conditions, the following is assumed:

.1 in Zone 1 wind pressure shall be taken: for vessels of unrestricted service - as for ships of restricted area of navigation **R1**, for vessels of restricted area of navigation **R1** – as for this area, but reduced by 25 per cent, for other areas of navigation – as for restricted area of navigation **R2**; amplitude of roll - as for restricted areas of navigation;

.2 in Zone 2 wind pressure and amplitude of roll shall be taken as per the area of navigation prescribed for the vessel in question.

3.8.4.3 Amplitude of roll of the dredgers shall be determined in compliance with 2.1.5

For restricted areas of navigation **R1** and **R2** amplitude of roll determined by formula (2.1.5.1) shall be multiplied by factor X_3, the value of which is taken from Table 3.8.4.3.

For hopper dredgers and hopper barges having bottom recesses for flap factor X_1 is taken from the Table 2.1.5.1-1 for the ratio B/d, multiplied by coefficient $(\nabla+\nabla_B)/\nabla$, where ∇ is the volume displacement of the vessel with no regard to bottom recess, in m^3, ∇_B is the volume of bottom recess, in m^3.

3.8.4.4 Stability of dredgers and hopper dredgers equipped with grab cranes when additional loading conditions (refer to 3.8.2.2) are considered shall meet the requirements of 4.1.

Table 3.8.4.3 **Factor X_3**

$\sqrt{h_0/B}$	≤ 0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	≥ 0.20
X_3	1.27	1.23	1.16	1.08	1.05	1.04	1.03	1.02	1.01	1.00	1.00	1.01	1.03	1.05	1.07	1.10	1.13

3.8.4.5 Stability of hopper dredgers and hopper barges whose construction of bottom flaps and their drive does not prevent the possibility of spoil discharge from one side shall be checked with due regard to such discharge only for compliance with weather criterion as specified in 3.8.4.6 and 3.8.4.7 for the most unfavourable loading condition out of first and second (refer to 3.8.2.2):

.1 where the spoil in the hopper has a density less than 1.3 t/m^3 with the amplitude of roll of 10° with regard to the static heeling angle equal to the sum of the static heeling due to spoil discharge θ_{sp} and the static heeling resulting from steady wind θ_{w1} as per 2.1.2.2;

.2 where the spoil in the hopper has a density equal to, or more than 1.3 t/m^3 with due regard to the dynamic character of discharge, with an amplitude of roll equal to the sum of 10º and the maximum amplitude of vessel's rolling θ_{3r} with respect to static heeling which, in its turn, is equal to the sum of heeling due to spoil discharge θ_{sp} and the heeling resulting from steady wind θ_{w1} in compliance with 2.1.2.2;

The value of θ_{3r}, in deg., is determined by the formula

$$\theta_{3r}=0.2\theta_{sp} \qquad (3.8.4.5.2)$$

3.8.4.6 The value of horizontal shifting of the vessel's centre of gravity y_g, in m, when discharging half the spoil from one side out of fully loaded hopper, is determined by the formula

$$y_g = Py/(2\Delta), \qquad (3.8.4.6\text{-}1)$$

where P is the total mass of spoil in the hopper, in t;

y is a distance from the centre of gravity of spoil discharged from one side to the centreline, in m;

$$\Delta = \Delta_{max} - P/2, \qquad (3.8.4.6\text{-}2)$$

where Δ_{max} is the vessel's displacement prior to spoil discharge, in t.

3.8.4.7 The vessel's curve of statical stability is calculated by formula

$$l_1 = l - y_g \cos\theta; \qquad (3.8.4.7)$$

where l is an arm of statical stability with the vessel's displacement Δ_{max}, calculated assuming that the vessel's centre of gravity coincides with the centreline.

3.8.4.8 When spoil is discharged by long chute or conveyor methods, stability of a dredger shall be checked for the case of statical action of the moment due to the mass forces of the long chute or the conveyor (in the athwartship plane) filled with spoil (with no regard to the waves and wind effects). In this case, the vessel's stability is considered to be adequate, if maximum statical heel is not more than the angle of flooding or the angle at which the freeboard becomes equal to 300 mm, whichever is less.

3.8.5 Effect of liquid cargoes

When calculating the effect of liquid cargoes as specified in 1.4.7 for hopper dredgers and hopper barges, it shall be assumed that:

.1 for a vessel with spoil having density over 1.3 t/m^3, the spoil is regarded as solid non-overflowing cargo; the lever of statical and dynamical stability is determined for the constant displacement and position of the spoil centre of gravity in the hopper;

.2 for a vessel with spoil having density equal to, or less than 1.3 t/m^3, the spoil is regarded as liquid cargo; the lever of statical and dynamic stability is determined at the variable displacement and position of the spoil centre of gravity, taking into account the spoil flowing overboard and reduction of the vessel's draught.

No such calculation is carried out if the vessel is provided with a longitudinal bulkhead in the hopper. The spoil in the latter case being regarded as solid cargo;

.3 for a vessel without spoil the hopper is in communication with sea water, that is flaps or valves are open; the lever of statical and dynamical stability is determined for the constant displacement (as for a damaged vessel).

3.8.6 Effect of dredging gear icing

When estimating the effect of icing of vessels of dredging fleet, the horizontal projection of dredging gear is added to the area of horizontal projection of decks (the centreline projection being included in the windage area). The vertical moment due to this additional ice load is determined by the centre of gravity elevation of the projection of the dredging gear in its working or secured for sea position to the centreline.

3.8.7 Righting lever curve

3.8.7.1 The righting lever curve of hopper dredgers and hopper barges during voyages and under working conditions shall meet the requirements of 2.2.

3.8.7.2 The righting lever curve of dredgers equipped with bucket ladder for all loading conditions specified in 3.8.2, as well as when taking into account icing, shall comply with the following requirements:

.1 the angle of vanishing stability θ_v shall be not less than 50°;

.2 the maximum righting arm with angle θ_m of not less than 25° shall be:

when vessels are operating in Zone 1, not less than 0.25 m;

during voyages, passages and when operating in Zone 2, not less than 0.4 m;

3.8.7.3 For bucket dredgers having B/D > 2.50, angles θ_v and θ_m may be reduced as compared to those required under 3.8.7.2 by the following values:

.1 for the angle of vanishing stability, by the value $\delta\theta_v$, to be determined by the following formula depending on the *B/D* ratio and the weather criterion *K* and provided the reduction by every 1º is accompanied with an increase of l_{max} by 0.01 m as compared to its normative value:

$$\delta\theta_v = 25^\circ\left(\frac{B}{D} - 2.5\right)(K - 1). \quad (3.8.7.3\text{-}1)$$

Where *B/D* = 3.0 subject to *B/D* > 3.0 and *K* = 1.5 subject to *K* > 1.5.

The value of $\delta\theta_v$ is rounded off to the nearest integer;

.2 for the angle corresponding to the maximum lever of the curve, by a value equal to half the reduction value of the angle of vanishing stability;

.3 for dredgers of unrestricted service the reduction of angles θ_m and θ_v is not permitted.

3.9 SHIPS UNDER 24 M IN LENGTH

3.9.1 When determining the cross-curves of stability, it is possible to take into consideration deckhouses of the first tier only which conform to 1.4.2.3.1 and from which there is either an additional exit to the deck above or exits to both sides.

3.9.2 Stability as for weather criterion shall not be checked. However, for the operation of the ships, restrictions on the distance to the port of refuge and the sea shall be introduced.

For small ships, restrictions on the area and conditions of navigation shall be set down and included in the Information on Stability.

.1 for ships of less than 15 m in length and passenger ships of less than 24 m in length restricted area of navigation **R3**, **R3-IN** and **D-R3-S**, **D-R3-RS**, respectively, may be prescribed.

For ships 15 m to 20 m in length, other than passenger ships, an area of navigation not higher than **R2** may be prescribed.

For ships 20 m to 24 m in length, other than passenger ships, an area of navigation not higher than **R1** may be prescribed.

.2 Non-passenger ships of less than 15 m in length may proceed to sea and be en route at sea state not more than 4, ships 15 m to 20 m in length – not more than 5; ships 20 m to 24 m – not more than 6.

.3 Passenger ships of less than 20 m in length may proceed to sea and be en route at sea state not more than 3; ships 20 m to 24 m – not more than 4.

.4 Considering stability and seaworthiness of ships and depending on the reliable provision of the area of navigation concerned with forecasts, as well as on the operating experience for ships of similar type and the same or approximately the same dimensions, available for this area of navigation, the Register may change the restrictions on the area of navigation and permissible area state specified in 3.9.2.1 to 3.9.2.3.

.5 When determining maximum permissible sea state for small craft carried on depot ships (for example, small fishing boats carried on mother ships), in addition to the provisions of 3.9.2.2 and 3.9.2.3, maximum sea state at which the craft can be safely lifted on board the depot ship shall be taken into account.

.6 At the discretion of the Register, additional restrictions shall be introduced in zones of special sea conditions.

Referred to such zones are:

zones of surf (breaking) waves);

zones of local abrupt increase in wave height and steepness (bars in estuaries, tossing, etc.).

Zones of special conditions are sent on the basis of the data of local hydrometeorological and hydrographic offices.

3.9.3 Reserved

3.9.4 The angle of flooding shall be not less than 40°.

3.9.5 The righting lever curve of a fishing vessel, when on fishing grounds, under the loading conditions stated in 3.5.4 may not conform to the requirements of 2.2.1 for the maximum arm. Under these loading conditions the maximum righting arm shall not be less than 0.2 m.

3.9.6 Under all loading conditions, the corrected initial metacentric height shall not be less than 0.5 м, except for the light ship condition (refer to 2.3.1) and the fishing vessels when under loading conditions stated in 3.5.4 for which it shall be not less than 0.35 м.

3.9.7 The initial stability of fishing vessels hauling in the nets and catch with cargo booms shall be sufficient (under loading conditions stated in 3.5.4 as well) to ensure that the static heel angle of the ship when handling the nets and operating the cargo boom at its maximum outreach would not exceed 10º or the angle at which the deck is immersed (whichever is less).

3.9.8 Operation of the ships under conditions of eventual icing shall not, in general, be permitted.

Where due to the mode of operation and purpose the possibility of sailing into regions where icing might occur cannot be completely ruled out for a ship, the values of initial metacentric height and other parameters of righting lever curves drawn taking icing into account shall not be less than those stated in 2.2, 3.9.3, 3.9.4 and 3.9.6.

3.9.9 Information on Stability shall include indications of the permissible speed and angle of rudder shifting in turning. The permissible values of initial turning speed and angle of rudder shifting shall be determined by tests during acceptance trials of the leading ship assuming that the list of the ship in steady turning shall not exceed:

.1 for non-passenger ships, the angle at which the freeboard deck is immersed or 12º, whichever is less;

.2 for passenger ships, taking into account additionally effect of the simulated heeling moment due to passengers crowding to one side (to be determined as per 3.1.2), the angle at which the freeboard deck is immersed or 15º, whichever is less.

The Register may apply the provisions of 3.9.9.2 to the stability of non-passenger ships (for example, when persons not belonging to the ship's crew are on board).

The requirements of 3.1.3 and 3.1.4 shall not apply to the ships of less than 24 m in length.

3.9.10 The initial stability of passenger ships shall be checked for conformity with 3.1.2. The angle of heel due to passengers crowding to one side shall not be greater than the angle corresponding to 0.1 m freeboard before the deck is immersed or 12º, whichever is less.

If necessary, the Register may apply the requirements of 3.1.2 to the stability of non-passenger ships (for instance, when persons are on board who are not members of the regular crew). In this case, the heel is determined on the assumption that all persons crowd to one side who are not engaged in handling the ship.

3.9.11 The Information on Stability shall specify that when the ship is under way in following sea, with the wave length equal to, or exceeding the length of the ship, its speed v_s, in knots, shall not be greater than determined by the formula

$$v_s = 1.4\sqrt{L}, \qquad (3.9.11)$$

where L is a length of the ship, in m.

3.9.12 Application of the requirements of 3.7 to the stability of tugs under 24 m in length is subject to special consideration by the Register in each case.

3.10 CONTAINER SHIPS

3.10.1 In calculating stability of container ships, the vertical centre of gravity position of each container shall be taken equal to half the height of the container of the type concerned.

3.10.2 Stability of container ships shall be checked for the following loading conditions:

.1 ship with maximum number of containers, each loaded container having the mass equal to one and the same part of the maximum gross mass for each type of containers with full stores at the draught up to the summer load line;

.2 ship in the same loading condition as in 3.10.2.1, but with 10 per cent of stores;

.3 ship with maximum number of containers, each loaded container having the mass equal to 0.6 of the maximum gross mass for each type of containers, with full stores;

.4 ship in the same loading condition as in 3.10.2.3, but with 10 per cent of stores;

.5 ship with containers, each loaded container having the mass equal to the maximum gross mass for each type of containers with full stores at the draught up to the summer load line;

.6 ship in the same loading condition as in 3.10.2.5, but with 10 per cent of stores;

.7 ship with maximum number of empty containers, but with full stores;

.8 ship in the same loading condition as in 3.10.2.7, but with 10 per cent of stores;

.9 ship without cargo, but with full stores;

.10 ship in the same loading condition as in 3.10.2.9, but with 10 per cent of stores.

When determining the arrangement of containers on board under the loading conditions mentioned above, the allowable loads upon the hull structures shall be considered.

3.10.3 If other loading conditions different from those listed in 3.10.2, are provided in the technical assignment, stability calculations shall also be made for such conditions with full stores and 10 per cent of stores.

3.10.4 Stability of container ships for any loading condition with containers shall be such that a heeling angle on steady turning or under the effect of continuous beam wind as determined from the statical stability curve does not exceed half the angle at which the freeboard deck immerses; in any case, the heeling angle shall not exceed 16º.

Where the deck cargo of containers is located on cargo hatch covers only, on agreement with the Register, the angle at which the hatch coaming edge or a container is immersed, whichever angle is less, may be taken instead of the angle at which the upper deck edge is immersed (provided the containers protrude beyond the coaming in question).

3.10.5 The heeling moment on steady turning, in kN·m, is determined by the formula

$$M = \frac{0.037\Delta v_s^2}{L}\left(z_g - \frac{d}{2}\right), \quad (3.10.5)$$

where v_s is ship's speed before entering into steady turning, in knots;

Δ is a displacement, in t.

3.10.6 The moment lever due to wind pressure used to determine the heeling angle according to 3.10.4 shall be determined by Formula (2.1.4.1-1), in which p_v is taken equal to that for ship of unrestricted service given in Table 2.1.4.1.

3.10.7 All calculations of statical heeling angle under the effect of beam wind or turning shall be made with no regard for icing, but having regard for the free surface effect of liquid cargoes as required by 1.4.7.

3.10.8 Where the requirement of 3.10.4 to the value of the angle of heel at steady turning of a ship at operational speed cannot be complied with, Information on Stability shall contain the maximum permissible ship's speed prior to steady turning determined at a condition of not exceeding the angle of heel specified in 3.10.4.

3.10.9 Container ships shall be equipped with tanks or other specific facilities approved by the Register, which permit to check the initial stability of the ship, bearing in mind the Register approved requirements for the in-service inclining test.

3.10.10 Requirements of this Part shall apply to ships of other types used for the carriages of cargoes in containers on deck.

Where acting in line with 3.10.2.1 and 3.10.2.5 it is not possible to load the ship to the summer load line the ship may be considered for the relevant loading conditions at the maximum draft possible.

3.11 SUPPLY VESSELS

3.11.1 The requirements of this Chapter apply to supply vessels 24 to 100 m in length. If the length of the supply vessel is over 100 m, the requirements for its stability shall be specially considered by the Register.

3.11.2 The stability of supply vessels shall be checked considering the trim that accompanies the inclination.

3.11.3 In addition to the loading conditions listed in 1.4.8.2, the stability of supply vessels shall be checked for the following loading conditions:

.1 ship with full stores and full deck cargo having the greatest volume per weight unit prescribed by the technical assignment in the most unfourable case of distribution of the rest of the cargo (when pipes are carried as deck cargo - taking the water entering the pipes into consideration);

.2 ship in the same loading condition as under 3.11.3.1, but with 10 per cent of stores.

