Polski Rejestr Statków

RULES
FOR THE CLASSIFICATION AND CONSTRUCTION OF NAVAL SHIPS

PART IV

STABILITY AND SUBDIVISION

2008

GDAŃSK

RULES FOR THE CLASSIFICATION AND CONSTRUCTION OF NAVAL SHIPS
prepared and edited by Polski Rejestr Statków, hereinafter referred to as PRS, consist of the following Parts:

Part I – Classification Regulations
Part II – Hull
Part III – Hull Equipment
Part IV – Stability and Subdivision
Part V – Fire Protection
Part VI – Machinery Installations and Refrigerating Plants
Part VII – Machinery, Boilers and Pressure Vessels
Part VIII – Electrical Installations and Control Systems
Part X – Statutory Equipment.

With regard to materials and welding, the requirements of *Part IX – Materials and Welding* of the *Rules for the Classification and Construction of Sea-going Ships,* apply.

Part IV – Stability and Subdivision, 2008, was approved by the PRS Board on 24 June 2008 and enters into force on 1 August 2008.

From the entry into force, the requirements of *Part IV – Stability and Subdivision* apply to:
- new naval ships, the building contract for which will be signed on or after 1 August 2008 – within the full scope,
- existing naval ships, in accordance with the principles specified in *Part I – Classification Regulations.*

The requirements of *Part IV – Stability and Subdivision* are extended by the below-listed Publications:

Publication No. 6/P – Stability
Publication No. 14/P – Principles of Approval of Computer Programs
Publication No. 66/P – Onboard Computers for Stability Calculations

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1.1.1 *Part IV – Stability and Subdivision* applies to naval mono-hull, displacement full deck ships, specified in *Part I – Classification Regulations.*

1.1.2 Multi-hull and special design ships are subject to special consideration of PRS in each particular case.

1.2 General

1.2.1 All naval ships shall comply with the applicable requirements of the present *Part.* Non-displacement ships shall comply with stability and subdivision requirements specified in Chapter 2 of the *International High Speed Craft Code*.

1.2.2 The stability of naval ships, excluding tankers, shall comply with the requirements specified in sub-Chapter 2.1 of the present *Part.*

1.2.3 The stability of tankers shall comply with the requirements specified in sub-chapter 2.8 of the present *Part.*

1.2.4 The requirements concerning the ship's subdivision are specified in Chapter 3 of the present *Part.*

1.2.5 With respect to existing naval ships, the scope of the requirements is specified by PRS in each particular case, having regard to the principles given in *Part I – Classification Regulations*.

1.3 Definitions

The definitions relating to the general terminology of the *Rules for the Classification and Construction of Naval Ships* (hereinafter referred to as the *Rules*) are given in *Part I – Classification Regulations*. In the present chapter, the definitions, symbols and abbreviations, specific for *Part IV*, have been provided.

A f t e r p e r p e n d i c u l a r – the perpendicular at the intersection of the design waterline with the axis of the rudder stock or with the line of the transom (for ships without classic rudders).

B a s e p l a n e – horizontal plane which crosses amidships the top of a flat keel or the intersection of the inner surface of the plating with the bar keel.

B r e a d t h o f t h e s h i p *B* – the greatest breadth of the ship measured between the outer edges of frames, at or below the deepest subdivision load line.

B u l k h e a d d e c k – the uppermost deck up to which transverse watertight bulkheads are carried.

Capsizing moment M_{kr} [tm] – a conventional design moment, applied dynamically taking account of the ship's rolling, which heels the ship to an angle equal to the angle of capsizing or the angle of flooding, or the dynamic margin angle of heel (where determined), whichever is the lesser.

Corrected metacentric height – the metacentric height decreased by correction for free surfaces.

Correction for free surfaces – a correction taking into account the decrease of the ship's stability due to the effect of liquids free surface.

Cross curve – curves of form stability arms.

Damage waterline – a waterline of the damaged ship with one compartment or a group of adjacent compartments flooded.

Deckhouse – a decked structure on the upper deck (or on the superstructure deck) with the sides (one or both) being inboard of the ship sides more than $0.04B$.

Deepest subdivision load line – the waterline which corresponds to the greatest draught permitted by the subdivision requirements which are applicable.

Design length of the ship L_0, [m] – a length measured on design waterline from the fore side of the stem to the centre of the rudder stock (or the line of the transom – for ships without classic rudders). The assumed value of L_0 is not to be less than 96% and need not be greater than 97% of the extreme length on the design waterline. In ships with unusual stern and bow arrangement, the length L_0 is subject to special consideration by PRS.

Design waterline – a waterline corresponding to the ship design draught.

Maximum displacement of the ship, D_{max}, [t] – displacement of the ship in maximum loading condition, with stability and minimum freeboard maintenance, with possible speed or navigation range limitation.

Normal displacement of the ship, D_n, [t] – standard displacement of the ship with 50% stores of fuel, lubricants and boiler water.

Full displacement of the ship, D_p, [t] – standard displacement of the ship with full stores of fuel, lubricants and boiler water.

Standard displacement of the ship, D, [t] – displacement of fully equipped ship, with the crew, cargo, full supply of munitions, provisions, drinkable water and remains of liquids in machinery, equipment and systems. This displacement does not include stores of fuel, lubricants and boiler water.

Design draught of the ship, T, [m] – the vertical distance from the base plane to the waterline corresponding to full displacement of the ship.

Maximum draught of the ship, T_{max}, [m] – the vertical distance from the base plane to the waterline corresponding to maximum displacement of the ship.

Minimum draught of the ship, T_{min}, [m] – the minimum average service draught of the ship without cargo, with 10% of stores, including such water ballast as may be necessary.

Equalization of the ship – activities aimed at eliminating or reducing the heel and trim after flooding a compartment/compartments as a result of damage – consisting in flooding and/or emptying of a tank (or a combination of tanks).

Forward perpendicular – the perpendicular at the intersection of the design waterline with the fore side of the stem. For ships with unconventional stem curvature, the position of the forward perpendicular is subject to special consideration by PRS.

Heeling moment, M_w, [tm] – a conventional design moment caused by dynamic action of the wind.

Homogeneous cargo – a cargo having constant stowage factor in its full capacity.

Inclining test – a test carried out to determine the lightweight of the ship and the position of its centre.

Intact ship flooding angle – the smallest angle of heel at which the ship's interior spaces are flooded by water through openings in the hull, superstructures or deckhouses, assumed open in operational loading conditions (see 1.6.8.2).

Light ship – a ship ready for operation, but without cargo, stores, munitions, ballast water, the crew and their belongings.

Lightweight, [t] – the mass of a ship, in tonnes, without cargo, munitions, fuel, lubricating oil, ballast water, fresh water and feed water in tanks, without consumable stores, as well as without the crew and their belongings.

Maximum waterline – a waterline corresponding to the ship's maximum displacement.

Midship section – hull cross-section at the middle of the distance between the fore perpendicular and aft perpendicular.

Moulded depth of the ship H – the vertical distance measured amidships from the base plane to the top of the uppermost continuous deck beam at side. In ships having a rounded gunwale, the moulded depth shall be measured to the point of intersection of the moulded lines of the deck and side.

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.

Passage outside the assigned area of navigation – the ship's navigation outside the assigned area of navigation after fulfilling the specified requirements and based on permission granted in each particular case.

Permeability of a space – the ratio of the volume which can be occupied by water to the whole volume of the space.

Stability booklet – a document containing reliable information enabling the commanding officer, by rapid and simple processes, to obtain accurate guidance as to the stability of the ship in any loading condition.

Subdivision – capability of a ship, after damage and flooding of a compartment or adjacent compartments, to maintain buoyancy and stability in accordance with the requirements specified in the present part of the *Rules.*

Subdivision breadth of the ship, B_s,[m] – the greatest breadth of the ship measured at the deepest subdivision load line between the outer edges of frames in a ship with metal shell plating or between the outer surface of the hull in a ship with the shell plating of any other material.

Subdivision length of the ship, L_s,[m], – the greatest projected moulded length of that part of the ship at or below deck (or decks) limiting the vertical extent of flooding with the ship at the deepest subdivision design waterline.

Subdivision waterline – a waterline used in determining the subdivision of the ship.

Superstructure – a decked structure on the upper deck, extending from side to side of the ship or with one side or both sides being inboard of the ship sides not more than 0.04*B*. A raised quarter deck is considered as a superstructure.

System of roll stabilization – a special active or passive equipment for reducing the ship's rolling amplitude.

Upper deck – the uppermost continuous deck extending over the full length of the ship.

Watertight compartment – part of the ship's inner space bounded by the ship's bottom, sides, bulkhead deck and two adjacent transverse watertight bulkheads or the bulkhead and shell plating of the peak.

1.4 Documentation

1.4.1 Depending on the ship's construction stage, the documentation, as specified in 1.4.1.1 and 1.4.1.2, shall be submitted to PRS for consideration.

1.4.1.1 Prior to the commencement of the ship's construction or alteration, the following shall be submitted for information:

.1 General arrangement plan;

.2 Arrangement plan of outer doors, companionways and sidescuttles (see also 1.6.5);

.3 Body lines or the body lines table;

.4 Hydrostatic curves, Bonjean scale, cross curves of stability – print-outs of calculation results where computer programs, not approved by PRS, are used;

.5 Calculations of: heeling levers due to the effect of wind (without icing and with icing), including the windage area diagram, flooding angles, icing (the mass of ice and the position of the centre of mass), liquid free surface effect on the ship's stability;

.6 Calculations and diagrams of the permissible value of the vertical coordinate of the ship's centre of mass KG_{max} (or GM_{min}), depending on the ship's draught or displacement (see 1.6.11.5);

.7 Calculations and diagrams of the permissible value of the vertical coordinate of the ship's centre of mass KG_{max} ensuring compliance with stability criteria for damaged ship (see 1.6.11.9);

.8 Plan of cargo compartments, tanks, including sounding tables and the plan of decks (see 1.6.4);

.9 Plan of permanent ballast, where provided;

and for acceptance (preliminary approval):

.10 Preliminary *Stability booklet* (see 1.6.11);

.11 Preliminary *Damage control plan* (see 3.2.4);

.12 Preliminary *Subdivision booklet*.

1.4.1.2 Upon completion of the ship's construction or alteration, the following shall be submitted for approval:

.1 *Stability and subdivision booklet* prepared on the basis of the inclining test data (see 1.7);

.2 *Damage control plan*;

and for information:

.3 Inclining test report, accepted by PRS;

.4 Updated documentation, referred to in 1.4.1.1.1 to 1.4.1.1.9 (if changes have been introduced thereto).

1.4.2 Where provision has been made on board for anti-rolling devices or other arrangements having effect on the ship's stability (e.g. anti-heeling system for use in port during loading/discharging operations), the scope of additional documentation and calculations shall be agreed with PRS.

1.4.3 Depending on the ship type, the scope of the required documentation may be extended or limited – in such cases, the detailed requirements are given in chapters referring to particular types of ships.

