



# RUSSIAN MARITIME REGISTER OF SHIPPING

CIRCULAR LETTER

No. 314-26- 1011c

dated 05.05.2017

Re:

amendments to the Rules for the Classification and Construction of Sea-Going Ships, 2017, ND No. 2-020101-095-E, in connection with coming into force of IACS Unified Requirement (UR) I2 (Rev.3 Apr 2016)

Item of technical supervision:

Sea-going ships under construction and in service

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Appendices: amendments to Chapter 1.2, Part XVII "Distinguishing Marks and Descriptive Notations in the Class Notation Specifying Structural and Operational Particulars of Ships" of the Rules for the Classification and Construction of Sea-Going Ships, 2017, ND No. 2-020101-095-E

Director General

K.G. Palnikov

Amends Rules for the Classification and Construction of Sea-Going Ships, 2017, ND No. 2-020101-095-E

We hereby inform that in connection with coming into force on 1 July, 2017 of IACS UR I2 (Rev.3 Apr 2016) Chapter 1.2, Part XVII "Distinguishing Marks and Descriptive Notations in the Class Notation Specifying Structural and Operational Particulars of Ships" of the Rules for the Classification and Construction of Sea-Going Ships, 2017, ND No. 2-020101-095-E shall be amended as specified in the Appendix to the Circular Letter.

Original IACS UR I2 (Rev. 3 Apr 2016) in English is posted on the RS website in the Section "RS External Normative Documents".

It is necessary to do the following:

- 1) Bring the content of the Circular Letter to the notice of RS surveyors and all parties concerned within region of the Branch Office activity.
- 2) Apply provisions of the Circular Letter during the RS practical activity.

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**RULES FOR THE CLASSIFICATION AND CONSTRUCTION OF SEA-GOING SHIPS, 2017,  
ND No. 2-020101-095-E**

**Part XVII. DISTINGUISHING MARKS AND DESCRIPTIVE NOTATIONS IN THE CLASS  
NOTATION DEFINING STRUCTURAL AND OPERATIONAL PARTICULARS OF SHIPS**

**Para. 1.2.1.1** shall be amended to read:

"1.2.1.1 The requirements of this Section apply to polar class ships in compliance with 1.1."

**Para. 1.2.2.1.** Two last sentence shall be amended to read:

"1.2.2.1... Besides, the Bow Intermediate, Midbody and Stern regions are further divided in the vertical direction into the Bottom (b), Lower (l) and Icebelt regions. The extent of ice strengthening area shall be determined in compliance with Fig.1.2.2.1."

**Figure. 1.2.2.1.** The inscription "x measured at the aft end of bow region" shall be amended to read:

"X measured from the aft end of bow region";

the inscription "0,7b→0,15L" shall be amended to read:

"max (0,7b; 0,15L)".

**Para. 1.2.2.6** shall be amended to read:

"1.2.2.6 If a ship is intended to operate astern in ice regions, the aft section of the ship shall be designed using the Bow and Bow Intermediate hull area requirements."

**New para 1.2.2.7** shall be introduced reading as follows:

"1.2.2.7 If the ship is assigned the additional notation **Icebreaker**, the forward boundary of the stern region shall be at least 0,04 L forward of the section where the parallel ship side at the upper ice waterline (UIWL) ends."

**Para 1.2.3.1.1** shall be amended to read:

"1.2.3.1.1 A glancing impact on the bow is the design scenario for determining the scantlings required to resist ice loads."

**Para 1.2.3.1.2** shall be amended to read:

"1.2.3.1.2 The design ice load is characterized by an average pressure  $P_{avg}$  uniformly distributed over a rectangular load patch of height  $b$  and width  $w$ ."

**Para 1.2.3.1.5** shall be amended to read:

"1.2.3.1.5 Design ice forces calculated according to 1.2.3.2.1.1 are applicable for bow forms where the buttock angle  $\gamma$  at the stem is positive and  $\gamma$  less than 80 deg and the normal frame angle  $\beta'$  at the centre of the foremost sub-region, as defined in 1.2.3.2.1, is greater than 10 deg."

Existing **para 1.2.3.1.6** shall be renumbered **1.2.3.1.9**.

**New paras 1.2.3.1.6, 1.2.3.1.7 and 1.2.3.1.8** shall be introduced reading as follows:

**"1.2.3.1.6** Design ice forces calculated according to 1.2.3.2.1 are applicable for ships which are assigned the Polar Class **PC6** or **PC7** and have a bow form with vertical sides. The formulae 1.2.3.2.1.2 shall apply where the normal frame angles  $\beta'$  at the considered sub-regions, as defined in 1.2.3.2.1 (i), are between 0 and 10 deg.

**1.2.3.2.1.7** For ships which are assigned the Polar Class **PC6** or **PC7**, and equipped with bulbous bows, the design ice forces on the bow shall be determined according to 1.2.3.2.1.2. In addition, the design forces shall not be taken less than those given in 1.2.3.2.1.1, assuming  $fa = 0,6$  and  $AR = 1,3$ .

**1.2.3.1.8** For ships with bow forms other than those defined in 1.2.3.1.5 to 1.2.3.1.7, design forces shall be determined according to the RS approved procedures."

**Para 1.2.3.2** shall be amended to read:

**"1.2.3.2** Glancing impact load characteristics.

The parameters defining the glancing impact load characteristics are reflected in the Class Factors listed in Table 1.2.3.2-1 and 1.2.3.2-2."

**Para 1.2.3.2.1.1** shall be renumbered 1.2.3.2.1.

Numeration of **paras 1.2.3.2.1.1.1 to 1.2.3.2.1.1.5** shall be deleted.

