RUSSIAN MARITIME REGISTER OF SHIPPING

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RULES
FOR THE CLASSIFICATION AND CONSTRUCTION OF SEA-GOING SHIPS

Part XVII

DISTINGUISHING MARKS AND DESCRIPTIVE NOTATIONS IN THE CLASS NOTATION SPECIFYING STRUCTURAL AND OPERATIONAL PARTICULARS OF SHIPS

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Rules for the Classification and Construction of Sea-Going Ships of Russian Maritime Register of Shipping have been approved in accordance with the established approval procedure and come into force on 1 January 2016.

The present nineteenth edition of the Rules is based on the eighteenth edition (2015) taking into account the additions and amendments developed immediately before publication.

The unified requirements, interpretations and recommendations of the International Association of Classification Societies (IACS) and the relevant resolutions of the International Maritime Organization (IMO) have been taken into consideration.

The Rules are published in the following parts:

Part I "Classification";

Part II "Hull";

Part III "Equipment, Arrangements and Outfit";

Part IV "Stability";

Part V "Subdivision";

Part VI "Fire Protection";

Part VII "Machinery Installations";

Part VIII "Systems and Piping";

Part IX "Machinery";

Part X "Boilers, Heat Exchangers and Pressure Vessels";

Part XI "Electrical Equipment";

Part XII "Refrigerating Plants";

Part XIII "Materials";

Part XIV "Welding";

Part XV "Automation";

Part XVI "Hull Structure and Strength of Glass-Reinforced Plastic Ships and Boats";

Part XVII "Distinguishing Marks and Descriptive Notations in the Class Notation Specifying Structural and Operational Particulars of Ships";

Part XVIII "Common Structural Rules for Bulk Carriers and Oil Tankers". The text of the part is identical to that of the IACS Common Structural Rules.

Parts I to XVII are published in electronic format and hard copy in Russian and English. In case of discrepancies between the Russian and English versions, the Russian version shall prevail.

Part XVIII is published in English and in electronic format only.

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As compared to the previous edition (2015), the nineteenth edition contains the following amendments.

The term "ice category" has been replaced by the term "ice class" throughout the text of the Rules.

RULES FOR THE CLASSIFICATION AND CONSTRUCTION OF SEA-GOING SHIPS

PART XVII. DISTINGUISHING MARKS AND DESCRIPTIVE NOTATIONS IN THE CLASS NOTATION SPECIFYING STRUCTURAL AND OPERATIONAL PARTICULARS OF SHIPS

1. Section 3: in para 3.1.2 the definitions "Bilge water", "Ballast water system" and "Sewage system" have been amended, the definition "Regular service" has been deleted and a new definition "Ballast water" has been introduced;

Table 3.3.2 has been amended considering IMO resolutions MEPC.240(65) and MEPC.244(66);

in para 3.4.2.1 the requirements to NO_x-reducing devices have been specified;

new para 3.4.2.6 regarding Record Book of SO_x-Reducing Device Parameters has been introduced;

paras 3.5.2.2.1 and 3.6.2.2.1 have been harmonized with regulation 13.1.2.1 of Annex VI to MARPOL 73/78 regarding non-application of the requirements to the engines used in emergency;

para 3.5.2.2.4 has been amended considering IMO resolution MEPC.198(62) with respect to the application of selective catalytic reduction (SCR) systems;

paras 3.5.2.7.1 and 3.5.2.7.3 have been amended considering IMO resolution MEPC.244(66) with respect to the Standard Specification for Shipboard Incinerators;

in para 3.5.3.3.4 the requirements to spills collection have been specified;

para 3.5.3.3.8 has been amended regarding devices preventing fuel, oil and oil residues escape to sea;

para 3.5.3.6.1 has been amended regarding application of the requirements to garbage management;

para 3.5.3.6.2 has been deleted;

in para 3.5.3.7.2 the requirements to sewage treatment plants have been specified and the para has been amended considering IMO resolution MEPC.227(64) with respect to the Guidelines on Implementation of Effluent Standards and Performance Tests for Sewage Treatment Plants;

in para 3.5.3.10.5 the requirements to capacity of the fuel oil tanks have been specified;

para 3.6.2.2.1 has been harmonized with regulation 13.1.2.1 of Annex VI to MARPOL 73/78 regarding non-application of the requirements to the engines used in emergency;

para 3.6.2.2.2 has been amended due to improvement of the requirements to NO_x emission standards;

in para 3.6.3.3.3 the requirements to spills collection have been specified;

para 3.6.3.6.3 has been deleted;

para 3.6.3.7.2 has been amended considering IMO resolution MEPC.227(64) with respect to the Guidelines on Implementation of Effluent Standards and Performance Tests for Sewage Treatment Plants;

2. Section 6: in para 6.3.4 the requirement to arrangement of the fixed safety net on the helideck has been specified.

3. Section 7: in paras 7.1.1.3.3, 7.3.1 to 7.3.3 the requirements have been specified;

para 7.3.4 has been deleted.

4. New Section 10 "Requirements to Baltic Class Ships" has been introduced.

5. Editorial amendments have been made.

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PART XVII. DISTINGUISHING MARKS AND DESCRIPTIVE NOTATIONS IN THE CLASS NOTATION SPECIFYING STRUCTURAL AND OPERATIONAL PARTICULARS OF SHIPS

1 REQUIREMENTS FOR POLAR CLASS SHIPS

1.1 POLAR CLASS DESCRIPTIONS AND APPLICATION

1.1.1 Application.

1.1.1.1 The requirements for polar class ships apply to ships constructed of steel and intended for navigation in ice-infested polar waters, except icebreakers (refer to **1.1.1.3**).

The requirements of the present Section apply to ships contracted for construction on or after 1 March 2008.

Note. The date of "contract for construction" means the date on which the contract to build the ship is signed between the prospective owner and the shipbuilder. For further details regarding the date of "contract for construction" refer to 1.1.2, Part I "Classification".

1.1.1.2 Ships that comply with requirements of **1.2** and **1.3** can be considered for a polar class notation as listed in Table **1.1.1.2**. The requirements of **1.2** and **1.3** are in addition to the Register requirements for ships without ice strengthening. If the hull and machinery are constructed such as to comply with the requirements of different polar classes, then both the hull and machinery shall be assigned the lower of these classes in the Classification Certificate. Compliance of the hull or machinery with the requirements of a higher polar class shall also be indicated in column "Other characteristics" of the Classification Certificate.

1.1.1.3 Ships that shall receive an "**Icebreaker**" notation may have additional requirements and shall receive special consideration. "**Icebreaker**" refers to any ship having an operational profile that includes escort or ice management functions, having powering and dimensions that allow it to undertake aggressive operations in ice-covered waters, and having a Classification Certificate endorsed with this notation.

1.1.2 Polar classes.

1.1.2.1 The polar class (**PC**) notations and descriptions are given in Table **1.1.1.2**. It is the responsibility of the shipowner to select an appropriate polar class. The descriptions in Table **1.1.1.2** are intended to guide owners, designers and flag state administrations in selecting an appropriate polar class to match the requirements for the ship with its intended voyage or service.

1.1.2.2 The polar class notation is used throughout the present Section to convey the differences between classes with respect to operational capability and strength.

1.1.3 Upper and lower ice waterlines.

1.1.3.1 The upper and lower ice waterlines upon which the design of the ship has been based shall be indicated in the Classification Certificate. The upper ice waterline (UIWL) shall be defined by the maximum draughts fore, amidships and aft. The lower ice waterline (LIWL) shall be defined by the minimum draughts fore, amidships and aft.

1.1.3.2 The lower ice waterline shall be determined with due regard to the ship's ice-going capability in the ballast loading conditions (e.g. propeller submergence).

1.2 STRUCTURAL REQUIREMENTS FOR POLAR CLASS SHIPS

1.2.1 Application.

1.2.1.1 The requirements of the present Section shall be applied to polar class ships indicated in **1.1**.

1.2.2 Hull areas.

1.2.2.1 The hull of all polar class ships is divided into areas reflecting the magnitude of the loads that are expected to act upon them. In the longitudinal direction, there are four regions: bow (*B*), bow intermediate (*BI*), midbody (*M*) and stern (*S*). The bow intermediate, midbody and stern regions are further divided in the vertical direction into the bottom (*b*), lower (*l*) and ice belt (*i*) regions. The extent of each hull area is illustrated in Fig. **1.2.2.1**.

1.2.2.2 The upper ice waterline (UIWL) and lower ice waterline (LIWL) are as defined in **1.1.3**.

1.2.2.3 Fig. **1.2.2.1** notwithstanding, at no time shall the boundary between the bow and bow intermediate regions be forward of the intersection point of the line of the stem and the ship baseline.

1.2.2.4 Fig. **1.2.2.1** notwithstanding, the aft boundary of the bow region need not be more than $0{,}45L$ aft of the forward perpendicular (**FP**).

1.2.2.5 The boundary between the bottom and lower regions shall be taken at the point where the shell is inclined 7° from horizontal.

Table 1.1.1.2

Polar class descriptions

Polar class	Ice description (based on WMO Sea Ice Nomenclature)
PC1	Year-round operation in all polar waters
PC2	Year-round operation in moderate multi-year ice conditions
PC3	Year-round operation in second-year ice which may include multi-year ice inclusions
PC4	Year-round operation in thick first-year ice which may include old ice inclusions
PC5	Year-round operation in medium first-year ice which may include old ice inclusions
PC6	Summer/autumn operation in medium first-year ice which may include old ice inclusions
PC7	Summer/autumn operation in thin first-year ice which may include old ice inclusions

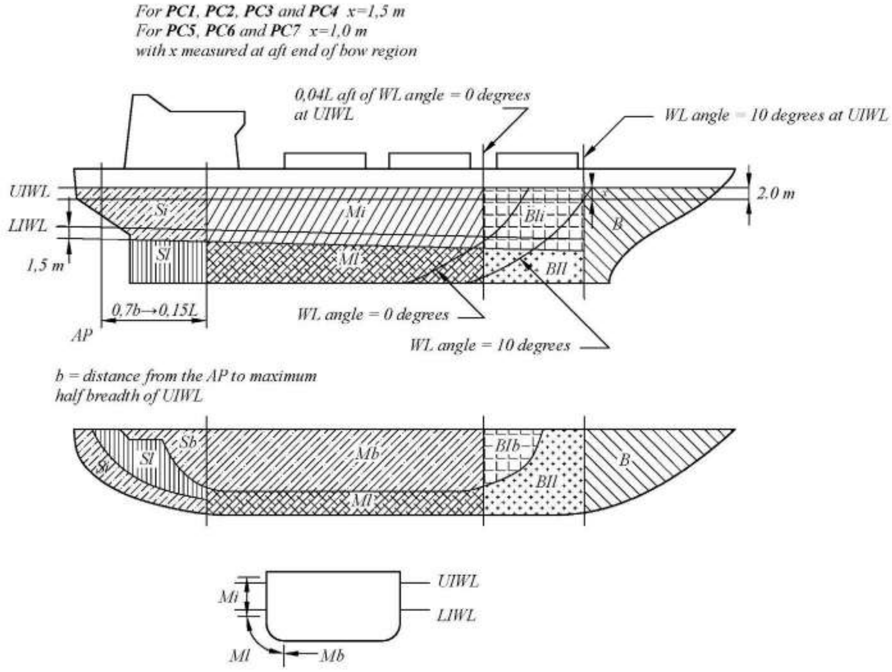


Fig. 1.2.2.1
Hull area extents

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.