1.5 Scope of Survey

1.5.1 PRS survey, within the scope of stability, covers:

1.5.1.1 Prior to the commencement of the ship's construction:

.1 consideration of the ship's stability documentation and verification of calculations;

.2 acceptance of preliminary stability booklet.

1.5.1.2 During and upon completion of the ship's construction:

.1 acceptance of the hull measurement results (the main dimensions, keel position) and the survey of draught marks location;

.2 supervision of the inclining test and the acceptance of inclining test report;

.3 consideration and approval of *Stability booklet;*

.4 approval of calculation programs for checking the ship's stability during service;

.5 checking compliance with the requirements concerning the hull watertight integrity.

1.5.1.3 Within the scope of the ship's periodical and occasional surveys:

.1 checking the validity of *Stability booklet* and loading plans considering the possible changes of the lightweight of the ship;

.2 checking and testing, before the ship departure, the stability control calculator;

.3 checking compliance with the requirements concerning the hull watertight integrity.

1.5.2 Within the scope of subdivision, PRS' survey covers:

1.5.2.1 Prior to the commencement of the ship's construction:

.1 consideration of documentation, verification of calculations and acceptance of the ship's subdivision or internal division;

.2 acceptance of the diagram of the permissible values of vertical coordinate of the ship's centre of mass during service (see 1.6.11.5);

.3 consideration of preliminary *Damage control plan*;

.4 consideration and approval of the ship's anti-heeling system, where provided;

.5 acceptance of preliminary *Subdivision booklet*.

1.5.2.2 During and upon completion of the ship's construction:

.1 examination of structural means and devices connected with ensuring the watertight integrity of compartments and the ship's stability after flooding a compartment/compartments;

.2 approval of *Subdivision booklet*;

.3 approval of *Damage control plan*;

.4 checking the correctness of the assignment and marking of draught marks.

1.6 General Requirements

1.6.1 General Assumptions and Principles

1.6.1.1 Compliance with the stability criteria does not provide immunity against capsizing. An additional requirement to ensure the safety of the ship is its proper operation, having regard to the prevailing circumstances, therefore compliance with stability criteria does not absolve the Commanding Officer from his responsibility for the safety of the ship.

Note: The term "stability", used in the present Part of the *Rules,* means intact stability.

1.6.1.2 It is assumed that the Commanding Officer operates the ship with prudence and good seamanship, with due regard paid to the season of the year, weather forecasts and the navigational zone and will take appropriate action as to speed and course warranted by the prevailing circumstances.

1.6.1.3 It is assumed that the cargo is properly stowed and secured so as to minimize the possibility of longitudinal and transverse shifting, while at sea, under the effect of rolling and pitching.

1.6.1.4 It is assumed that the ship is so loaded and ballasted (where necessary) that the stability criteria, specific for a given ship, are at all times during a voyage complied with.

1.6.1.5 The number of partially filled tanks shall be kept to a minimum due to their adverse effect on the ship's stability.

1.6.1.6 The stability criteria, given in Chapter 2, provide the required minimum values of metacentric height. The maximum values have not been determined. It is advisable that excessive values of metacentric height should be avoided since they may lead to high acceleration and forces – prejudicial to the ship, its equipment, the crew and the carried cargo.

1.6.2 Calculation Methods

1.6.2.1 It is recommended that calculations should be made using programs approved by PRS in accordance with *Publication No. 14/P – Principles of Approval of Computer Programs.*

1.6.3 Calculation of Cross Curves of Stability

1.6.3.1 Hydrostatic and stability curves shall be calculated on a design trim basis. However, where the operating trim or the form and arrangement of the ship are such that change in trim has an appreciable effect on righting levers, such change in trim shall be taken into account.

1.6.3.2 When calculating cross curves of stability, account may be taken of those tiers of the enclosed superstructures which comply with the requirements specified in the relevant paragraphs of *Part III – Hull Equipment.* A bridge (midship section) or a poop shall not be regarded as enclosed unless access is provided for the crew to reach machinery or other working spaces inside those superstructures by alternative means which are available at all times when bulkhead openings are closed .

1.6.3.3 Superstructures, in which no entrance is provided from an exposed deck above (ensuring the crew access to working spaces inside the superstructures and to the machinery space when the bulkheads openings are closed), may be taken into account in stability cross curves calculations in full height if the upper edges of door sills in superstructures at the ship's maximum draught immerse at the angle of

heel equal to or greater than the required angle of static stability range. If the upper edges of door sills in superstructures immerse at an angle less than the required angle of static stability range, the design height of superstructures shall be assumed to be half their actual height.

1.6.3.4 When calculating the cross curves of stability, account may be taken of full height of deckhouses situated on the upper deck, provided they comply with the requirements for enclosed superstructures, set forth in 1.6.3.2. Where, in deckhouses, there is no exit to the deck above, such deckhouses shall not be taken into account when calculating the cross curves of stability; however, any deck openings inside such deckhouses may be considered as closed – irrespective of whether means of closures are provided.

1.6.3.5 Deckhouses, the doors of which do not comply with the requirements specified in the relevant paragraphs of *Part III – Hull Equipment*, shall not be taken into account when calculating the cross curves of stability; however, any deck openings inside the deckhouses shall be considered as closed if their coamings and means of closure comply with the requirements set forth in the relevant paragraphs of *Part II – Hull* and *Part III – Hull Equipment*.

1.6.3.6 When calculating the cross curves of stability, account may be taken of the volumes of hatches, situated on the upper deck and fitted with closing devices complying with the requirements set forth in the relevant paragraphs of *Part III – Hull Equipment*.

1.6.3.7 The drawing or table of cross curves of stability shall contain a scheme of superstructures and deckhouses taken into account in calculations, indicating the openings considered to be open, as well as a scheme of the part of the upper deck with the wood sheathing taken into account. The location of the point, to which cross curves of stability are related, shall be indicated.

1.6.4 Plans of Cargo Compartments, Tanks and Decks

1.6.4.1 The plan of cargo compartments shall incorporate data, for each cargo space, containing approved permissible load on cargo surfaces, capacities, the centre of volume coordinates and data enabling to determine the centre of mass coordinates of the loaded cargo.

1.6.4.2 The plan of tanks shall incorporate all tanks other than cargo tanks, tables of volumes and the centre of volume coordinates, as well as data necessary to determine the free surface effect on stability. The plan of tanks shall be supplemented with valid sounding tables.

1.6.4.3 The plan of decks shall contain all data necessary to determine the permissible masses of deck cargoes and cargoes on hatch covers, as well as coordinates of the centres of mass.

1.6.5 The Arrangement Plan of Doors, Companionways and Sidescuttles

1.6.5.1 The arrangement plan of doors and companionways shall include all doors and companionways leading to open decks, as well as all doors and hatches in the shell plating, with reference made to their drawings. The plan shall include also all sidescuttles located below the continuous upper deck, as well as sidescuttles in the superstructures and deckhouses taken into account in calculations of cross curves of stability.

1.6.5.2 Openings assumed to be open, for which angle of flooding has been determined, shall be indicated on the plan.

1.6.6 Windage Area Calculations

1.6.6.1 The windage area F_w and its static moment shall be calculated for the ship's draught T_{min}.

The windage area for other draughts may be calculated by linear interpolation taking the second point of the draught corresponding to the maximum waterline.

1.6.6.2 The position of the centre of the windage area shall be determined by a method generally used in determining the coordinates of the geometric centre of a plane figure.

1.6.6.3 The windage area includes the projections, on the ship's centre plane, of all continuous walls and surfaces of the hull, superstructures and deckhouses, masts, ventilators, boats, deck machinery, as well as all tents which may be stretched in stormy weather, and the projections of lateral surfaces of cargoes to be carried on deck.

It is recommended that the windage area of discontinuous surfaces of rails and rigging (except masts) of ships not provided with sails, as well as the windage area of various small objects should be taken into account by increasing the windage area calculated for draught T_{min} by 5% and the static moment of this area – by 10%.

In order to take into account the windage area of discontinuous surfaces and small objects under icing conditions, the projected lateral area and the static moment of this area, calculated for T_{min}, shall be increased by 10% and 20% or by 7.5% and 15%, respectively, depending on the mass of ice per square metre, specified in 1.6.12.4 and 1.6.12.5. These increased values of windage areas of discontinuous surfaces and small objects, as well as their static moments shall be assumed constant for all service draughts.

1.6.7 Effect of Free Surfaces of Liquids

1.6.7.1 The ship's static stability characteristics shall take into account, for all loading conditions, the effect of free surfaces of liquids on the position of the ship's centre of mass, the initial metacentric height and the righting levers curves.

1.6.7.2 The effect of free surfaces of liquids shall be taken into account if the filling level in a tank is less than 98% of full condition. Free surface effects of small tanks may be disregarded in conditions specified in 1.6.7.10.

1.6.7.3 Tanks which shall be taken into consideration when determining the free surface correction may be divided into two groups:

.1 tanks with filling levels fixed (e.g. liquid cargo, water ballast);

.2 tanks with filling levels variable (e.g. fuel oil, oils, fresh water, as well as liquid cargo and water ballast during filling/discharging operations).

Except cases specified in 1.6.7.5 and 1.6.7.6, the free surface correction taken shall be the maximum value attainable between the filling limits envisaged for each tank, consistent with operating instructions.

1.6.7.4 In the case of tanks containing consumable liquids it shall be assumed that, for each type of liquid, at least one transverse pair or a single centreline tank has a free surface and the tank or a combination of tanks, taken into account in calculations, shall be those where the effect of free surfaces is the greatest.

1.6.7.5 Where water ballast tanks, as well as anti-rolling tanks and anti-heeling tanks shall be filled or discharged during the course of a voyage, the free surfaces effect shall be calculated for the most unfavourable stages of such operations.

1.6.7.6 For ships engaged in liquid transfer operations to another ship – RAS system – the free surface correction may be determined in accordance with the filling level in each tank in the considered stage of operation.

1.6.7.7 The effect of free surfaces of liquids on the values of the vertical coordinate of the centre of mass and the metacentric height in the considered loading condition shall be taken into account using G_0G correction, calculated from the formula:

$$G_0G = \frac{\sum i_1\rho_1 + i_2\rho_2 + ... + i_n\rho_n}{D} \qquad (1.6.7.7\text{-}1)$$

where:

G_0G – free surface correction, [m];

i – moment of inertia, at the angle of heel $\Theta = 0°$, [m^4];

ρ – density of liquid in the tank, [t/m^3];

D – displacement of the ship, [t].

The corrected vertical coordinate of the ship's centre of mass KG is equal to:

$$KG = KG_0 + G_0G \qquad (1.6.7.7\text{-}2)$$

The corrected ship's metacentric height GM is equal to:

$$GM = KM - KG \tag{1.6.7.7-3}$$

where:
KM – height of metacentre above the base plane, [m];
KG_0 – vertical coordinate of the centre of mass, without free surface correction, [m].