**Fig. 1.2.3.2.1.1.1** shall be renumbered 1.2.3.2.1.

**Formulae 1.2.3.2.1.1.3.1-2, 1.2.3.2.1.1.3.1-3, 1.2.3.2.1.1.3.1-4.** The numeration shall be deleted.

**Formula 1.2.3.2.1.1.3.1-1** shall be renumbered 1.2.3.2.1-1.

**Formula 1.2.3.2.1.1.3.2** shall be renumbered 1.2.3.2.1-2.

**Formula 1.2.3.2.1.1.3.3** shall be renumbered 1.2.3.2.1-3.

**Table 1.2.3.2.1** shall be renumbered 1.2.3.2-1. The heading shall be amended to read "Class factors to be used for calculations according to 1.2.3.2.1."

**Table 1.2.3.2-1.** The text in the head of the table shall be amended to read:

Polar Class	Crushing failure Class Factor $CF_C$	Flexural failure Class Factor $CF_F$	Load patch dimensions Class Factor $CF_D$	Displacement Class Factor $CF_{DIS}$	Longitudinal strength Class Factor $CF_L$
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New Table 1.2.3.2-2 shall be introduced reading as follows:

Table 1.2.3.2-2

**Class factors to be used for calculations according to 1.2.3.2.1.2**

Polar Class	Crushing failure Class Factor $CF_{CV}$	Line load Class Factor $CF_{QV}$	Pressure Class Factor $CF_{PV}$
<b>PC6</b>	3,43	2,82	0,65
<b>PC7</b>	2,60	2,33	0,65

**Paras 1.2.3.2.1 to 1.2.3.2.1.1.2.5** shall be amended to read:

**"1.2.3.2.1** Bow Area.

In the Bow area, the force  $F$ , line load  $Q$ , pressure  $P$  and load patch aspect ratio  $AR$  associated with the glancing impact load scenario are functions of the hull angles measured at the upper ice waterline UIWL. The influence of the hull angles is captured through calculation of a bow shape coefficient  $fa$ . The hull angles are defined in Fig. 1.2.3.2.1.

The waterline length of the bow region is generally to be divided into 4 sub-regions of equal length. The force  $F$ , line load  $Q$ , pressure  $P$  and load patch aspect ratio  $AR$  shall be calculated with respect to the mid-length position of each sub-region (each maximum of  $F$ ,  $Q$  and  $P$  shall be used in the calculation of the ice load parameters  $P_{avg}$ ,  $b$  and  $w$ ).

**1.2.3.2.1.1** The Bow area load characteristics for bow forms defined in 1.2.3.1.5 are determined as follows:

Shape coefficient,  $fa_i$ :

$$fa_i = \min(fa_{i,1}; fa_{i,2}; fa_{i,3});$$

$$fa_{i,1} = (0,097 - 0,68 \cdot (x/L - 0,15)^2) \cdot \alpha_i / (\beta'_i)^2;$$

$$fa_{i,2} = 1,2 CF_F / (\sin(\beta'_i) \cdot CF_C \cdot D^{0,64});$$

$$fa_{i,3} = 0,60;$$

Force,  $F$ , in kN:

$$F_i = fa_i \cdot CF_C \cdot D^{0,64};$$

Load patch aspect ratio,  $AR$ :

$$AR = 7,46 \cdot \sin(\beta'_i) \geq 1,3;$$

Line load,  $Q$ , in MN/m:

$$Q_i = F_i^{0,61} \cdot CF_D / AR_i^{0,35};$$

Pressure,  $P$ , in kPa:

$$P_i = F_i^{0,22} \cdot CF_D^2 \cdot AR_i^{0,3},$$

where  $i$  = sub-region considered;

$L$  = ship length as defined in 1.1.3, Part II "Hull", but measured on the upper ice waterline UIWL in m;

$x$  = distance from the forward perpendicular  $FP$  to station under consideration, in m;

$\alpha$  = waterline angle, in deg. (refer to Fig. 1.2.3.2.1);

$\beta'$  = normal frame angle, in deg., measured as per normal to the outer shell (refer to Fig. 1.2.3.2.1);

$D$  = ship displacement, in kt, not to be taken less than 5 kt;

$CF_C$  = Crushing failure Class Factor according to Table 1.2.3.2-1.

$CF_F$  = Flexural failure Class Factor according to Table 1.2.3.2-1.

$CF_D$  = Load patch dimensions Class Factor from Table 1.2.3.2-1.

**1.2.3.2.1.2** The Bow area load characteristics for bow forms defined in 1.2.3.1.6 are determined as follows:

Shape coefficient,  $fa_i$ :

$$fa_i = \alpha_i / 30;$$

Force,  $F$ , in kN:

$$F_i = fa_i \cdot CF_{CV} \cdot D^{0,47};$$

Line load,  $Q$ , in MN/m:

$$Q_i = F_i^{0,22} \cdot CF_{QV};$$

Pressure,  $P$ , in kPa:

$$P_i = F_i^{0,56} \cdot CF_{PV},$$

where  $i$  = sub-region considered

$\alpha$  = waterline angle, deg (refer to Fig. 1.2.3.2.1);

$D$  = ship displacement, in kt, not to be taken less than 5 kt;

$CF_{CV}$  = Crushing failure Class Factor according to Table 1.2.3.2-2.

$CF_{QV}$  = Line load Class Factor according to Table 1.2.3.2-2.

$CF_{PV}$  = Pressure Class Factor according to Table 1.2.3.2-2."