1.2.3 Design ice loads.

1.2.3.1 General.

1.2.3.1.1 For ships of all polar classes, a glancing impact on the bow is the design scenario for determining the scantlings required to resist ice loads.

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.

1.2.3.1.3 Within the bow area of all polar classes, and within the bow intermediate ice belt area of polar classes **PC6** and **PC7**, the ice load parameters are functions of the actual bow shape. To determine the ice load parameters P_{avg}, b and w, it is required to calculate the following ice load characteristics for sub-regions of the bow area; shape coefficient f_{a_i}, total glancing impact force F_i, line load Q_i and pressure P_i.

1.2.3.1.4 In other ice-strengthened areas, the ice load parameters P_{avg}, b_{NonBow} and w_{NonBow} are determined independently of the hull shape and based on a fixed load patch aspect ratio, AR = 3,6.

1.2.3.1.5 Design ice forces calculated according to 1.2.3.2 are only valid for ships with icebreaking forms. Design ice forces for any other bow forms shall be specially considered by the Register.

1.2.3.1.6 Ship structures that are not directly subjected to ice loads may still experience inertial loads of stowed cargo and equipment resulting from ship/ice interaction. These inertial loads, based on accelerations determined according to the procedure approved by the Register, shall be considered in the design of these structures.

1.2.3.2 Glancing impact load characteristics.

1.2.3.2.1 The parameters defining the glancing impact load characteristics are reflected in the class factors listed in Table 1.2.3.2.1.

Table 1.2.3.2.1

Class factors

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
PC1	17,69	68,60	2,01	250	7,46
PC2	9,89	46,80	1,75	210	5,46
PC3	6,06	21,17	1,53	180	4,17
PC4	4,50	13,48	1,42	130	3,15
PC5	3,10	9,00	1,31	70	2,50
PC6	2,40	5,49	1,17	40	2,37
PC7	1,80	4,06	1,11	22	1,81

1.2.3.2.1.1 Bow area.

1.2.3.2.1.1.1 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. The influence of the hull angles is captured through calculation of a bow shape coefficient fa. The hull angles are defined in Fig. 1.2.3.2.1.1.1.

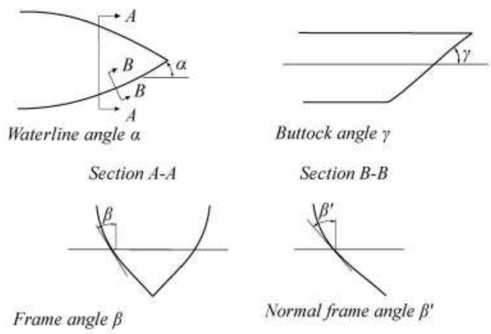


Fig. 1.2.3.2.1.1.1
Definition of hull angles

N o t e s : β' = normal frame angle at upper ice waterline, in deg.;
α = upper ice waterline angle, in deg.;
γ = buttock angle at upper ice waterline (angle of buttock line measured from horizontal), in deg.;
$\mathrm{tg}\beta = \mathrm{tg}\alpha/\mathrm{tg}\gamma$;
$\mathrm{tg}\beta' = \mathrm{tg}\beta/\cos\alpha$.

1.2.3.2.1.1.2 The waterline length of the bow region shall generally 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).

1.2.3.2.1.1.3 The bow area load characteristics are determined as follows:

.1 shape coefficient fa_i shall be taken as:

$$fa_i = \min(fa_{i,1}; fa_{i,2}; fa_{i,3}) \qquad (1.2.3.2.1.1.3.1\text{-}1)$$

where

$$fa_{i,1} = (0{,}097 - 0{,}68(x/L - 0{,}15)^2) \cdot \alpha_i/(\beta_i')^{0{,}5}; \qquad (1.2.3.2.1.1.3.1\text{-}2)$$

$$fa_{i,2} = 1{,}2CF_F/(\sin(\beta_i') \cdot CF_C \cdot D^{0{,}64}); \qquad (1.2.3.2.1.1.3.1\text{-}3)$$

$$fa_{i,3} = 0{,}60; \qquad (1.2.3.2.1.1.3.1\text{-}4)$$

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 to station under consideration, in m;
α = waterline angle, in deg. (refer to Fig. 1.2.3.2.1.1.1);
β' = normal frame angle, in deg. (refer to Fig. 1.2.3.2.1.1.1);
D = ship displacement, in kt, not to be taken less than 5 kt;
CF_C = refer to Table 1.2.3.2.1;
CF_F = refer to Table 1.2.3.2.1;

.2 force F, in MN:

$$F_i = fa_i \cdot CF_C \cdot D^{0{,}64} \qquad (1.2.3.2.1.1.3.2)$$

where i = sub-region considered;
fa_i = shape coefficient of sub-region i;
CF_C = refer to Table 1.2.3.2.1;
D = ship displacement, in kt, not to be taken less than 5 kt;

.3 load patch aspect ratio AR:

$$AR_i = 7{,}46 \cdot \sin(\beta'_i) \geqslant 1{,}3 \qquad (1.2.3.2.1.1.3.3)$$

where i = sub-region considered;
β'_i = normal frame angle of sub-region i, in deg.;

.4 line load Q, in MN/m:

$$Q_i = F_i^{0{,}61} CF_D / AR_i^{0{,}35} \qquad (1.2.3.2.1.1.3.4)$$

where i = sub-region considered;
F_i = force of sub-region i, in MN;
CF_D = refer to Table 1.2.3.2.1;
AR_i = load patch aspect ratio of sub-region i;

.5 pressure P, in MPa:

$$P_i = F_i^{0{,}22} CF_D{}^2 AR_i^{0{,}3} \qquad (1.2.3.2.1.1.3.5)$$

where i = sub-region considered;
F_i = force of sub-region i, in MN;
CF_D = reefer to Table 1.2.3.2.1;
AR_i = load patch aspect ratio of sub-region i.

1.2.3.2.2 Hull areas other than the bow.

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

.1 force F_{NonBow}, in MN:

$$F_{NonBow} = 0{,}36 CF_C DF \qquad (1.2.3.2.2.1.1)$$

where CF_C = refer to Table 1.2.3.2.1;
DF = ship displacement factor:
$DF = D^{0{,}64}$ for $D \le CF_{DIS}$;
$DF = CF_{DIS}^{0{,}64} + 0{,}10(D - CF_{DIS})$ for $D > CF_{DIS}$;
D = ship displacement, in kt, not to be taken less than 10 kt;
CF_{DIS} = refer to Table 1.2.3.2.1;

.2 line load Q_{NonBow}, in MN/m:

$$Q_{NonBow} = 0{,}639 F_{NonBow}^{0{,}61} CF_D \qquad (1.2.3.2.2.1.2)$$

where F_{NonBow} force from Formula (1.2.3.2.2.1.1), in MN;
CF_D = refer to Table 1.2.3.2.1.

1.2.3.3 Design load patch.

1.2.3.3.1 In the bow area and the bow intermediate ice belt area for ships with class notation **PC6** and **PC7**, the design load patch has dimensions of width w_{Bow} and height b_{Bow}, in m, determined as follows:

$$w_{Bow} = F_{Bow}/Q_{Bow}; \qquad (1.2.3.3.1\text{-}1)$$

$$b_{Bow} = Q_{Bow}/P_{Bow} \qquad (1.2.3.3.1\text{-}2)$$

where F_{Bow} = maximum force F_i in the bow area (refer to 1.2.3.2.1.1.3.2), in MN;
Q_{Bow} = maximum line load Q_i in the bow area (refer to 1.2.3.2.1.1.3.4), in MN/m;
P_{Bow} = maximum pressure P_i in the bow area (refer to 1.2.3.2.1.1.3.5), in MPa.

1.2.3.3.2 In hull areas other than those covered by 1.2.3.3.1, the design load patch has dimensions of width w_{NonBow} and height b_{NonBow}, in m, determined as follows:

$$w_{NonBow} = F_{NonBow}/Q_{NonBow}; \quad (1.2.3.3.2\text{-}1)$$

$$b_{NonBow} = w_{NonBow}/3{,}6 \quad (1.2.3.3.2\text{-}2)$$

where F_{NonBow} = force determined by Formula (1.2.3.2.2.1.1), in MN;
Q_{NonBow} = line load determined by Formula (1.2.3.2.2.1.2), in MN/m.

1.2.3.4 Pressure within the design load patch.

1.2.3.4.1 The average pressure P_{avg}, in MPa, within a design load patch is determined as follows:

$$P_{avg} = F/(b{\cdot}w) \quad (1.2.3.4.1)$$

where F = F_{Bow} or F_{NonBow} as appropriate for the hull area under consideration, in MN;
b = b_{Bow} or b_{NonBow} as appropriate for the hull area under consideration, in m;
w = w_{Bow} or w_{NonBow} as appropriate for the hull area under consideration, in m.

1.2.3.4.2 Areas of higher, concentrated pressure exist within the load patch. In general, smaller areas have higher local pressures. Accordingly, the peak pressure factors listed in Table 1.2.3.4.2 are used to account for the pressure concentration on localized structural members.

1.2.3.5 Hull area factors.

1.2.3.5.1 Associated with each hull area is an area factor that reflects the relative magnitude of the load expected in that area. The area factor for each hull area is listed in Table 1.2.3.5.1.

1.2.3.5.2 In the event that a structural member spans across the boundary of a hull area, the largest hull area factor shall be used in the scantling determination of the member.

1.2.3.5.3 Ships having propulsion arrangements with azimuthing thruster(s) or "podded" propellers shall have specially considered by the Register stern ice belt S_i and stern lower S_l hull area factors.

Table 1.2.3.4.2

Peak pressure factors

Structural member		Peak pressure factor PPF_i
Plating	Transversely-framed	$PPF_p = (1{,}8 - s) \geqslant 1{,}2$
	Longitudinally-framed	$PPF_p = (2{,}2 - 1{,}2\,s) \geqslant 1{,}5$
Frames in transverse	With load distributing stringers	$PPF_t = (1{,}6 - s) \geqslant 1{,}0$
	Framing systems with no load distributing stringers	$PPF_t = (1{,}8 - s) \geqslant 1{,}2$
Load carrying stringers Side and bottom longitudinals Web frames		$PPF_s = 1$, if $S_w \geqslant 0{,}5w$ $PPF_s = 2{,}0 - 2{,}0{\cdot}S_w/w$, if $S_w < 0{,}5w$

where s = frame or longitudinal spacing, in m;
S_w = web frame spacing, in m;
w = ice load patch width, in m.