1.6.7.8 The effect of free surfaces of liquids on the values of the static stability righting lever GZ (Θ) shall be taken into account, assuming:

.1 correction, calculated in accordance with 1.6.7.7, for each angle of heel, applying the formula:

$$GZ(\Theta) = l_k(\Theta) - KG\sin\Theta \tag{1.6.7.8}$$

where: Θ – angle of heel; or

.2 correction, calculated on the basis of actual moments of inertia of liquids free surfaces for each angle of heel; or

.3 correction, calculated on the basis of the sum of free surfaces moments M_{fs} developed by the liquids in all tanks taken into account, determined in accordance with 1.6.7.9; in this case, the provisions of para. 1.6.7.3 do not apply.

In *Stability booklet*, only one method of calculating the correction shall be used.

Where, in the instructions for stability calculations and assessment, alternative calculation methods for cargo loading conditions are applied, examples of calculating the free surface corrections according to each of the methods, as well as explanations of differences between the final corrected values obtained shall be given.

1.6.7.9 The values of M_{fs} moments for each tank shall be calculated from the formula:

$$M_{fs} = vbk\rho\sqrt{\delta} \tag{1.6.7.9}$$

where:
M_{fs} – free surface moment at any angle of heel, [tm];
v – tank total capacity, [m^3];
b – tank maximum breadth, [m];
k – dimensionless coefficient, determined from Table 1.6.7.9, depending on b/h value; the intermediate values shall be determined by linear interpolation;
ρ – density of liquid in the tank, [t/m^3];
δ – tank block coefficient; $\delta = v / blh$;
l – tank maximum length, [m];
h – tank maximum height, [m].

Table 1.6.7.9
Factor *k* for calculating free surface corrections

$k = \frac{\sin\Theta}{12}\left(1+\frac{\tan^2\Theta}{2}\right)(b/h)$ if $\operatorname{ctan}\Theta \geq b/h$														$k = \frac{\cos\Theta}{8}\left(1+\frac{\tan\Theta}{b/h}\right) - \frac{\cos\Theta}{12(b/h)^2}\left(1+\frac{\operatorname{ctan}^2\Theta}{2}\right)$ if $\operatorname{ctan}\Theta < b/h$
Θ / b/h	5	10	15	20	30	40	45	50	60	70	75	80	85	Θ / b/h
20	0.11	0.12	0.12	0.12	0.11	0.10	0.09	0.09	0.07	0.05	0.04	0.03	0.02	20
10	0.07	0.11	0.12	0.12	0.11	0.10	0.10	0.09	0.07	0.05	0.04	0.03	0.02	10
5	0.04	0.07	0.10	0.11	0.11	0.11	0.10	0.10	0.08	0.07	0.06	0.05	0.04	5
3	0.02	0.04	0.07	0.09	0.11	0.11	0.11	0.10	0.09	0.08	0.07	0.06	0.05	3
2	0.01	0.03	0.04	0.06	0.09	0.11	0.11	0.11	0.10	0.09	0.09	0.08	0.07	2
1.5	0.01	0.02	0.03	0.05	0.07	0.10	0.11	0.11	0.11	0.11	0.10	0.10	0.09	1.5
1	0.01	0.01	0.02	0.03	0.05	0.07	0.09	0.10	0.12	0.13	0.13	0.13	0.13	1
0.75	0.01	0.01	0.01	0.02	0.02	0.04	0.04	0.05	0.09	0.16	0.18	0.21	0.16	0.75
0.5	0.00	0.01	0.01	0.02	0.02	0.04	0.04	0.05	0.09	0.16	0.18	0.21	0.23	0.5
0.3	0.00	0.00	0.01	0.01	0.01	0.02	0.03	0.03	0.05	0.11	0.19	0.27	0.34	0.3
0.2	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.04	0.07	0.13	0.27	0.45	0.2
0.1	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.04	0.06	0.14	0.53	0.1

1.6.7.10 When calculating the free surface effect, small tanks which satisfy the following conditions may be ignored:

.1 when calculating corrections in accordance with 1.6.7.8.3:

$$vb\rho k\sqrt{\delta} / D_{\min} < 0.01\,\text{m}$$

for the value of *k* corresponding to an angle of heel $\Theta = 30°$;

.2 when calculating corrections in accordance with 1.6.7.8.1 or 1.6.7.8.2:

$$0.0834vh\rho\sqrt{\delta}(b/l) / D_{\min} < 0.01\,\text{m}$$

where:

$D_{\min}$ – minimum ship displacement at draught $T_{\min}$, [t];

$T_{\min}$ – see 1.3.

1.6.8 Flooding Angle and Hull Watertight Integrity

1.6.8.1 The flooding angle of an intact ship shall be calculated on the basis of the arrangement plan of doors, companionways and sidescuttles, referred to in 1.6.5, having regard to the below given guidelines.

1.6.8.2 Openings in the ship's sides, decks, side walls, as well as in bulkheads of superstructures and deckhouses are assumed closed if their means of closure comply, in respect of tightness, strength and efficiency, with the requirements specified in *Part III – Hull Equipment.*

1.6.8.3 Small openings, such as those for passing wires and chains, tackle and anchors, as well as holes of scuppers, discharge and sanitary pipes shall not be considered as open if they submerge at an angle of heel more than 30°. Such openings shall be assumed open if they submerge at an angle of 30° or less and may be a source of significant flooding of the ship's inner compartment taken into consideration in the stability cross curves calculations.

1.6.8.4 The detailed requirements concerning the ship's hull watertight integrity are given in Annex 1.

1.6.9 Loading Conditions

1.6.9.1 Loading conditions, for which the ship's stability shall be verified, are given in paragraph 1.6.9.2.

1.6.9.2 The stability of ships (except tankers) shall be verified for the following loading conditions (the loading conditions for tankers are given in paragraph 2.8):

.1 fully equipped, empty ship;

.2 ship in the loading condition corresponding to full displacement:
- fully equipped, empty ship,
- 100% of the crew and outsiders with their personal equipment,
- 100% cargo (if anticipated),
- 100% warfare stores,
- 100% provisions and fresh water stores,
- 100% fuel, lubricating oil and boiler water stores,

.3 ship in the loading condition corresponding to normal displacement:
- fully equipped, empty ship,
- 100% of the crew and outsiders with their personal equipment,
- 100% cargo (if anticipated),
- 100% warfare stores,
- 100% provisions and fresh water stores,
- 50% fuel, lubricating oil and boiler water stores,

.4 ship in the loading condition corresponding to standard displacement:
- fully equipped, empty ship
- 100% of the crew and outsiders with their personal equipment,
- 100% cargo (if anticipated),
- 100% warfare stores,
- 100% provisions and fresh water stores,
- no fuel, lubricating oil and boiler water stores,

.5 ship in the loading condition corresponding to maximum displacement:
- ship as in .2 with overload, i.e. with additional fuel, lubricating oil, fresh water, ammunition, provisions, with the minimum freeboard maintained, with possible speed or navigation range limitation,

.6 ship equipped + 10% stores:
- fully equipped, empty ship,

- 100% of the crew and outsiders with their personal equipment,
- 100% cargo (if anticipated),
- 10% warfare stores,
- 10% provisions and fresh water stores,
- 10% fuel, lubricaiting oil and boiler water stores, if the minimum quantities of stores, resulting from the principles of machinery operation and stores management, are not greater.

1.6.9.3 If the loading conditions, anticipated in the ship's normal service, are less favourable as regards stability than those given in 1.6.9.2 or specified in Chapter 2, then for each such loading condition the stability shall be also verified.

1.6.9.4 If there is a permanent ballast on board, its mass shall be included in the lightweight of the ship.

1.6.9.5 If, in any loading condition, provision has been made for water ballast, such ballast – considering influence of the free surfaces effect in the worst ballasting moment – shall be taken into account when calculating the stability.

1.6.9.6 For loading conditions, other than those described in 1.6.9, but required by the Owner, the stability shall be also calculated.

1.6.10 Stability Curves

1.6.10.1 For all loading conditions considered, stability curves shall be prepared with allowance for free surface corrections (see 1.6.7).

1.6.10.2 The stability curves are considered as existing only for an angle of heel corresponding to the angle of flooding. At the angle of heel exceeding the flooding angle it shall be assumed that the ship has entirely lost its stability and the stability curves cut short at this angle.

1.6.10.3 If the spread of water, coming into a superstructure through openings considered to be open, is limited to 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 static stability curve shall be stepped and the dynamic stability curve – broken.

1.6.11 Stability Booklet and Stability Control Means

1.6.11.1 The ship shall be provided with reliable information and appropriate means to enable the Commanding Officer to obtain, by simple and rapid processes, data on the ship's stability in varying operating conditions.

1.6.11.2 Every ship shall be provided with *Stability booklet* approved or confirmed by PRS in accordance with the provisions set forth in the Present Part of the *Rules*.

1.6.11.3 The form and scope of *Stability booklet* shall conform to the ship type and operating conditions.

1.6.11.4 The assessment of the ship's stability shall be based on the approved diagram or print-out of the permissible values of the vertical coordinate of the ship's centre of mass (KG_{max}), determined taking into account all required criteria (specified in the present part of the *Rules*) and including the whole operation range of the ship's displacement and draught.

1.6.11.5 *Stability booklet* shall additionally contain:

.1 the ship's identification data (name of the ship, type of the ship, shipyard, No. and year of build, the main dimensions, navigation area, maximum draught, maximum displacement, the number of crew, the lightweight of the ship and the lightweight centre coordinates);

.2 specification of stability criteria taken for stability assessment and the ship's stability short characteristics;

.3 guidance on service, weather and other restrictions associated with design features or ship's operation, necessary to ensure the safety of the ship as regards stability;

.4 data on the ship's stability in loading conditions required by the *Rules* and in operating conditions, specified by the Owner (the plan of the ship indicating the arrangement of cargo, stores, ballast, etc., calculations of stability parameters, draughts, stability curves);

.5 instructions for calculation and assessment of the ship's stability in loading conditions other than those given in stability booklet (see 1.6.11.5); it is recommended that this instructions should contain a calculation example;

.6 materials and data enabling to make the necessary calculations and to assess the ship's stability by a rapid and simple process;

.7 instructions concerning the proper operation of anti-rolling devices and anti-heeling system in port, as well as information on operational limits associated with the use of these arrangements and systems;

.8 plan of permanent ballast, where provided;

.9 the inclining test report of the ship or of a sister ship, which was the basis for assuming the light ship parameters. The inclining test report may be issued as a separate document.

Note: When considering the form and editorial quality of stability booklet, due regard shall be paid to its intended many years' usage.

1.6.11.6 As an alternative to stability booklet according to 1.6.11.6, PRS may accept a simplified, in form and scope, *Stability booklet* containing sufficient information to enable the Commanding Officer to operate the ship in compliance with the applicable requirements of the present Part of the *Rules.*

1.6.11.7 *Stability booklet* shall be drawn up on the basis of the light ship data, specified in the valid inclining test report; in the case of a ship exempted from inclining test in accordance with 1.7.4, calculations of the lightweight of the ship and coordinates of its centre, according to 1.7.5, shall be given.