**Para 1.2.3.2.2** shall amended to read:

"**1.2.3.2.2** Hull areas other than the bow

In the hull areas other than the bow, the force  $F_{NonBow}$ , in MN and line load  $Q_{NonBow}$ , in MN/m, used in the determination of the load patch dimensions  $b_{NonBow}$ ,  $w_{NonBow}$  and design pressure  $P_{avg}$  are determined as follows:

$$F_{NonBow} = 0,36 \cdot CF_C \cdot DF;$$

$$Q_{NonBow} = 0,639 \cdot F_{NonBow}^{0,61} \cdot CF_D,$$

where:

$CF_C$  = Crushing failure Class Factor according to Table 1.2.3.2-1;

$DF$  = ship displacement factor:

$$DF = D^{0,64} \text{ if } D \leq CF_{DIS};$$

$$DF = CF_{DIS}^{0,64} + 0,10 \cdot (D - CF_{DIS}) \text{ if } D > CF_{DIS};$$

$D$  = ship displacement, in kt, not to be taken less than 10 kt;

$CF_{DIS}$  = Displacement Class Factor according to Table 1.2.3.2-1."

**Para. 1.2.3.3** shall be amended to read:

"**1.2.3.3** Design load patch.

In the Bow area, and the Bow Intermediate Icebelt area for ships with class notation **PC6** and **PC7**, the design load patch has dimensions of width,  $w_{Bow}$ , and height,  $b_{Bow}$ , defined as follows:

$$w_{BOW} = F_{Bow}/Q_{Bow};$$

$$b_{BOW} = Q_{Bow}/P_{Bow},$$

where  $F_{Bow}$  = maximum force  $F_i$ , kN, in the Bow area in compliance with 1.2.3.2.1;

$Q_{Bow}$  = maximum line load  $Q_i$  in the Bow area, in MN/m in compliance with 1.2.3.2.1;

$P_{Bow}$  = maximum pressure  $P_i$  in the Bow area, in MPa in compliance with 1.2.3.2.1.

In other hull areas, the design load patch has dimensions of width,  $w_{NonBow}$ , in m, and height,  $b_{NonBow}$  in m, defined as follows:

$$w_{NonBOW} = F_{NonBow}/Q_{NonBow};$$

$$b_{NonBow} = w_{NonBow}/3,6,$$

where  $F_{NonBow}$  = force, in kN, as defined in 1.2.3.2.2;

$Q_{NonBow}$  = line load, in MN/m, as defined in 1.2.3.2.2."

**Table 1.2.3.4.2** shall be amended to read:

## Peak Pressure Factors

"Table 1.2.3.5-2

Hull Area		Area	Polar Class						
			PC1	PC2	PC3	PC4	PC5	PC6	PC7
Stern (S)	Ice belt	$S_i$	0.90	0.85	0.80	0.75	0.65	0.55	0.50
	Lower	$S_l$	0.60	0.55	0.50	0.45	0.40	0.40	0.40
	Bottom	$S_b$	0.35	0.30	0.30	0.25	0.15	1	1

<sup>1</sup>Indicates that strengthening for ice loads is not necessary

Table 1.2.3.5-3

Hull area		Area	Polar Class						
			PC1	PC2	PC3	PC4	PC5	PC6	PC7
Bow (B)	All	$B$	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Bow intermediate (BI)	Ice belt	$BI_i$	0.90	0.85	0.85	0.85	0.85	1.00	1.00
	Lower	$BI_l$	0.70	0.65	0.65	0.65	0.65	0.65	0.65
	Bottom	$BI_b$	0.55	0.50	0.45	0.45	0.45	0.45	0.45
Midbody (M)	Ice belt	$M_i$	0.70	0.65	0.55	0.55	0.55	0.55	0.55
	Lower	$M_l$	0.50	0.45	0.40	0.40	0.40	0.40	0.40
	Bottom	$M_b$	0.30	0.30	0.25	0.25	0.25	0.25	0.25
Stern (S)	Ice belt	$S_i$	0.95	0.90	0.80	0.80	0.80	0.80	0.80
	Lower	$S_l$	0.55	0.50	0.45	0.45	0.45	0.45	0.45
	Bottom	$S_b$	0.35	0.30	0.30	0.30	0.30	0.30	0.30

**Formula 1.2.4.1.** In the explication the definition of  $t_{net}$  shall be amended to read:

" $t_{net}$  = plate thickness required to resist ice loads according to 1.2.4.2, in mm."

**Para 1.2.4.2** shall be amended to read:

"1.2.4.2 The thickness of shell plating required to resist the design ice load,  $t_{net}$  in mm, depends on the orientation of the framing.

In the case of transversely-framed plating ( $\Omega \geq 70$  deg), including all bottom plating, i.e. In hull areas  $BI_b$ ,  $M_b$  and  $S_b$ , the net thickness is given by

$$t_{net} = 500 \cdot s \cdot ((AF \cdot PPF_p \cdot P_{avg}) / \sigma_y)^{0.5} / \left(1 + \frac{s}{2b}\right)$$

In the case of longitudinally-framed plating ( $\Omega \leq 20$  deg) when  $b \geq s$ , the net thickness is given by:

$$t_{net} = 500 \cdot s \cdot ((AF \cdot PPF_p \cdot P_{avg}) / \sigma_y)^{0.5} / \left(1 + \frac{s}{2l}\right)$$

In the case of longitudinally-framed plating ( $\Omega \leq 20^\circ$ ) when  $b < s$ , the net thickness is given by

$$t_{net} = 500 \cdot s \cdot ((AF \cdot PPF_p \cdot P_{avg}) / \sigma_y)^{0.5} \cdot (2 \cdot b/s - (b/s)^2)^{0.5} / \left(1 + \frac{s}{2l}\right),$$

where  $\Omega$  - smallest angle between the chord of the waterline and the line of the first level framing as illustrated in Fig. 1.2.4.2, in deg;