Table 1.2.3.5.1

Hull area factors AF

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	0,80	0,80	1,00[1]	1,00[1]
	Lower	BI_l	0,70	0,65	0,65	0,60	0,55	0,55	0,50
	Bottom	BI_b	0,55	0,50	0,45	0,40	0,35	0,30	0,25
Midbody (M)	Ice belt	M_i	0,70	0,65	0,55	0,55	0,50	0,45	0,45
	Lower	M_l	0,50	0,45	0,40	0,35	0,30	0,25	0,25
	Bottom	M_b	0,30	0,30	0,25	[2]	[2]	[2]	[2]
Stern (S)	Ice belt	S_i	0,75	0,70	0,65	0,60	0,50	0,40	0,35
	Lower	S_l	0,45	0,40	0,35	0,30	0,25	0,25	0,25
	Bottom	S_b	0,35	0,30	0,30	0,25	0,15	[2]	[2]

[1]Refer to 1.2.3.1.3.
[2]Indicates that strengthening for ice loads is not necessary.

1.2.4 Shell plate requirements.

1.2.4.1 The required minimum shell plate thickness t, in mm, is determined by the formula

$$t = t_{net} + t_s \qquad (1.2.4.1)$$

where t_{net} = plate thickness required to resist ice loads according to 1.2.4.2, in mm;
t_s = corrosion and abrasion allowance according to 1.2.11, in mm.

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 ($\Omega \geqslant 70$ deg.), including all bottom plating, i.e. plating in hull areas BI_b, M_b and S_b, the net thickness is determined by the formula

$$t_{net} = 500s((AF \cdot PPF_p \cdot P_{avg})/\sigma_y)^{0,5}/(1 + s/2b) \qquad (1.2.4.2\text{-}1)$$

where Ω = 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 Table 1.2.3.5.1;
PPF_p = peak pressure factor from Table 1.2.3.4.2;
P_{avg} = average patch pressure according to Formula (1.2.3.4.1), in MPa;
σ_y = minimum upper yield stress of the material, in N/mm^2;
b = height of design load patch, in m, where $b \geqslant (l - s/4)$ in the case determined by Formula (1.2.4.2-1);
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, in 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.

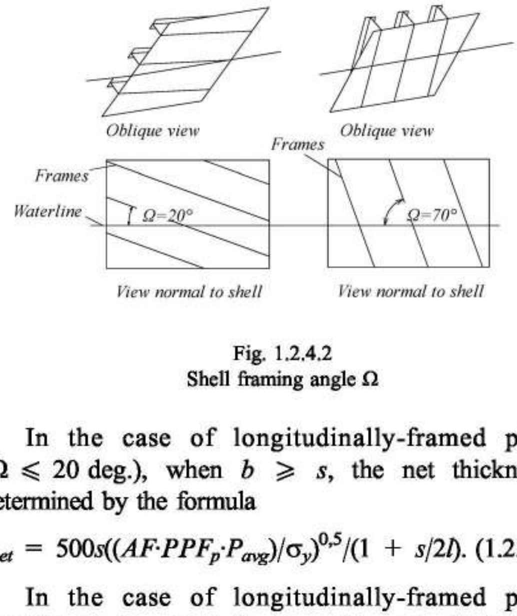


Fig. 1.2.4.2
Shell framing angle Ω

In the case of longitudinally-framed plating ($\Omega \leqslant 20$ deg.), when $b \geqslant s$, the net thickness is determined by the formula

$$t_{net} = 500s((AF \cdot PPF_p \cdot P_{avg})/\sigma_y)^{0,5}/(1 + s/2l). \qquad (1.2.4.2\text{-}2)$$

In the case of longitudinally-framed plating ($\Omega \leqslant 20$ deg.), when $b < s$, the net thickness is determined by the formula

$$t_{net} = 500s((AF \cdot PPF_p \cdot P_{avg})/\sigma_y)^{0,5} \cdot (2b/s - (b/s)^2)^{0,5}/(1 + s/2l). \qquad (1.2.4.2\text{-}3)$$

In the case of obliquely-framed plating (70 deg > Ω > 20 deg.), linear interpolation shall be used.

1.2.5 Framing. General.

1.2.5.1 Framing members of polar class ships shall be designed to withstand the ice loads defined in 1.2.3.

1.2.5.2 The term "framing member" refers to transverse and longitudinal local frames, load-carrying stringers and web frames in the areas of the hull exposed to ice pressure (refer to Fig. 1.2.2.1). Where load-distributing stringers have been fitted, the arrangement and scantlings of these shall be in accordance with the Register requirements.

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 shall 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, as well as the details for securing the ends of framing members at supporting sections, shall be in accordance with the requirements of the Register.

1.2.5.5 The design span of a framing member shall be determined on the basis of its moulded length. If brackets are fitted, the design span may be reduced in accordance with the Register requirements. 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 (if fitted) 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 cm^2, of a framing member is determined by the formula

$$A_w = ht_{wn}\sin\varphi_w/100 \qquad (1.2.5.7)$$

where h = height of stiffener, in mm, refer to Fig. 1.2.5.7;
t_{wn} = net web thickness, in 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 (according to 3.10.4.1, Part II "Hull", but not less than t_s as required by 1. 2.11.3);
φ_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 φ_w may be taken as 90 deg., provided the smallest angle is not less than 75 deg.

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 cm^3, is determined by the formula

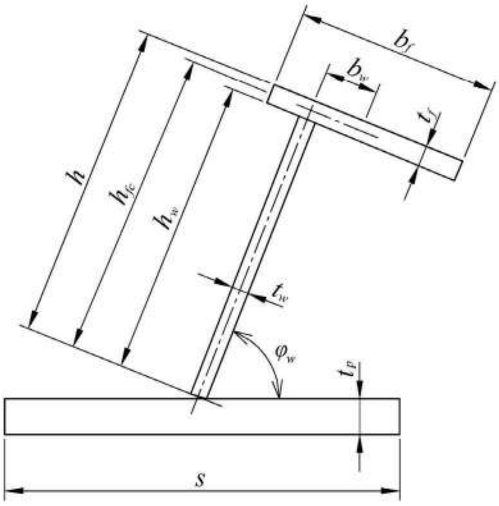


Fig. 1.2.5.7
Stiffener geometry

$$Z_p = A_{pn}t_{pn}/20 + \frac{h_w^2 t_{wn}\sin\varphi_w}{2000} + A_{fn}(h_{fc}\sin\varphi_w - b_w\cos\varphi_w)/10 \quad (1.2.5.8\text{-}1)$$

where h, t_{wn}, t_c, and φ_w are as given in 1.2.5.7 and s as given in 1.2.4.2;
A_{pn} = net cross-sectional area of attached plate, in cm^2 (equal to $10t_{pn}s$, but not to be taken greater than the net cross-sectional area of the local frame);
t_{pn} = fitted net shell plate thickness, in mm (shall comply with t_{net} as required by 1.2.4.2);
h_w = height of local frame web, in mm (refer to Fig. 1.2.5.7);
A_{fn} = net cross-sectional area of local frame flange, in cm^2;
h_{fc} = height of local frame measured to centre of the flange area, in mm (refer to Fig. 1.2.5.7);
b_w = distance from mid thickness plane of local frame web to the centre of the flange area, in mm (refer to Fig. 1.2.5.7).

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 at a distance z_{na}, in mm, above the attached shell plate, determined by the formula

$$z_{na} = (100A_{fn} + ht_{wn} - 1000t_{pn}s)/2t_{wn} \quad (1.2.5.8\text{-}2)$$

and the net effective plastic section modulus Z_p, in cm^3, is determined by the formula

$$Z_p = t_{pn}s\,(z_{na} + t_{pn}/2)\sin\varphi_w + \Big(\frac{((h_w - z_{na})^2 + z_{na}^2)t_{wn}\sin\varphi_w}{2000} + A_{fn}((h_{fc} - z_{na})\sin\varphi_w - b_w\cos\varphi_w)/10\Big) \quad (1.2.5.8\text{-}3)$$

1.2.5.9 In the case of oblique framing arrangement (70 deg. > Ω > 20 deg., where Ω is defined as given in 1.2.4.2), linear interpolation shall be used.

1.2.6 Framing. Transversely-framed side structures and bottom structures.

1.2.6.1 The local frames in transversely-framed side structures and in bottom structures (i.e. hull areas BI_b, M_b and S_b) 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.

1.2.6.2 The actual net effective shear area of the frame A_w, in cm^2, as defined in 1.2.5.7, shall comply with the following condition: $A_w \geqslant A_t$, where

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

where LL = length of loaded portion of span = lesser of a and b, in m;
a = frame span as defined in 1.2.5.5, in m;
b = height of design ice load patch according to (1.2.3.3.1-2) or (1.2.3.3.2-2), in m;
s = transverse frame spacing, in m;
AF = refer to Table 1.2.3.5.1;
PPF_t = refer to Table 1.2.3.4.2;
P_{avg} = average pressure within load patch according to (1.2.3.4.1), in MPa;
σ_y = minimum upper yield stress of the material, in N/mm^2.

1.2.6.3 The actual net effective plastic section modulus of the plate/stiffener combination Z_p as defined in 1.2.5.8, shall comply with the following condition: $Z_p \geqslant Z_{pt}$, where Z_{pt}, in cm^3, shall be the greater calculated on the basis of two load conditions: ice load acting at the midspan of the transverse frame; and the ice load acting near a support.

$$Z_{pt} = 100^3\, LL \cdot Y \cdot s(AF \cdot PPF_t \cdot P_{avg})a \cdot A_1/(4\sigma_y) \quad (1.2.6.3)$$

where AF, PPF_t, P_{avg}, LL, b, s, a and σ_y are as given in 1.2.6.2;
$Y = 1 - 0{,}5(LL/a)$;
A_1 = maximum of:
$A_{1A} = 1/(1 + j/2 + k_wj/2[(1 - a_1^2)^{0{,}5} - 1])$;
$A_{1B} = (1 - 1/(2a_1 \cdot Y))/(0{,}275 + 1{,}44k_z^{0{,}7})$;
j = 1 for framing with one simple support outside the ice-strengthened areas;
j = 2 for framing without any simple supports;
$a_1 = A_t/A_w$;
A_t = minimum shear area of transverse frame as given in 1.2.6.2, in cm^2;
A_w = effective net shear area of transverse frame (calculated according to 1.2.5.7), in cm^2;
$k_w = 1/(1+2A_{fn}/A_w)$, with A_{fn} as given in 1.2.5.8;
$k_z = z_p/Z_p$, in general;
k_z = 0,0, when the frame is arranged with end bracket;
z_p = sum of individual plastic section moduli of flange and shell plate as fitted, in cm^3;
$z_p = (b_f t_{fn}^2/4 + b_{eff} t_{pn}^2/4)/1000$;
b_f = flange breadth, in mm, refer to Fig. 1.2.5.7;
t_{fn} = net flange thickness, in mm;
$t_{fn} = t_f - t_c$ (t_c as given in 1.2.5.7);
t_f = as-built flange thickness, in mm, refer to Fig. 1.2.5.7;
t_{pn} = the fitted net shell plate thickness, in mm (not to be less than t_{net} as given in 1.2.4);
b_{eff} = effective width of shell plate flange, in mm;
b_{eff} = 500 s;
Z_p = net effective plastic section modulus of transverse frame (calculated according to 1.2.5.8), in cm^3.