3.11.4 The volume of water V_a, lingering in the pipes carried on deck shall be determined by Formula (3.11.4) proceeding from the total volume of the pipe pile V_{at} and the ratio of the freeboard amidships f to the ship's length L. The volume of a pipe pile shall be regarded as the sum of the inner volumes of the pipes and spaces between them.

$$V_a = \begin{cases} 0{,}3V_{at}, \text{якщо } \dfrac{f}{L} \le 0{,}015; \\ \left(0{,}5 - \dfrac{40}{3}\dfrac{f}{L}\right)V_{at}, \\ \text{якщо } 0{,}015 < \dfrac{f}{L} < 0{,}03; \\ 0{,}1V_{at}, \text{якщо } \dfrac{f}{L} \ge 0{,}03. \end{cases} \quad (3.11.4)$$

Reducing of the design value for the volume of water in the pipes, where they are plugged or where the pipe line is higher than 0.4 of the draught, shall be determined as agreed with the Register.

3.11.5 In case of supply vessels having $B/D > 2$, the angle corresponding to the maximum righting arm may be reduced to 25°; the maximum lever l_{max}, in m, and the weather criterion K values shall be not less than the greatest values determined by the following formulae:

$$l_{max} \ge 0.25 + 0.005(60^\circ - \theta_v) \text{ or}$$

$$l_{max} \ge 0.25 + 0.01(30^\circ - \theta_m); \quad (3.11.5\text{-}1)$$

$$K \ge 1 + 0.1(30^\circ - \theta_m), \text{ or}$$

$$K \ge 1 + 0.05(60^\circ - \theta_v) \quad (3.11.5\text{-}2)$$

3.11.6 When the effect of icing is computed, the upper surface of the deck cargo shall be considered as the deck, and its lateral area projection above the bulwark - as a part of the design windage area.

The icing allowance shall be assumed as per 2.4.

3.11.7 For supply vessels operating in the areas where icing is possible, the ice and water in the pipes should be considered simultaneously when making stability calculations for the carriage of pipes on deck.

The icing of pipes carried on deck shall be determined as follows:

the mass of ice M_{ice} inside the pipe pile is determined by the formula

$$M_{ice} = \sum_{i=1}^{k} m_{ice\,i}\, n_i ,$$

where $m_{ice\,i}$ is a mass of ice per one pipe obtained from Table 3.11.7;

n_i is quantity of pipes of the i-th diameter;

k is a number of standard pipe sizes with regard to diameter.

When calculating the mass of ice on the outer surfaces of a pipe line, the area of the upper and the side surfaces shall be determined taking the curvature of the pipe surface in the pile into consideration.

The rate of icing shall be taken as per 2.4.

Table 3.11.7 **Rate of icing**

Pipe diameter, in m;	0.05	0.1	0.2	0.3	0.4	0.5	0.6
Ice mass per one pipe, in kg	0.2	2.1	26.7	125	376	899	1831

Note. For pipes of intermediate diameters, the mass of ice is determined by interpolation.

3.11.8 Supply vessels which may be engaged in towing operations as well shall comply with 3.7.

Besides, arrangements for quick releasing of the tow line shall be provided on board.

3.11.9 Supply vessels which may be engaged in operation of lifting the anchors of mobile offshore drilling unites as well shall comply with the requirements of 4.1.

3.11.10 Requirements of the present Chapter shall apply to other types of vessels fit for carrying pipes as deck cargo.

3.11.11 A minimum freeboard at the stern of at least 0.005*L* shall be maintained in all operation conditions.

3.12 SHIPS OF COMBINED (RIVER-SEA) NAVIGATION

3.12.1 Stability of ships of river-sea navigation (restricted areas of navigation **R2-RS**, **R2-RS(4,5)** and **R3-RS** as per 2.2.5, Part I "Classification") shall meet the requirements of Sections 1 and 2, as well as additional requirements of Section 3 (depending upon the purpose of the ship).

Moreover, the stability of dry cargo ships with restricted area of navigation **R2-RSN** shall be checked by acceleration criterion in compliance with 3.12.3.

3.12.2 The stability of dry cargo ships shall be checked for the loading conditions given in 3.2, as well as for the case of holds partly filled with heavy cargoes (ore, scrap metal, etc.) at the draught to the load line.

3.12.3 The stability as concerns the acceleration criterion *K** is considered satisfactory if in the loading condition under consideration the calculated acceleration (in fractions of *g*) does not exceed the permissible value, i.e. the following condition is fulfilled:

$$K^* = 0.3 / a_{\text{calc}} \geq 1, \qquad (3.12.3)$$

Table 3.12.3 **Coefficient k_θ**

B/d	≤2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	≥ 6.5
k_θ	1.0	1.08	1.11	1.11	1.20	1.30	1.45	1.56	1.61

where a_{calc} is a calculated value of acceleration (in fractions of *g*) determined by the formula

$$a_{\text{розр}} = 0,0105 \frac{h_0}{c^2 B} k_\theta \theta_r .$$

where θ_r is a calculated amplitude of roll determined as per 2.1.5, in deg.;

h_0 is an initial metacentric height regardless of the correction for the liquid cargo free surfaces;

c is an inertia coefficient determined as per 2.1.5.1;

k_θ is a coefficient considering the peculiarities of roll for ships of river-sea navigation taken from Table 3.12.3.

3.12.4 In certain cases, upon well-grounded presentation by the shipowner, the Register may allow the operation of a ship with the criterion *K** < 1.

In these cases, an additional wave height restriction shall be introduced. The permissible wave height with 3 per cent probability of exceeding level is estimated proceeding from the value of the criterion *K** as per Table 3.12.4.

The specific loading conditions with *K** < 1 shall be stated in the Information on Stability.

Table 3.12.4 **Permissible wave height with 3 per cent probability of exceeding level**

*K**	1.0 - 0.75	≤ 0.75
Permissible wave height with 3 per cent probability of exceeding level	5.0	4.0

4. REQUIREMENTS FOR THE STABILITY OF FLOATING CRANES, CRANE SHIPS, TRANSPORT PONTOONS, DOCKS AND BERTH-CONNECTED SHIPS

4.1 FLOATING CRANES AND CRANE SHIPS[6]

4.1.1 General

4.1.1.1 The requirements of the Chapter cover floating cranes and crane ships for which the hook load mass exceeds 0.02Δ, in t, under one type of loading conditions at least as provided by 4.1.3.1, or at least one of the following condition is met:

$$|y_g| > 0.05h \qquad (4.1.1.1\text{-}1)$$

or

$$|x_g - x_c| > 0.025H \qquad (4.1.1.1\text{-}2)$$

The Register may demand compliance with the requirements of this Chapter even where the above conditions are not met.

4.1.1.2 As far as unique (single-time, episodic) cargo handling operations are concerned, particular requirements for the stability of floating cranes and crane ships may be omitted or lowered, if a project of the operations is developed and it is demonstrated to the satisfaction of the Register that special technical and organizational measures have been taken to avoid certain dangerous situations (load drop, etc.).

4.1.1.3 The design centre of gravity position of the load on the hook is assumed to be at the point of its suspension from the boom is to be considered. If cargo handling operations are carried out using a compound catenary suspension, i.e. two hooks (bifilar suspension), three hooks (trifilar suspension), etc., or the crane structure has an anti-swaying device, or the movement of suspended cargo is limited with the considered range of the floating crane/crane ship inclination angles, the stability shall be verified bearing in mind the actual shift of the cargo mass centre at inclination.

Boom radius is the distance between a vertical line drawn through the cargo suspension point with the floating foundation in the upright position and trimmed on an even keel, and determined up to:

axis of the slewing crane structure rotation;

axis of rotation joint of the non-slewing crane structure boom.

For non-slewing crane structures intended for boom operation in the longitudinal plane, the stability shall be verified with regard for the possibility of unsymmetrical loading on the hooks.

4.1.2 Design conditions:

.1 working condition (cargo handling operations and carriage of cargo in

[6] Relevant paragraphs of the Chapter contain precise instructions as for applicability of the paragraphs to both floating cranes and crane ships, or exclusively to floating cranes, or exclusively to crane ships respectively. In the absence of such instructions in the paragraph heading and texts, the requirements will be equally applicable to floating cranes and crane ships.

the assigned area of navigation and with the boom not secured for sea);

.2 voyage (navigation and lay-up within assigned area of navigation including both with cargo on deck and/or in hold and with the boom secured for sea);

.3 non-working condition (lay-up in port with machinery out of operation under the most unfourable loading conditions in respect of stability and with the boom positions when there is no load on hook);

.4 passage (navigation outside the assigned area of navigation by special permission of the Register after conversion on the basis of the project approved by the Register).

4.1.3 Loading conditions

4.1.3.1 Under working condition stability shall be verified without regard for icing and with liquid ballasting where necessary for the following loading conditions:

.1 maximum hook load with the maximum jib radius for the load at the specified slewing angle of the crane structure φ with regard to the centreline of the floating crane/crane ship:

with full load and full stores;

with full load and 10 per cent of stores;

without load and with full stores;

without load and with 10 per cent of stores;

.2 no hook load, highest position of the crane structure boom at the specified slewing angle of the boom φ:

with full load and full stores;

with full load and 10 per cent of stores;

without load and with full stores;

without load and with 10 per cent of stores;

.3 load drop, i.e. a quick release of the crane structure boom from the load suspended from the hook. In case of load drop, to be verified are the most unfavourable loading conditions with regard to stability, taking into consideration the possibility of unsymmetrical cargo stowage on deck and/or in the hold.

4.1.3.2 During a voyage the stability shall be verified (taking up liquid ballast where necessary) for the following loading conditions:

with full load and full stores;

with full load and 10 per cent of stores;

without load and with full stores;

without load and with 10 per cent of stores.

Where a deck cargo of hollow structures or pipes is carried, the mass of water therein shall be considered assuming the caves in the structures (taking account of their possible icing) and the pipes as per 3.11.4 and 3.11.7.

4.1.3.3 Under non-working condition stability shall be verified for the most unfavourable loading conditions with regard to stability out of those mentioned in 4.1.3.1.2.

4.1.3.4 For floating cranes/crane ships engaged in winter traffic in winter seasonal zones established by the Load Line Rules for Sea-Going Ships, stability during a voyage/passage and under non-working condition shall be verified with due regard for icing and for the most unfavourable loading conditions as regards stability out of those mentioned under 4.1.3.1.2 and 4.1.3.2. In this case the allowance for icing shall be taken as per 4.1.7.

4.1.4 Stability curves calculation

As agreed with the Register the arms of stability curves can be calculated taking into account the hook load immersing in water during the inclinations of the floating crane/crane ship.

4.1.5 Calculation of windage area

4.1.5.1 The designed windage area component A_{vi} , in m², is:

.1 a projected area restricted by the outline of a structure, item of machinery, arrangement, etc. in the case of bulk structures, deck machinery, arrangements, etc.;

.2 a projected area restricted by the structure outline with apertures between girders deducted, in case of a lattice type structure;

.3 projected area of fore beam where the beam spacing is less than the fore beam height, in the case of the structure of a boom, crane body frame, etc. comprising several beams of equal height located one after another (refer to Fig.4.1.5.1.3); or

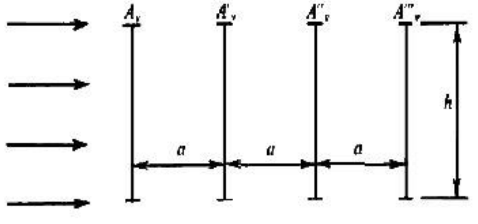


Fig. 4.1.5.1.3.

$a < h$: $A_{vi} = A_v = A'_v = A''_v = A'''_v$;

$h \le a < 2h$: $A_{vi} = A_v + 0.5(A'_v + A''_v + A'''_v)$;

$a \ge 2h$: $A_{vi} = A_v + A'_v + A''_v + A'''_v$.

total projected area of fore beam plus 50 per cent of the areas of subsequent beams, if the beam spacing is equal to, or greater than, the beam height, but is not less than the double height of the beam; or

total projected area of all beams, if the beam spacing is equal to, or greater than, the beam double height.

If the beams are not equal in height, parts of subsequent beams not overlapped by those lying in front of them shall be fully taken into account;

.4 for a number of ropes of the same diameter arranged one after another at the distance a (refer to Fig.4.1.5.1.4-1), the projected area shall be determined by the formula

$$A_{vi} = A_v \frac{1 - K_a^N}{1 - K_a}, \qquad (4.1.5.1.4\text{-}1)$$

where A_v is a projected area of a single rope;

N is a number of ropes;

K_a is a factor to be taken from Table 4.1.5.1.4 on the basis of the a/d_r relationship (where d_r is the rope diameter).

Where the angle α between the rope axis and the wind velocity vector is not equal to 90° (refer to Fig.4.1.5.1.4-2), $A_{vi} = A_v \sin^2 \alpha$ shall be taken. (4.1.5.1.4-2)

4.1.5.2 The design arms of windage area z_v, z'_v, in m, shall be determined by the formulae:

under the effect of constant wind

$$z_v = \frac{\sum k_i n_i A_{vi} z_i}{\sum k_i n_i A_{vi}}; \qquad (4.1.5.2\text{-}1)$$

under the effect of squall

$$z'_v = \frac{\sum k_i A_{vi} z_i}{\sum k_i A_{vi}}, \qquad (4.1.5.2\text{-}2)$$

where i is a number of the windage area component A_{vi};

z_i is an elevation of the centre of gravity of area component A_{vi} above waterline, in m;

k_i is an aerodynamic flow coefficient for component A_{vi};

n_i is a zone coefficient for component A_{vi}.

The values of A_v, z_v, z'_v may be determined taking trim into account.

4.1.5.3 For some windage area components, the aerodynamic flow coefficients k_i are given in Table 4.1.5.3.

Table 4.1.5.1.4 **Factor K_a**

a/d_r	3	4	5	6	7	8	9	10	20	30	40	50
K_a	0.444	0.492	0.531	0.564	0.592	0.616	0.638	0.657	0.780	0.844	0.883	0.909

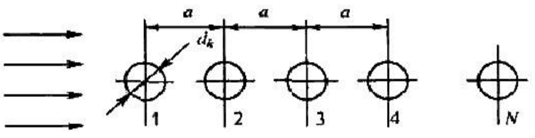


Fig.4.1.5.1.4-1

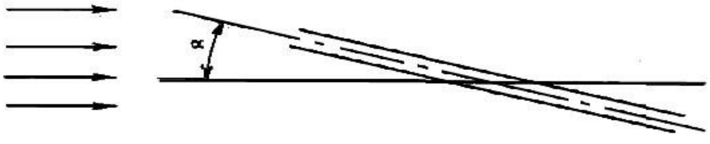


Fig.4.1.5.1.4-2

Table 4.1.5.3 **Aerodynamic flow coefficient k_i**

Windage area components	k_i
Trusses and continuous beams	1.4
Above-water part of the hull, superstructures, deckhouses, rectangular cabins, balance weights of crane structure and other box structures with smooth outside surfaces	1.2
Isolated truss structures (crane, boom) made of:	
beams	1.5
tubular components	1.3
Tubular structures (depending on the product of the calculated dynamic wind velocity head q, in Pa, and by the square of the tube diameter d_T, in m) at:	
if $qd_T^2 \leq 10\ N$;	1.2
if $qd_T^2 \geq 15\ N$	0.7
Cargo ropes at:	
if $d_r \leq 20$ mm;	1.2
if $d_r > 20$ mm	1.0
Deck machinery and small items on deck	1.4
Cargo (if no data are available for substantiated flow coefficient)	1.2

End of Table (4.1.5.3)

N o t e s : 1. The dynamic wind velocity head q is related to the wind pressure p by the ratio $p=k_iq$, where k_i is the aerodynamic flow coefficient.

2. For intermediate values of qd_T^2 the k_i values shall be determined by linear interpolation.

3. The values of k_i for structural elements not specified in the Table are subject to special consideration of the Register in each case.

4. The value q corresponds to the design condition of the floating crane/crane ship under consideration as per Table 4.1.8.6 -1 or Table 4.1.10.2.

4.1.5.4 The height (zone) $n_i = (V_{hi}/V_v)^2$ with regard to the increase of wind velocity V_{hi}, in m/s, according to the height of the upper border of the zone above the waterline, in which the i-th component of the windage area A_{vi} lies shall be determined by the formula

$$n_i = \left(\frac{V_{hi}}{V_v}\right)^2 = \left[1 + 2.5\ln\left(\frac{h_{vi}}{10}\right)\sqrt{(0.71 + 0.071\,V_v)\cdot 10^{-3}}\right]^2 \quad (4.1.5.4)$$

where V_v is a design velocity, in m/s (average wind velocity during 10 min at a height of 10 m above sea surface);

V_{hi} is a wind velocity, in m/s, within the zone at the height h_v above sea surface;

h_{vi} is above-water height, in m, of the upper border of the zone in which the i-th component of the windage area A_{vi}, in m (where $h_{vi} \leq 10$ m, the coefficient $n_i = 1.00$).