1.6.11.8 When preparing KG_{max} diagram (or print-out) (see 1.6.11.5), the stability criteria of a damaged ship, specified in the present Part of the *Rules*, shall be taken into account.

The above-mentioned diagram (or print-out) shall contain information on the possible operational limits.

1.6.11.9 As a supplement to the approved *Stability booklet*, computer programs may be used to facilitate calculations and checking the stability. The computer used shall be of the type approved by PRS.

1.6.11.10 Stability calculation programs for normal operating conditions and the emergency conditions shall comply with the requirements specified in *Publication No. 66/P – Onboard Computers for Stability Calculations.* These programs are subject to PRS' approval.

1.6.11.11 To facilitate the stability calculations for operating conditions, loading computers, approved by the PRS, for the stability, heel, trim and ship's draught may be used. Application of such devices does not constitute a basis for excluding any data and recommendations from the stability booklet required by 1.6.11.5.

1.6.11.12 *Stability booklet* shall contain a statement that compliance with the requirements and recommendations, given therein, does not protect a ship against loss of stability or capsizing, regardless of the circumstances or absolve the Commanding Officer from his duty to observe the principles of good seamanship and from the responsibility for the ship's safety (see 1.6.1).

1.6.12 Icing

1.6.12.1 For ships intended for winter navigation within winter seasonal zones in addition to stability calculations for the main loading conditions, stability with regard to icing shall be also checked in accordance with the present sub-chapter. The calculations, due to icing, shall take into account, changes of displacement, height of the centre of mass and the centre of the windage area. The stability calculation under icing shall be carried out for the most unfavourable, as regards stability, loading condition. When calculating the stability under icing, the mass of ice shall be regarded as an additional mass, not included in the ship's normal displacement.

1.6.12.2 When determining the heeling and capsizing moments for ships navigating in winter seasonal zones to the north of latitude 66°30′ N and to the south of latitude 60°00′ S, the conventional rates of icing shall be taken in accordance with 1.6.12.3 and 1.6.12.4.

1.6.12.3 The mass of ice per square metre of the total area of horizontal projection of exposed weather decks shall be taken equal to 30 kg. The total horizontal projection of these decks shall include horizontal projections of all exposed decks and gangways, irrespective of awnings above them. The moment due to this loading related to a horizontal plane shall be determined for heights of the centres of mass of the corresponding areas of decks and gangways.

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

1.6.12.4 The mass of ice per square metre of the windage area shall be taken equal to 15 kg. The windage area and the position of its centre of mass shall be determined for draught T_{min} in accordance with 1.6.6, but without allowance for icing.

1.6.12.5 For ships intended for navigation in the areas of the winter seasonal zones, other than those specified in 1.6.12.2, the rates of icing shall be taken equal to half those specified in 1.6.12.3 and 1.6.12.4, with the exception of areas where, at PRS' consent, icing may be disregarded.

1.6.12.6 The mass of ice and the moment related to the base plane, calculated in accordance with the provisions set forth in 1.6.12.3 to 1.6.12.5, shall be taken into account as constant, irrespective of loading condition.

1.6.12.7 For small ships, at PRS's consent, the effect of unsymmetrical icing on the ship's stability shall be taken into account.

1.7 Inclining Test

1.7.1 An inclining test shall be carried out for:

- **.1** every new ship;
- **.2** a ship after modification – in accordance with 1.7.2;
- **.3** a ship after ballast installation – in accordance with 1.7.3.

1.7.2 After modification, repair or re-equipment, the inclining test shall be carried out for ships in which the following changes, verified by calculations, have taken place:

- **.1** mass exchange (the total quantity of subtracted and added masses) of more than 6% for a light ship, or
- **.2** the change of the light ship mass by more than 2%, or
- **.3** increase of the height of the light ship centre of mass by more than 4 cm or by 2% (whichever is the lesser).

1.7.3 Every ship, in which permanent ballast has been installed, shall be subjected to inclining test. The inclining test need not be carried out if PRS Surveyor is convinced that the mass of the ballast and the position of its centre may be reliably determined by calculations or weighing.

1.7.4 PRS may allow the inclining test of a new ship, as required in 1.7.1.1, to be dispensed with, provided the basic stability data are available from the inclining test of a sister ship and it is verified that the difference of the light ships' mass does not exceed 2%, and the difference of the longitudinal centre of mass does not exceed 1% of the ship's length. In such case, the sister ship data may be accepted by PRS as valid for a new ship.

1.7.5 For a ship exempted from the inclining test in accordance with 1.7.6, the lightweight of the ship and longitudinal centre of mass shall be verified and it shall be proved that the requirements of the present Part of the *Rules* are complied with for the height of the centre of mass of a light ship greater than the design height by 20%.

1.7.6 The ship shall be subjected to the inclining test at the final stage of construction, modification or repair, in condition, as close as possible, to that of the light ship. The mass of the subtracted elements shall be not greater than 2% of the lightweight of the ship and the mass of the superfluous elements, without shifting ballast – not greater than 4% of the lightweight of the ship.

1.7.7 The ship's metacentric height *GM* during the inclining test shall be not less than 0.2 m. For this purpose, the necessary amount of ballast shall be taken. In the case of liquid ballast, the tanks shall be fully loaded.

1.7.8 To determine the angles of heel, at least two plumb lines or at least two devices, approved by PRS, and one plumb line, shall be used.

1.7.9 When the inclining test has been carried out correctly, the obtained value of the metacentric height may be taken for calculations without subtracting the probable error of the test.

The inclining test is considered to be correct when:

.1 for each inclination, the following requirement is complied with:

$$\left|GM_i - GM_k\right| \le 2\sqrt{\frac{\Sigma\left(GM_i - GM_k\right)^2}{n-1}} \qquad (1.7.9\text{–}1)$$

GM_i – metacentric height obtained from a given inclination, [m];
GM_k – the inclining test mean metacentric height, [m];

$$GM_k = \frac{\Sigma GM_i}{n}$$

n – number of measurements.

The measurements, for which the above condition is not satisfied, are not taken into consideration in the repeated calculations of the metacentric height GM_k;

.2 the probable error of the test ε, calculated from the formula:

$$\varepsilon = t_{\alpha n}\sqrt{\frac{\Sigma\left(GM_i - GM_k\right)^2}{n(n-1)}} \qquad (1.7.9\text{–}2)$$

satisfies the conditions

$\varepsilon \le 0.02(1 + GM_k)$ for $GM_k \le 2$ m, or

$\varepsilon \le 0.04GM_k$ for $GM_k > 2$m,

where:

$t_{\alpha n}$ – factor determined from Table 1.7.9.2:

Table 1.7.9.2
Factor $t_{\alpha n}$

n	6	7	8	9	10	11	12	13	14	15	16
$t_{\alpha n}$	6.9	6.0	5.4	5.0	4.8	4.6	4.5	4.3	4.2	4.1	4.0

.3 in the most unfavourable loading condition, as regards GM or GZ_m, the following condition is satisfied:

$$0.04 \text{ m} \le \varepsilon\frac{D_0}{D_1} \le \min(0.05\ GM;\ 0.1\ GZ_m)$$

where:

D_0 – light ship displacement, [t];
D_1 – ship displacement in the most unfavourable loading condition, [t];
GM – corrected metacentric height, [m];
GZ_m – maximum value of the static stability righting lever within the heeling angles range up to 70°, [m].

.4 the number of correct measurements is not less than 8.
Non consideration of more than one measurement satisfying the condition given in 1.7.9.1 shall be agreed with PRS.

1.7.10 When the requirements of 1.7.9 are not complied with, then, upon PRS agreement, the value of the metacentric height obtained during the inclining test, with the probable error determined according to 1.7.9.2 deducted, may be taken for calculations.

1.7.11 The inclining test shall be carried out in the presence of PRS' Surveyor and in accordance with the principles specified in *Publication No. 6/P – Stability*.

1.8 Stability Criteria

1.8.1 The stability of ships in all loading conditions shall comply with the following requirements:

.1 the stability of unrestricted service ships, as well as restricted service ships shall be such as to comply with the criteria specified in sub-chapter 2.1;
.2 tankers shall comply with the criteria specified in sub-chapter 2.8.

The effect of icing, where applicable, shall be taken into account in stability calculations in accordance with the directions given in 1.6.12.

1.8.2 The intact stability of ships shall be such that after damage and flooding of a compartment/compartments, the damage stability criteria are complied with.

1.8.3 The requirements, set forth in the present Part of the *Rules*, are the minimum requirements and reflect the level of safety considered adequate, provided the general assumptions and principles applied are observed (see 1.6).

1.9 Departures from the *Rules* and the *Rules* Interpretations

1.9.1 Interpretation of the requirements and provisions, contained in the present Part of the *Rules*, may be made exclusively by PRS.

1.9.2 At the request of the designer and/or Owner, PRS may, in a well-justified case, depart from a specified requirement or provision, provided the ship's safety is not thereby impaired.

1.9.3 For floating objects incorporating novel design features with respect to buoyancy and stability, the valid requirements of the present Part of the *Rules* may, at PRS consent, be applied within reasonable scope; in each particular case, such novel design features shall be assessed with respect to safety according to the current state of art.

1.9.4 Where, with respect to any ship complying with the requirements of the present Part of the *Rules*, there are any doubts as regards stability or subdivision, additional requirements may be set forth by PRS for such a ship.

1.9.5 Where deemed necessary, PRS may insert entries on operational limits in the approved documentation and the issued documents.

1.10 Passage beyond the Specified Navigation Area

1.10.1 The ship's stability, during a passage beyond navigation area specified in Certificate of Class, shall comply with stability requirements concerning the navigation area through which the passage shall be undertaken.

1.10.2 Where a ship does not comply with stability requirements, as required in 1.10.1, then, at PRS' consent, it may be permitted to undertake the passage, provided weather restrictions are applied.

2 STABILITY – BASIC REQUIREMENTS AND CRITERIA

2.1 Calculation of Heeling Moments Acting on the Ship

2.1.1 Heeling Moment due to Wind Pressure

The heeling moment due to wind pressure, M_w, shall be calculated from the formula:

$$M_w = 2 \cdot 10^{-5} \cdot F_w \cdot z_w \cdot v_w^2 \cos^2 \phi \text{ ,[tm]} \qquad (2.1.\ 1\text{-}1)$$

where:

F_w – windage area calculated according to 1.6.6, [m^2];
z_w – vertical distance from the centre of windage area to the half of the ship's draught, T, in the considered loading condition, [m];
ϕ – angle of heel (0, 10, 20 …80), [degrees];
T – the ship's draught in the given loading condition, [m];
v_w – wind speed at height z_w in the centre of windage area, calculated from the formula:

$$v_w = v_{10} \cdot \left(\frac{z_w}{10} \right)^{0.15}, \text{ [knots]} \qquad (2.1.\ 1\text{-}2)$$

V_{10} – wind speed at the height of 10 m above waterline, to be taken
- V_{10} = 80 knots – for unrestricted service and restricted service area I ships,
- V_{10} = 60 knots – for restricted service area II ships,
- V_{10} = 40 knots – for restricted service area III ships.