$s$  = transverse frame spacing in transversely-framed ships or longitudinal frame spacing in longitudinally-framed ships, in m;

$AF$  - Hull Area Factor from 1.2.3.5;

$PPF_p$  = Peak Pressure Factor from Table 1.2.3.4.2;

$P_{avg}$  = average patch pressure as defined in 1.2.3.4, in MPa;

$\sigma_y$  = minimum upper yield stress of the material, in N/mm<sup>2</sup>;

$b$  = height of design load patch, m, where  $b$  shall be taken not greater than  $b \leq l - s/4$ ; in the case of determination of the net thickness for transversely framed plating;

$l$  = distance between frame supports, i.e. equal to the frame span as given in 1.2.5.5, but not reduced for any fitted end brackets, m. When a load-distributing stringer is fitted, the length  $l$  need not be taken larger than the distance from the stringer to the most distant frame support;

When  $20^\circ < \Omega < 70^\circ$  the linear interpolation shall be used for net thickness determination."

**Figure 1.2.4.2.** The texts shall be replaced only in Russian. "Oblique View" shall be amended to read " Oblique View".

The text "View normal to shell" in Fig. 1.2.4.2 shall be replaced by the text "View normal to shell".

**Paras 1.2.5.2 - 1.2.5.7** shall be amended to read:

**"1.2.5.2** The term "framing member" refers to transverse and longitudinal local frames, loadcarrying stringers and web frames in the areas of the hull exposed to ice pressure, refer to Fig. 1.2.2.1.

**1.2.5.3** The strength of a framing member is dependent upon the fixity that is provided at its supports. Fixity can be assumed where framing members are either continuous through the support or attached to a supporting section with a connection bracket. In other cases, simple support shall be assumed unless the connection can be demonstrated to provide significant rotational restraint. Fixity is to be ensured at the support of any framing which terminates within an ice-strengthened area.

**1.2.5.4** The details of framing member intersection with other framing members, including plated structures be in accordance with 3.10.2.4.5, Part II "Hull". The details for securing the ends of framing members at supporting sections, shall comply with 1.7.2.2 and 2.5.5, Part II "Hull".

**1.2.5.5** The effective span of a framing member shall be determined on the basis of its moulded length. If brackets are fitted, the effective span may be reduced in accordance with 3.10.2.2.3, Part II "Hull". Brackets shall be configured to ensure stability in the elastic and post-yield response regions.

**1.2.5.6** When calculating the section modulus and shear area of a framing member, net thicknesses of the web, flange and attached shell plating shall be used. The shear area of a framing member may include that material contained over the full depth of the member, i.e. web area including portion of flange, if fitted, but excluding attached shell plating.

**1.2.5.7** The actual net effective shear area,  $A_w$ , in  $\text{cm}^2$ , of a transverse or longitudinal local frame is given by the formula:

$$A_w = h \cdot t_{wn} \cdot \sin \varphi_w / 100,$$

where  $h$  = height of stiffener, mm, refer to Fig. 1.2.5.7;

$t_{wn}$  = net web thickness, mm;

$$t_{wn} = t_w - t_c;$$

$t_w$  = as built web thickness, in mm, refer to Fig. 1.2.5.7;

$t_c$  = corrosion deduction, in mm to be subtracted from the web and flange thickness (as specified by 1.1.5.2, Part II "Hull", but not less than  $t_c$  as required by 1.2.11.3;

$\varphi_w$  = smallest angle between shell plate and stiffener web, measured at the midspan of the stiffener, (refer to Fig. 1.2.5.7). The angle  $\varphi_w$  may be taken as 90 deg. provided the smallest angle is not less than 75 deg."

**Para 1.2.5.8.** The first paragraph shall be amended to read:

**"1.2.5.8** When the cross-sectional area of the attached plate flange exceeds the cross-sectional area of the local frame, the actual net effective plastic section modulus,  $Z_p$ , in  $\text{cm}^3$  , of a transverse or longitudinal frame is given by:... .";



the second paragraph shall be amended to read:

**1.2.5.8...**When the cross-sectional area of the local frame exceeds the cross-sectional area of the attached plate flange, the plastic neutral axis is located a distance  $z_{na}$ , in mm, above the attached shell plate, and the actual net effective plastic section modulus,  $Z_p$ , in cm<sup>3</sup>, of a transverse or longitudinal frame is given by:

**Formula 1.2.5.8-1.** The explication shall be amended to read:

" $A_{pn}$  - net cross-sectional area of the local frame, cm<sup>2</sup>;"

$t_{pn}$  - fitted net shell plate thickness, mm, complying with  $t_{net}$  as required by 1.2.4.2;

$A_{fn}$  = net cross-sectional area of local frame flange, cm<sup>2</sup>; "

the text between **Formulae 1.2.5.8-1 and 1.2.5.8-2** shall be deleted.

**Para 1.2.5.9** shall be amended to read:

**1.2.5.9** In the case, when  $20^\circ < \Omega < 70^\circ$ , where  $\Omega$  is defined as given in 1.2.4.2, linear interpolation shall be used."

**Paras 1.2.6 and 1.2.6.1** shall be amended to read:

**1.2.6 Framing. Local frames in bottom structures and transverse local frames in side structures.**

**1.2.6.1** The local frames in bottom structures and transverse local frames in side structures shall be dimensioned such that the combined effects of shear and bending do not exceed the plastic strength of the member. The plastic strength is defined by the magnitude of midspan load that causes the development of a plastic collapse mechanism. For bottom structure the patch load shall be applied with the dimension  $b$  parallel with the frame direction."