1.2.6.4 The scantlings of the frame shall meet the structural stability requirements of 1.2.9.

1.2.7 Framing. Side longitudinals (longitudinally-framed ships).

1.2.7.1 Side longitudinals 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.

1.2.7.2 The actual net effective shear area of the frame A_w as defined in 1.2.5.7, shall comply with the following condition: $A_w \geqslant A_L$, where

$$A_L = 100^2(AF \cdot PPF_s \cdot P_{avg}) \cdot 0{,}5 b_1 a/(0{,}577\sigma_y), \text{ in cm}^2 \quad (1.2.7.2)$$

where AF = refer to Table 1.2.3.5.1;
PPF_s = refer to Table 1.2.3.4.2;
P_{avg} = average pressure within load patch according to (1.2.3.4.1), in MPa;
$b_1 = k_0 b_2$, in m;
$k_0 = 1 - 0{,}3/b'$;
$b' = b/s$;
b = height of design ice load patch from (1.2.3.3.1-2) or (1.2.3.3.2-2), in m;
s = spacing of longitudinal frames, in m;
$b_2 = b(1-0{,}25b')$, in m, if $b' < 2$;
$b_2 = s$, in m, if $b' \geqslant 2$;
a = longitudinal design span as given in 1.2.5.5, in m;
σ_y = minimum upper yield stress of the material, in N/mm^2.

1.2.7.3 The actual net effective plastic section modulus of the plate/stiffener combination Z_p as defined in 1.2.5.8, shall comply with the following condition: $Z_p \geqslant Z_{pL}$, where

$$Z_{pL} = 100^3(AF \cdot PPF_s \cdot P_{avg}) b_1 a^2 A_4 / 8\sigma_y, \text{ in cm}^3, \quad (1.2.7.3)$$

where AF, PPF_s, P_{avg}, b_1, a and σ_y are as given in 1.2.7.2;
$A_4 = 1/(2 + k_{wl}[(1 - a_4^2)^{0,5} - 1])$;
$a_4 = A_L/A_w$;
A_L = minimum shear area for longitudinal as given in 1.2.7.2, in cm^2;
A_w = net effective shear area of longitudinal (calculated according to 1.2.5.7), in cm^2;
$k_{wl} = 1/(1+2A_{fn}/A_w)$ with A_{fn} as given in 1.2.5.8.

1.2.7.4 The scantlings of the longitudinals shall meet the structural stability requirements of 1.2.9.

1.2.8 Framing. Web frame and load-carrying stringers.

1.2.8.1 Web frames and load-carrying stringers shall be designed to withstand the ice load patch as defined in 1.2.3. The load patch shall be applied at locations where the capacity of these members under the combined effects of bending and shear is minimised.

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) defined by the Register. Where these members form part of a structural grillage system, appropriate methods of analysis shall be used. Where the structural configuration is such that members do not form part of a grillage system, the appropriate peak pressure factor PPF from Table 1.2.3.4.2 shall be used. Special attention shall be paid to the shear capacity in way of lightening holes and cutouts in way of intersecting members.

1.2.8.3 The scantlings of web frames and load-carrying stringers shall meet the structural stability requirements of 1.2.9.

1.2.9 Framing. Structural stability.

1.2.9.1 To prevent local buckling in the web, the ratio of web height h_w to net web thickness t_{wn} of any framing member shall not exceed:

for flat bar sections:

$$h_w / t_{wn} \leqslant 282/\sigma_y^{0,5}; \quad (1.2.9.1\text{-}1)$$

for bulb, tee and angle sections:

$$h_w / t_{wn} \leqslant 805/\sigma_y^{0,5} \quad (1.2.9.1\text{-}2)$$

where h_w = web height;
t_{wn} = net web thickness;
σ_y = minimum upper yield stress of the material, in N/mm^2.

1.2.9.2 Framing members for which it is not practicable to meet the requirements of 12.9.1 (e.g. load carrying stringers or deep web frames) are required to have their webs effectively stiffened. The scantlings of the web stiffeners shall ensure the structural stability of the framing member. The minimum net web thickness for these framing members t_{wn}, in mm, is determined by the formula

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

where $c_1 = h_w - 0{,}8h$, in mm;
h_w = web height of stringer/web frame, in mm (refer to Fig. 1.2.9.2);
h = height of framing member penetrating the member under consideration (0 if no such framing member), in mm (refer to Fig. 1.2.9.2);
c_2 = spacing between supporting structure oriented perpendicular to the member under consideration, in mm (refer to Fig. 1.2.9.2);
σ_y = minimum upper yield stress of the material, in N/mm^2.

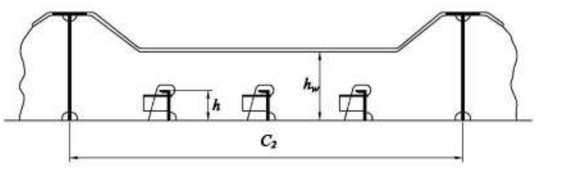


Fig. 1.2.9.2
Parameter definition for web stiffening

1.2.9.3 In addition, the following shall be satisfied:

$$t_{wn} \geqslant 0{,}35 t_{pn}(\sigma_y/235)^{0,5} \quad (1.2.9.3)$$

where σ_y = minimum upper yield stress of the material, in N/mm^2;
t_{wn} = net thickness of the web, in mm;
t_{pn} = net thickness of the shell plate in way the framing member, in mm.

1.2.9.4 To prevent local flange buckling of welded profiles, the following shall be satisfied:

.1 the flange width b_f, in mm, shall not be less than five times the net thickness of the web t_{wn};

.2 the flange outstand b_{out}, in mm, shall meet the following requirement:

$$b_{out}/t_{fn} \leqslant 155/\sigma_y^{0,5} \quad (1.2.9.4.2)$$

where t_{fn} = net thickness of flange, in mm;
σ_y = minimum upper yield stress of the material, in N/mm^2.

1.2.10 Plated structures.

1.2.10.1 Plated structures are those stiffened plate elements in contact with the hull and subject to ice loads. These requirements are applicable to an inboard extent which is the lesser of:

.1 web height of adjacent parallel web frame or stringer; or

.2 2,5 times the depth of framing that intersects the plated structure.

1.2.10.2 The thickness of the plating and the scantlings of attached stiffeners shall be such that the degree of end fixity necessary for the shell framing is ensured.

1.2.10.3 The stability of the plated structure shall adequately withstand the ice loads defined in 1.2.3.

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 all polar ships.

1.2.11.2 The values of corrosion/abrasion additions t_s to be used in determining the shell plate thickness for each polar class are listed in Table 1.2.11.2.

Table 1.2.11.2

Corrosion/abrasion additions for shell plating

Hull area	t_s, in mm					
	With effective protection			Without effective protection		
	PC1 to PC3	**PC4 and PC5**	**PC6 and PC7**	**PC1 to PC3**	**PC4 and PC5**	**PC6 and PC7**
B, BI_i	3,5	2,5	2,0	7,0	5,0	4,0
BI_l, M_i, S_i	2,5	2,0	2,0	5,0	4,0	3,0
M_l, S_l, BI_b, M_b, S_b	2,0	2,0	2,0	4,0	3,0	2,5

1.2.11.3 Polar 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.

1.2.12 Materials.

1.2.12.1 Plating materials for hull structures shall be not less than those given in Tables 1.2.12.4 and 1.2.12.5 based on the as-built thickness of the material, the polar ice class notation assigned to the ship 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 ships regardless of the ship's length. In addition, material classes for weather and sea exposed structural members and for members attached to the weather and sea exposed shell plating of polar class ships are given in Table 1.2.12.2. Where the material classes in Table 1.2.12.2 and those in Table 1.2.3.7-1, Part II "Hull" differ, the higher material class shall be applied.

1.2.12.3 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 Figure 1.2.12.3, shall be obtained from Table 1.2.3.7-2, Part II "Hull" based on the material class for structural members in Table 1.2.12.2 above, regardless of polar class.

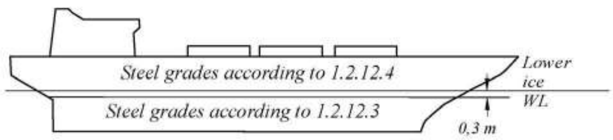


Fig. 1.2.12.3
Steel grade requirements for submerged and weather exposed shell plating

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 Steel grades for all inboard framing members attached to weather exposed plating shall be not less than given in Table 1.2.12.5. This applies to all

Table 1.2.12.2

Material classes for structural members of polar ships

Structural members	Material class
Shell plating within the bow and bow intermediate ice belt hull areas (B, BI_i)	II
All weather and sea exposed secondary and primary (as defined in Table 1.2.3.7-1, Part II "Hull") structural members outside 0,4L amidships	I
Plating materials for stem and stern frames, rudder horn, rudder, propeller nozzle, shaft brackets, ice skeg, ice knife and other appendages subject to ice impact loads	II
All inboard framing members attached to the weather and sea-exposed plating including any contiguous inboard member within 600 mm of the shell plating	I
Weather-exposed plating and attached framing in cargo holds of ships which by nature of their trade have their cargo hold hatches open during cold weather operations	I
All weather and sea exposed special (as defined in Table 1.2.3.7-1, Part II "Hull") structural members within 0,2L from FP	II

Table 1.2.12.4

Steel grades for weather exposed plating

Thickness t, in mm	Material Class I				Material Class II				Material Class III					
	PC1 to PC5		**PC6 and PC7**		**PC1 to PC5**		**PC6 and PC7**		**PC1 to PC3**		**PC4 and PC5**		**PC6 and PC7**	
	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT
$t \leqslant 10$	B	AH	B	AH	B	AH	B	AH	E	EH	E	EH	B	AH
$10 < t \leqslant 15$	B	AH	B	AH	D	DH	B	AH	E	EH	E	EH	D	DH
$15 < t \leqslant 20$	D	DH	B	AH	D	DH	B	AH	E	EH	E	EH	D	DH
$20 < t \leqslant 25$	D	DH	B	AH	D	DH	B	AH	E	EH	E	EH	D	DH
$25 < t \leqslant 30$	D	DH	B	AH	E	EH2	D	DH	E	EH	E	EH	E	EH
$30 < t \leqslant 35$	D	DH	B	AH	E	EH	D	DH	E	EH	E	EH	E	EH
$35 < t \leqslant 40$	D	DH	D	DH	E	EH	D	DH	F	FH	E	EH	E	EH
$40 < t \leqslant 45$	E	EH	D	DH	E	EH	D	DH	F	FH	E	EH	E	EH
$45 < t \leqslant 50$	E	EH	D	DH	E	EH	D	DH	F	FH	F	FH	E	EH

Notes: 1. Includes weather-exposed plating of hull structures and appendages, as well as their outboard framing members, situated above a level of 0,3 m below the lowest ice waterline.
2. Grades D, DH are allowed for a single strake of side shell plating not more than 1,8 m wide from 0,3 m below the lowest ice waterline.