2.1.2 Heeling Moment from Turning

The heeling moment from turning , *Mc*, shall be calculated from the formula:

$$Mc = \frac{D \cdot v_c \cdot (KG - T/2)}{g \cdot R} \cdot \cos\phi \text{ , [tm]} \qquad (2.1.\ 2)$$

where:

v_c = 0.9 V_{max}, [m/s]
v_{max} – the maximum ship's speed, [m/s];
KG – corrected height of the ship's centre mass, [m];
T – the ship's draught in the given loading condition, [m];
g – acceleration of gravity, g = 9,81 m/s^2;
R – turning radius, [m] – shall not be greater than 2.5 L_o;
L_o – design length of the ship, [m], according to 1.3;
ϕ – the angle of heel; (0, 10, 20, …80), [degrees];
D – displacement in the given loading condition, [t].

2.1.3 Heeling Moment due to Crowding of the Crew to One Side

The heeling moment from crowding of the crew to one side, *Mp*, shall be calculated from the formula:

$$Mp = m_z \cdot l \cdot \cos\phi, \ [\text{tm}] \tag{2.1.3}$$

where:

m_z – the mass of all crew members, [t];

l – distance between the centre of mass of the crew gathered on one side of the ship and the centre plane, [m];

– the mass of a single crew member shall be assumed as 80 kg,

– the crowding of the crew; 5 persons per square metre,

– centre of the crew mass – 1.1 m above the deck level,

ϕ – the angle of heel; (0, 10, 20, …80), [degrees].

2.1.4 Heeling Moment due to Operation of Deck Cranes

For ships equipped with deck hoist cranes, the heeling moment due to the cranes operation, M_z, shall be calculated from the formula:

$$Mz = m_d \cdot r \cdot \cos\phi, \ [\text{tm}] \tag{2.1.4}$$

where:

m_d – the mass of hoisted load, [t]

r – the length of the crane's arm, [m]

ϕ – the angle of heel, (0, 10, 20,…80), [degrees].

2.1.5 Heeling Moment due to Nuclear Explosion

The heeling moment due to nuclear explosion, *Wj,* shall be calculated from the formula:

$$Wj = \Delta p \cdot F_w \cdot z_w, \ [\text{kNm}] \tag{2.1.5}$$

where:

Δp – the air pressure caused by explosion, [kPa];

F_w, z_w – according to 2.1.1.

The value of the pressure, Δp, shall be determined from the diagram – Fig. 2.1.5, depending on the distance from explosion epicentre and the power of explosive charge; intermediate values shall be determined by interpolation.

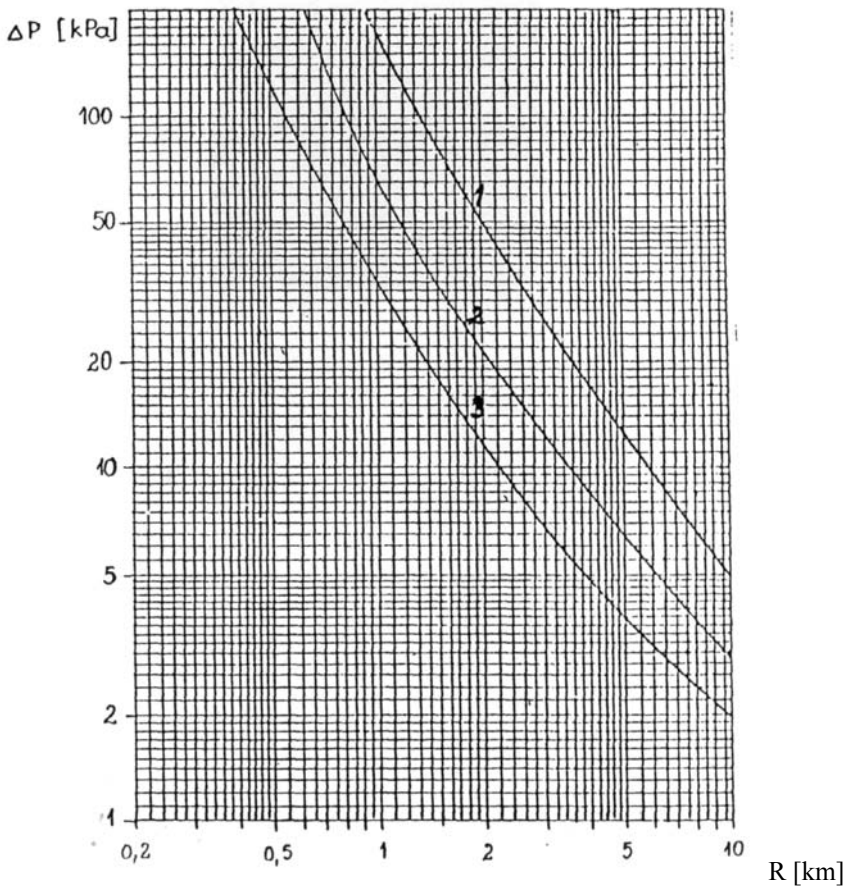

Fig. 2.1.5

1 – C = 150 kt [TNT]

2 – C = 30 kt [TNT]

3 – C = 8kt [TNT]

C – power of explosion, kt [TNT];

R – distance from explosion epicentre, [km] – shall be determined from the formula:

$$R = \sqrt{R_e^{\,2} + H_w^{\,2}}\ , \ [\text{km}] \qquad (2.1.5)$$

Re – horizontal distance from the explosion epicentre, [km];

H_w – vertical distance from the explosion epicentre, [km].

2.2 Calculation of Accelerations due to Ship's Rolling

Calculated value of the linear acceleration due to ship's rolling shall be determined from the formula:

$$a_{OBL} = 1.10 \cdot 10^{-3} \cdot B_w \cdot f^{\,2} \cdot \Phi_A, \ [\text{m/s}^2] \qquad (2.2\text{-}1)$$

where:

B_w – breadth of the ship at the waterline, [m]

f – frequency of the ship's natural rolling:

$$f = f_o / \sqrt{GM}\ , \ [s^{-1}] \qquad (2.2\text{-}2)$$

f_o – factor determined from Table 2.2, depending on the value calculated from the formula:

$$\frac{GM}{\sqrt[3]{V}} \cdot \frac{B_w}{KG},$$

Table 2.2

$\frac{GM}{\sqrt[3]{V}} \cdot \frac{B_w}{KG}$	f_o	$\frac{GM}{\sqrt[3]{V}} \cdot \frac{B_w}{KG}$	f_o
≤0,10	0,34	1,00	1,96
0,15	0,42	1,50	2,45
0,25	0,64	2,00	2,69
0,50	1,13	2,50	2,86
0,75	1,58	≥3,00	2,94

GM – corrected metacentric height in the given loading condition, [m]

V – buoyancy of the ship, [m^3]

KG – corrected height of the centre of mass, [m]

Φ_A – the roll amplitude, determined according to 2.3, [degrees]

2.3 Calculation of the Roll Amplitude

2.3.1 The roll amplitude shall be calculated from the formula:

$$\Phi_A = kX_1X_2Y, \ [\text{degrees}] \qquad (2.3.1)$$

where:

k – factor, to be taken as follows:

k = 1 for ships with a rounded bilge, a flat keel and without bilge keels,

k = 0.7 for ships with a sharp bilge,

k = value from Table 2.3.1-1 for ships with bilge keels, a bar keel, or with both types of keels, depending on F_k/L_oB ratio,

F_k – total area of bilge keels or area of bar keel's lateral projection, or sum of these areas, [m^2];

L_o – design length of the ship, [m];

B – breadth of the ship, [m];

X_1 – factor to be taken from Table 2.3.1-2;

X_2 – factor to be taken from Table 2.3.1-3;

Y – amplitude of the standard ship, to be taken from Table 2.3.1-4, [degrees];

GM – metacentric height in considered condition, corrected for free surfaces effect, [m].

Table 2.3.1-1
Factor *k*

F_k / L_0B, %	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

Table 2.3.1-2
Factor X_1

B/T_{sr}	≤ 2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	≥ 3.5
X_1	1.00	0.98	0.96	0.95	0.93	0.91	0.90	0.88	0.86	0.84	0.82	0.80

Table 2.3.1-3
Factor X_2

δ	≤ 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

δ – block coefficient for draught T_{sr}

Table 2.3.1-4
Amplitude *Y*, [degrees]

$\frac{\sqrt{GM}}{B}$	≤ 0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	≥ 0.13
Unrestricted service area	24.0	25.0	27.0	29.0	30.7	32.0	33.4	34.4	35.3	36.0
Restricted service areas **I** and **II**	16.0	17.0	19.7	22.8	25.4	27.6	29.2	30.5	31.4	32.0

Note: Intermediate values in Tables 2.3.1–1, 2.3.1–2, 2.3.1–3 and 2.3.1–4 shall be obtained by linear interpolation.

2.3.2 For ships with the ice strengthening, at PRS' consent, for roll amplitude calculations bilge keels effect may be taken into account.

2.3.3 For ships fitted with stabilizing arrangements other than bilge keels, the roll amplitude shall be determined according to 2.3.1, without taking into account stabilizing arrangements effect, however fulfilment of stability criteria during stability equipment operation shall be demonstrated.

2.3.4 For the roll amplitude calculations, stabilizing arrangements effect is taken into account at PRS' consent in each case.

2.4 Stability Criteria

2.4.1 The stability of the ships in all operational loading conditions shall comply with the requirements specified in 2.5.

2.4.2 The values of static stability righting levers curve parameters shall comply with the requirements of 2.6.

2.4.3 The value of the corrected metacentric height shall be not less than that specified in 2.7.

2.4.4 In stability calculations, the icing effect (where applicable) shall be taken into account, as specified in 1.6.12.

2.4.5 Stability of the ship in intact condition shall be such that after damage and flooding of watertight compartment/compartments, the damage stability criteria for that condition are complied with.

2.4.6 The ship's stability shall comply with the additional requirements for special purpose ships, specified by PRS.

2.4.7 The stability of the ship during her towing shall comply with the above requirements as for normal operation. If the ship does not comply with the requirements, PRS may allow towing, provided stability calculations including weather condition limitations are presented.

2.5 The Ship Stability Requirements

2.5.1 Heeling due to Wind Criterion

2.5.1.1 The value of wind heeling lever, l_w, shall be calculated from the formula:

$$l_w = \frac{M_w}{D}, \text{ [m]} \qquad (2.5.1.1)$$

where:

M_w – heeling moment from wind pressure, calculated according to 2.1.1-1, [tm];

D – the ship's displacement in the given loading condition, [t].