**Formula 1.2.6.2** shall be replaced by new Formula (1.2.6.2):

$$A_t = \frac{100^2 \cdot 0,5 \cdot LL \cdot s \cdot (AF \cdot PPF \cdot P_{avg})}{0,577 \cdot \sigma_y} \quad (1.2.6.2);$$

The explication to Formula (1.2.6.2) shall be amended to read:

" $b$  = height of design ice load patch as defined in 1.2.3.3;

$AF$  = Hull Area Factor from 1.2.3.5;

$PPF$  = Peak Pressure Factor,  $PPF_t$  or  $PPF_s$  as appropriate from Table 1.2.3.4.2;

$P_{avg}$  = average pressure within load patch as defined in 1.2.3.4;"

**Paras 1.2.7 and 1.2.7.1** shall be amended to read:

**1.2.7 Framing. Longitudinal local frames in side structures.**

**1.2.7.1** Longitudinal local frames in side structures shall be dimensioned such that the combined effects of shear and bending do not exceed the plastic strength of the member. The plastic strength is defined by the magnitude of midspan load that causes the development of a plastic collapse mechanism."

**Formula 1.2.7.2.** The explication shall be amended to read:

" $b$  = height of design ice load patch as defined in 1.2.3.3;

$AF$  = Hull Area Factor from 1.2.3.5;

$P_{avg}$  = average pressure within load patch as defined in 1.2.3.4; "

$a$  = effective span of longitudinal local frame as given in 1.2.5.5;"

**Para 1.2.8.2** shall be amended to read:

"**1.2.8.2** Web frames and load-carrying stringers shall be dimensioned such that the combined effects of shear and bending do not exceed the limit state(s). Where the structural configuration is such that members do not form part of a grillage system."

Existing **Para 1.2.8.3** shall be renumbered **1.2.8.4**.

New **Para 1.2.8.3** shall be introduced after existing Para 1.2.8.2, reading as follows:

"**1.2.8.3** For determination of scantlings of load carrying stringers, web frames supporting local frames, or web frames supporting load carrying stringers forming part of a structural grillage system, appropriate methods as outlined in 1.2.17 shall normally be used."

**Para 1.2.9.2** prior to the explication of Formula (1.2.9.2), and **Formula (1.2.9.2)** shall be amended to read:

"**1.2.9.2** Framing members for which it is not practicable to meet the requirements of 1.2.9.1 (e.g. load carrying stringers or deep web frames) are required to have their webs effectively stiffened. The scantlings of the web stiffeners are to ensure the structural stability of the framing member. The minimum net web thickness for these framing members is given by:

$$t_{wn} = 2,63 \cdot 10^{-3} \cdot c_1 \cdot \sqrt{\frac{\sigma_y}{5,34 + 4 \cdot \left(\frac{c_1}{c_2}\right)^2}} \quad (1.2.9.2)''$$

**Paras 1.2.11 to 1.2.11.4** shall be amended to read:

"**1.2.11 Corrosion/abrasion additions and steel renewal.**

**1.2.11.1** Effective protection against corrosion and ice-induced abrasion is recommended for all external surfaces of the shell plating for Polar Class ships.

**1.2.11.2** The values of corrosion/abrasion additions,  $t_s$ , in mm, to be used in determining the shell plate thickness are listed in Table 1.2.11.2.

**1.2.11.3** Polar Class ships shall have a minimum corrosion/abrasion addition of  $t_s = 1,0$  mm applied to all internal structures within the ice-strengthened hull areas, including plated members adjacent to the shell, as well as stiffener webs and flanges.

**1.2.11.4** Steel renewal for ice strengthened structures is required when the gauged thickness is less than  $t_{net} + 0,5$  mm."

**Paras 1.2.12 to 1.2.12.5** shall be amended to read:

"**1.2.12 Materials.**

**1.2.12.1** Steel grades of plating for hull structures shall be not less than those given in Table 1.2.12.4 and 1.2.12.5 based on the as-built thickness, the Polar Class and the material class of structural members according to 1.2.12.2.

**1.2.12.2** Material classes specified in Table 1.2.3.7-1, Part II "Hull" are applicable to polar Class ships regardless of the ship's length. 1.2.3.7-1, Part II "Hull". In addition, in table 1.2.12.2 material classes for weather and sea exposed structural members and for members attached to the weather and sea exposed plating are given. Where the material classes in Table 1.2.3.7-1, Part II "Hull" and in Table 1.2.12.2 differ, the higher material class shall be applied.

**1.2.12.3** Regardless of Polar Class, steel grades for all plating and attached framing of hull structures and appendages situated below the level of 0,3 m below the lower waterline, as shown

in Fig. 1.2.12.3, shall be obtained from table 1.2.3.7-2, Part II "Hull" for structural members in Table 1.2.12.2.

**1.2.12.4** Steel grades for all weather exposed plating of hull structures and appendages situated above the level of 0.3 m below the lower ice waterline, as shown in Fig. 1.2.12.3, shall be not less than given in Table 1.2.12.4.

**1.2.12.5** Castings shall have specified properties consistent with the expected service temperature for the cast component. "

**Figure 1.2.12.3** shall be replaced by new **Figure 1.2.12.3**:

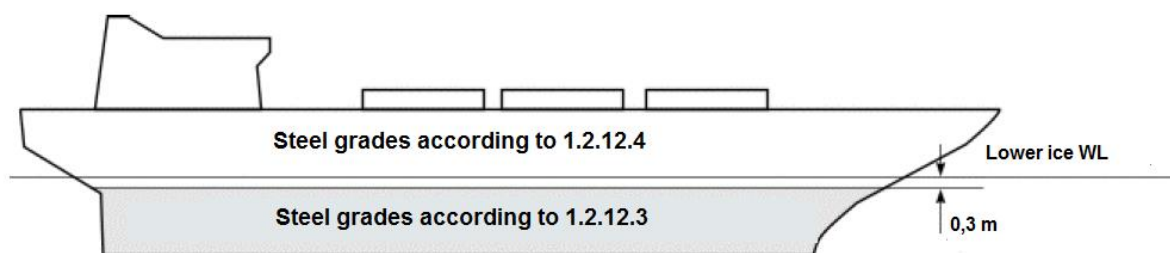


Fig. 1.2.12.3

Steel grades requirements for submerged and weather exposed shell plating

**Para 1.2.12.6** and **Table 1.2.12.5** shall be deleted.

Existing **Para 1.2.13.1.1** shall be deleted.