Table 1.2.12.5

Steel grades for inboard framing members attached to weather exposed plating

Thickness t, in mm	PC1 to PC5		PC6 and PC7	
	MS	HT	MS	HT
$t \leqslant 20$	B	AH	B	AH
$20 < t \leqslant 35$	D	DH	D	AH
$35 < t \leqslant 45$	D	DH	D	DH
$45 < t \leqslant 50$	E	EH	E	DH

inboard framing members as well as to other contiguous inboard members (e.g. bulkheads, decks) within 600 mm of the exposed plating.

1.2.12.6 Castings shall have specified properties consistent with the expected service temperature for the cast component.

1.2.13 Longitudinal strength.

1.2.13.1 Application.

1.2.13.1.1 Ice loads need 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.

1.2.13.2 Design vertical ice force at the bow.

1.2.13.2.1 The design vertical ice force at the bow F_{IB}, MN, shall be taken as:

$$F_{IB} = \min(F_{IB,1};\ F_{IB,2}) \qquad \textbf{(1.2.13.2.1-1)}$$

where $F_{IB,1} = 0{,}534K_1^{0,15}\sin^{0,2}(\gamma_{stem})\,(DK_h)^{0,5}CF_L$; (1.2.13.2.1-2)

$F_{IB,2} = 1{,}20CF_F$; (1.2.13.2.1-3)

K_I = indentation parameter = K_f / K_h;

.1 for the case of a blunt bow form:

$K_f = (2C{\cdot}B^{1-eb}/(1+e_b))^{0,9}\mathrm{tg}\,(\gamma_{stem})^{-0,9(1+eb)}$;

.2 for the case of wedge bow form ($\alpha_{stem} < 80°$), $e_b = 1$ and the above simplifies to:

$K_f = (\mathrm{tg}\,(\alpha_{stem})/\mathrm{tg}^2(\gamma_{stem}))^{0,9}$;

$K_h = 0{,}01A_{wp}$, in MN/m;

CF_L = longitudinal strength class factor from Table 1.2.3.2.1;

e_b = bow shape exponent which best describes the waterplane (refer to Figs. 1.2.13.2.1-1 and 1.2.13.2.1-2);

$e_b = 1{,}0$ for a simple wedge bow form;

$e_b = 0{,}4$ to $0{,}6$ for a spoon bow form;

$e_b = 0$ for a landing craft bow form;

an approximate e_b determined by a simple fit is acceptable;

γ_{stem} = stem angle to be measured between the horizontal axis and the stem tangent at the upper ice waterline, deg. (buttock angle as per Fig. 1.2.3.2.1.1.1 measured on the centreline);

α_{stem} = waterline angle measured in way of the stem at the upper ice waterline (UIWL), in deg. (refer to Figure 1.2.13.2.1-1);

$C = 1/(2(L_B/B)^{e_b})$;

B = ship moulded breadth, in m;

L_B = bow length used in the equation $y = B/2(x/L_B)^{eb}$, in m (refer to Figs. 1.2.13.2.1-1 and 1.2.13.2.1-2);

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

A_{wp} = ship waterplane area, in m^2;

CF_F = flexural failure class factor from Table 1.2.3.2.1.

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

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 determined by the formula

$$F_I = C_f F_{IB} \qquad \textbf{(1.2.13.3.1)}$$

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

.1 positive shear force:

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

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

.2 negative shear force:

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

$C_f = -0{,}5$ between $0{,}2L$ and $0{,}6L$ from aft;

$C_f = 0{,}0$ between $0{,}8L$ from aft and the forward end of L.

Intermediate values shall be determined by linear interpolation.

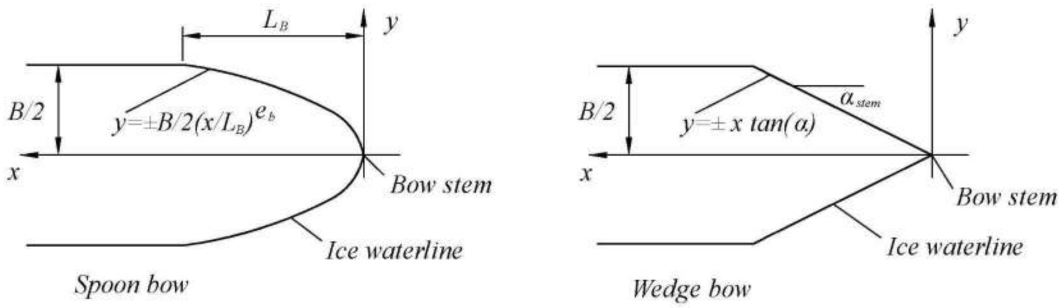


Fig. 1.2.13.2.1-1
Bow shape definition

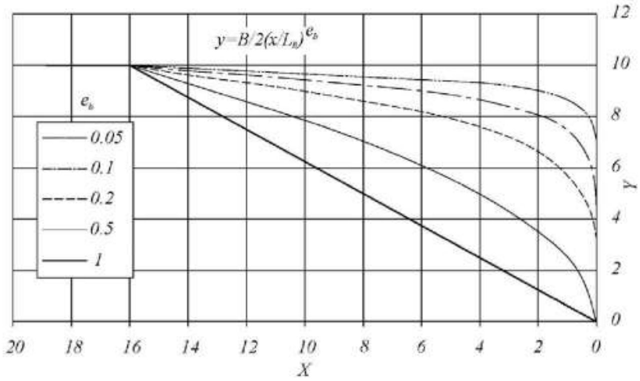


Fig. 1.2.13.2.1-2
Illustration of e_b effect on the bow shape for B = 20 and L_B = 16

1.2.13.3.2 The applied vertical shear stress τ_a 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 for the design vertical wave shear force.

1.2.13.4 Design vertical ice bending moment.

1.2.13.4.1 The design vertical ice bending moment M_I, MNm, along the hull girder shall be determined by the formula

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

where L = ship length (length as defined in 1.1.3, Part II "Hull"), in m;
γ_{stem} 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 = 1,0 between 0,5L and 0,7L from aft;
C_m = 0,3 at 0,95L from aft;
C_m = 0,0 at the forward end of L.

Intermediate values shall be determined by linear interpolation. 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 σ_a 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 bending moment for the design vertical wave bending moment. The ship still water bending moment shall be taken as the maximum sagging moment.

1.2.13.5 Longitudinal strength criteria.

1.2.13.5.1 The strength criteria provided in Table 1.2.13.5.1 shall be satisfied. The design stress is not to exceed the permissible stress.

1.2.14 Stem and stern frames.

1.2.14.1 The stem and stern frame shall be designed according to the Register requirements. For **PC6** and **PC7** ships requiring **1AS** and **1A** equivalency, the stem and stern requirements of the Finnish-Swedish Ice Class Rules may need to be additionally considered.

1.2.15 Appendages.

1.2.15.1 All appendages shall be designed to withstand forces appropriate for the location of their attachment to the hull structure or their position within a hull area.

1.2.15.2 Load definition and response criteria shall be determined by the Register.

1.2.16 Local details.

1.2.16.1 For the purpose of transferring ice-induced loads to supporting structure (bending moments and

Table 1.2.13.5.1

Longitudinal strength criteria

Failure mode	Applied stress	Permissible stress when $\sigma_y/\sigma_u \leqslant 0{,}7$	Permissible stress when $\sigma_y/\sigma_u > 0{,}7$
Tension	σ_a	$\eta\sigma_y$	$\eta 0{,}41(\sigma_u + \sigma_y)$
Shear	τ_a	$\eta\sigma_y/3^{0,5}$	$\eta 0{,}41(\sigma_u + \sigma_y)/3^{0,5}$
Buckling	σ_a	σ_c for plating and for web plating of stiffeners $\sigma_c/1{,}1$ for stiffeners	
	τ_a	τ_c	

where σ_a = applied vertical bending stress, in N/mm^2;
τ_a = applied vertical shear stress, in N/mm^2;
σ_y = minimum upper yield stress of the material, in N/mm^2;
σ_a = ultimate tensile strength of material, in N/mm^2;
σ_c = critical buckling stress in compression, according to 1.6.5.3, Part II "Hull", in N/mm^2;
τ_c = critical buckling stress in shear, according to 1.6.5.3, Part II "Hull", in N/mm^2;
η = 0,8.

shear forces), local design details shall comply with the Register requirements.

1.2.16.2 The loads carried by a member in way of cut-outs shall not cause instability. Where necessary, the structure shall be stiffened.

1.2.17 Direct calculations.

1.2.17.1 Direct calculations shall not be utilised as an alternative to the analytical procedures prescribed in the present Chapter.

1.2.17.2 Where direct calculation is used to check the strength of structural systems, the load patch specified in **1.2.3** shall be applied.

1.2.18 Welding.

1.2.18.1 All welding within ice-strengthened areas shall be of the double continuous type.

1.2.18.2 Continuity of strength shall be ensured at all structural connections.

1.3 MACHINERY REQUIREMENTS FOR POLAR CLASS SHIPS

1.3.1 Application.

The requirements of this Chapter apply to main propulsion, steering gear, emergency and essential auxiliary systems essential for the safety of the ship and the survivability of the crew.

1.3.2 General.

1.3.2.1 Drawings and particulars to be submitted:

.1 details of the environmental conditions and the required ice class for the machinery, if different from ship's ice class;

.2 detailed drawings of the main propulsion machinery. Description of the main propulsion, steering, emergency and essential auxiliaries shall include operational limitations. Information on essential main propulsion load control functions;

.3 description detailing how main, emergency and auxiliary systems are located and protected to prevent problems from freezing, ice and snow and evidence of their capability to operate in intended environmental conditions;

.4 calculations and documentation indicating compliance with the requirements of this Chapter.