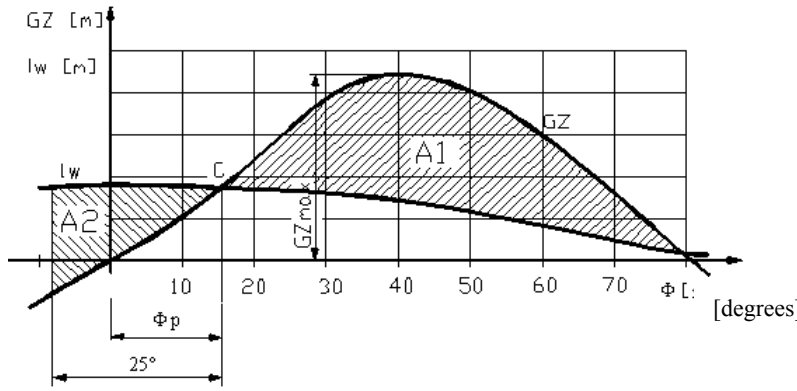

Fig. 2.5.1.1

2.5.1.2 The ship's stability with respect to wind pressure is considered sufficient, when:

.1 the wind heeling lever, GZ_p, at the point of intersection of heeling lever curve, l_w, with the righting lever curve, *GZ*, (point C in Fig. 2.5.1.1) shall not be greater than 0.6 the value of the maximum heeling lever, GZ_{max};

.2 the angle, Φ_p, of intersection of heeling levers curve, l_w, with the righting levers curve, *GZ*, shall not exceed 15 degrees;

.3 the area A1 shall not be less than 140% of A2 area.

The area A1 is the area between *GZ* curve and l_w curve, measured in a range from Φ_p (intersection point of the curves) to flooding angle or the second intersection of the curves, whichever is the lesser.

The area A2 is the area between *GZ* curve and l_w curve, measured in a range from Φ_p to heel angle of 25°, measured to the opposite side.

2.5.2 Heeling due to the Ship's Turning Criterion

2.5.2.1 The value of the heeling moment due to the ship's turning, l_c, shall be calculated from the formula:

$$l_c = \frac{M_c}{D}, \text{ [m]} \qquad (2.5.2.1)$$

where:

M_c – heeling moment calculated according to 2.1.2, [tm];

D – displacement of the ship in the given loading condition, [t].

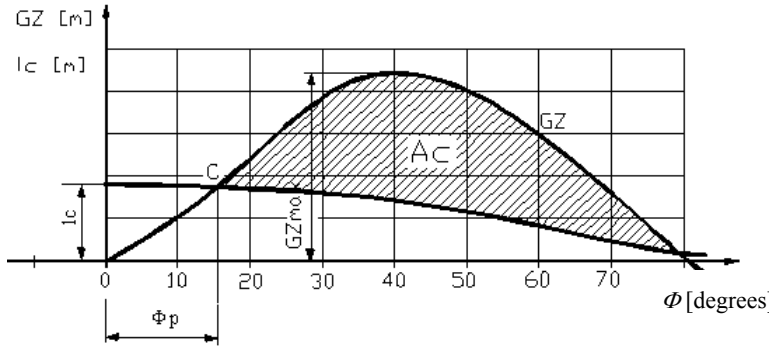

Fig. 2.5.2.2

2.5.2.2 The ship's stability due to turning is considered sufficient, when:

.1 the requirements specified in 2.5.1.2.1 and 2.5.1.2.2 for the heeling lever l_c, calculated according to 2.5.2.1, are complied with,

.2 the area A_c (dynamic stability reserve – the shaded area in Fig. 2.5.2.2) is not lesser than 0.4 of the total area under righting levers curve, *GZ*.

2.5.3 Heeling due to Crowding of the Ship's Crew to One Side Criterion

2.5.3.1 The value of the heeling moment due to crowding of the crew to one side, l_p, shall be calculated from the formula:

$$l_p = \frac{M_p}{D}, \quad [\text{m}] \tag{2.5.3.1}$$

where:

M_p – heeling moment calculated according to 2.1.3, [tm];

D – displacement of the ship in the given loading condition, [t].

2.5.3.2 The ship stability due to crowding of the crew to one side is considered sufficient, when:

.1 the requirements specified in 2.5.1.2.1 and 2.5.1.2.2 for the heeling lever l_c, calculated according to 2.5.3.1, are complied with,

.2 the area A_p (dynamic stability reserve – the shaded area in Fig. 2.5.3.2) is not less than 0.4 of the total area under the righting levers curve, *GZ*.

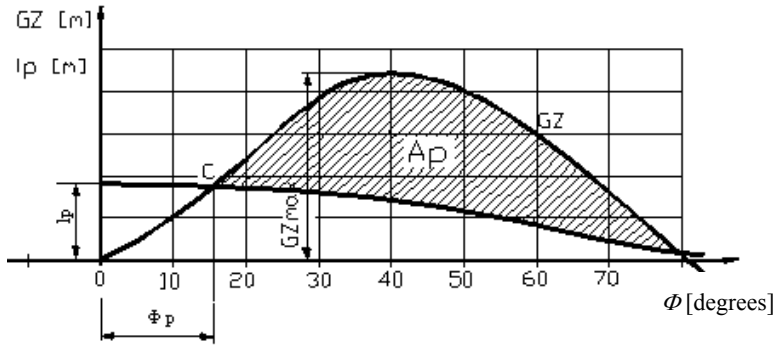

Fig. 2.5.3.2

2.5.4 Heeling due to Operation of Deck Cranes or Reloading at Sea System (RAS) Criterion

2.5.4.1 The value of the heeling moment due to operation of deck cranes or reloading at sea system (RAS), l_z, shall be calculated from the formula:

$$l_z = \frac{M_z}{D}, \quad [\text{m}] \tag{2.5.4.1}$$

where:

M_z – heeling moment calculated according to 2.1.4, [tm] or heeling moment (calculated in consultation with PRS), due to operation of reloading at sea system (RAS), [tm], (whichever is greater);

D – displacement of the ship in the given loading condition, [t].

2.5.4.2 The stability of the ship due to operation of deck cranes or reloading at sea system (RAS) is considered sufficient, when:

.1 the requirements specified in 2.5.1.2.1 and 2.5.1.2.2 for heeling lever, l_z, calculated according to 2.5.4.1, are complied with,

.2 the area A_z (dynamic stability reserve – the marked area in Fig. 2.5.4.2) is not lesser than 0.4 of the total area under righting levers curve, *GZ*.
The area A_z is the area between *GZ* curve and l_z curve, measured in a range from Φ_p (intersection point of the curves) to flooding angle or the second intersection point of the curves, whichever is the lesser.

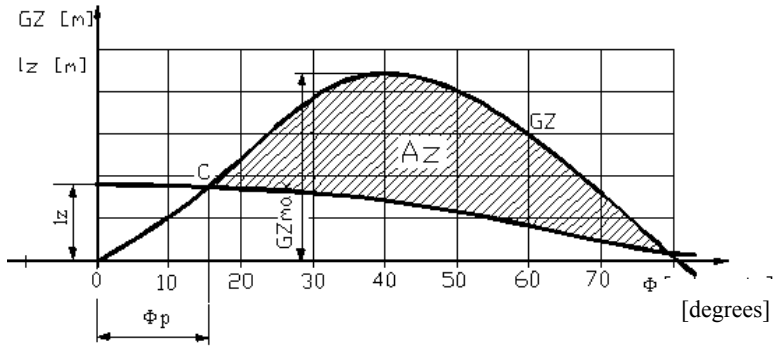

Fig. 2.5.4.2

2.5.5 Heeling due to Nuclear Explosion Criterion

2.5.5.1 The angle of heel of the ship located at the distance *R* from nuclear explosion epicentre shall not exceed:

$$\Phi_{max} = 50^{o} \tag{2.5.5.1}$$

R value shall be determined for various kinds of a nuclear explosion (surface, air, etc.), according to 2.1.5.

2.5.6 Acceleration due to the Ship Rolling Criterion

2.5.6.1 The ship's stability is considered sufficient if the following condition is complied with:

$$K_p = \frac{0.3}{a_{OBL}} \geq 1, \tag{2.5.6.1}$$

where:

K_p – factor of acceleration due to the ship rolling criterion,

a_{OBL} – acceleration determined according to 2.2.

2.5.7 Heeling due to Towing Line Jerk Criterion

2.5.7.1 The ships intended for towing operations shall have dynamic stability sufficient to withstand the assumed transverse action of a towing line jerk, i.e. dynamic heel angle Φ_{dh} due to assumed towing line jerk effect shall not exceed the angles determined in 2.5.7.2.1 and 2.5.7.3.1

2.5.7.2 Ships Intended for Harbour Towing

2.5.7.2.1 The angle of dynamic heel shall not be greater than the flooding or capsizing angle, whichever is the lesser.

The ship meets this requirement if the following condition is satisfied:

$$K_1 = \sqrt{\frac{l_{dk}}{l_{dw}}} \geq 1.00 \qquad (2.5.7.2.1\text{-}1)$$

where:

K_1 – criterion of towing line jerk for ships performing harbour towing,

l_{dk} – the lever of dynamic stability at the angle of heel equal to the flooding angle (see 2.5.7.2.2) or capsizing angle Θ_k, determined without allowance for rolling, whichever is the lesser, [m];

l_{dw} – the dynamic heeling lever characterizing the assumed jerk effect of the towing line, [m].

$$l_{dw} = l_v \left(1 + 2\frac{T}{B}\right) \frac{b^2}{\left(1 + c^2\right)\left(1 + c^2 + b^2\right)} \text{ [m]} \qquad (2.5.7.2.1\text{-}2)$$

where:

l_v – vertical coordinate in relation to the base plane of the hydraulic pressure load point corresponding to the assumed top velocity v_R [m], determined from the formula:

$$l_v = \frac{v_R^2}{2g}$$

v_R – top velocity of the towing line transverse jerk, taken, depending on power P, from Table 2.5.7.2.1; top velocity v_R for the intermediate values of the engine power shall be determined by linear interpolation.

Table 2.5.7.2.1
Values of v_R

P [kW]	0÷150	300	450	600	750	900	1050	1200	1350	1500
v_R [m/s]	1.30	1.33	1.37	1.43	1.55	1.70	1.88	2.08	2.29	2.50

T – mean draught in the given loading condition, [m];

B – breadth of the ship, [m];

c – "dynamic" abscisssa of the towing hook suspension point, to be determined from the formula:

$$c = 4.55\frac{X_H}{L_0} \qquad (2.5.7.2.1\text{-}3)$$

X_H – distance between the towing hook suspension and the ship's centre of mass, measured in horizontal plane, [m];

L_0 – design length of the ship, [m];

b – "dynamic" ordinate of the towing hook suspension point, to be determined from the formula, [m]:

$$b = \frac{\frac{Z_H}{B} - a}{e} \qquad (2.5.7.2.1\text{-}4)$$

Z_H – vertical coordinate of the towing hook suspension point in relation to the base plane, [m];

$$a = \frac{0.2 + 0.3\left(\frac{2T}{B}\right)^2 + \frac{KG_0}{B}}{1 + 2\frac{T}{B}} \qquad (2.5.7.2.1\text{-}5)$$

$$e = 0.145 + 0.2\ \frac{KG_0}{B} + 0.06\ \frac{B}{2T} \qquad (2.5.7.2.1\text{-}6)$$

KG_0 – vertical coordinate of the ship's centre of mass above the base plane, [m];

2.5.7.2.2 When calculating the stability of ships for the towing line jerk effect, the angle of flooding shall be determined assuming that all doors leading to the engine and boiler casing and to the upper deck superstructure, as well as the doors of all companionways to the spaces below the upper deck, are open, irrespective of the doors design.