For particular wind velocities corresponding to different service regimes of floating sea structures, the values of the n_i coefficient can be found in Table 4.1.5.4.

4.1.5.5 For each design condition of the floating crane/crane ship (working condition, non-working condition, voyage, passage), it is recommended that the windage area of non-continuous surfaces (rails, spars, rigging and various miscellaneous surfaces) shall be taken into account by increasing the maximum total windage area of continuous surfaces by 2 per cent with regard to coefficients k_i and n_i, and by increasing the static moment of this area by 5 per cent.

Under icing conditions this increase shall be taken 4 per cent and 10 per cent or by 3 per cent and 7.5 per cent, respectively, depending on the icing rate for area lying up to 30 m above the waterline.

Table 4.1.5.4 **Height (zone) coefficient n_i**

Height above sea level, in m	V_v, in m/s		
	25.8	36.0	51.5
1	2	3	4
10	1	1	1
20	1.182	1.208	1.242
30	1.296	1.339	1.396
40	1.379	1.435	1.510
50	1.446	1.513	1.602
60	1.502	1.578	1.680
70	1.550	1.633	1.746
80	1.592	1.682	1.805
90	1.630	1.726	1.858
100	1.664	1.766	1.905
110	1.695	1.802	1.949
120	1.723	1.836	1.990
130	1.750	1.867	2.027
140	1.775	1.896	2.062
150	1.798	1.924	2.095
160	1.820	1.949	2.126
170	1.840	1.973	2.155
180	1.860	1.996	2.183
190	1.879	2.018	2.209
200	1.896	2.039	2.235
210	1.913	2.059	2.259
220	1.929	2.078	2.282
230	1.945	2.097	2.304
240	1.960	2.114	2.326
250	1.974	2.131	2.346

The values of non-continuous surface windage areas and of static moments of these areas shall be calculated for minimal draught and, where necessary, be recalculated for particular loading conditions and relevant condition of the floating crane/crane ship.

4.1.5.6 The design windage area of the cargo on hook is determined by its actual outline with due regard for its aerodynamic coefficient and maximum lifting height, i.e. as stipulated in 4.1.5.1 considering the provisions of 4.1.5.3 and 4.1.5.4.

The centre of the wind pressure to the cargo on the hook shall be assumed at the point of the load suspension to the boom.

With no actual data available, the design windage area of cargo on the hook is taken from Table 4.1.5.6.

Table 4.1.5.6 **Windage area of cargo kA_{vi}**

Cargo mass, in t	kA_{vi}, m^2	Cargo mass, in t	kA_{vi}, m^2
10	12	300	81
20	18	350	88
30	22	400	96
40	26	500	108
50	29	600	120
60	33	700	130
80	38	800	140
100	44	900	150
120	48	1000	159
140	53	1500	200
160	57	2000	235
180	61	2500	265
200	64	3000	295
225	69	3500	322
250	73	4000	348
275	77	5000	380

Note. For intermediate values of cargo mass, the values of kA_{vi} shall be determined by linear interpolation.

4.1.6 Calculation of roll amplitude

4.1.6.1 General

The roll amplitude shall be obtained from model tests or determined as per 4.1.6.2, 4.1.6.3, 4.1.6.4.[7].

Model tests to obtain roll amplitudes shall be carried out and their results shall be processed as per the procedures approved by the Register.

Where the hook load mass exceeds 0.1Δ for particular loading conditions, the Register may require the roll amplitude to be determined with regard for the effect of cargo swinging.

Wave height with 3 per cent probability of exceeding level $h_{3\%}$, in m, shall be taken as follows:

from Table 4.1.8.6-2 in working condition on the basis of wave intensity at which cargo-handling operations are permitted;

from Table 4.1.10.2 during the voyage or passage of a floating crane proceeding from the area of navigation assigned.

The roll amplitude of a crane ship during a voyage or a passage shall be determined as per 4.1.6.4.

Calculated roll amplitude values determined in compliance with 4.1.6 shall be rounded to the length part of a degree in working condition and to whole degrees during voyages or passage.

4.1.6.2 The roll amplitude of a floating crane in a working condition, during the voyage or passage of a floating crane/crane ship.

4.1.6.2.1 The roll amplitude θ_r,, in deg., of a floating crane in its calculated conditions as mentioned under 4.1.2.1, 4.1.2.2 and 4.1.2.4 (i.e. in working condition, during voyage and passage), and of a crane ship in working condition shall, under all loading conditions under consideration, be determined by the formula

[7] The roll amplitude is obtained from model tests with 1.1 per cent probability of exceeding level.

$$\theta_r = \theta_{r0} X_4 X_5 \qquad (4.1.6.2.1)$$

considering the instructions given in 4.1.6.2.2 to 4.1.6.2.9, and 4.1.6.3.

4.1.6.2.2 The function θ_{r0}, in deg., shall be determined by the formula

$$\theta_{r0} = \left(Y + \delta\theta r\right) Z \qquad (4.1.6.2.2)$$

The function θ_{r0} and calculated roll amplitude shall be assumed equal to zero where the parameter

$$W = h_{3\%} / \sqrt{C_B B d} \le 0.1.$$

4.1.6.2.3 The values of the function Y shall be taken from Table 4.1.6.2.3-2 basing on the parameters W and K.

The K parameter shall be determined by the formula

$$K = \left[G - 0.505(P - 2.4)\right]\frac{1}{P^2} \ .(4.1.6.2.3\text{-}1)$$

The parameter G shall be determined by the formula

$$G = \frac{z_g - d}{\sqrt{C_B B d}} \qquad (4.1.6.2.3\text{-}2)$$

The parameter P shall be taken from Table 4.1.6.2.3-1 proceeding from the values of expression $(z_m - d)/\sqrt{C_B B d}$.

Table 4.1.6.2.3-1 **Parameter *P***

$\frac{(z_m - d)}{\sqrt{C_B B d}}$	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2
P	1.89	1.99	2.07	2.15	2.23	2.30	2.37	2.44	2.56
$\frac{(z_m - d)}{\sqrt{C_B B d}}$	1.4	1.6	1.8	2.0	2.5	3.0	3.5	4.0	4.5
P	2.67	2.77	2.87	2.96	3.17	3.36	3.52	3.67	3.82

N o t e : z_m is a metacentric height, in m

Table 4.1.6.2.3-2 **Function *Y*, in deg.**

Parameter W	Parameter K					
	0.00	0.04	0.08	0.10	0.12	0.14
0.1	0.24	0.10	0.05	0.04	0.04	0.04
0.2	2.83	1.58	0.40	0.27	0.23	0.23
0.6	21.6	22.9	13.85	7.71	3.41	1.14
1.0	28.15	37.53	38.73	26.07	12.74	5.93
1.4	30.18	42.31	53.37	45.02	28.05	13.61

4.1.6.2.4 The function $\delta\theta_r$, in deg., shall be determined by the formula

$$\delta\theta_r = \left\{\left[\left(A_4 X + A_3\right) X + A_2\right] X + A_1\right\} X \ , \qquad (4.1.6.2.4\text{-}1)$$

where X is a factor to be determined by the formula

$$X = 10\left(F + 0.813K - 0.195\right), \ (4.1.6.2.4\text{-}2)$$

where the parameter F shall be determined by the formula

$$F = n\frac{\sqrt{h}}{B}\sqrt[4]{C_B B d}\ , \quad (4.1.6.2.4\text{-}3)$$

where n is a factor depending on the slewing angle of the crane structure φ (refer to 4.1.3.1) and determined by the formula

$$n = \frac{0.414}{\sqrt{1+0.564\sin^2\varphi}}\ , \quad (4.1.6.2.4\text{-}4)$$

as well as per 4.1.6.2.9-1.

The factors A_1, A_2, A_3, A_4 shall be taken from Table 4.1.6.2.4 proceeding from the parameters W and K.

4.1.6.2.5 The function Z shall be taken from Table 4.1.6.2.5 basing on the parameters K, P and W.

4.1.6.2.6 The function X_4 shall be taken from Table 4.1.6.2.6 basing on the ratio $\theta_{r0}/(\theta_v - \theta_0)$, where $\theta_v - \theta_0$ is the angle range of positive static stability.

Table 4.1.6.2.4 **Factors A_1, A_2, A_3, A_4**

Parameter W	A_i	Parameter K					
		0.00	0.04	0.08	0.10	0.12	0.14
0.1	A_1	0.61	0.18	0.08	0.08	0.09	0.10
	A_2	0.55	0.07	0.12	0.07	–0.02	0.08
	A_3	–1.00	–0.33	0.51	0.15	–0.47	0.09
	A_4	–2.30	–0.53	0.65	0.15	–0.65	0.12
0.2	A_1	2.21	4.14	1.23	0.61	0.58	0.57
	A_2	–2.82	–4.83	3.62	0.94	–0.14	1.02
	A_3	2.88	–31.9	8.57	2.06	–3.57	3.74
	A_4	4.66	–31.44	7.76	2.19	–4.84	5.60
0.6	A_1	–17.51	–0.48	22.15	–20.28	16.27	4.90
	A_2	14.25	–37.97	–18.40	6.86	–16.30	19.34
	A_3	123.01	68.09	–16.97	72.58	–204.08	52.58
	A_4	–83.49	112.34	–13.24	168.08	–264.5	43.24
1.0	A_1	–36.34	–42.33	–0.84	51.49	27.78	19.65
	A_2	38.54	45.08	–220.45	–61.11	14.01	–52.77
	A_3	110.50	108.83	–58.65	–329.54	198.88	–238.50
	A_4	123.15	–220.03	348.71	–390.73	371.65	–200.83
1.4	A_1	–40.61	–60.76	–55.09	14.98	39.93	29.55
	A_2	50.44	103.44	–185.31	–184.15	–132.82	–66.33
	A_3	117.86	67.17	170.10	–9.26	–224.91	32.57
	A_4	194.79	–230.32	250.47	247.05	–37.89	356.57

4.1.6.2.7 The factor X_5 shall be taken from Table 4.1.6.2.7 basing on the ratio C_{CL}/C_{WL}, where C_{CL} is the lateral area coefficient, and C_{WL} is the waterline line area coefficient.

4.1.6.2.8 Where the floating crane/crane ship has bilge keels, the roll amplitude θ'_r, in deg., shall be determined by the formula

$$\theta'_r = K_{вк}\theta_r \quad (4.1.6.2.8\text{-}1)$$

The factor $K_{вк}$ shall be taken from Table 4.1.6.2.8 basing on the parameter $m_{вк}$, to be determined by the formula

$$m_{вк} = \frac{1}{2}\frac{A_k}{C_B L B d}\sqrt{(z_g + d)^2 + B^2} \quad (4.1.6.2.8\text{-}2)$$

where A_k is a total (on both sides) area of bilge keels, in m^2;

L is the hull length of floating crane/crane ship, in m.

In the case of floating cranes and crane ships having ice category mark **Ice4** and more in their class notation, the bilge keels shall be ignored.

Table 4.1.6.2.5 **Function *Z***

Parameter *P*	Parameter *W*	Parameter *K* 0.00	0.04	0.08	0.10	0.12	0.14
2.1	0.1	2.17	1.59	1.56	1.95	2.71	4.51
	0.2	2.23	1.55	1.35	1.58	2.11	4.38
	0.6	3.44	1.59	1.10	1.08	1.06	3.52
	1.0	4.34	1.73	1.28	1.33	1.28	2.56
	1.4	2.30	1.65	1.25	1.28	1.51	2.05
2.5	0.1	1.22	1.21	1.47	1.89	2.36	3.15
	0.2	1.27	1.20	1.28	1.55	1.96	2.81
	0.6	1.32	1.23	1.03	0.97	1.00	1.77
	1.0	1.26	1.27	1.19	1.05	0.72	1.09
	1.4	1.26	1.24	1.16	1.02	0.68	0.51
2.9	0.1–1.4	1	1	1	1	1	1
3.3	0.1	0.77	0.85	0.87	0.81	0.68	0.58
	0.2	0.89	0.88	0.91	0.92	0.84	0.62
	0.6	0.84	0.88	0.93	1.03	1.06	0.81
	1.0	0.84	0.81	0.83	0.91	0.94	0.99
	1.4	0.87	0.84	0.87	0.92	0.91	1.02
3.7	0.1	0.61	0.77	0.84	0.75	0.49	0.37
	0.2	0.64	0.82	0.94	0.97	0.87	0.49
	0.6	0.70	0.82	0.98	1.21	1.41	1.04
	1.0	0.72	0.69	0.78	1.00	1.13	1.44
	1.4	0.77	0.77	0.84	1.00	1.00	1.46

4.1.6.2.9 In well-grounded cases, the peculiarities of floating crane/crane ship mass distribution and those of the area of navigation may be considered on agreement with the Register when determining the roll amplitude:

.1 where the inertia coefficient *c* is known in the formula of the roll period $T = 2cB/\sqrt{h}$, the value of the factor *n* in formula (4.1.6.2.4-3) can be replaced by a value determined as

$$n_i = 1/(4.6c); \qquad (4.1.6.2.9\text{-}1)$$

.2 where the frequency of the maximum wave spectral density ω_m, in s^{-1}, is known, which is characteristic of a particular area of navigation with the specified wave height with 3 per cent probability of exceeding level $h_{3\%}$, the roll amplitude θ_r, in deg., determined by the Formula (4.1.6.2.1) can be specified via the formula

$$\theta_r = \theta_{r0} X_4 X_5 K_C, \qquad (4.1.6.2.9.2\text{-}1)$$

where K_C, in $m \cdot s^{-2}$, shall be determined by the formula

$$K_C = 0.27\omega_m^2 h_{3\%}; \qquad (4.1.6.2.9.2\text{-}2)$$

while in Tables 4.1.6.2.3-2, 4.1.6.2.4 and 4.1.6.2.5 instead of

$$W = h_{3\%} / \sqrt{C_B B d}$$

shall be used the value

$(1/K_C)(h_{3\%}/\sqrt{C_B B d}) = (1/K_C)W$.

Table 4.1.6.2.6 ***Factor X₄***

$\frac{\theta_{r0}}{\theta_v - \theta_0}$	X_4
0	1.000
0.2	0.878
0.4	0.775
0.6	0.668
0.8	0.615
1.0	0.552
1.2	0.449
1.4	0.453
1.6	0.413
1.8	0.379
2.0	0.349
2.2	0.323
2.4	0.300
2.6	0.279
2.8	0.261
3.0	0.245

Table 4.1.6.2.7 ***Factor X_5***

$\frac{C_{CL}}{C_{WL}}$	X_5
0.60	0.326
0.65	0.424
0.70	0.553
0.75	0.646
0.80	0.756
0.85	0.854
0.90	0.932
0.95	0.983
1.00	1.000
1.05	0.983
1.10	0.932
1.15	0.854
1.20	0.756
1.25	0.646
1.30	0.553
1.35	0.424

Table 4.1.6.2.8 ***Factor $K_{вк}$***

$m_{вк}$	$K_{вк}$
0	1.000
0.025	0.882
0.050	0.779
0.075	0.689
0.100	0.607
0.125	0.535
≥ 0.135	0.500

4.1.6.3 Corrections to the roll amplitude of a floating crane during the voyage/passage.

Where the roll amplitude θ_r or θ'_r of a floating crane during the voyage/passage, obtained as per 4.1.6.2 or 4.1.6.2.8, respectively exceeds the angle of deck immersion θ_d or the immersion angle of a bilge middle on a midship frame θ_b at which the middle of bilge at amidships frame comes out of water the design roll amplitude θ''_r, in deg., shall be determined by the following formula:

at $\theta_d < \theta_r \leq \theta_b$

$$\theta''_r = (\theta_d + 5\theta_r)/6; \qquad (4.1.6.3\text{-}1)$$

at $\theta_b < \theta_r \leq \theta_d$

$$\theta''_r = (\theta_b + 5\theta_r)/6; \qquad (4.1.6.3\text{-}2)$$

at $\theta_r > \theta_b$ i $\theta_r > \theta_d$

$$\theta''_r = (\theta_d + \theta_b + 4\theta_r)/6. \qquad (4.1.6.3\text{-}3)$$

4.1.6.4 Roll amplitude of a crane ship during voyage/passage.

The roll amplitude of a crane ship during voyage/passage under any loading conditions considered shall be determined as per 2.1.3.

The roll amplitude of a crane ship equipped with anti-rolling devices shall be determined without regard for their operation.

4.1.7 Allowance for icing

For areas lying up to 30 m above the waterline, allowance for icing shall be made on the basis of the provisions of 2.4.1 to 2.4.6, 2.4.8. For area lying higher than 10 m above the waterline, the standard of icing shall be taken at half the value stated under 2.4.3 and 2.4.4.