1.3.2.2 System design.

1.3.2.2.1 Machinery and supporting auxiliary systems shall be designed, constructed and maintained to comply with the requirements of periodically unmanned machinery spaces with respect to fire safety. Any automation plant (i.e. control, alarm, safety and indication systems) for essential systems installed shall be maintained to the same standard.

1.3.2.2.2 Systems, subject to damage by freezing, shall be drainable.

1.3.2.2.3 Single screw vessels classed **PC1** to **PC5** inclusive shall have means provided to ensure sufficient ship operation in the case of propeller damage including CP-mechanism.

1.3.3 Materials.

1.3.3.1 Materials exposed to sea water.

Materials exposed to sea water, such as propeller blades, propeller hub and blade bolts shall have an elongation not less than **15** per cent on a test piece the length of which is five times the diameter.

Charpy V-notch impact test (determination of impact energy *KV* for sharply-notched specimen) shall be carried out for other than bronze and austenitic steel materials. Test pieces taken from the propeller castings shall be representative of the thickest section of the blade. An average impact energy *KV* value of **20** J taken from three Charpy V-notch tests shall be obtained at minus **10** °C.

1.3.3.2 Materials exposed to sea water temperature.

Materials exposed to sea water temperature shall be of steel or other approved ductile material. An average impact energy *KV* value of **20** J taken from three tests shall be obtained at minus **10** °C.

1.3.3.3 Material exposed to low air temperature.

Materials of essential components exposed to low air temperature shall be of steel or other approved ductile material.

An average impact energy *KV* value of 20 J taken from three Charpy V-notch tests shall be obtained at 10 °C below the lowest design temperature.

1.3.4 Ice interaction load.

1.3.4.1 Propeller ice interaction.

The present requirements cover open and ducted type propellers situated at the stern of a ship having controllable pitch or fixed pitch blades. Ice loads on bow propellers and pulling type propellers shall receive special consideration by the Register.

The given loads are expected, single occurrence, maximum values for the whole ships service life for normal operational conditions.

These loads do not cover off-design operational conditions, for example when a stopped propeller is dragged through ice.

The present requirements considering loads due to propeller ice interaction apply also for azimuthing (geared and podded) thrusters. However, ice loads due to ice impacts on the body of azimuthing thrusters are not covered by the present Section.

The loads given in 1.3.4 are total loads (unless otherwise stated) during ice interaction and shall be applied separately (unless otherwise stated) and are intended for component strength calculations only. The different loads given here shall be applied separately.

F_b is a force bending a propeller blade backwards when the propeller mills an ice block while rotating ahead.

F_f is a force bending a propeller blade forwards when a propeller interacts with an ice block while rotating ahead.

1.3.4.2 Ice class factors.

The Table 1.3.4.2 below lists the design ice thickness and ice strength index to be used for estimation of the propeller ice loads.

Table 1.3.4.2

Ice class	H_{ice}, in m	S_{ice}	S_{qice}
PC1	4,0	1,2	1,15
PC2	3,5	1,1	1,15
PC3	3,0	1,1	1,15
PC4	2,5	1,1	1,15
PC5	2,0	1,1	1,15
PC6	1,75	1	1
PC7	1,5	1	1

where H_{ice} = ice thickness for machinery strength design;
S_{ice} = ice strength index for blade ice force;
S_{qice} = ice strength index for blade ice torque.

1.3.4.3 Design ice loads for open propeller.

1.3.4.3.1 Maximum backward blade force F_b, in kN:

when $D < D_{limit}$:

$$F_b = -27S_{ice}[nD]^{0,7}[EAR/Z]^{0,3}\,[D]^2; \qquad (1.3.4.3.1\text{-}1)$$

when $D \geqslant D_{limit}$:

$$F_b = -23S_{ice}[nD]^{0,7}[EAR/Z]^{0,3}(H_{ice})^{1,4}[D]^2 \qquad (1.3.4.3.1\text{-}2)$$

where $D_{limit} = 0{,}85(H_{ice})^{1,4}$;

n = nominal rotational speed (at MCR free running condition) for CP-propeller and 85 per cent of the nominal rotational speed (at MCR free running condition) for a FP-propeller (regardless driving engine type).

F_b shall be applied as a uniform pressure distribution to an area on the back (suction) side of the blade for the following load cases:

.1 load case 1: from 0,6*R* to the tip and from the blade leading edge to a value of 0,2 chord length;

.2 load case 2: a load equal to 50 per cent of the F_b shall be applied on the propeller tip area outside of 0,9*R*;

.3 load case 5: for reversible propellers a load equal to 60 per cent of the F_b shall be applied from 0,6*R* to the tip and from the blade trailing edge to a value of 0,2 chord length.

Refer to load cases 1, 2 and 5 in Table 1 of the Appendix.

1.3.4.3.2 Maximum forward blade force F_f, in kN:

when $D < D_{limit}$:

$$F_f = 250[EAR/Z][D]^2; \qquad (1.3.4.3.2\text{-}1)$$

when $D \geqslant D_{limit}$:

$$F_f = 500\frac{1}{(1-\frac{d}{D})}H_{ice}[EAR/Z][D]^2 \qquad (1.3.4.3.2\text{-}2)$$

where

$$D_{limit} = \frac{2}{(1-\frac{d}{D})}H_{ice}; \qquad (1.3.4.3.2\text{-}3)$$

d = propeller hub diameter, in m;
D = propeller diameter, in m;
EAR = expanded blade area ratio;
Z = number of propeller blades.

F_f shall be applied as a uniform pressure distribution to an area on the face (pressure) side of the blade for the following loads cases:

.1 load case 3: from 0,6*R* to the tip and from the blade leading edge to a value of 0,2 chord length;

.2 load case 4: a load equal to 50 per cent of the F_f shall be applied on the propeller tip area outside of 0,9*R*;

.3 load case 5: for reversible propellers a load equal to 60 per cent F_f shall be applied from 0,6*R* to the tip and from the blade trailing edge to a value of 0,2 chord length.

Load cases 3, 4 and 5 — refer to Table 1 of the Appendix.

1.3.4.3.3 Maximum blade spindle torque Q_{Smax}.

Spindle torque Q_{Smax}, in kNm, around the spindle axis of the blade fitting shall be calculated both for the load cases described in 1.3.4.3.1 and 1.3.4.3.2 for F_b and F_f. If these spindle torque values are less than the default value given below, the default minimum value shall be used. Default value:

$$Q_{Smax} = 0{,}25Fc_{0,7} \qquad (1.3.4.3.3)$$

where $c_{0,7}$ = length of the blade chord at 0,7*R* radius, in m;
F is either F_b or F_f which ever has the greater absolute value.

1.3.4.3.4 Maximum propeller ice torque applied to the propeller Q_{max}, in kNm:

when $D < D_{limit}$:

$$Q_{max} = 105(1 - d/D)S_{qice}(P_{0,7}/D)^{0,16}(t_{0,7}/D)^{0,6}(nD)^{0,17}D^3; \quad (1.3.4.3.4\text{-}1)$$

when $D \geqslant D_{limit}$:

$$Q_{max} = 202(1 - d/D)S_{qice}H_{ice}^{1,1}(P_{0,7}/D)^{0,16}(t_{0,7}/D)^{0,6}(nD)^{0,17}D^{1,9} \quad (1.3.4.3.4\text{-}2)$$

where $D_{limit} = 1,8H_{ice}$;
S_{qice} = ice strength index for blade ice torque;
$P_{0,7}$ = propeller pitch at $0,7R$, in m;
$t_{0,7}$ = max thickness at $0,7R$, in m;
n is the rotational propeller speed, in rps, at bollard condition. If not known, n shall be taken according to Table 1.3.4.3.4.

Table 1.3.4.3.4

Propeller type	n
CP propellers	n_n
FP propellers driven by turbine or electric motor	n_n
FP propellers driven by diesel engine	$0,85n_n$
where n_n = nominal rotational speed at MCR, free running condition.	

For CP propellers, propeller pitch $P_{0,7}$ shall correspond to MCR in bollard condition. If not known, $P_{0,7}$ shall be taken as $0,7P_{0,7n}$, where $P_{0,7n}$ is propeller pitch at MCR free running condition.

1.3.4.3.5 Maximum propeller ice thrust (applied to the shaft at the location of the propeller).

Maximum forward propeller ice thrust:

$$T_f = 1,1F_f; \quad (1.3.4.3.5\text{-}1)$$

Maximum backward propeller ice thrust:

$$T_b = 1,1F_b. \quad (1.3.4.3.5\text{-}2)$$

1.3.4.4 Design ice loads for ducted propeller.

1.3.4.4.1 Maximum backward blade force F_b:

where $D < D_{limit}$:

$$F_b = -9,5S_{ice}(EAR/Z)^{0,3}(nD)^{0,7}D^2; \quad (1.3.4.4.1\text{-}1)$$

where $D \geqslant D_{limit}$:

$$F_b = -66S_{ice}(EAR/Z)^{0,3}(nD)^{0,7}(H_{ice})^{1,4}D^{0,6} \quad (1.3.4.4.1\text{-}2)$$

where $D_{limit} = 4H_{ice}$;
n shall be taken as in 1.3.4.3.1.

F_b shall be applied as a uniform pressure distribution to an area on the back side for the following load cases (refer to Table 2 of the Appendix):

.1 load case 1: on the back of the blade from $0,6R$ to the tip and from the blade leading edge to a value of 0,2 chord length;

.2 load case 5: for reversible rotation propellers a load equal to 60 per cent of F_b is applied on the blade face from $0,6R$ to the tip and from the blade trailing edge to a value of 0,2 chord length.

1.3.4.4.2 Maximum forward blade force F_f, in kN:

when $D < D_{limit}$:

$$F_f = 250(EAR/Z)D^2; \quad (1.3.4.4.2\text{-}1)$$

when $D \geqslant D_{limit}$:

$$F_f = 500\frac{1}{(1 - \frac{d}{D})}H_{ice}[EAR/Z][D]^2 \quad (1.3.4.4.2\text{-}2)$$

where $D_{limit} = \frac{2}{(1 - \frac{d}{D})}H_{ice}$, in m. (1.3.4.4.2-3)

F_f shall be applied as a uniform pressure distribution to an area on the face (pressure) side for the following load case (refer to Table 2 of the Appendix):

.1 load case 3: on the blade face from $0,6R$ to the tip and from the blade leading edge to a value of 0,5 chord length;

.2 load case 5: a load equal to 60 per cent F_f shall be applied from $0,6R$ to the tip and from the blade leading edge to a value of 0,2 chord length.