2.5.7.2.3 When calculating the stability of ships for the towing line jerk effect, no account shall be taken of icing and the effect of free surfaces of liquids in tanks.

2.5.7.2.4 Where the ship is provided with special appliances for shifting the towing hook downwards or abaft, with the towing line athwartships, PRS may consider the assumption of X_H and Z_H values other than those specified in 2.5.7.2.1.

2.5.7.3 Ships Intended for Ocean Towing

2.5.7.3.1 The angle of heel due to the towing line jerk under rolling shall not exceed the angle corresponding to the maximum of the static stability curve or the angle of flooding, whichever is the lesser.

The ship satisfies this condition if the following requirement is met:

$$K_2 = \sqrt{\frac{l_{dm}}{l_{dw}}} - \Delta K \geq 1.0 \qquad (2.5.7.3.1\text{-}1)$$

where:

K_2 – criterion of towing line jerk for ships performing ocean towing,

l_{dm} – lever of dynamic stability at an angle of heel corresponding to the maximum of the static stability curve or the angle of flooding, whichever is the lesser, [m];

l_{dw} – dynamic heeling lever calculated in accordance with 2.5.7.2.1-2, [m]; l_v shall be taken equal to 0.200 m.

The value of ΔK accounts for the effect of rolling on the resultant angle of heel; it shall be determined from the formula:

$$\Delta K = 0.03\Phi_A\left[\frac{1+c^2}{b} - \frac{1}{e}\left(a - \frac{KG}{B}\right)\right]\sqrt{\frac{GM_0}{1+2\frac{T}{B}}} \qquad (2.5.7.3.1\text{-}2)$$

GM_0 – metacentric height, in the given condition, without the correction for free surface effect, [m];

Φ_A – amplitude of roll, determined in accordance with 2.3.1, [degrees].

The values *c, b, e* and *a* shall be calculated in accordance with 2.5.7.2.1-3, 2.5.7.2.1-4, 2.5.7.2.1-5 and 2.5.7.2.1-6.

2.5.7.3.2 When calculating the stability of ships intended for ocean towing, it shall be taken into account that:

.1 the requirement of 2.5.7.2.4 applies;

.2 for the curve of static stability with two maxima or an extended horizontal region (see 2.5.7.3.1), the value of the angle at the first maximum or that corresponding to the middle of the horizontal region shall be taken;

.3 stability for the towing line jerk effect shall be calculated without taking into account the effect of free surfaces of liquids in tanks.

2.5.7.3.3 When calculating the stability of ships intended for towing in winter conditions, icing shall be taken into consideration, and the following icing rates shall be taken:

.1 for ships specially designed for salvage operations – twice that specified in 1.6.12;

.2 for other ships – in accordance with 1.6.12.

2.5.7.3.4 Where the ship intended for ocean towing operations may perform also harbour towing, the necessity to comply, by such a ship, with the requirements of 2.5.7.2.1 is subject to special consideration by PRS.

2.6 Static Stability Curve

2.6.1 The static stability curve shall comply with the requirements given below:

.1 the maximum static stability righting lever, GZ_{max} shall not be less than:
- 0.25 m for ships with the length $L_o \leq 24$ m,
- 0.20 m for the remaining ships,

at the heel angle not less than 30^o. For the curve of static stability with two maxima the first maximum shall occur at the angle not less than 25^o.

.2 the range of the positive static stability righting levers curve shall not be less than 70^o.

.3 static stability righting levers curve, *GZ*, shall have positive values in the whole required range.

2.6.2 The angle of flooding shall be not less than the required values of the positive static stability range.

2.6.3 The required parameters of the static stability curves shall be complied with taking into account the free surface correction in accordance with 1.6.7.

2.7 Metacentric Height

2.7.1 The corrected metacentric height shall not be less than:

.1 0.5 m for ships with the length $L_o \leq 24$ m,,

.2 0.2 m for the remaining ships.

2.7.2 In the "light ship" loading condition, the metacentric height can be determined taking into account trim, however the value of the metacentric height is subject to special consideration by PRS.

2.8 Additional Requirements for Tankers

2.8.1 The stability of tankers shall be verified for the following loading conditions:

.1 the ship loaded to the design waterline, in the fully loaded condition with full stores;

.2 the ship in the fully loaded condition and with 10% stores;

.3 the ship without cargo, but with 100% stores;

.4 the ship without cargo, but with 10% stores.

2.8.2 For supply tankers, the stability shall be additionally verified for the ship loading condition with 75% of cargo, with free surface in tanks for each kind of cargo and 50% stores, but without ballast water. The free surface effect in tanks for stores and in cargo tanks shall be determined according to the requirements of subchapter 1.6.7.

2.8.3 Stability characteristics of tankers provided with spill collecting boxes and gutter bars installed on the weather deck in way of cargo manifold shall take into account the free surface effect caused by liquids contained by the boxes and gutter bars. Where the boxes and gutter bars installed are greater than 300 mm in height, they shall be treated as bulwarks with freeing ports, provided with effective closures for use during loading and discharging operations.

2.8.4 It is recommended that tankers of 5000 t deadweight and above comply with the requirements of Regulation 25A, Annex I to *MARPOL 73/78 Convention*.

2.8.5 Commanding Officers of tankers, not subject to the requirements of Regulation 25A, referred to above, shall be provided with instructions containing procedures for liquid loading operations to comply with stability criteria specified in the Regulation. Such instructions shall be prepared in accordance with the requirements given in the a.m. Regulation.

3 SUBDIVISION AND DAMAGE STABILITY OF THE SHIP

3.1 Application

.1 The requirements of the present Chapter apply to all ships specified in 1.1.1.

.2 It is recommended that tankers additionally comply with the requirements of Regulation 25A, Annex I to *MARPOL 73/78 Convention*, as amended.

3.2 General

3.2.1 Naval ships shall comply with subdivision requirements in respect of:

.1 subdivision,

.2 damaged ship stability parameters – in the final stage of flooding a compartment / compartments,

.3 damaged ship stability parameters – in intermediate stages of flooding a compartment/compartments, where the ship equalization is necessary,

.4 the hull watertight integrity.

3.2.2 Permeability

3.2.2.1 In calculations of the damaged ship stability, the following values of permeability shall be applied:

Compartments	Permeability
Designated for solid stores (other than liquid)	0.60
Designated for accommodation	0.95
Designated for steering gear	0.85
Empty	0.95
Loaded with homogenous cargo	0.60
Designated for liquids	0 or 95*
Empty refrigerated holds	0.93
Holds designated for wheeled vehicles	0.80
Designated for ammunitions	**
Others	**

* – whichever results in the more severe requirements.

** – to be agreed with PRS.

Note: Actual, calculated permeability factors, other than those given in the Table may be applied, subject to PRS' approval in each particular case.

3.2.2.2 In the case of detailed calculation of cargo spaces permeability (including refrigerated cargo spaces), the permeability of the cargo shall be taken equal to 0.60, while that of cargo in containers, trailers and vans – equal to 0.71.

3.2.2.3 In special cases, justified by the ship's arrangement or nature of its service, PRS may require that other permeability values should be applied.

3.2.3 Calculation of Damage Stability Characteristics

3.2.3.1 The volume and free surfaces of water which can flood the ship's compartments shall be calculated to the inner surface of the shell plating.

3.2.3.2 When plotting static stability curves for a damaged ship, enclosed superstructures, deckhouses, deck cargo, the angles of flooding through openings in the ship's sides, decks, bulkheads of hull and superstructures, considered to be open, as well as correction for the effect of free surfaces of liquids shall be taken into account in the same way as it is shown in 1.6.7 for intact stability curves.

3.2.3.3 The volumes of superstructures and deckhouses which sustained damage shall be taken for calculations with adequate permeability only or shall be disregarded. Openings in such structures, leading to spaces which are not flooded, shall be considered as open at the relevant angles of heel only in the cases where they are not provided with weathertight closures.

3.2.3.4 When calculating the draught, heel and trim, as well as damage stability of a damaged ship, the changes in loading conditions of the ship shall be taken into account by substituting liquid cargo and liquid stores, in damaged tanks, by adequate amount of sea water filling the tanks up to damage waterline level.

3.2.3.5 Surface permeability values – the conventional numerical factors used in determining waterline areas, static moments and moments of inertia, changed due to cargo, machinery and equipment in way of damage waterline – shall be taken as equal to the volume permeability, determined in accordance with 3.2.2.

3.2.3.6 The time of the ship's equalization after damage to attain the permissible angles of heel shall not exceed 15 minutes. If the calculated time of equalization after damage is longer, it shall be agreed with PRS in each case.

3.2.3.7 The arrangements for the ship's equalization after damage shall be of the type approved by PRS. It is recommended that they are self-acting.

3.2.3.8 For subdivision and damage stability calculations, method of constant displacement shall be applied (i.e. it shall be assumed that the flooded compartment is in direct contact with sea water). Where the compartment is not in direct contact with sea water, for calculations added weight method shall be applied. Subject to PRS acceptance, application of other calculation method is allowed.

3.2.4 Subdivision Booklet

3.2.4.1 *Subdivision booklet* shall contain requirements and guidance enabling the Commanding Officer to estimate the condition of the ship safety when its compartment/compartments are flooded and to undertake necessary measures to maintain the damaged ship afloat.

Subdivision booklet shall contain the following:

.1 information necessary to maintain such stability of a damaged ship which is sufficient to obtain, in the case of a compartment/compartments flooded, the required stability parameters for the most unfavourable loading condition – the basic information is KG_{max}/GM_{min} curve in relation to draught or displacement (except tankers);

.2 instructions on loading and ballasting the ship, with recommendations on distributing the cargo, stores and ballast so as to comply with the requirements for the ship subdivision, trim and stability;

.3 results of calculations of symmetrical and unsymmetrical flooding, containing the data on:
- the initial and damage draught,
- heel,
- trim,
- the location of the ship's centre of mass, both before and after equalization or improving the ship's stability,
- the recommended measures for improving the ship's stability, indicating the period of time required for their application;

.4 static stability curves of a damaged ship in the selected typical loading conditions (most unfavourable as regards subdivision) for all compartments or a group of adjacent compartments;

.5 data on structural measures to ensure the ship's subdivision/survival capability, instructions concerning the operation of cross-flooding arrangements and other emergency appliances;

.6 recommendations, specific for the given ship, for proceedings under normal service conditions, as well as instructions for proceedings in the case of ship damage specifying the activities related to the ship's survival.