The windage area and the height of the centre of the windage area above the waterline shall be determined as follows

as per 4.1.3.2 under loading conditions with the smallest draught out of those verified;

as per 4.1.3.3 under loading conditions chosen for stability verification.

When pipes or other deck cargoes are carried, their icing shall be considered as per 3.11.6 and 3.11.7 adopting the icing standard stated above.

4.1.8 Stability of a floating crane/crane ship in working condition

4.1.8.1 Stability shall be considered adequate provided that

.1 the heeling angle θ_{d2}, in deg., due to the combined effect of the initial heeling moment (from hook load, balance weight, anti-heel ballast, etc.) θ_0, in deg., due to wind θ_S (refer to 4.1.8.4) and roll θ_r, in deg., does not exceed the angle of deck edge immersion or the middle of the bilge emergence in way mid-section, whichever is less.

In any case, the following conditions shall be observed:

$$\theta_0 + \theta_S \le \begin{cases} 0.2(\theta_v - \theta_0) + 2^\circ, \\ 10^\circ \end{cases} \qquad (4.1.8.1.1\text{-}1)$$

and

$$\theta_r \le \begin{cases} 0.15(\theta_v - \theta_0) - 1^\circ, \\ 5^\circ \end{cases}. \qquad (4.1.8.1.1\text{-}2)$$

The above acceptable heel angles static $\theta_0 + \theta_S$ and dynamic θ_r shall not exceed relevant angles at which reliable operation of the crane structure is ensured. These angles shall be in conformity with the delivery specifications of the crane structure and/or with its maintenance manual.

For floating cranes/crane ships, which crane structure operates reliably at large angles of heel, the acceptable angle of heel is subject to special consideration by the Register in each case;

.2 the vertical distance between the lower edges of openings by which the flooding angle is determined in operation and the waterline corresponding to the static heel and trim is not less than 0.6 m or 0.025 *B*, whichever is greater;

.3 the area A_m, in m·rad, of the righting lever curve between the angles θ_0 and θ_m is in compliance with the following conditions:

$$A_m \ge \begin{cases} 0.115 - 0.0075(\theta_v - 20^\circ), \\ 0.100 \quad ; \end{cases} \qquad (4.1.8.1.3)$$

.4 if $\theta_m - \theta_0 \ge 10^\circ$ and $\theta_v - \theta_0 \ge 20^\circ$;

.5 if maximum righting arm l_{max} of a floating crane/crane ship equipped with an automatic anti-heel system is not less than 0.25 m where this system fails to operate;

.6 if capsizing moment (refer to 4.1.8.7) determined with regard to the combined effect of load drop and roll is at least twice the heeling moment due to wind pressure. The value of $g\Delta l_m$ shall be twice as great as the heeling moment at least. In the case of floating cranes/crane ships equipped with an anti-heel system, the system shall be considered non-working after load drop, and the anti-heel ballast shall be considered to remain in the same position in which it was at the moment of load drop;

.7 the lower edges of openings considered to be open during the operation of the floating crane/crane ship are above the waterline by the value of h_f (being not less than 0.6 m or 0.025B, whichever is greater) under conditions of dynamic heel θ_{d3}, in deg., due to the combined effect of load drop, wind and roll.

The height h_f shall be determined by the formula

$$h_f = (z_f - d)\cos\theta_{d3} - y_f \sin\theta_{d3}, \quad (4.1.8.1.7)$$

where y_f, z_f are the ordinate and the applicate, in m, respectively, of the lower edge of the opening in question;

d is a draught after load drop, in m.

4.1.8.2 If a floating crane/crane ship shall be engaged in handling a submerged cargo having a mass greater than 0.1Δ, in t, under particular loading conditions, the Register may require calculations to be made to demonstrate that the safety of the floating crane/crane ship against capsizing is ensured for the case of submerged load drop.

4.1.8.3 Where a floating crane/crane ship does not comply with the above requirements when it has a hook load of a mass equal to the full cargo-lifting capacity of the crane structure, the cargo-lifting capacity may be limited by a value at which the requirements of the present Section are met.

4.1.8.4. The heeling angle of a floating crane/crane ship due to the combined effect of initial heeling moment, wind and roll θ_{d2} shall be determined by Formulae (4.1.8.4.1-2) or (4.1.8.4.2-2), proceeding from the critical value of the parameter G_{cr}, to be determined by the formula below with C = 1.0

$$G_{кр} = (1/f_2)[\left((z'_v - 0{,}34z_v)/\sqrt{C_B Bd}\right) - 0{,}34Cf_1 - f_3], \quad (4.1.8.4)$$

where f_1, f_2, f_3 are the factors to be taken from Tables 4.1.8.4 -1, 4.1.8.4-2.

4.1.8.4.1 If the parameter

$$G \le 0{,}9G_{cr}, \quad (4.1.8.4.1\text{-}1)$$

it is inherent in pontoon cranes; then

$$\theta_{d2} = \theta_0 + \theta_S + \theta_r \text{, in deg.,} \quad (4.1.8.4.1\text{-}2)$$

where θ_0, θ_S shall be determined by the formulae:

$$\theta_0 = 57.3\, y_g / h, \quad (4.1.8.4.1\text{-}3)$$

$$\theta_S = 57.3 M_v / g\Delta h; \quad (4.1.8.4.1\text{-}4)$$

M_v shall be determined by the formula (4.1.8.5-1), and the angle θ_r shall be determined as per 4.1.6.2.

4.1.8.4.2 If the parameter

$$G \ge 1.1G_{cr}, \quad (4.1.8.4.2\text{-}1)$$

it is inherent in crane ships, which lines are similar to those of conventional ships; then

$$\theta_{d2} = \theta_0 + \theta'_s + \theta_r \text{, in deg.,} \quad (4.1.8.4.1\text{-}2)$$

where θ'_S shall be determined by the formula

$\theta'_s = 100\, M'_v / g\Delta h$; (4.1.8.4.2-3)

M'_v shall be determined by the formula (4.1.8.5-2).

The directions of the angles $\theta_0, \theta_S, \theta'_S, \theta_r$ shall be assumed to coincide. For a floating crane/crane ship, which shall not operate at rough sea, the angle θ_r shall be taken equal to zero.

Table 4.1.8.4-1 **Factor f_1**

Parameter P	θ_0, in deg.					
	0	2	4	6	8	10
2.0	0.43	0.44	0.42	0.36	0.27	0.18
2.2	0.64	0.67	0.62	0.47	0.33	0.22
2.4	0.88	0.96	0.92	0.58	0.39	0.26
2.6	1.18	1.28	1.02	0.69	0.46	0.31
2.8	1.53	1.68	1.22	0.80	0.52	0.35
3.0	1.95	2.06	1.43	0.91	0.58	0.39
3.2	2.43	2.48	1.64	1.02	0.64	0.43
3.4	2.99	2.89	1.87	1.13	0.71	0.48
3.6	3.62	3.30	2.09	1.24	0.77	0.52
3.8	4.32	3.71	2.33	1.35	0.83	0.56

Note. The intermediate values of the f_1 shall be determined by linear interpolation.

Table 4.1.8.4-2 **Factors f_2 and f_3**

P^2	Factors		P^2	Factors	
	f_2	f_3		f_2	f_3
4.0	0.600	0.027	9.0	0.750	0.214
4.5	0.625	0.051	9.5	0.759	0.229
5.0	0.646	0.073	10.0	0.767	0.243
5.5	0.663	0.095	10.5	0.774	0.256
6.0	0.682	0.115	11.0	0.781	0.269
6.5	0.693	0.133	11.5	0.787	0.282
7.0	0.708	0.152	12.0	0.792	0.295
7.5	0.720	0.167	13.0	0.803	0.320
8.0	0.731	0.185	14.0	0.813	0.344
8.5	0.741	0.198			

Note. The intermediate values of the f_2 and f_3 shall be determined by linear interpolation.

4.1.8.5 The heeling moments M_v, M'_v, in kN·m, shall be determined by

.1 Formula (4.1.8.5-1) where the value of the parameter G is in compliance with the condition (4.1.8.4.1-1)

$$M_v = 0.6q\left(z_v + f_1\sqrt{C_B Bd}\right)\sum k_i n_i A_{vi} ; \quad (4.1.8.5\text{-}1)$$

.2 Formula (4.1.8.5-2) where the value of the parameter G is in compliance with the condition (4.1.8.4.2-1)

$$M'_v = q\left(z'_v - f_2\left(z_g - d\right) - f_3\sqrt{C_B Bd}\right)\sum k_i A_{vi} ; \quad (4.1.8.5\text{-}2)$$

.3 either of Formulae (4.1.8.5-1) or (4.1.8.5-2) which yields the greater heeling angle, provided the following condition is met:

$$0{,}9G_{cr} < G < 1.1G_{cr}. \qquad (4.1.8.5\text{-}3)$$

4.1.8.6 The values of the rated wind velocity head q and the wave height with 3 per cent probability of exceeding level $h_{3\%}$ shall be taken from Tables 4.1.8.6-1 and 4.1.8.6-2 as per the weather restrictions assigned.

Table 4.1.8.6-1 **Design wind velocity head *q* in squall**

Wind restriction assigned, in numbers	q, kPa
1	0.02
2	0.03
3	0.05
4	0.09
5	0.15
6	0.23
7	0.35
8	0.50

Table 4.1.8.6-2 **Wave height with 3 per cent probability of exceeding level $h_{3\%}$**

Wind restriction assigned, in numbers	$h_{3\%}$, in m
1	0.25
2	0.75
3	1.25
4	2.00
5	3.50
6	6.00

4.1.8.7 Recommendations concerning the capsizing moment and dynamic heeling angle determination for a floating crane/crane ship in working condition with load drop are given in 1.1, Appendix 2.

The heeling angle before load drop shall be taken equal to

$$\theta'_{d2} = \theta_0 + \theta_r \qquad (4.1.8.7)$$

4.1.8.8 The effect of anchoring and mooring upon the stability of a floating crane/crane ship in working condition may be considered using the procedure approved by the Register.

4.1.8.9 When the crane structure is tested by the hook load with the mass exceeding the design one, the stability of the floating crane/crane ship shall be verified with regard to the actual mass of the test load. It shall be demonstrated to the satisfaction of the Register that the floating crane/crane ship safety against capsizing is ensured by the development of special procedure at least, including weather restrictions.

4.1.9 Stability of a floating crane/crane ship during voyage

4.1.9.1 Stability shall be considered sufficient (considering 4.1.3.4) if:

.1 the range of righting lever curve between the angles θ_0 and θ_v is 40º at least;

.2 the area of righting lever curve is between the angles θ_0 and θ_1 being obtained from the formula

$$\theta_1 \geq 15^\circ + 0.5(\theta_v - 40^\circ), \qquad (4.1.9.1.2)$$

is not less than 0.16 m·rad;

.3 the capsizing moment determined with regard to roll and flooding angle is not less than the heeling moment, i.e. $M_c \geq M_v$.

Recommendations concerning the capsizing moment determination procedure during voyage are given in 1.2, Appendix 2.

4.1.9.2 The heeling moments M_v and M'_v, in kN·m, shall be determined by

.1 where the value of parameter G is in conformity with condition (4.1.8.4.1-1) at its critical value determined by Formula (4.1.8.4) if C = 0.5 under the formula

$$M_v = 0.6q\left(z_v + 0.5 f_1 \sqrt{C_B Bd}\right) \sum k_i n_i A_{vi} \qquad (4.1.9.2.1)$$

.1 Formula (4.1.8.5.-2) where the value of parameter G is in conformity with condition (4.1.8.4.2-1) at its critical value determined by Formula (4.1.8.4) if C = 0.5;

.3 either of Formulae (4.1.9.2.1) or (4.1.8.5-2) which yields the greater heeling angle, provided condition (4.1.8.5-3) is met with C = 0.5.

4.1.9.3 Factor f_1 shall be taken from Table 4.1.8.4-1 proceeding from the value of the parameter P and considering the angle θ_0. The values of factors f_2 and f_3 shall be taken from Table 4.1.8.4-2.

4.1.9.4 For a floating crane, the wind velocity head q and the wave height with 3 per cent probability of exceeding level $h_{3\%}$ shall be taken from Table 4.1.10.2. If the floating crane is to operate in a particular geographical region, q and $h_{3\%}$ may be specially taken for that region as agreed with the Register.

4.1.9.5 For a crane ship, the wind velocity head shall be taken as per Table 4.1.10.2.

4.1.10 Stability of a floating crane/crane ship during passage

4.1.10.1 Where a floating crane/crane ship shall undertake a passage through sea regions lying beyond the prescribed area of navigation, a plan of such passage shall be prepared which is subject to special consideration by the Register in each case.

4.1.10.2 Stability shall be checked with due regard for 4.1.3.4 under loading conditions provided by 4.1.3.2 and taking into account the preparation arrangements specified in the passage plan (including possible partial or complete dismantling of the crane structure), and is considered to be adequate, if the requirements of 4.1.9 for conditions of passage areas are met.

The design wind velocity head q and wave height with 3 per cent probability of exceeding level $h_{3\%}$ shall be taken as per Table 4.1.10.2.

Table 4.1.10.2 **Wind velocity head *q* and wave height with 3 per cent probability of exceeding level $h_{3\%}$**

Area of navigation through which voyage or passage is made	q, in kPa	$h_{3\%}$, in m
Unrestricted	1.40	11.0
Restricted **R1**	1.00	6.0
Restricted **R2**	0.80	6.0
Restricted **R3**	0.60	At the Register discretion in each case

4.1.11 Stability of a floating crane/crane ship in non-working condition

4.1.11.1 Stability is considered adequate, if the capsizing moment is at least 1.5 times greater than the heeling moment under loading condition as per 4.1.3.3 and in the absence of rolling $\theta_r = 0^\circ$ giving regard to 4.1.3.4.

4.1.11.2 The capsizing and heeling moments shall be determined as per 4.1.9.2 for q = 1.4 kPa. In case mentioned under 4.1.9.2.1, the capsizing moment shall be defined under 1.3 of Appendix 2, and in case mentioned under 4.1.9.2.2, it shall be determined as per 1.2 of Appendix 2 for $\theta_r = 0^\circ$.

4.2 PONTOONS

4.2.1 This Chapter applies to pontoons with the ratio $B/D \geq 3$ and the block coefficient 0.9 and more.

4.2.2 Loading conditions

4.2.2.1 Stability of a pontoon shall be checked for the following loading conditions:

.1 with full load;

.2 without load;

.3 with full load and icing.

4.2.2.2 When carrying timber cargo, the stability shall be calculated considering the possible addition in mass of timber cargo due to water absorption as under 3.3.7.

4.2.2.3 When carrying pipes, the stability shall be calculated considering trapped water in the pipes as under 3.11.4.

4.2.3 Calculation of cross-curves of stability

When calculating the cross-curves of stability for a pontoon carrying timber cargo, the volume of timber cargo may be included in the calculation with full breadth and height and permeability of 0.25.

4.2.4 Allowance for icing

4.2.4.1 Rates for icing shall be taken as per 2.4

4.2.4.2 When carrying timber cargo, rates of icing shall be taken as under 3.3.7.

4.2.4.3 When carrying pipes, icing is determined as under 3.11.7.

4.2.5 Stability of a pontoon

4.2.5.1 Stability of a pontoon shall be considered sufficient:

.1 if the area under the righting curve up to the angle of heel θ_m is not less than 0.08 m·rad;

.2 if the static angle of heel due to wind heeling moment determined under 4.2.5.2 does not exceed half the angle of immersion of the deck;

.3 if the range of righting lever curve is not less than:

20° – for the ships with the length 100 m and less;

15° – for the ships with the length more than 150 m.

For intermediate values of *L*, the range of stability is determined by linear interpolation.

4.2.5.2 The heeling moment shall be calculated by the formula

$$M_v = 0{,}001 p_v z_v A_v, \quad (4.2.5.2)$$

where p_v is a wind pressure equal to 540 Pa;

z_v is an arm of windage area determined as per 2.1.4.1;

A_v is a windage area determined as per 1.4.6.

4.3 FLOATING DOCKS

4.3.1 Stability of floating docks shall be checked for the following loading conditions:

.1 floating dock in operating condition;

.2 floating dock during submersion and immersion;

4.3.2 Calculation of liquid cargo effect shall be made in compliance with 1.4.7. The correction factor for the effect of free surfaces of liquid ballast shall be calculated at tank filling levels corresponding to the actual ones under loading condition in question.

4.3.3 Stability of a floating dock in operating condition

4.3.3.1 Stability shall be checked of fully emersed dock with a supported ship under conditions of maximum lifting capacity and moment of sail of the dock - ship system without icing.