1.3.4.4.3 Maximum propeller ice torque applied to the propeller Q_{max}, in kNm, is the maximum torque on a propeller due to ice-propeller interaction:

when $D \leqslant D_{limit}$:

$$Q_{max} = 74(1 - d/D)S_{qice}(P_{0,7}/D)^{0,16}(t_{0,7}/D)^{0,6}(nD)^{0,17}D^3; \quad (1.3.4.4.3\text{-}1)$$

when $D \geqslant D_{limit}$:

$$Q_{max} = 141(1 - d/D)S_{qice}H_{ice}^{1,1}(P_{0,7}/D)^{0,16}(t_{0,7}/D)^{0,6}(nD)^{0,17}D^{1,9} \quad (1.3.4.4.3\text{-}2)$$

where $D_{limit} = 1,8H_{ice}$, in m;
n = rotational propeller speed, in rps, at bollard condition.

If not known, n shall be taken according to Table 1.3.4.4.3.

Таблица 1.3.4.4.3

Propeller type	n
CP propellers	n_n
FP propellers driven by turbine or electric motor	n_n
FP propellers driven by diesel engine	$0,85n_n$
where n_n = nominal rotational speed at MCR, free running condition.	

For CP propellers, propeller pitch $P_{0,7}$ shall correspond to MCR in bollard condition. If not known, $P_{0,7}$ shall be taken as $0,7P_{0,7n}$, where $P_{0,7n}$ is propeller pitch at MCR free running condition.

1.3.4.4.4 Maximum blade spindle torque for CP-mechanism design Q_{smax}.

Spindle torque Q_{smax}, in kNm, around the spindle axis of the blade fitting shall be calculated for the load case described in 1.3.4.1. If these spindle torque values are less than the default value given below, the default value shall be used.

Default value:

$$Q_{smax} = 0{,}25Fc_{0,7} \quad (1.3.4.4.4)$$

where $c_{0,7}$ = length of the blade section at $0{,}7R$ radius;
F = either F_b or F_f whichever has the greater absolute value.

1.3.4.4.5 Maximum propeller ice thrust (applied to the shaft at the location of the propeller).

Maximum forward propeller ice thrust:

$$T_f = 1{,}1F_f. \quad (1.3.4.4.5\text{-}1)$$

Maximum backward propeller ice thrust:

$$T_b = 1{,}1F_b. \quad (1.3.4.4.5\text{-}2)$$

1.3.4.5 Reserved.

1.3.4.6 Design loads on propulsion line.

1.3.4.6.1 Torque.

The propeller ice torque excitation for shaft line dynamic analysis shall be described by a sequence of blade impacts which are of half sine shape and occur at the blade. The torque due to a single blade ice impact as a function of the propeller rotation angle is then:

$$Q(\varphi) = C_qQ_{max}\sin(\varphi(180/\alpha_i)) \text{ when } \varphi = 0...\alpha_i;$$

$$Q(\varphi) = 0 \text{ when } \varphi = \alpha_i...360. \quad (1.3.4.6.1\text{-}1)$$

C_q and α_i parameters are given in Table 1.3.4.6.1.

Table 1.3.4.6.1

Torque excitation	Propeller-ice interaction	C_q	α_i
Case 1	Single ice block	0,5	45
Case 2	Single ice block	0,75	90
Case 3	Single ice block	1,0	135
Case 4	Two ice blocks with 45 degree phase in rotation angle	0,5	45

The total ice torque is obtained by summing the torque of single blades taking into account the phase shift 360 deg/Z. The number of propeller revolutions during a milling sequence shall be determined by the formula

$$N_Q = 2H_{ice}. \quad (1.3.4.6.1\text{-}2)$$

The number of impacts is ZN_Q (refer to Fig. 1 in the Appendix).

Milling torque sequence duration is not valid for pulling bow propellers, which are subject to special consideration by the Register in each particular case.

The response torque at any shaft component shall be analysed considering excitation torque $Q(\varphi)$ at the propeller, actual engine torque Q_e and mass elastic system.

Q_e = actual maximum engine torque at considered speed.

Design torque along propeller shaft line.

The design torque Q_r of the shaft component shall be determined by means of torsional vibration analysis of the propulsion line. Calculations shall be carried out for all excitation cases given above and the response shall be applied on top of the mean hydrodynamic torque in bollard condition at considered propeller rotational speed.

1.3.4.6.2 Maximum response thrust (maximum thrust along the propeller shaft line).

Maximum thrust along the propeller shaft line shall be calculated with the formulae below. The factors 2,2 and 1,5 take into account the dynamic magnification due to axial vibration. Alternatively the propeller thrust magnification factor may be calculated by dynamic analysis.

Maximum shaft thrust forwards, in kN:

$$T_r = T_n + 2{,}2T_f. \quad (1.3.4.6.2\text{-}1)$$

Maximum shaft thrust backwards, in kN:

$$T_r = 1{,}5T_b \quad (1.3.4.6.2\text{-}2)$$

where T_n = propeller bollard thrust, in kN;
T_f = maximum forward propeller ice thrust, in kN;
T_b = maximum backward propeller ice thrust, in kN.

If hydrodynamic bollard thrust T_n is not known, T_n shall be taken according to Table 1.3.4.6.2.

Table 1.3.4.6.2

Propeller type	T_u
CP propellers (open)	$1{,}25T$
CP propellers (ducted)	$1{,}1T$
FP propellers driven by turbine or electric motor	T
FP propellers driven by diesel engine (open)	$0{,}85T$
FP propellers driven by diesel engine (ducted)	$0{,}75T$
where T = nominal propeller thrust at MCR at free running open water conditions.	

1.3.4.6.3 Blade failure load for both open and nozzle propeller.

The force is acting at $0{,}8R$ in the weakest direction of the blade and at a spindle arm of 2/3 of the distance of axis of blade rotation of leading and trailing edge which ever is the greatest.

The blade failure load F_{ex}, in kN, is determined by the formula

$$F_{ex} = \frac{0{,}3ct^2\sigma_{ref}}{0{,}8D - 2r} \cdot 10^3 \quad (1.3.4.6.3)$$

where $\sigma_{ref} = 0{,}6\sigma_{0,2} + 0{,}4\sigma_u$;
σ_u and $\sigma_{0,2}$ are representative values for the blade material;
c, t and r are respectively the actual chord length, thickness and radius of the cylindrical root section of the blade at the weakest section outside root fillet, and typically will be at the termination of the fillet into the blade profile.

1.3.5 Design.

1.3.5.1 Design principle.

The strength of the propulsion line shall be designed:

for maximum loads in 1.3.4;

such that the plastic bending of a propeller blade shall not cause damages in other propulsion line components;

with sufficient fatigue strength.

1.3.5.2 Azimuthing main propulsors.

In addition to the above requirements special consideration shall be given to the loading cases which are extraordinary for propulsion units when compared with conventional propellers. Estimation of the loading cases shall reflect the operational realities of the ship and the thrusters. In this respect, for example, the loads caused by impacts of ice blocks on the propeller hub of a pulling propeller shall be considered. Also loads due to thrusters operating in an oblique angle to the flow shall be considered. The steering mechanism, the fitting of the unit and the body of the thruster shall be designed to withstand the loss of a blade without damage. The plastic bending of a blade shall be considered in the propeller blade position, which causes the maximum load on the studied component.

Azimuth thrusters shall also be designed for estimated loads due to thruster body/ice interaction as per **1.2.15**.

1.3.5.3 Blade design.

1.3.5.3.1 Maximum blade stresses.

Blade stresses shall be calculated using the backward and forward loads given in section **1.3.4.3** and **1.3.4.4**. The stresses shall be calculated with recognised and well-documented FE-analysis or other acceptable alternative method.

The stresses on the blade shall not exceed the allowable stresses σall for the blade material given below.

Calculated blade stress for maximum ice load shall comply with the following:

$$\sigma_{calc} < \sigma_{all} = \sigma_{ref}/S \qquad \textbf{(1.3.5.3.1-1)}$$

where S = 1,5;
σ_{ref} = reference stress, defined as:
σ_{ref} = 0,7σ_u; or (1.3.5.3.1-2)
σ_{ref} = 0,6$\sigma_{0,2}$ + 0,4σ_u , whichever is less, (1.3.5.3.1-3)
where σ_u and $\sigma_{0,2}$ = representative values for the blade material.

1.3.5.3.2 Blade edge thickness.

The blade edge thicknesses t_{edge} and t_{ip} thickness ttip shall be greater than t_{edge} determined by the formula the following formula

$$t_{edge} \geqslant x S S_{ice} \sqrt{3 p_{ice}/\sigma_{ref}} \qquad \textbf{(1.3.5.3.2)}$$

where x = distance from the blade edge measured along the cylindrical sections from the edge and shall be 2,5 per cent of chord length, however not to be taken greater than 45 mm. In the tip area (above 0,975R) x shall be taken as 2,5 per cent of 0,975R section length and shall be measured perpendicularly to the edge, however not to be taken greater than 45 mm;
S = safety factor;
S = 2,5 for trailing edges;
S = 3,5 for leading edges;
S = 5 for tip;
S_{ice} = according to 1.3.4.2;
p_{ice} = ice pressure;
p_{ice} = 16 MPa for leading edge and tip thickness;
σ_{ref} = according to 1.3.5.3.1.

The requirement for edge thickness shall be applied for leading edge and in case of reversible rotation open propellers also for trailing edge. Tip thickness refers to the maximum measured thickness in the tip area above 0,975R. The edge thickness in the area between position of maximum tip thickness and edge thickness at 0,975R shall be interpolated between edge and tip thickness value and smoothly distributed.

1.3.5.3.3 to **1.3.5.4.2** Reserved.

1.3.5.5 Reserved.

1.3.5.6 Prime movers.

1.3.5.6.1 The main engine shall be capable of being started and running the propeller with the CP in full pitch.

1.3.5.6.2 Provisions shall be made for heating arrangements to ensure ready starting of the cold emergency power units at an ambient temperature applicable to the polar class of the ship.

1.3.5.6.3 Emergency power units shall be equipped with starting devices with a stored energy capability of at least three consecutive starts at the design temperature in **1.3.5.6.2** above. The source of stored energy shall be protected to preclude critical depletion by the automatic starting system, unless a second independent means of starting is provided. A second source of energy shall be provided for an additional three starts within **30** min, unless manual starting can be demonstrated to be effective.

1.3.6 Machinery fastening loading accelerations.

1.3.6.1 Essential equipment and main propulsion machinery supports shall be suitable for the accelerations as indicated in as follows. Accelerations shall be considered acting independently.

1.3.6.2 Longitudinal impact accelerations a_l.

Maximum longitudinal impact acceleration at any point along the hull girder, in m/s^2, is determined by the formula

$$a_l = (F_{IB}/\mathrm{A})\{[1{,}1\tan(\gamma+\varphi)]+[7H/L]\} \qquad \textbf{(1.3.6.2)}$$

where φ = maximum friction angle between steel and ice, normally taken as 10 deg.;
γ = bow stem angle at waterline, in deg.;
A = displacement;
L = length between perpendiculars, in m;
H = distance from the waterline to the point being considered, in m;
F_{IB} = vertical impact force, defined in 1.2.13.2.1;
F_i = total force normal to shell plating in the bow area due to oblique ice impact, defined in 1.2.3.2.1.