New **Paras 1.2.13.1.1** to **1.2.13.1.3** shall be introduced reading as follows:

**"1.2.13.1.1** A ramming impact on the bow is the design scenario for the evaluation of the longitudinal strength of the hull.

**1.2.13.1.2** Intentional ramming is not considered as a design scenario for ships which are designed with vertical or bulbous bows. Hence the longitudinal strength requirements given in 1.2.13 shall not to be considered for ships with stem angle  $\gamma_{stem}$  equal to or larger than 80 deg.

**1.2.13.1.3** Ice loads shall only be combined with still water loads. The combined stresses shall be compared against permissible bending and shear stresses at different locations along the ship's length. In addition, sufficient local buckling strength shall also be verified."

Paras 1.2.13.3 to **1.2.13.3.2** shall be amended to read:

**"1.2.13.3 Design vertical shear force.**

**1.2.13.3.1** The design vertical ice shear force,  $F_I$  in MN, along the hull girder shall be taken as:

$$F_I = C_f \cdot F_{IB}, \quad (1.2.13.3.1)$$

where  $C_f$  = longitudinal distribution factor to be taken as follows:

Positive shear force

$C_f = 0,0$  between the aft end of L and  $0,6L$  from aft;

$C_f = 1,0$  between  $0,9 L$  from aft and the forward end of L;

Negative shear force

$C_f = 0,0$  at the aft end of L;

$C_f = -0,25 \cdot x/L$  between the aft end of L and 0,2L from aft;  
 $C_f = -0,5$  between 0,2 L and 0,6L from aft;  
 $C_f = 2,5$  between the aft end of L and 0,6L from the aft;  
 $C_f = 0.0$  between 0,8 L from aft and the forward end of L;  
x = distance from of the design section to the aft perpendicular, in m;  
L = ship length measured on the upper ice waterline UIWL, as defined in 1.1.3, Part II "Hull".

**1.2.13.3.2** The applied vertical shear stress shall be determined along the hull girder in a similar manner as in 1.6.5.1, Part II "Hull" by substituting the design vertical ice shear force  $N_w$ , in kN, for the design vertical wave shear force  $F_l$ , in kN. "

**Paras 1.2.13.4.1 and 1.2.13.4.2** shall be amended to read:

The design vertical ice bending moment,  $M_I$ , along the hull girder shall be taken as:

$$M_I = 0,1 C_m \cdot L \cdot \sin^{-0,2}(\gamma_{stem}) \cdot F_{IB}, \quad (1.2.13.4.1)$$

where  $L$  = ship length measured on UIWL, as defined in 1.1.3, Part II "Hull";

$\gamma_{stem}$  is as given in 1.2.13.2.1;

$F_{IB}$  – design vertical ice force at the bow, in MN;

$C_m$  = longitudinal distribution factor for design vertical ice bending moment to be taken as follows:

$C_m = 0,0$  at the aft end of L;

$C_m = 2,0 \cdot x/L$  between the aft end of L and 0,5L from aft;

$C_f = 1,0$  between 0,5 L and 0,7L from aft;

$C_f = 2,96 - 2,8$  between the aft end of L and 0,95L from aft;

$C_m = 0,3$  at 0,95L from aft;

$C_f = 6,0 \cdot x/L$  between the aft end of L and 0,2L from aft;

$C_m = 0,0$  at the aft end of L;

x = distance from the design section to the aft perpendicular, in m.

Where applicable, draught dependent quantities shall be determined at the waterline corresponding to the loading condition under consideration.

**1.2.13.4.2** The applied vertical bending stress,  $\sigma_a$  shall be determined as given in 1.6.5.1, Part II "Hull" by substituting the design vertical ice bending moment for the design vertical wave bending moment. The ship still water bending moment shall be taken as the maximum sagging moment."

**Table 1.2.13.5.1** shall be supplemented with the reference:

" $\eta = 0,6$  for ships which are assigned the additional notation **Icebreaker**."

**Paras 1.2.14 to 1.2.14.2** shall amended to read:

**"1.2.14 Stem and stern frames.**

**1.2.14.1** Ice class ships shall have a solid section stem made of steel. The stems and sternframes of polar class ships and icebreakers of **PC1**, **PC**, as well as the sternframes of polar class **PC1**, **PC2**, **PC3**, **PC4** и **PC5** ships, shall be made of forged or cast steel. Stems and sternframes welded of cast or forged parts are admissible.

**1.2.14.2** In **PC3**, **PC4**, **PC5**, **PC6**, **PC7** polar class ships and polar class icebreakers less than **PC4**, a stem of combined structure consisting of a bar with thickened plates welded thereto or plate structure may be used. Welding seams of the combined or plated structure stems shall be made with full penetration in compliance with the requirements of Part XIV "Welding".

In **PC6** and **PC7** polar class ships a stem of combined structure or plate structure may be used.