4.3.3.2 Stability is considered to be sufficient provided:

.1 angle of heeling with dynamically applied heeling moment due to wind pressure as per 4.3.3.5 or 4.3.3.6 does not exceed the permissible heeling angle for dock cranes in non-operating condition or 4°, whichever is less;

.2 angle of heeling with dynamically applied heeling moment due to wind pressure as per 4.3.4.4 does not exceed the angle at which safe operation of cranes is ensured;

.3 angle of trim with statically applied trimming moment due to crane weight with maximum load for the most unfavourable service case of their arrangement does not exceed the angle at which efficient operation of cranes is ensured or the angle of pontoon deck immersion, whichever is less.

4.3.3.3 The dynamic angle of heel of a floating dock, in deg., if it does not exceed the angle of immersion of the pontoon deck, shall be determined by the formula

$$\theta = 1.17 \cdot 10^{-2} p_v A_v z / (\Delta h) \qquad (4.3.3.3)$$

where p_v is a wind pressure, in Pa;

z is a distance from the centre of the windage area to the plane of the waterline of floatation;

Δ is a displacement, in t.

4.3.3.4 An angle of heel of floating dock, if it exceeds the angle of immersion of the pontoon deck, is determined from statical or dynamical stability curve when the dock is affected by the dynamically applied heeling moment, in kN·m, determined by the formula

$$M_v = 0.001\, p_v A_v z \qquad (4.3.3.4)$$

4.3.3.5 Wind pressure is assumed to be 1700 Pa.

4.3.3.6 Wind pressure may be taken from Table 4.3.3.6-1 depending upon the prescribed geographical area of the floating dock operation as per Fig.4.3.3.6.

Table 4.3.3.6-1 **Wind pressure for zone of 0–10 m above the actual waterline p_v, in Pa**

Geographical area of floating deck service (refer to Fig. 4.3.3.6)	Pressure p_v, in Pa
1	460
2	590
3	730
4	910
5	1110

To account for the increase of wind pressure with regard to the elevation of some top zones of windage area in the dock - ship system above the actual waterline the wind pressure values from Table 4.3.3.6-1 are multiplied by the relevant zone coefficients from Table 4.3.3.6-2.

In this case, the values of p_v, A_v and z are determined for each zone separately, the sum of their products for all height zones comprising windage area of the dock - ship system is included in Formulae (4.3.3.3) and (4.3.3.4).

Table 4.3.3.6-2 **Height (zone) coefficient n_i**

Height above the waterline (zone boundary), in m	n_i
Up to 10	1.0
10-20	1.25
20-30	1.4
30-40	1.55
40-50	1.69
50-60	1.75

60-70	1.94
80-90	2.02
90-100	2.1

4.3.3.7 With geographical service area of the floating dock prescribed, the wind pressure may be taken for this particular area.

4.3.3.8 With several geographical service areas of the floating dock prescribed, maximum wind pressure for these areas shall be taken.

4.3.3.9 The angle of trim, in deg., of the floating dock shall be determined by the formula

$$\psi = 57.3 M_{\psi} / (\Delta H) \qquad (4.3.3.9)$$

4.3.4 Stability of a floating dock during submersion or emersion

4.3.4.1 Stability of a floating dock shall be checked in the process of submersion or emersion for the most unfavourable case, as regards stability, of the supported ship displacement, moment of windage area of the dock - ship system and dock ballasting with the cranes not in operation, without icing.

4.3.4.2 Stability considered to be adequate if the angle of heel with dynamically applied heeling moment due to wind pressure does not exceed the permissible heeling angle for dock cranes in non-operating condition or 4º, whichever is less.

4.3.4.3 The angle of heel of the floating dock shall be determined as per 4.3.3.3 and 4.3.3.4.

4.3.4.4 Specific wind pressure is assumed to be 400 Pa.

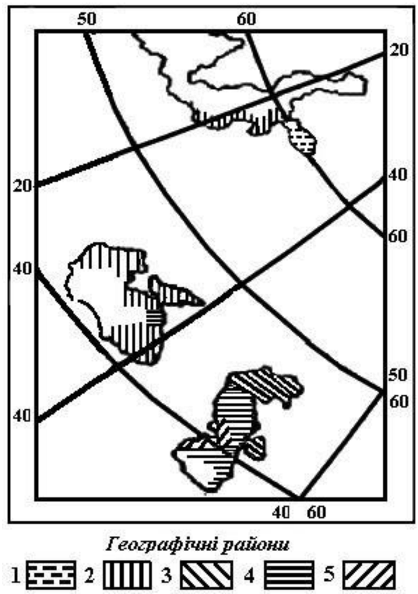


Fig. 4.3.3.6.

4.3.5 The arm of windage area shall be determined as per 1.4.6.3. As agreed with the Register, in each particular case the arm of windage area *z* may be assumed as the elevation of the windage area centre of the dock - ship system above the plane of the positioning system fastening to the dock.

4.3.6 These requirements shall apply to floating docks having sufficiently reliable positioning system.

4.4 BERTH-CONNECTED SHIPS

4.4.1 Stability of a berth-connected ship is considered sufficient provided:

.1 the metacentric height complies with the requirements of 2.3 with due regard for the distribution of passengers among decks likely to occur in service;

.2 the angle of heel under applied wind heeling moment as determined by Formula (4.3.3.3) considering 4.3.3.5 to 4.3.3.8, does not exceed the maximum permissible area.

4.4.2 Under dynamically applied

wind heeling moment, the ship stability is checked for the most unfavourable loading conditions as regards stability.

4.4.3 As the maximum permissible heel, the angle is assumed at which the freeboard deck or fender edge immerses or the middle of the bilge comes out from water, whichever is less.

These angles are determined considering the immersion or emergence of the ship when inclined to final angles of heel and the actual position of deck edge, fenders and the middle of the bilge. The maximum permissible angle shall not exceed 10º.

APPENDIX 1

INSTRUCTIONS ON DRAWING UP INFORMATION ON STABILITY

1 GENERAL

1.1 Each ship shall be provided with the Information on Stability[8] in order to assist the master and control authorities in maintaining stability of the ship during service as per the requirements of international agreements, Maritime Administrations and these Rules.

Formal compliance with the provisions contained in the Information does not relieve the Master from the responsibility for the ship's stability.

1.2 These Instructions contain guidelines for the form and contents of the Information.

The scope of Information may vary subject to the type, purpose, stability reserve and service area of a ship. It shall be selected most carefully and agreed with the Register.

The form of the Information shall comply with these Instructions.

1.3 The Information shall contain the following sections:

.1 Particulars of Ship;

.2 Guidance to the Master;

.3 Technical Information;

.4 Reference Information.

The contents of the sections are given below.

1.4 The Information shall have an identification number.

1.5 Each sheet (page) of the Information shall be marked with the identification number of the Information, the number of the sheet (page) and the total number of sheets (pages). The numbering of sheets (pages) shall be continuous, including plans and drawings.

Tables, plans and drawings are not allowed to have identical numbers.

1.6 The front page shall contain:

.1 name of the document: Information on Stability;

.2 identification number;

.3 name of ship;

.4 IMO number;

1.7 The front page shall be succeeded by a table of contents.

1.8 For ships engaged on international voyages, the Information and the drawings and plans included shall be translated into English. The pages containing the original text and those containing the translation shall alternate. It is not allowed to draw up the translation as

[8] Hereinafter referred to as "the Information".

a separate volume.

1.9 The Information shall list the documents on the basis of which it was drawn up.

1.10 The Information shall contain a Record of Familiarization with the Document.

2 PARTICULARS OF SHIP

2.1 The Section shall contain the following information:

.1 ship's name;

.2 type of ship (dry cargo ship, oil tanker, etc.);

.3 purpose of ship (for what kind of cargo the ship is designed as per specification);

.4 name of builder and hull number;

.5 date on which the keel was laid, date of completion of construction, date of conversion;

.6 ship's class, classification society and Register number;

.7 ship's flag;

.8 port of registry;

.9 principal dimensions (length, breadth, depth; where the bulkhead deck does not coincide with the upper deck, the depth up to the bulkhead deck shall be stated);

.10 service area and restrictions imposed (sea state, distance to port of refuge, seasons, geographical service areas, etc.);

For dredgers and floating cranes, restrictions for both operating and voyage conditions shall be stated;

.11 draughts to the summer load line and summer timber load line, diagram of the load line marks and the corresponding displacement and deadweight;

.12 speed;

.13 type of anti-rolling devices; dimensions of bilge keels, if any;

.14 inclining test data, on which the Information is based (light-ship displacement and center of gravity coordinates for light-ship condition), place and date of the inclining test with the reference to the Inclining Test Report approved by the Register Branch Office or another body;

If the data for the light-ship condition have been assumed based on the results of the light-weight check taking into consideration the results of the inclining test performed on a sister ship, the data on the ship light-weight check and on the inclining test performed on a sister ship, including the name and serial number of this ship shall be stated in the Information; the data shall contain reference to the Light-Weight Check Reports and Inclining Test Reports approved by the Register Branch Officer or another body;

.15 a sketch showing the quantity and location of solid ballast, if any, on board;

.16 ship inertia coefficient C in the formula for determining the roll period $\tau = CB/\sqrt{h_0}$ to be calculated on the basis of the roll period, if determined, during the inclining test;

.17 other data deemed necessary by the developer of the Information (for instance, carrying capacity of the ship, designed trim, stores endurance).

3 GUIDANCE TO THE MASTER

3.1 General

3.1.1 The Chapter shall contain the following information:

.1 Statement of the purpose of the document, i.e. to provide the necessary information to the master for ensuring the ship's trim and stability during loading, unloading, ballasting and other operations for which the ship is intended, and to provide guidance on and methods for satisfying the requirements of normative documents;

.2 list of normative documents (IMO, IACS, Maritime Administrations, Rules of Register and other classification societies) on the basis of which the Information was drawn up;

.3 list of stability criteria applicable to the ship with sketches (where necessary) and indication of criteria (criterion) limiting the ship's stability, damage stability criteria included, where these are applicable to the ship and limiting with regard to intact stability;

.4 general instructions to the master to exercise good maritime practice, having regard to the season of the year, the navigational area and weather forecasts, and to take the appropriate action as to speed and course warranted by the prevailing conditions;

.5 general instructions to the effect that the stability criteria (except for the criteria relevant to the carriage of grain and non-cohesive bulk cargoes) do not take possible cargo shifting into consideration and to prevent such cargo shifting one shall be guided by approved documents for securing and stowage of cargo;

.6 explanations on the use of optional information given in the document at the discretion of the shipowner.

It shall be stated that such information falls under the responsibility of the shipowner.

3.2 Terms, symbols and units

3.2.1 The Chapter shall contain the following information:

.1 a table of symbols showing the terms and symbols used in the Information, relevant explanations (where necessary) and the units of measurement. The unit system shall be uniform throughout the document and it shall be the same as the unit system adopted for Information on Damage Trim and Stability.

The main symbols to be used in the Information are given in Table 3.2.1.1;

.2 a sketch (refer to Fig. 3.2.1.2) explaining the main symbols.

3.3 General explanations to the Information

3.3.1 The Chapter shall contain explanations and guidance pertinent to all the sections of the Information as for use of the following technical data:

.1 coordinate system. The coordinate system for determining mass moments, volumes, buoyancy, draughts, shall be uniform throughout the Information, and it shall be the same as the coordinate system adopted for the Information on Damage Trim and Stability and the design documentation;

.2 rules for the signs of heel and trim;

.3 applicability of hydrostatic data with regard to trim;

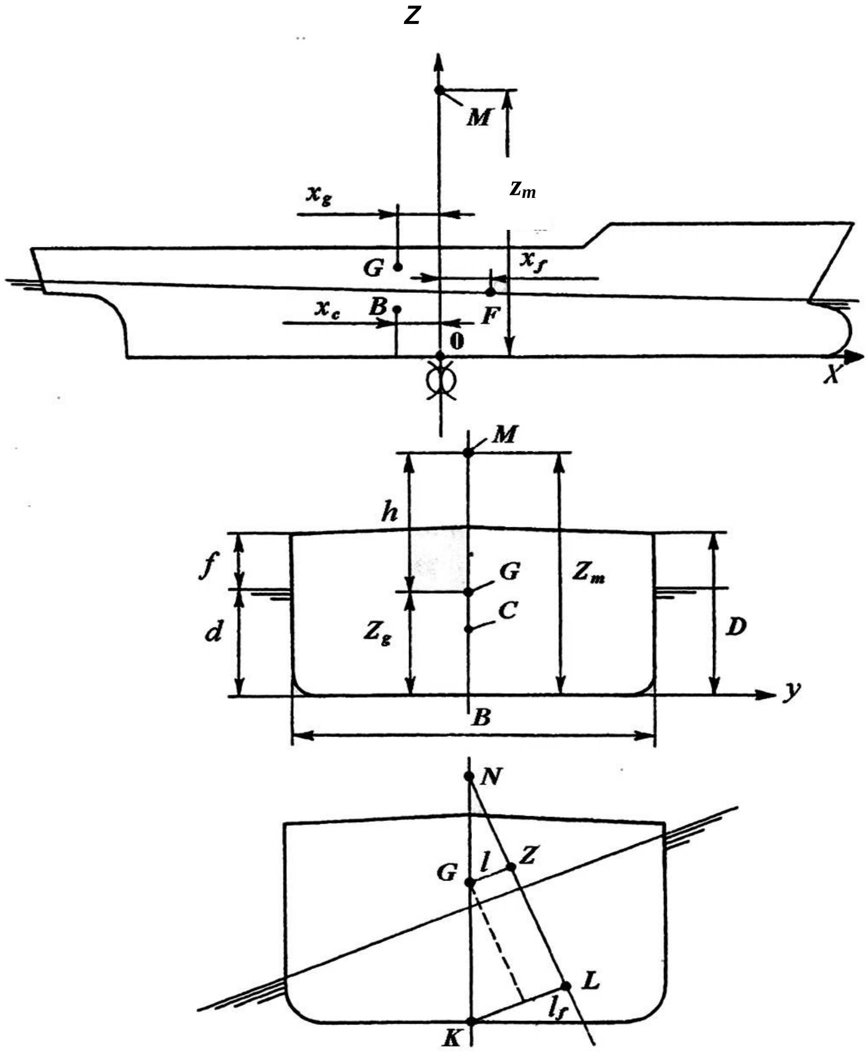
.4 applicability of stability limits as for trim;

.5 permissible windage area of deck cargo;

.6 accuracy of calculations and interpolation, and other guidance proceeding from the contents of the Information.