3.2.4.2 The required, in 1.4.1.1.11, damage control plan shall be displayed in the Combat information center, in the Main Steering Station, as well as in the main routes of communication, assuring the crew everyday contact with the plan. The plan should demonstrate the watertight boundaries of compartments, openings in watertight bulkheads, decks and sides, their closing appliances together with position of their controls, as well as the arrangement of equalization systems. Moreover, additional information in a form of simplified *Subdivision booklet* extract shall be made available to the ship's officers.

3.2.4.3 The *Subdivision booklet* extract shall contain information on equalization and stability of the ship after damage, as well as on position of the damage waterlines in relation to openings through which progress flooding of the ship may take place. The layout of the extract shall be compatible with the damage control plan.

3.2.5 Subdivision Load Line Position

3.2.5.1 An approved subdivision load line shall not be situated above the waterline corresponding to the maximum draught of the ship.

3.2.6 Interpretations and Departures from the Requirements

3.2.6.1 Departures from the requirements of the present part of the *Rules* concerning subdivision are the subject to PRS' consideration and decision in each particular case.

3.2.6.2 Where there are doubts as to requirements' interpretation, PRS's opinion is authoritative.

3.3 Detailed Subdivision Requirements

3.3.1 Subdivision

3.3.1.1 A ship shall be adequately divided into watertight compartments.

3.3.1.2 The ship's division into watertight compartments is considered to be adequate if it complies with the requirements for subdivision and damage stability after flooding a compartment/ compartments as a result of damage, specified in the present Part of the *Rules*.

3.3.2 Extent of Damage

3.3.2.1 The ship shall remain afloat after damage and the flooding of any one compartment, assuming the following extent of damage:

.1 longitudinal extent:

- the ship with the length $L_s \leq 30$ m should maintain floatability and damage stability after flooding of any one watertight compartment.
  The distance between the main transverse watertight bulkheads shall be at least $(2 + 0.03L_s)$ meters. If the distance is less than required, then the bulkhead shall be considered damaged.
  The length (extent) of longitudinal damage of any one compartment shall be assumed equal to the length of the compartment, decreased by 1 m.
- the ship with the length 30 m $< L_s <$ 90 m shall maintain floatability and damage stability after flooding of at least any two adjacent watertight compartments.
  The length (extent) of longitudinal damage in any place shall be assumed equal to $(0.15\ L_s - 2.6)$ meters.
- the ship with the length $L_s >$ 90 m shall maintain floatability and damage stability after damage that occurred in any place.
  The length (extent) of longitudinal damage shall be assumed equal to 15% of the length L_s.

.2 transverse extent (damage depth) – damage extending from the side to the ship centre plane, but not causing damage to the longitudinal watertight bulkhead placed in the centre plane (where fitted);

.3 vertical extent – the damage extending from the base plane upwards, without limits.

3.3.2.2 If any damage of the extent lesser than indicated in 3.3.2.1 gives more unfavourable results with respect to heel, trim or metacentric height loss, then such a damage shall also be considered in the calculations.

3.3.2.3 Irrespective of the ship's length, the Owner may, if considered necessary, increase the number of compartments assumed for damage stability calculations, after damage of which the ship shall comply with the requirements of sub-chapter 3.4.

3.4 Damage Stability Criterion

3.4.1 It is assumed that a ship complies with the requirements for survival capability after damage if:

.1 the final waterline after damage, during and after equalization of the ship is below the openings in bulkheads, decks and the ship's sides at a distance of at least 0.30 m;

Such openings include:

– closing means for ventilators,
– closing means for air pipes,
– closing means for ventilation ducts,
– all other openings closed by doors or weathertight covers.

Openings which may be submerged in water during damage are:

– manholes,
– watertight closing appliances of hatches,
– watertight doors,
– deadlights with covers.

If pipes, ducts or tunnels are located in the area of damages indicated in 3.3.2.1, then the flooding of compartments connected by these arrangements shall be also taken into account.

.2 the angle of heel in the final stage of flooding after the ship equalization (point C in Fig. 3.4.1.2) shall not be greater than 15°.

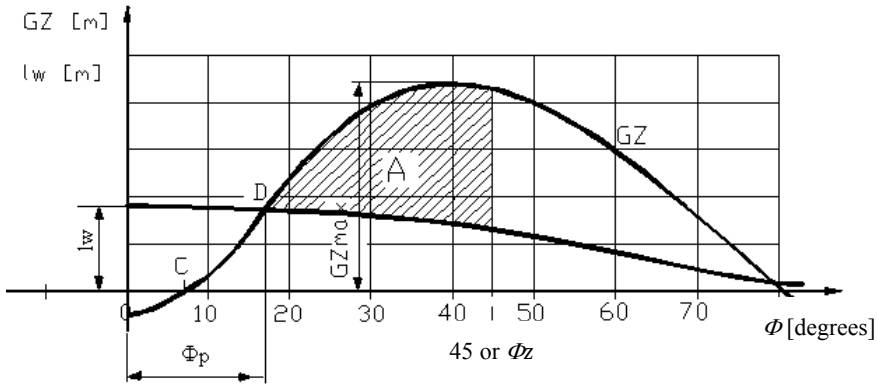

Fig. 3.4.1.2

.3 taking into account wind pressure according to 2.1.1 and wind speed equal to:
- 40 knots for ships of unrestricted service and for ships of restricted service I,
- 30 knots for ships of the remaining service areas,

the following criterion shall be complied with:
dynamic stability (the shaded area in Fig. 3.4.1.2) from point *D* to the angle of 45°, or the flooding angle (whichever is the lesser), shall not be less than 0.025 m-rad.

.4 the initial metacentric height of the damaged ship – determined by constant displacement method shall not be less than 0.05 m.

3.4.2 Stability of a damaged ship in intermediate stages of flooding shall satisfy the following requirements:
- the angle of heel shall not exceed 20°,
- intermediate damage waterline shall be situated below openings, through which undamaged compartments can be flooded (see 3.4.1.1),
- the requirement of 3.4.1.3 shall be complied with.

ANNEX 1

HULL WATERTIGHT INTEGRITY

1 Hull

1.1 Each ship shall be provided with watertight bulkheads system, dividing the hull to watertight compartments, assuring maintenance of the required ship's floatability and compliance with the damage stability criteria in the event of damage of the number of watertight compartments specified by the *Rules*.

1.2 The structure of the hull and watertight bulkheads shall comply with the requirements specified in relevant paragraphs of *Part II – Hull*.

1.3 The number of openings in the shell, having regard to design assumptions and normal ship's service, shall be reduced to the minimum.

1.4 The bulkhead deck shall be watertight. All openings in the open deck shall be provided with the coamings of sufficient height and strength and shall be fitted with weathertight closing appliances.

2 Hatches

2.1 Cargo and other hatches in the ship shall comply with the requirements specified in the relevant paragraphs of *Part III – Hull Equipment*.

3 Machinery Space Openings

3.1 Openings in the machinery space shall comply with the requirements specified in the relevant paragraphs of *Part III – Hull Equipment*.

3.2 Access to the machinery space shall lead, as far as practicable, from the superstructure. Each access to the machinery space from the open deck shall be fitted with a weathertight closing appliance.

4 Doors

4.1 All access openings in the superstructure end bulkheads shall be fitted with weathertight doors, made of steel or other equivalent material, strong and permanently fixed to the bulkhead and framed, stiffened and so placed that the whole structure of the openings is of strength equivalent to the strength of the bulkhead without openings.

4.2 Each watertight doors in the ships' bulkheads shall be equipped with open/closed indicators, placed in all remote control stations, as well as in places where manual control is required. Remote control stations shall be located above the bulkhead deck.

4.3 Doors shall comply with the requirements specified in the relevant paragraphs of *Part III – Hull Equipment*.

5 Cargo Ports and other Similar Openings

5.1 Cargo and access ports located below the bulkhead deck shell be of sufficient strength. They shall be effectively closed in a way assuring their watertightness before the ship's departure and shall be kept closed at sea. The ports shall be equipped with alarms and open/closed indicators, placed in Combat information Center/wheelhouse.

5.1.1 The ports in no case shall be so placed that their lower edge is located below the deepest subdivision load line.

5.2 Cargo and access ports shall comply with the requirements specified in the relevant paragraphs of *Part III – Hull Equipment*.

6 Sidescuttles, Windows, Scuppers, Inlets and Discharges

6.1 Sidescuttles and their covers, which are not accessible during navigation, shall be closed and secured before the ship departs the harbour.

6.1.1 Sidescuttles shall comply with the requirements specified in the relevant paragraphs of *Part III – Hull Equipment*.

6.2 The number of the deck scuppers, sanitary outlets and other similar openings in the ship's shell shall be reduced to the minimum.

6.2.1 Freeing ports, railings and deck scuppers shall be so arranged as to ensure quick water flow from the deck in all weather conditions.

6.2.2 All outlets and inlets in the ship's shell shall be provided with effective, easily accessible devices preventing accidental ingress of water into the ship.

6.2.3 Freeing ports, deck scuppers, as well as all outlets and inlets in the hull shell shall comply with the requirements specified in the relevant paragraphs of *Part III – Hull Equipment* and *Part VI – Machinery Installations and Refrigerating Plants*.

7 Various Openings in the Deck

7.1 Manholes and closures without coamings located on the bulkhead deck shall be closed by means of strong covers, ensuring watertightness and shall comply with the requirements specified in the relevant paragraphs of *Part III – Hull Equipment*.

8 Ventilators, Air Pipes and Sounding Divices

8.1 Air pipes and ventilation ducts shall be located in sheltered places and protected against damage and the possibility of flooding the ship's compartments through them.

It is recommended that the ventilation ducts from the machinery space are led above superstructure deck or to the height equivalent to the height of that deck; air pipes led to the open deck shall be fitted with self-closing devices.

8.1.1 Air pipes and ventilation ducts shall comply with the requirements specified in the relevant paragraphs of *Part III – Hull Equipment* and *Part VI – Machinery Installations and Refrigerating Plants*.

9 Miscellaneous

9.1 Each ship shall be fitted with effective bilge system, capable to pump out and drain every watertight compartment, other than that designated for the carriage of fresh water, water ballast, fuel or liquid cargo, for which other means of pumping – effective in all anticipated operation conditions – are applied.

9.1.1 The bilge system shall be capable of functioning in all anticipated operation condition, after the ship damage, despite of the ship's heel and/or trim.

9.2 The ship shall be fitted with the portable means for drying the flooded compartments.

9.3 For the use of the crew, and especially for the ship's Commanding Officer, the ship's subdivision plan, indicating in a clear form the boundaries of watertight compartments for each deck and hold, their openings with closing appliances and their controls location, as well as the arrangement of after damage heel equalization systems, shall be permanently displayed. Moreover, the above information in simplified form should be made available to the ship's officers.

9.4 The crew shall be trained in scope of the ship's damage survivability/anti-damage protection maintenance – OPA.