**1.2.14.3** In **PC3, PC4, PC5, PC6, PC7** polar class ships, the stem shall be strengthened by a centre line web having its section depth equal to  $h_p$  at least (refer to Table 1.2.14.3) with a face plate along its free edge or a longitudinal bulkhead fitted on the ship centreline, on the entire stem length from the keel plate to the nearest deck or platform situated above the area B (refer to Fig. 1.2.2.1) The thickness of this plate shall not be less than that of the brackets as referred to in 1.2.14.4. In all polar class icebreakers and **PC1, PC2** Polar class ships, a longitudinal bulkhead may be substituted for the centre line web.

Table 1.2.14.3

$h_p$ , in m				
<b>PC7</b>	<b>PC6</b>	<b>PC5</b>	<b>PC4</b>	<b>PC3</b>
0,6	0,6	1,0	1,3	1,5

**1.2.14.4** Within the vertical extent defined in 1.2.14.3, the stem shall be strengthened by horizontal webs at least 0,6 m in depth and spaced not more than 0,6 m apart. Where in line with side stringers, the webs shall be attached to them. In stems of combined or plate type, the webs shall be extended beyond the welded butts of the stem and shell plating.

Above the deck or platform located higher than the upper boundary of region B, the spacing of horizontal webs may gradually increase to 1,2 m in polar class icebreakers and **PC1, PC2, PC3** polar class ships, and to 1,5 m in ships of other polar class.

The web thickness shall be adopted not less than half the stem plate thickness according to 1.2.4.7. The free edges of webs shall be strengthened with face plates welded to the frames at their ends. The side stringers of the fore peak shall be connected to the webs fitted in line with them.

In case of a full bow, vertical stiffeners may be required additionally to be fitted to the stem plates.

**1.2.14.5** Where the stern frame has an appendage (ice knife), the clearance between the latter and the rudder plate shall not exceed 100 mm. The appendage shall be reliably connected to the stern frame. Securing the appendage to plate structures is not permitted.

**1.2.14.6** In icebreakers, the lower edge of sole piece shall be constructed with a slope of 1:8 beginning from the propeller post.

**1.2.14.7** Cross-sectional area of the stem,  $A_{st}$ ,  $\text{cm}^2$ , any type stem, shall be at least as given by the formula

$$A_{st} = c_t \cdot c_k \cdot f(D),$$

(1.2.14.7-1)

where  $c_k$  = coefficient as given in Table 1.2.14.7;

$$f(D) = 31D + 137 \text{ if } D < 5 \text{ kt};$$

$$f(D) = 100 \cdot D^{2/3} \text{ if } D \geq 5 \text{ kt};$$

$D$  = displacement of the ship, in kt;

$c_t$  = coefficient equal to 1,0 for polar class ships; 1,4 for icebreakers.

$c_k$  = coefficient as given in Table 1.2.14.7.

Table 1.2.14.3

$k$						
<b>PC7</b>	<b>PC6</b>	<b>PC5</b>	<b>PC4</b>	<b>PC3</b>	<b>PC2</b>	<b>PC1</b>
0,54	0,54	0,66	1,02	1,25	1,40	1,55

Section modulus  $Z_{st}$ , in  $\text{cm}^3$ , of the stem cross-sectional area to the axis perpendicular to the centreline, shall be at least those defined by the Formula

$$Z_{st} = 1,2 Q_{Bow}, \quad (1.2.14.7-2)$$

where  $Q_{Bow}$  = line load as given in 1.2.3.2.1, in kN/m.

The areas of outer shell plates and vertical plate adjoining the stem or longitudinal bulkhead in the centreline at the width not exceeding ten times of thickness of the appropriate plates are assumed as the estimated stem cross-section.

The minimum thickness of stem plate  $t_{net}^{stem}$ , mm, of combined or plate type stem, shall be as given the Formula

$$t_{net}^{stem} = 1,2 \cdot t_{net} \cdot \frac{a_b}{s} \cdot \sqrt{\frac{\sigma_y}{\sigma_{y1}}} \quad (1.2.14.7-3)$$

$t_{net}$  = net thickness of other shell, as given in 1.2.4.2;

$s$  = transverse frame spacing, in m;

$a_b$  = distance between the brackets, in m;

$\sigma_y$  = minimum upper yield stress of outer shell material, in  $\text{N/mm}^2$ ;

$\sigma_{y1}$  = minimum upper yield stress of stem material, in  $\text{N/mm}^2$ .

"Paras 1.2.17 – 1.2.17.2 shall be amended to read:

"1.2.17 Direct calculations.

1.2.17.1 Application.

Direct calculations shall be used for load carrying stringers and web frames forming part of a grillage system and shall not to be utilised as an alternative to the analytical procedures prescribed for the shell plating and local frame requirements given in 1.2.4, 1.2.6 and 1.2.7.

Direct calculations shall be made by the finite element method in the static nonlinear elastoplastic design. While calculating, the nonlinear dependence between the stresses and deformations shall be considered, if the yield stress reached.

The tensile diagram with linear hardening shall be used to describe the material properties.

1.2.17.2 Requirements to finite element model (FEM).

3-D finite element model shall be used for calculations. The model dimensions shall be specified so that to include web frames forming part of a grillage system in the ice reinforcement area as given in 1.2.2, and to meet the minimum requirements to the finite element model as given in Table 1.2.17.2-1.

Table 1.2.17.2-1

**Minimum requirements to finite element model dimensions**

Boundary	Type of side structure	
	Double side structure	Single side structure
Fore	Transverse bulkhead	
Aft	Transverse bulkhead	
Upper	Upper deck	Deck, platform or double bottom, located above icebelt region

Lower	Double bottom	Deck, platform or double bottom, located below icebelt region
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The FEM model shall represent the geometry of the hull form.

Boundary conditions for FEM model shall comply with the requirements given in Table 1.2.17.2-2.