Table 3.2.1.1 **Main symbols**

Nos.	Symbol	Translation in English	International symbol
		Term	
1	***L***	Length	***L***
2	***B***	Breadth	***B***
3	***D***	Depth	***D***
4	***d***	Draught	***d***
5	***f***	Freeboard	***f***
6	∇	Displacement volume	∇
7	Δ	Displacement weight	Δ
8	***G***	Centre of gravity	***G***
8.1	x_g	abscissa	x_g **(XG)**
8.2	y_g	ordinate	y_g **(YG)**
8.3	z_g	applicate	**KG**
9	***C***	Centre of buoyancy	***C***
9.1	x_c	abscissa	**XB**
9.2	z_c	applicate	**KB**
10	x_f	Abscissa of centre of flotation	x_f **(XF)**
11		Elevation of metacentre above base line	
11.1	Z_m	transverse	**KMT**
11.2	z_m	longitudinal	**KML**
12		Metacentric height	
12.1	***h***	transverse	**GM**
12.2	***H***	longitudinal	**GML**
13	***l***	Righting lever	**GZ**
14	l_k	Cross curve lever	l_k **(KL)**



Term symbols (refer to Table 3.2.1.1)							
For ship engaged in domestic voyages *)	x_c	x_f	x_g	h	z_g	Z_m	z_m
For ship engaged in international voyages	**XB**	**XF**	**XG**	**GM**	**KG**	**KMT**	**KML**

*) Symbols given on the figure

Figure (3.2.1.2)

3.4 Operation of the ship

3.4.1 The Chapter shall contain the following information:

.1 data on the light ship as for her trim, stability and strength. If the light ship has a heel and a trim due to asymmetrical distribution of equipment, instructions shall be given on stowing the ballast, stores and cargo so as to eliminate the heel and reduce the trim. It shall be stated that elimination of heel by appropriate stowage of solid bulk cargo is not permitted;

.2 principles on the basis of which instructions on consuming the stores were drawn up; distribution of 50 per cent and 10 per cent of stores; effect of stores consumption on the vertical centre of gravity of the ship; specific instructions on consuming the stores with indication of conditions proceeding from which the consumption pattern shall be applied (stability, trim and damage stability requirements);

.3 the procedure for taking ballast during voyage for the compensation of increase of the vertical centre of gravity due to stores consumption; instructions on weather conditions under which ballasting is permitted;

.4 the principal ballast patterns for the carriage of heavy deck cargo, like containers, or light cargo in the hold, like ro-ro vehicles, and explanations to the patterns;

.5 information regarding the effect of hoisted crane booms, filled swimming pool and other heavy top masses on the ship's stability;

.6 operating limits as for loading, unloading, ballasting and distribution of cargo shall be listed and explained, as follows:

.6.1 draught limits and, in particular, statement that ship's draught shall not exceed the value corresponding to the freeboard according to the ship's Load Line Certificate;

.6.2 statement that the height of the ship's centre of gravity shall not exceed the maximum allowable value;

.6.3 statement that the shear forces and bending moments shall not exceed the maximum allowable values;

.6.4 minimum draught forward and aft with regard to seakeeping and bridge visibility;

.6.5 numerical values of deck cargo dimensions with regard to bridge visibility;

.6.6 maximum draught forward due to minimum bow height requirement;

.6.7 maximum mass for container stacks;

.6.8 permissible load for plating, decks and hatch covers on which cargo is stowed;

.6.9 maximum mass per hold for bulk cargo;

.6.10 ship's speed on the turn;

.6.11 permissible quantities of fish on the deck of fishing vessels;

.6.12 deck areas of passenger ships to which the access of passengers is prohibited;

.6.13 restrictions to the application of anti-rolling devices;

.6.14 guidelines for the use of anti-rolling tanks;

.6.15 other limitations proceeding from ship's purpose and construction;

.7 list of openings which shall be closed when at sea to prevent the flooding of spaces in hull, superstructures or deckhouses which shall be taken into consideration for stability calculation purposes. Where necessary, a diagram of the openings shall be attached;

.8 instructions for the case of damage to bilge keels;

.9 general instructions as for tanks which shall be either emptied or pressed up, except for those tanks out of which or into which liquid is taken. An instruction to the effect that the number of tanks with free surfaces shall be reduced to a minimum;

.10 general instructions to the effect that the heeling of a ship adversely effects stability and, therefore, efforts shall be made to maintain the ship in the upright position;

.11 instructions to the effect that the cargo shall be secured in compliance with the approved Cargo Securing Manual or in accordance with the recommendations of the master for the safe methods of stowing and securing the carried cargo (for fishing vessels);

.12 instructions to the effect that trimming is necessary in compliance with the International Code of Safe Practice for Solid Bulk Cargoes (during transportation of bulk cargoes);

.13 measures to ensure stability when, during a voyage or passage, the ships enter a region where the navigating conditions are more severe than those specified when assigning the area of navigation to the ship (provided such measures are necessary);

.14 instructions for preserving ship's stability when water is used for fire extinguishing;

.15 restrictions and instructions aimed at insuring an intact stability sufficient to satisfy the damage trim and stability requirements of the Register where these are compulsory for the ship in question;

.16 recommendations to the master which shall include recommendations for choosing the direction and speed with regard to the seaway as for the danger of parametric resonance of rolling when carrying deck cargo and/or at low initial stability, for minimum draught forward, manoeuvring directions (for instance, permissible speed with regard to heel on the turn for ships carrying containers on deck), recommendations for icing control, scale of forward and aft draught variations as a result of taking cargo on board the ship, directions for operating of heavy derricks (if installed on board the ship), etc.

Recommendations to the master for maintaining sufficient stability, including information deemed useful by the developer.

They shall not be overburdened with well-known provisions of good maritime practice.

3.5 Typical loading conditions

3.5.1 This Chapter shall contain the following information:

.1 plan of tanks, cargo spaces, machinery space, spaces intended for crew and passengers; the numbers and names shall be the same as in the ship documentation;

.2 tables showing distribution of stores and ballast among tanks under typical loading conditions with indication of mass and centre of gravity coordinates of the tanks as well as of relevant moments.

The numbers and names of the tanks shall be the same as those to be found in plan referred to in 3.5.1.1. The tanks as for which corrections for free surfaces were made, taken into consideration for typical loading conditions at 100 per cent, 50 per cent and 10 per cent filling, shall be indicated in the tables;

.3 mass and centre of gravity position, adopted for calculation purposes, of mass groups, such as passengers with their luggage and crew with their luggage, mass and centre of gravity position of cargo items (vehicles, containers, etc.);

.4 typical loading conditions including the following:

.4.1 light-ship condition;

.4.2 docking condition;

.4.3 loading conditions required by the Rules, loading conditions for all cargoes mentioned in the specification; marginal conditions of the ship operation as per its purpose to be encountered in practice and conditions of commencement of ballasting during the voyage for the purpose of maintaining stability;

.5 a summary tale of typical loading conditions.

The summary table shall include:

.5.1 name of the loading condition;

.5.2 displacement;

.5.3 trim parameters of the ship (forward and aft draught, draught at perpendiculars, mean draught, trim);

.5.4 coordinates of the centre of gravity;

.5.5 free surface correction value to the initial metacentric height;

.5.6 initial metacentric height with regard to the free surface correction;

.5.7 height of the centre of gravity of the ship as for the free surface effect;

.5.8 permissible values of the height of the ship's centre of gravity;

.5.9 standardized parameters and stability criteria (weather criterion, righting lever curve parameters, angle of heel due to passengers crowding to one side or angle of heel on the turn, etc.) and their permissible values;

.5.10 angle of flooding through opening considered to be open as per the present Part of the Rules.

3.5.2 As typical loading conditions are used to assess the cargo carrying capabilities of the ship, a limited number of conditions with 50 per cent stores shall be included in the typical loading conditions.

3.5.3 As a rule, the stability calculation for typical loading conditions shall be made for mean draught with initial trim disregarded.

3.5.4 Typical loading conditions shall be presented on special forms. In one and the same form, two or more loading conditions may be entered which may differ in the quantity of stores and ballast, characterizing the variations of loading during the voyage.

3.5.5 A form shall contain:

.1 description (name) of typical loading conditions;

.2 drawing showing the location of basic mass groups on the ship that shall be included in the displacement; a plan and directions for the stowage of deck cargo;

.3 table for determining the ship's weight, coordinates of its centre of gravity and relevant mass moments with regard to coordinate planes including the weight moments and centre of gravity positions of particular mass groups and of the light ship, and where icing is concerned, taking the ice weight into consideration; correction for the free surface effect of liquid stores and ballast shall be given in the table;

.4 displacement;

.5 ships' draught at forward and aft perpendiculars, mean draught, draught at centre of waterline area, draught at draught marks; draught statements shall refer to bottom of keel, which shall be clearly indicated;

.6 moment to change trim one unit;

.7 abscissa/longitudinal position of centre of buoyancy;

.8 abscissa/longitudinal position of centre of gravity;

.9 abscissa/longitudinal position of centre of waterline area;

.10 trim over perpendiculars;

.11 total correction for the effect of free surfaces of liquids;

.12 vertical position of the transverse metacentre (for trimmed condition if trim exceeds 0.5 per cent of the ship's length);

.13 height of the ship's centre of gravity, its correction to free surface effect and the corrected value;

.14 initial metacentric height adopted with regard for free surface effect;

.15 permissible value of the height of the ship's centre of gravity or of the metacentric height determined on the basis of the Rules, and the comparison with the corresponding value obtained;

.16 stability criteria required for the ship in question by the Rules (weather criterion for the particular condition, standardized parameters of righting lever curve, heel angles due to passengers crowding to one side, etc.);

.17 table of righting arms;

.18 righting lever curve plotted with regard for free surface effect, the flooding angle indicated (the scales used in the diagrams shall be the same for all loading conditions);

.19 statement of the ship's stability under the particular loading condition;

.20 information, where applicable, with regard to operating limits, ballasting during voyage, water soaking of deck cargo, limitations to stowage factor of cargo, limitations to average container masses per tier; restrictions to the usage of heavy equipment and of swimming pools; and any other important aspects.

3.5.6 Notwithstanding the fact that for the carriage of grain a ship shall have a separate Information on Ship Stability and Grain Loading drawn up as per the Rules for the Carriage of Grain, typical loading conditions shall contain grain loading conditions without regard to the shifting (where applicable).

3.6 Evaluation of stability for non-typical loading conditions

3.6.1 Where an approved computer and programs for the evaluation of stability are available on board the ship, general data regarding the computer, the programs and the programmer, and the information on the approval of the programs shall be given (by whom, when and for what period they were approved).

3.6.2 Notwithstanding a computer being available on board the ship, the "manual" method of calculation and evaluation of stability shall be explained in detail.

The explanation shall contain a description of the calculations sequence. As a rules, the description shall include the following sections.

3.6.2.1 The first Section shall contain:

.1 calculation of displacement and coordinates of the ship's centre of gravity;

.2 determination of mean draught

and comparison with permissible draught as per load line;

.3 determination of correction for free surface effect of liquid stores;

.4 height of the centre of gravity corrected for free surface effect of liquid stores;

.5 comparison of the value obtained for the height of the centre of gravity with the permissible value and condition of sufficient stability;

.6 actions and measures to be taken if the condition of sufficient stability is not fulfilled.

A note shall be made when describing the method of calculation adopted for this Section that the calculation shall be presented in the form of a table. The constants adopted (for instance, lightship weight, crew, etc.) shall be specified and entered in the table. The numbers of the tables, diagrams, etc. from which data for calculation are taken shall be indicated in the text. The recommended table form is given below (refer to Table 3.6.2.1.6).

If containers, vehicles, etc. are carried, auxiliary table forms for determining the weight and the coordinates of the centre of gravity of the cargo and explanations with regard to the use of the tables shall be given.

Instructions concerning allowance for icing shall be given.

3.6.2.2 The second Section shall contain:

.1 calculation of trim;

.2 actions and measures to be taken if the trim exceeds permissible values;

.3 calculation of draughts at draught marks.

Calculations sequence, adopted formulae, tables, curves, charts, diagrams or references to their numbers shall be given in the text of the Section.

3.6.2.3 The third Section shall contain:

instructions for the calculation of the righting lever curves, formulae, references to the numbers of tables, curves, charts and diagrams.

The calculations shall be tabulated.

The recommended table form is given below (refer to Table 3.6.2.3).

A form plotting the righting lever curve shall be provided (Fig. 3.6.2.3).

Where an approved computer and programs for the evaluation of stability are available on board the ship, this Section is optional.

3.6.2.4 The fourth Section shall contain:

explanation in the text and graphic form for determining the weather criterion;

instructions for the calculation, formulae, references to the numbers of tables, curves, charts and diagrams used.

This Section may be optional in the following cases:

the weather criterion is not a limiting one;

an approved computer and programs enabling the calculation of the weather criterion are available on board the ship.

3.6.2.5 The fifth Section shall contain:

instructions for calculating the angle of heel due to the effect of wind and/or angle of heel on the turn (if applicable).

The formulae and norms adopted in the calculations shall be given.

3.6.2.6 The sixth Section shall contain a calculated example and a detailed explanation of the calculation and the evaluation of stability for a non-typical loading condition.

3.6.2.7 If the ship is equipped with an approved installation for performing in-service inclining tests, a guidance for performing such inclining tests shall be given in accordance with the operation manual of the installation.

Guidance for determining the ship's stability in service shall enable the master to determine the actual stability of the ship with adequate accuracy and without undue loss of time.

This Section shall contain:

.1 instructions on the conditions and procedure for carrying out the in-service inclining test using the facilities available on board the ship (automatic systems for measuring and control of trim and stability, equalizing tanks, calibrated tanks for measuring stability and heel by means of a load the weight of which is known, etc.);

.2 data to assess the precision of measurements during the in-service inclining test and to estimate the quality of the test as a whole;

.3 instructions and materials to control initial metacentric height by measuring the roll period;

.4 explanations for the master concerning the assessment of the ship's stability via the procedures mentioned above.

3.6.2.8 The document shall contain forms on which independent calculations can be made.

Table 3.6.2.1.6 **Stability verification and draught calculation**

Nos.	Type of loading	Mass, in t	Abscissa x_g, in m	Moment M_x, in t·m, (3)x(4)	Applicate Z_g, in m	Moment M_z, in t·m, (3)x(6)	Moment of free surface of liquid $M_{f.s}$, in t·m
1	2	3	4	5	6	7	8
1	Light ship	×	×	× · ×	×	×·×	-
2	Crew	×	×	× · ×	×	× · ×	
3							
n	Displacement	Δ		ΣM_x		ΣM_z	$\Sigma M_{f.s}$
1	Abscissa of ship centre of gravity $X_g = \Sigma M_x / \Delta = (5)/(3)$						______m
2	Centre of gravity elevation above moulded base line $Z_g = \Sigma M_z / \Delta = (7)/(3)$						______m
3	Correction for free surface effect of liquid stores $\Sigma M_{f.s} / \Delta = (8)/(3)$						
4	Corrected centre of gravity elevation above moulded base line $Z_{g\text{вип}} = Z_g + (\Sigma M_{f.s} / \Delta)$						______m
5	Permitted centre of gravity elevation above moulded base line						______m
6	By the value M_x as per diagram (table) of forward and aft draughts: draught at forward perpendicular, d_f draught at aft perpendicular, d_a draught amidships, $d_{\otimes} = (d_f + d_a)/2$						 ______m ______m ______m

Table 3.6.2.3 **Table for righting lever curve calculation**

Angle of heel θ, in deg.	5	10	15	20	30	40	50	60	70	80
$\sin\theta^{o}$										
Arm of form l_f										
$Z_{gcor} \times \sin\theta^{o}$										
Arm of static stability curve $l = l_f - Z_{gcor} \times \sin\theta^{o}$										

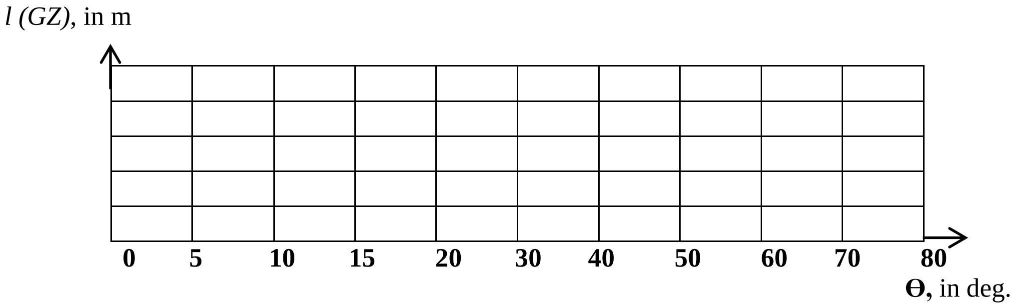


Fig. 3.6.2.3

4 TECHNICAL INFORMATION

4.1 All drawings, diagrams, curves and tables shall be named and numbered.

The Section shall contain:

.1 the ship's general arrangement plan;

.2 capacity plan.

The capacity plan shall show the layout of cargo spaces, tanks, stores, machinery spaces and crew and passenger accommodation. Cargo spaces and tanks shall bear names and numbers adopted on board the ship.

Moreover, the plan shall present:

.2.1 coordinate axes;

.2.2 frame, frame spacing and numbering;

.2.3 location of draught marks;

.2.4 diagram of the load line marks showing the position of the deck line relative to the ship, draught to the summer load line, draught to the summer timber load line (if any) and corresponding freeboards;

.2.5 deadweight scale.

It is permitted to incorporate the general arrangement plan and the capacity plan into a single plan;

.3 cargo space information.

Information on each cargo space shall include:

.3.1 name and number;

.3.2 location (frames);

.3.3 volume at 100 per cent filling;

.3.4 coordinates of the centre of volume;

.3.5 bale cargo capacity and grain capacity;

.3.6 permissible load for plating;

3.7 permissible cargo mass for bulk carriers;

3.8 on oil tankers, volume at 98 per cent filling and the corresponding moment of inertia of the free surface;

3.9 for dry cargo holds intended for the carriage of solid bulk cargoes, volume and coordinates of the centre of gravity depending on the level of filling;

.3.10 on container ships and ships equipped for the carriage of containers, container stowage plan (including deck containers) on the basis of which one can calculate the masses and the position of the centre of gravity of containers in the assumed loading condition. Maximum stack masses and maximum stack heights of containers shall be specified in the plan. A sketch shall be presented to confirm that the requirements for bridge visibility is fulfilled;

.3.11 on roll-on/roll-off ships, vehicle stowage plan;

.3.12 stowage plan for the deck cargo of timber as for stowage factor and the requirements for bridge visibility;

.4 tank space information.

Information on each tank space, including cargo tanks, shall include:

.4.1 name and number of tank;

.4.2 location (frames);

.4.3 volume, volumetric centre coordinates and the moment of inertia of the free surface depending on the level of filling.

Intervals of 0.10 m shall, as a rule, de adopted for the level of liquid. In grounded cases a greater interval may be adopted;

.5 hydrostatic particulars.

Hydrostatic particulars shall be calculated for the ship on even keel or design trim (without deflection) against displacement over a range from light ship to 15 per cent of the displacement of the load line. The draught intervals shall be 0.05 m. In grounded cases a greater interval may be adopted. The particulars shall be presented in the form of a table.

If the ship is intended for operation with a trim exceeding ±0.5 per cent of the ship's length, additional tables of hydrostatic particulars shall be presented for a suitable range of trim. The trim interval shall not exceed 1 per cent of the ship's length.

Draught statements shall refer to bottom of keel;

.6 cross-curves of stability data.

Cross-curves of stability data shall be provided for heeling angles up to 20° at 5° intervals, and from 20° to 80° at 10° intervals.

The displacement range shall correspond to that in 4.5; draught (displacement) intervals shall be 2 per cent of the draught (displacement) range. Cross-curves of stability values shall be presented in the form of a table. The table shall be supplemented by a sketch showing the ship's watertight spaces, which were taken into account for the calculation.

If the ship is intended for operation with a trim exceeding ±0.5 per cent of the ship's length, additional tables of cross-curves of stability shall be presented for the ship with a trim. The trim interval shall not exceed 1 per cent of the ship's length.

If the buoyancy of the deck cargo is taken into account when performing stability calculation, an additional separate cross-curves of stability table and a relevant sketch shall be drawn up.

Cross-curves of stability shall be calculated with due regard to the accompanying trim;

.7 solid cargo information.

If solid cargo is stowed on board the ship, a sketch shall be resented showing the stowage of the ballast, with a specification containing information on the weight of each ballast group and coordinates of the centre of gravity;

.8 information for stability control.

Information for stability control shall include permissible values of the height of the centre of gravity of the ship (or of permissible metacentric heights) depending on displacement (draught). The information shall be presented in the form of a table.

The information may include more than one table for different conditions of the ship's operation (for instance, for operation without deck cargo, with timber cargo on board the ship, with deck cargoes of timber having different permeabilities, under conditions of icing, when carrying one or two or three tiers of containers on deck, etc.). The permissible values of the height of the ship's centre of gravity shall be calculated considering subdivision requirements and damage trim and stability requirements where such requirements are compulsory for a ship.

If the ship is intended for operation with a trim exceeding ±0.5 per cent of the ship's length, additional tables (diagrams) of permissible values of the height of the centre of gravity of the ship with the trim shall be presented. The trim interval shall not exceed 1 per cent of the ship's length; the tables (diagrams) shall specify the trim range they apply to.

Where necessary, a table shall be presented containing minimum values of the height of the ship's centre of gravity at which the requirements of the Rules for the acceleration criterion are fulfilled;

.9 information on angles of flooding.

Information on flooding angles in the form of a table (tables) proceeding from displacement or draught within a plan of openings assumed to be open. The names of openings and their coordinates shall be indicated. Openings for ventilation of machinery spaces which ensure operation of machinery and its maintenance and which may not be closed in rough weather shall be assumed to be open;

.10 tables showing free surface correction values for liquid cargoes.

Free surface correction values to the initial metacentric height and righting lever for liquid cargoes, in tabular form;

.11 a diagram of forward and aft draughts.

A diagram (or table) of forward and aft draughts (at perpendiculars) plotted on a graph of displacement versus the longitudinal static mass moment of the ship. The diagram shall enable the master to speedily determine the draughts at forward and aft perpendiculars;

.12 a diagram (or table) correlating the draught at perpendiculars with the draughts at draught marks;

.13 data for direct calculation of weather criterion on the basis of the static or dynamic stability curves. If the weather criterion is not a limiting one, the data mentioned above shall be given in the Section 5 of the Appendix.

5 REFERENCE INFORMATION

5.1 This Section shall contain information which may be useful for the master, Port Administration and Flag Administration when resolving the matters connected with the ship's stability.

This Section shall contain:

.1 a detailed diagram of permissible heights of the ship's centre of gravity, including curves for each of the stability criteria applicable to the ship in question. Resulting curves of permissible heights of the ship's centre of gravity shall be highlighted on the diagram;

.2 data for direct calculation of weather criterion on the basis on the static or dynamic stability curves (at the discretion of the developer);

.3 a copy of the Inclining Test Report for the ship or its prototype and a copy of the Light-Weight Check Report (if any);

.4 any other data included in the Information at discretion of the shipowner.

5.2 Information for floating cranes

5.2.1 Information for floating cranes shall contain data on their stability as for the rated criteria for various boom radius and various loads on the hook (by mass and windage area), including loading conditions in which the stability becomes unsatisfactory by any criterion (criteria).

5.2.2 For floating cranes which stability in case of load drop is limited by the angle of flooding in the working condition, the Information shall contain requirements for reliable battening down of openings which are not permanently open during cargo handling operations.

5.2.3 Due to the variety of their loading conditions, data on the stability of floating cranes shall be presented in a simple and obvious form (for instance, in tables and diagrams characterizing the loading and stability of the floating crane in each of the loading condition).

5.2.4 In the case of floating cranes with luffing booms, the following rule shall be applied: in order to reduce the influence of external forces upon the floating crane the boom shall be lowered to the lowest position (secured for sea) on completion of cargo handling operations.

5.2.5 In case of floating cranes with slewing cranes and a cargo platform on deck it is not recommended to perform cargo handling operations when under way (e.g. carriage of loads hanging on the hook semi-submerged or raised above water: small ships, metal structures, etc.). Where this is performed by floating cranes of any type, restrictions on the area of navigation and weather shall be specified for such a voyage in each case, and arrangements shall be made for reliable securing to prevent the boom, hanger and the handling load from swinging. The possibility of a voyage with a load on the hook shall be confirmed by calculation and approved by the Register in each case.

5.3 The Information for the tug shall include a direction to the effect the maneuvering close to a stopped ship without casting off a tow rope is dangerous at the current speed above 1.3 m/s.

APPENDIX 2

DETERMINATION OF CAPSIZING MOMENT

1 DETERMINATION OF CAPSIZING MOMENT FOR A FLOATING CRANE

1.1 Determination of capsizing moment and the angle of dynamic heel in working condition in case of load drop

1.1.1 To determine the capsizing moment and the angle of dynamic heel after load drop, the curve of dynamical stability (to arm scale) shall be constructed for the loading condition under consideration, but without load on hook. In case the floating crane centre of gravity after the load drop does not coincide with centreline, the curve is to be constructed with regard to angle of heel θ'_0 due to unsymmetrical loading (including also unsymmetrical arrangement of cargo on deck). A portion of the curve shall be constructed in the negative angle area. To be plotted to the left from the origin of the coordinates is the initial angle of heel θ'_{d2} of the floating crane with a load on the hook, equal to the sum of the amplitude of roll θ_r in the working condition and the angle of statical heel θ_o when the load is lifted (Fig.1.1.1).

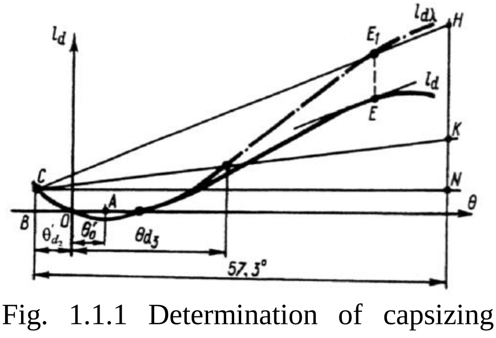


Fig. 1.1.1 Determination of capsizing moment and the angle of dynamic heel at the indication after load drop

The appropriate point *C* is fixed on the curve. The curve of the reduced arm is plotted to the right from the origin of the coordinates above the curve of statical stability, whose ordinates, in m, are determined by the formula

$$l_{d\lambda} = l_d + \delta l_\lambda\,, \qquad (1.1.1\text{-}1)$$

where δl_λ is the correction considering damping forces to be obtained as per 1.4 of the present Appendix.

The secant CE_1 is drawn from the point *C* so that the point of its intersection E_1 with the reduced arm curve lies on the same vertical line with point *E*, in which the straight line parallel to the secant touches the curve. From point *C* segment *CN* equal to 57.3º is laid off parallel to the axis of abscissae. From point *N* the perpendicular is erected up to its intersection with the secant at point *H*.

Segment *NH* is equal to the arm of the capsizing moment, $M_{c\lambda}$, in kN·m, with due regard for damping to be determined by the formula

$$M_{c\lambda} = g\Delta\,\overline{NH} \qquad (1.1.1\text{-}2)$$

where Δ is a displacement, in t.

From point *N* segment *NK* is laid off equal to the arm of the heeling moment, in m, to be determined by the formula

$$NK = M_v / g\Delta, \qquad (1.1.1\text{-}3)$$

where M_v is a heeling moment due to wind pressure, in kN·m.

Point *C* and *K* are connected by the straight line, whose point of intersection with the curve of reduced arms determines the angle of dynamical heel θ_{d3} at the inclination after load drop.

Stability may be checked taking no account of damping. In this case, the curve of reduced arms is not constructed, but the tangent is drawn from point *C* to the curve of dynamical stability. The angle of dynamical heel θ_{d3} is determined by the point of intersection of straight line *CK* with the curve.

1.2 Determination of capsizing moment during voyage

1.2.1 The capsizing moment M_c of the floating crane under the effect of rolling and steady wind may be determined both by the curve of dynamical stability and the righting lever curve, some portions of which are constructed for negative angles.

When using the curve of dynamical stability the positions of initial point *A* and point A_1 (Fig. 1.2.1) are so selected that tangent *AC* is parallel to the tangent A_1K and the difference of angles of heel corresponding to points A_1 and *A*, is equal to the amplitude of roll.

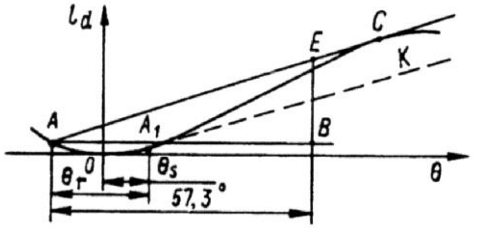


Fig. 1.2.1 Determination of capsizing moment of a floating crane during voyage from the curve of dynamical stability

Angle θ_s, obtained therefrom corresponds to the angle of statical heel due to limiting wind pressure, and segment *BE* is equal to the capsizing moment if the curve of dynamical stability is plotted to scale of moments, and to the arm of the capsizing moment, if the curve of dynamical stability is plotted to scale of arms.

In the latter case, the capsizing moment, in kN·m, is determined by the formula

$$M_c = \Delta \overline{BE} \,. \quad (1.2.1)$$

1.2.2 When the righting lever curve is used, the capsizing moment can be determined assuming the work of the capsizing moment and that of the righting moment to be equal and taking account of the effect of rolling and statical heel due to limiting wind pressure (Fig. 1.2.2). For this purpose, the righting lever curve is continued in the region of negative angles for such a portion that straight line *MK* parallel to the axis of abscissae cuts off the cross-hatched areas S_1 and S_2 equal to each other and the difference of angles corresponding to points A_1 and *A*, is equal to the amplitude of roll.

Ordinate *OM* will correspond to the capsizing moment, or to the arm of the capsizing moment, if righting arms are plotted along the axis of ordinates.

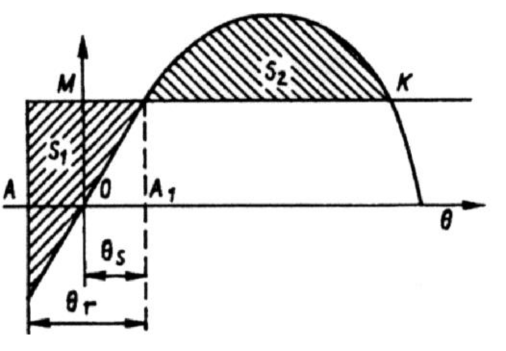


Fig. 1.2.2 Determination of the capsizing moment of a floating crane during voyage from the righting lever curve

1.2.3 If the curves of statical and dynamical stability are cut short at the angle of flooding, the capsizing moment shall be determined as specified in 1.2.1 and 1.2.2, yet the reserve of stability S_2 is restricted to the angle of flooding θ_f.

Capsizing moment M'_c, in kN·m, is determined similar to the moment M_c, provided the amplitude of roll θ_r in Fig. 1.2.2 is plotted in way of negative abscissa values from the reference point.

1.3 Determination of capsizing moment in non-working condition

The capsizing moment is determined from the righting lever curve (Fig. 1.3) for non-working loading condition with due regard for the free surface effect as well as the initial angle of heel θ'_0 due to the boom turn in the plane of the frame for floating cranes and crane ships with slewing cranes.

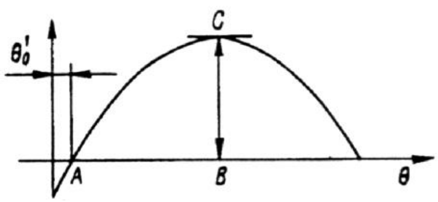


Fig. 1.3 Determination of capsizing moment in non-working condition

Segment *CB* is equal to the capsizing moment if the curve is plotted to scale of moments, and to the arm of the capsizing moment l_{max}, if the curve is plotted to scale of arms. In the latter case, the capsizing moment, in kNm, is determined by the formula

$$M_c = g\,\Delta\,l_{max}, \qquad (1.1.3)$$

where Δ is a displacement, in t.

1.4 Determination of the correction to the curve of dynamical stability considering damping forces

Correction δl_λ, in m, considering damping forces shall be determined by the formula

$$\delta l_\lambda = l_\lambda \sqrt{C_B B d}\left(\theta_p / 57{,}3\right)^2 F_5, \qquad (1.4\text{-}1)$$

where B is the breadth of the ship, in m;

d is the moulded draught of the ship, in m;

C_B is the block coefficient of the ship;

θ_P is a double swing value counting from the angle equal to the initial heel at the moment of load drop, in deg.;

l_λ is a factor determined by the formula:

$$l_\lambda = F_0\left(F_1 + \frac{z_g - d}{\sqrt{C_B B d}} F_2\right) + \frac{z_g - d}{\sqrt{C_B B d}} F_3 + F_4, \qquad (1.4\text{-}2)$$

where z_g is a centre of gravity height above the base line, in m;

F_0 is taken from Fig. 1.4 depending on characteristic F and $P = B/\sqrt{C_B B d}$;

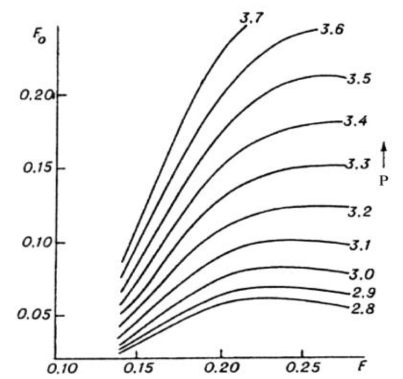


Fig. 1.4

F is determined by the formula (4.1.6.2.4-3) of this Chapter of the Rules;

The factors F_1, F_2, F_3, F_4 shall be taken from Table 1.1.4-1 depending on *P*;

F_5 is a factor taken from Table 1.1.4-2 depending on the ratio $(\theta_d + \theta'_{d2})/\theta_p$;

θ_d is an angle of deck immersion.

Table 1.4-1 **Factors F_1, F_2, F_3, F_4**

P	F_1	F_2	F_3	F_4
2.8	1.987	–3.435	0.0725	–0.021
2.9	2.087	–3.313	0.0856	–0.028
3.0	2.144	–3.097	0.1007	–0.037
3.1	2.157	–2.823	0.1150	–0.047
3.2	2.138	–2.525	0.1273	–0.057
3.3	2.097	–2.230	0.1357	–0.067
3.4	2.043	–1.955	0.1417	–0.076
3.5	1.982	–1.711	0.1454	–0.084
3.6	1.921	–1.497	0.1474	–0.091
3.7	1.861	–1.312	0.1475	–0.097

Table 1.1.4-2 **Factor F_5**

$\frac{\theta_d+\theta'_{d2}}{\theta_p}$	F_5	$\frac{\theta_d+\theta'_{d2}}{\theta_p}$	F_5
1.0	1.000	0.5	1.500
0.9	1.053	0.4	1.626
0.8	1.138	0.3	1.747
0.7	1.253	0.2	1.862
0.6	1.374		

2 DETERMINATION OF CAPSIZING MOMENT FOR CARGO AND FISHING FLEET

2.1. The capsizing moment M_c considering the effect of rolling may be determined both by the curve of dynamical stability and the righting lever curve. When determining the capsizing moment the following two cases can be traced:

2.1.1 the ship has standard curves of dynamic stability and righting lever curve, or stepped righting lever curve, while the curves of dynamic stability are broken.