Table 1.2.17.2-2

Boundary conditions						
Location of finite element model boundaries	Translational			Rotational		
	$\delta_x$	$\delta_y$	$\delta_z$	$\theta_x$	$\theta_y$	$\theta_z$
Top and bottom boundaries	-	x	x	x	x	x
Fore and aft boundaries	x	x	-	x	x	x

Note. X - fixed.

Structures to be modelled shall include side shell, web frames, stringers, local frames, inner skin and attached local frames, web stiffeners and brackets.

Structural idealization shall reasonably represent the non-linear behavior of the structure with the following minimum requirements to be satisfied:

shell elements shall be used for representing the side shell, inner skin, web frames, stringers, and local frames web and flange;

beam elements shall be used for representing local frames outside icebelt region;

rod elements shall be used for representing web stiffeners.

Mesh size shall be selected such that the modelled structures reasonably represent the non-linear behavior of the structures with the following minimum requirements to be satisfied:

it is preferable to use quadrilateral elements that are nearly square in shape, the aspect ratio of the elements shall be kept below 1/3;

triangular elements shall be avoided as much as practical;

web of the web frames shall be divided into at least five elements;

web of the local frames shall be divided into at least three elements;

areas where high local stress or large deflections are expected could be modeled with finer mesh, while the areas outside ice belt region could be modelled with coarser mesh.

Finite elements thickness shall be equal to the net-thickness of the structure.

New **Paras 1.2.17.3 to 1.2.17.6** shall be introduced reading as follows:

#### 1.2.17.3 Acceptance criteria.

The direct calculation shall demonstrate that ultimate structural capacity of the grillage structure,  $P_{ult}$ , in MPa, is not less than the design ice pressure within the hull area under consideration, as specified in 1.2.3.4. The criteria shall be satisfied for representative locations of the design load patch, as specified in 1.2.17.4.

The ultimate structural capacity of the grillage structure shall be calculated in accordance with 1.2.17.5.

#### **1.2.17.4 Load patch**

The design load patch specified in 1.2.3.3 shall be applied, without being combined with any other load.

The design load patch shall be applied normal to the side shell plating.

The load patch shall be located where the bending and shear capacity of the web frame or load carrying stringer is minimized. The minimum required locations of the design load patch are as follows:

top edge of the load patch is in line with top boundary of the ice belt, at the central web frame of the grillage;

bottom edge of the load patch is in line with the bottom boundary of the ice belt, at the central web frame of the grillage;

load patch centroid is located at the midspan of the central web frame of the grillage;

load patch centroid is located at the midspan of the central load carrying stringer of the grillage.

#### **1.2.17.5 Ultimate structural capacity.**

The ultimate structural capacity of the grillage shall be based on a non-linear static FEM analysis with the gradually increasing loads. The load increment shall be sufficiently fine to ensure the accuracy of the curve ( $P-\delta$ ).

The analysis shall reliably capture buckling of the elements by the method agreed by Register.

The value of the ultimate structural capacity,  $P_{ult}$ , shall be based on pressure-deflection ( $P-\delta$ ) curve using modified tangent intersection method as demonstrated on Fig. 1.2.17.5



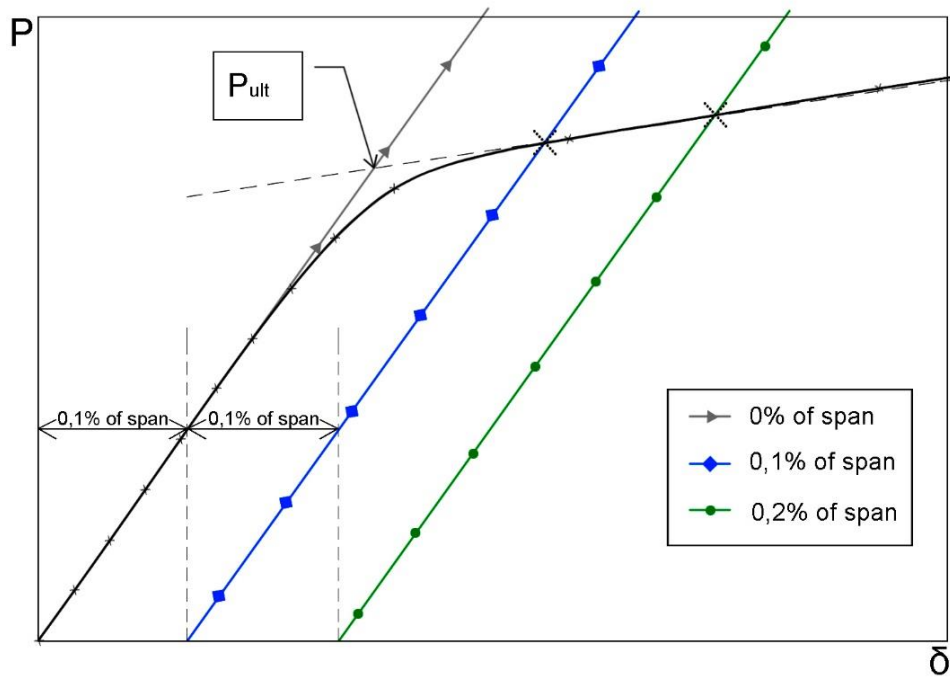


Fig.1.2.17.5

Ultimate structural capacity calculation using tangent intersection method

$P$  – pressure applied to the grillage structure;  $\delta$  - maximum deflection of the web frame or load-carrying stringer in the grillage structure

#### 1.2.17.6 Software.

FEM computation program shall be able to address the aspects of non-linear material behavior, structural idealization, meshing, load application and elasto-plastic calculations specified in 1.2.17.1 to 1.2.17.5. FEM computation program shall be able to address all possible computational errors."