In this case the capsizing moment shall be determined as follows:

.1 an auxiliary point *A* shall be found on curves in advance when using the curves of dynamic stability. The roll amplitude is plotted to the right from the origin of the coordinates and the corresponding point *A′* is fixed at the curve of dynamic stability (Fig. 2.1.1.1).

After that a straight line is to be drawn parallel to the axis of abscissae through the point *A′* and from the auxiliary point *A′* segment *A’A* is to be laid off to the left being equal to the double amplitude of the roll ($A'A=2\theta_r$). The point *A*, being symmetrical to the point *A*’, shall be the initial point. The tangent *AC* is drawn from the initial point *A* to the curve of dynamic stability and the segment *AB* equal to 1 rad (57.3°) is laid off from the point *A* on the straight line parallel to the axis of abscissae. From point *B* the perpendicular *BE* is erected up to its intersection with the tangent *AC* at point *E.* Segment *BE* is equal to the capsizing moment if the curve of dynamical stability is plotted to scale of moments, and to the arm of the capsizing moment, if the curve of dynamical stability is plotted to scale of arms.

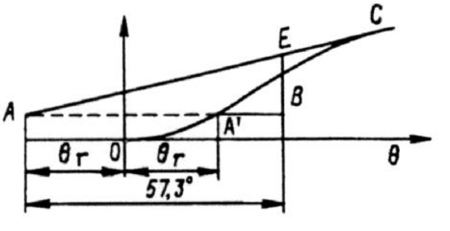


Fig. 2.1.1.1 Determination of the capsizing moment as per the curve of dynamic stability

In the latter case to determine the capsizing moment M_c, in kN·m, the length of segment *BE*, in m, shall be multiplied by the corresponding ship’s displacement Δ, in kN,

$$M_c = \Delta\,\overline{BE}\,; \qquad (2.1.1.1)$$

.2 when the righting lever curve is used, the capsizing moment can be determined assuming the work of the capsizing moment and that of the righting moment to be equal and considering the effect of rolling. For this purpose, the righting lever curve is continued in the region of negative abscissae equal to the amplitude of roll (Fig.2.1.1.2) and the straight line *MK* parallel to the axis of abscissae lines up with the cross-hatched areas S_1 and S_2 equal to each other. Ordinate *OM* shall be the desired capsizing moment if moments are plotted along the axis of ordinates, or the arm of capsizing moment if the righting arms are plotted along the axis of ordinates. In the latter case to determine the capsizing moment M_c, in kNm, the ordinate *OM*, in m, shall be multiplied by the corresponding ship's displacement, in kN·

$$M_c = \Delta \overline{OM}\ ; \qquad (2.1.1.2)$$

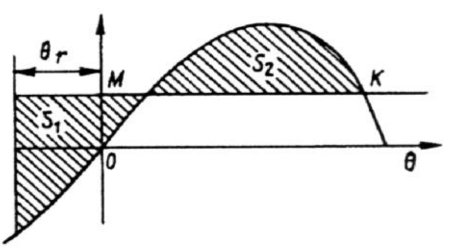


Fig. 2.1.1.2 Determination of capsizing moment as per the righting lever curve

2.1.2 The curves of statical and dynamic stability are cut short at the angle of flooding. Meanwhile, the capsizing moment is determined via one of the following ways:

.1 when the curve of dynamic stability is used, the capsizing moment shall be determined as follows. The position of the initial point *A* (Fig. 2.1.2.1) shall be determined in a way specified in 2.1.1.1. The tangent shall be drawn from the initial point *A* to the curve of dynamic stability that is possible only in the case when the angle of heel corresponding to the tangency point is less than the angle of flooding.

Capsizing moment or its arm shall be determined via the tangent under the same way as in the first case mentioned above.

If the tangent cannot be drawn, the straight line shall be plotted from the initial point *A* crossing the upper final point *F* of the curve of dynamic stability corresponding to the angle of flooding. Straight line parallel to the axis of abscissae is laid off from the same initial point *A* where the Segment *AB* equal to 57.3° is plotted. From point *B* the perpendicular *BE* is drawn up to its intersection with the inclined line *AF* at point *E.* Segment *BE* is equal to the capsizing moment if along the axis of ordinates the curve of dynamical stability is plotted to scale of moments, and to the arm of the capsizing moment, if along the axis of ordinates the curve of dynamical stability is plotted to scale of arms. In other case the capsizing moment shall be determined by the formula (2.1.1.1);

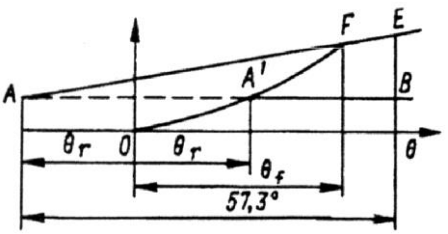


Fig. 2.1.2.1 Determination of capsizing moment via righting lever considering the angle of flooding

.2 where the righting lever is used, the capsizing moment for the angle of flooding θ_f shall be determined as follows.

The righting lever curve is continued in the region of negative angles equal to the amplitude of roll (Fig.2.1.2.2) and the straight line *MK* parallel to the axis of abscissae lines up with the cross-hatched areas S_1 and S_2 equal to each other. Ordinate *OM* shall be the desired capsizing moment M_c or its arm depending on the type of the curves construction. In the latter case the capsizing moment shall be defined by the formula (2.1.1.2).

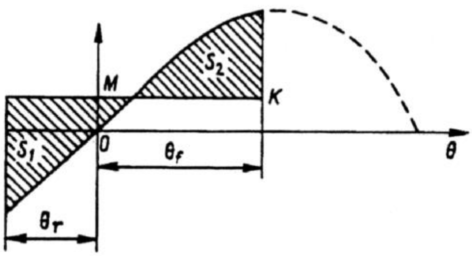


Fig. 2.1.2.2 Determination of capsizing moment via the righting lever curve considering the angle of flooding

3 DETERMINATION OF CAPSIZING MOMENT FOR DREDGERS

3.1 To determine capsizing moment the curve of dynamic stability after spoil is discharged as per the formula (3.8.4.7-2) of these Rules shall be constructed in a portion of the curve in the negative angle area. The segment being equal to the amplitude of roll θ_r shall be laid off to the left along the axis of abscissae from the point *A* corresponding to the minimum of the curve (angle of heel θ_{BC_1}) (Fig. 3.1-1).

The amplitude of roll in this case shall be equal to 10º with regard to the static action of the spoil discharge where the spoil in the hopper has a density less than 1.3 t/m^3 and shall be equal to 10º plus θ_{3r} (the maximum ship's amplitude of oscillation as for the static inclination right after the discharge) considering the dynamic type of the spoil discharge. The corresponding point *C*, is fixed at the curve of dynamic stability from which the tangent *CE* shall be drawn to the right leg of the curve. From point *C* the segment *CN* equal to 57.3º is laid off being parallel to the axis of abscissae. From point *N* the perpendicular is drawn up to its intersection with the tangent at point *H*. The segment *NH* is equal to the arm of capsizing moment M_c, in kN·m, to be determined by the formula

$$M_c = \Delta\,\overline{NH}\,. \qquad (3.1)$$

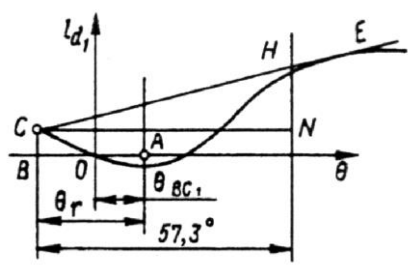


Fig.3.1-1 Determination of capsizing moment for dredgers

If it turns out that the angle of flooding θ_f is less than the angle of heel corresponding to the point *E* of the curve (refer to Fig. 3.1-1), the secant *CF* shall be drawn from the point *C* to the right leg of the curve as shown at Fig. 3.1-2.

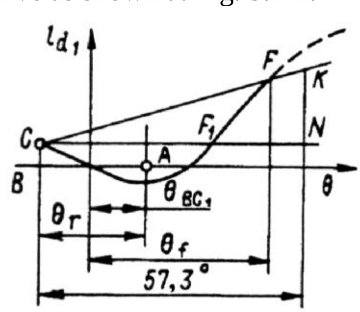


Fig. 3.1-2 Determination of capsizing moment for dredgers considering angle of flooding

The arm of capsizing moment shall be determined by the segment *NK* in this case.

If the point *F* of the curve corresponding to the angle of flooding (refer to Fig. 3.1-2) is to be lower than the intersection point F_1 with the line *CN*, the ship's stability shall not be considered satisfied.

In case of absence of the curve of the dynamic stability, the minimum capsizing moment shall be defined as per the righting lever curve (Fig. 2.1.1.2) in the same way as per 2.1.1.1 considering the initial statical heel.

TABLE OF SYMBOLS FOR THE VALUES TAKEN IN PART IV "STABILITY"

Register	IMO	Value
1	2	3
Δ	Δ	Displacement
$\Delta_{\min}$	-	Displacement corresponding to the minimum loading condition of the ship specified by the Rules
$\Delta_{\max}$	-	Full-load displacement
Δ_0	-	Light-ship displacement
Δ_1	-	Ship's displacement in the most unfavourable loading condition regarding the values of h or $l_{\max}$
γ	γ	Density
A_v	A_v	Windage area
A_k	–	Area of keels
A_{vi}	–	Windage area component of a floating crane
A_{calc}	–	Calculated value of acceleration (in fractions of g)
B	B	Breadth of the ship
b_0	–	Shroud spacing
C_B	C_B	Block coefficient of the ship
C_b	C_b	Tank block coefficient
c_T, b_T, a_T	–	Tank overall length, breadth and height (by base line)
c, b	–	Relative "dynamic' abscissa and ordinate of tow hook suspension point
D	D	Depth, moulded
d	d	Draught of the ship, moulded
$d_{\min}$	–	Draught, moulded, for minimum practicable ship's loading condition
$d_{⊗}$	–	Draught amidships
g	g	Acceleration due to gravity
h	GM	Corrected metacentric height (with correction for free surfaces)
h_0	GM_0	Initial metacentric height (not corrected for free surfaces)
$h_{3\%}$	–	Wave height with 3 per cent probability of exceeding level
H	–	Corrected longitudinal metacentric height of a floating dock, floating crane, crane ship (with correction for free surfaces)
K	–	Weather criterion
K^*	–	Acceleration criterion
K_1	–	Safety factor with respect to low line jerk for general service and ship handling tugs
K_2	–	Safety factor with respect to low line jerk for sea-going tugs
ΔK	–	Component of K_2 allowing for effect of rolling on resultant angle of heel
ψ	–	Angle of trim of a floating dock
k	–	Factor allowing for effect of bilge keels
k_θ		Coefficient considering the peculiarities of roll for ships of river-sea navigation
k_i	–	Aerodynamic flow coefficient for crane structures
L	L	Length of the ship

Continuation of Table

1	2	3
l	GZ	Arm of statical stability corrected for free surfaces
$l_{\max}$	GZ_m	Maximum arm of statical stability corrected for free surfaces
l_d	l	Arm of dynamic stability corrected for free surfaces
l'_d	–	Ditto, but not corrected for free surfaces
l_1; l_{d1}	–	Arms of statical and dynamical stability with permanent heeling moment due to load, as corrected for free surfaces
l'_{d1}	–	Ditto, but not corrected for free surfaces
l_F	–	Arm of form stability with respect to the centre of buoyancy
l_M	–	Arm of form stability with respect to metacentre
l_P	–	Arm of form stability with respect to arbitrary pole
l_K	–	Arm of form stability with respect to moulded base line
l_c	–	Capsizing lever corrected for free surfaces
l_v	–	Heeling lever
$l_{d\mathrm{cap}}$	–	Arm of dynamical stability defined as an ordinate of the dynamic stability curve for a tug at the angle of heel equal to flooding or capsizing angle, whichever is less
l_{dheel}	–	Dynamic heeling lever characterizing assumed jerk of tow line
$l_{d\max}$; l_{df}	–	Ordinate of dynamic stability curve at the angle of heel equal to angle of the maximum of righting lever curve or angle of flooding, whichever is less
$\overline{l}_\theta$	k	Non-dimensional coefficient for determination of free surface correction at heel θ
θ	θ	Angle of heel
θ_f	θ_f	Angle of flooding
θ_v	θ_v	Angle of vanishing stability
θ_d	–	Angle of deck immersion
θ_b	–	Angle of coming out of water of bilge middle
θ_m	θ_m	Angle of heel corresponding to the maximum of the righting lever curve
θ_{cap}	–	Capsizing angle
θ_{d1}	–	Angle of dynamic heel of tug due to assumed jerk of tow line
θ'_{cap}	–	Angle of tug capsizing defined as abscissa of the tangency point of dynamical stability curve and tangent to it passing through origin of the coordinates
θ_{BC1}	–	Statical heel after spoil discharge
θ_{1r}	θ_r	Amplitude of roll for a round-bilged ship
θ_{2r}	θ_r	Amplitude of roll for a ship with keels
θ_{3r}	θ_r	Maximum amplitude of dredger rolling with respect to statical inclination immediately after spoil is discharged from one side
θ_r	–	Roll amplitude of a floating crane
θ'_r	–	Roll amplitude of a floating crane considering bilge coming out of water or deck immersion
$\delta\theta_r$	–	Correction having regard to the effect of the floating crane centre of gravity elevation above waterline
θ_0	–	Initial static heel of a floating crane due to load hook and unsymmetrical stowage of cargo on deck
θ_s	–	Angle of heel of a pontoon floating crane due to heeling moment caused by permanent wind
θ_{d2}	–	Angle of heel of a floating crane due to combined effect of initial heeling moment, statical wind effect and rolling
θ'_{d2}	–	Calculated angle of heel of a floating crane prior to load drop equal to the sum of angles θ_0 and θ_r minus θ_s

End of Table

1	2	3
M_c	M_c	Capsizing moment
M_v	M_v	Heeling moment due to wind pressure
M_{h1}	M_h	Heeling moment due to passengers crowding
M_{h2}	M_h	Heeling moment due to turning
M_{h3}	M_h	Heeling moment of long chute or conveyor
M_ψ	–	Trimming moment due to crane mass with maximum load for the most unfavourable service case of crane arrangement on a floating dock
ΔM_θ	M_h	Heeling moment due to liquid overflow at ship's heel θ
Δm_h	–	Correction of stability coefficient for liquid cargo effect
n_i	–	Zone coefficient considering changes in wind velocity head depending on the height of windage area centre of gravity of a floating crane
P	P	Mass of spoil in the hopper
p_v	p_v	Rated wind pressure
q	–	Rated wind velocity head
v_T	–	Tank volume
$v_{0,8}$	–	Speed during ship's turning shall be equal to 80 per cent of speed of a ship under way
v_0	–	Speed of straightline movement of a ship
x_H	–	Longitudinal distance between tow hook suspension point and ship's centre of gravity as measured over horizontal
$X, X_1, X_2, X_{1,2}, X_3, X_4, X_5$	–	Factors for determination of roll amplitude
y	–	Ship's centre of gravity ordinate from centreline
y_g	–	Side shifting of ship's centre of gravity from centreline
Y	–	Factor for determination of roll amplitude
z	–	Arm of windage area above the waterline of floatation
z_v		Arm of windage area equal to the distance from the centre of the windage area to the half of the ship draught
z_g	KG	Centre of gravity elevation above moulded base line
z_H	–	Elevation of tow hook suspension point above moulded base plane
z_0	–	Elevation of shroud mounting point
z_i	–	Elevation of centres of areas A_{vi} within a zone above the actual waterline of a floating crane
z_w	–	Arm of windage area of a floating crane due to the permanent wind
z'_w	–	Arm of windage area of a floating crane due to the effect of squall
C_{CL}	–	Lateral area coefficient of a floating crane, crane ship
C_{WL}	–	Water-plane coefficient of a floating crane, crane ship
θ''_r	–	Roll amplitude of a floating crane during voyage/passage with regard to bilge coming out of water at midsection or deck immersion
θ'_s	–	Angle of heel of a crane ship which hull shape is similar to the ship lines, exposed to heeling moment M'_v caused by squall
X_c	X_B	Abscissa of the centre of buoyancy
X_g	X_G	Abscissa of centre of ship's gravity