1.3.6.3 Vertical acceleration a_v.

Combined vertical impact acceleration at any point along the hull girder, in m/s^2, is determined by the formula

$$a_v = 2{,}5(F_{IB}/\mathrm{A})F_x \qquad \textbf{(1.3.6.3)}$$

where F_x = 1,3 at FP;
F_x = 0,2 at midships;
F_x = 0,4 at AP;
F_x = 1,3 at AP for ships conducting ice breaking astern.

Intermediate values to be interpolated linearly.

1.3.6.4 Transverse impact acceleration a_t.

Combined transverse impact acceleration at any point along hull girder, in m/s^2, is determined by the formula

$$a_t = 3F_t\, F_x/\Delta \qquad \textbf{(1.3.6.4)}$$

where F_x = 1,5 at FP;
F_x = 0,25 at midships;
F_x = 0,5 at AP;
F_x = 1,5 at AP for ships conducting ice breaking astern.

Intermediate values to be interpolated linearly.

1.3.7 Auxiliary systems.

1.3.7.1 Machinery shall be protected from the harmful effects of ingestion or accumulation of ice or snow. Where continuous operation is necessary, means shall be provided to purge the system of accumulated ice or snow.

1.3.7.2 Means shall be provided to prevent damage due to freezing, to tanks containing liquids.

1.3.7.3 Vent pipes, intake and discharge pipes and associated systems shall be designed to prevent blockage due to freezing or ice and snow accumulation.

1.3.8 Sea inlets and cooling water systems.

1.3.8.1 Cooling water systems for machinery that are essential for the propulsion and safety of the vessel, including sea chests inlets, shall be designed for the environmental conditions applicable to the ice class.

1.3.8.2 At least two sea chests shall be arranged as ice boxes for class **PC1** to **PC5** ships. The calculated volume for each of the ice boxes shall be at least **1** m^3 for every **750** kW of the total installed power. For **PC6** and **PC7** there shall be at least one icebox located preferably near centre line.

1.3.8.3 Ice boxes shall be designed for an effective separation of ice and venting of air.

1.3.8.4 Sea inlet valves shall be secured directly to the ice boxes. The valve shall be a full bore type.

1.3.8.5 Ice boxes and sea chests shall have vent pipes and shall have shut off valves connected direct to the shell.

1.3.8.6 Means shall be provided to prevent freezing of sea chests, ice boxes, ship side valves and fittings above the load waterline.

1.3.8.7 Efficient means shall be provided to re-circulate cooling seawater to the ice box. Total sectional area of the circulating pipes shall not be less than the area of the cooling water discharge pipe.

1.3.8.8 Detachable gratings or manholes shall be provided for ice boxes. Manholes shall be located above the deepest load line. Access shall be provided to the ice box from above.

1.3.8.9 Openings in ship sides for ice boxes shall be fitted with gratings, or holes or slots in shell plates. The net area through these openings shall be not less than 5 times the area of the inlet pipe. The diameter of holes and width of slot in shell plating shall be not less than **20** mm. Gratings of the ice boxes shall be provided with a means of clearing. Clearing pipes shall be provided with screw-down type non return valves.

1.3.9 Ballast tanks.

1.3.9.1 Efficient means shall be provided to prevent freezing in fore and after peak tanks and wing tanks located above the water line and where otherwise found necessary.

1.3.10 Ventilation system.

1.3.10.1 The air intakes for machinery and accommodation ventilation shall be located on both sides of the ship.

1.3.10.2 Accommodation and ventilation air intakes shall be provided with means of heating.

1.3.10.3 The temperature of inlet air provided to machinery from the air intakes shall be suitable for the safe operation of the machinery.

1.3.11 Reserved.

1.3.12 Alternative design.

1.3.12.1 As an alternative — a comprehensive design study may be submitted and may be requested to be validated by an agreed test programme.

APPENDIX

Table 1

Load cases for open propeller

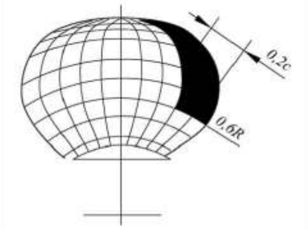
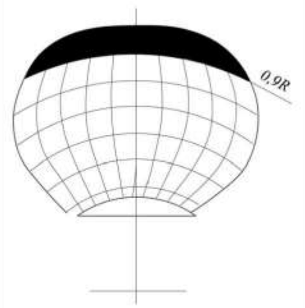
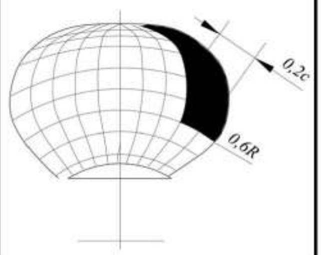
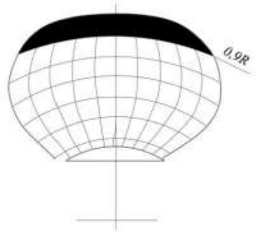
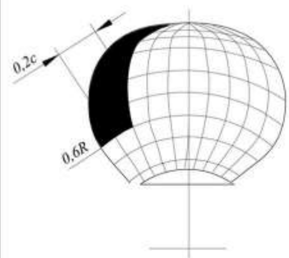
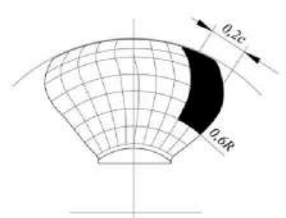
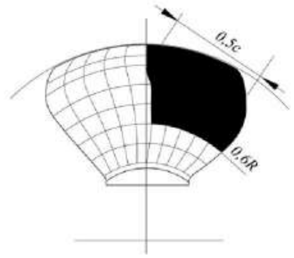
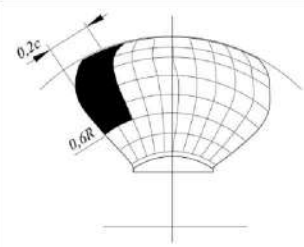
	Force	Loaded area	Right handed propeller blade seen from back
Load case 1	F_b	Uniform pressure applied on the back of the blade (suction side) to an area from 0,6*R* to the tip and from the leading edge to 0,2 times the chord length	
Load case 2	50 per cent of F_b	Uniform pressure applied on the back of the blade (suction side) on the propeller tip area outside of 0,9*R*	
Load case 3	F_f	Uniform pressure applied on the blade face (pressure side) to an area from 0,6*R* to the tip and fromthe leading edge to 0,2 times the chord length	
Load case 4	50 per cent of F_f	Uniform pressure applied on propeller face (pressure side) on the propeller tip area outside of 0,9*R*	
Load case 5	60 per cent of F_f or F_b which one is greater	Uniform pressure applied on propeller face (pressure side) to an area from 0,6*R* to the tip and from the trailing edge to 0,2 times the chord length	

Table 2

Load cases for ducted propeller

	Force	Loaded area	Right handed propeller blade seen from back
Load case 1	F_b	Uniform pressure applied on the back of the blade (suction side) to an area from 0,6R to the tip and from the leading edge to 0,2 times the chord length	
Load case 3	F_f	Uniform pressure applied on the blade face (pressure side) to an area from 0,6R to the tip and from the leading edge to 0,5 times the chord length	
Load case 5	60 per cent of F_f or F_b which one is greater	Uniform pressure applied on propeller face (pressure side) to an area from 0,6R to the tip and from the trailing edge to 0,2 times the chord length	

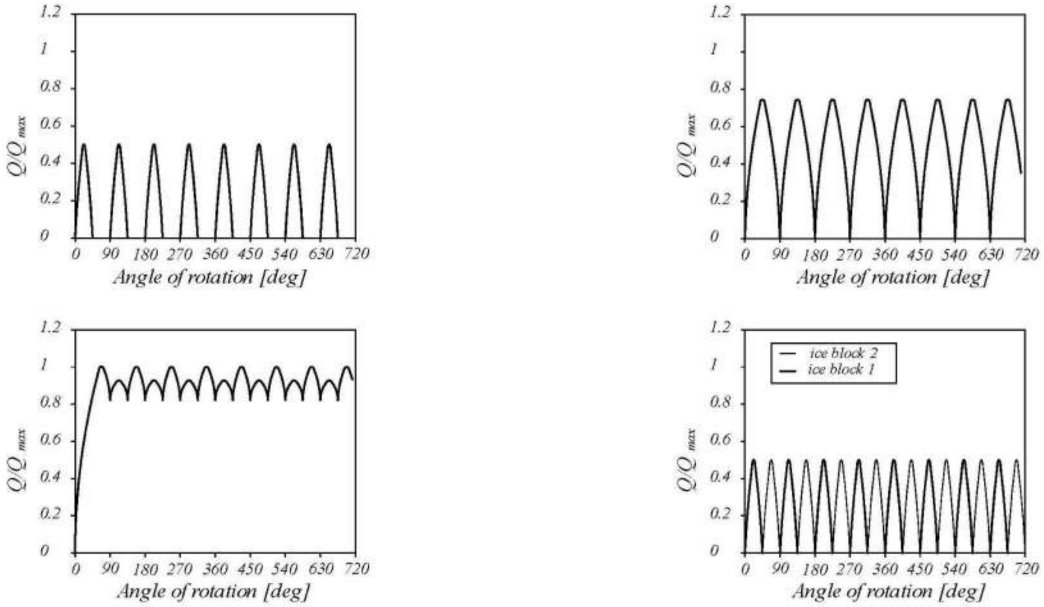


Fig. 1
The shape of the propeller ice torque excitation for 45, 90, 135 degrees single blade impact sequences and 45 degrees double blade impact sequence (two ice pieces) on a four bladed propeller

2 TECHNICAL REQUIREMENTS FOR ESCORT TUGS

2.1 GENERAL

2.1.1 Scope of application.

2.1.1.1 The technical requirements for escort tugs apply to tugs intended for escort service. These requirements are additional to the requirementsof Parts I to XV of the Rules.

2.1.1.2 Tugs complying with the requirements of the present Section may be assigned the descriptive notation **Escort tug** added to the character of classification.

2.1.2 Definitions and explanations.

Fox the purpose of the present Section the following definitions and explanations have been adopted.

Manoeuvring time means a minimum manoeuvring time, in s, from maintained oblique position of the tug (from the centerline of the assisted ship) giving the maximum transverse steering force on one side of the assisted ship to mirror position on the other side.

Maximum steering pull of the tug means the maximum transverse steering force, in t, exerted by the tug on the stern of the assisted ship at the escort test speed of 8 and/or 10 knots.

Escort test speed means the speed, in knots, of the assisted ship during full scale trials.

Assisted ship means the ship being escorted by the escort tug.

Full scale trials mean sea trials of the escort tug to determine escort characteristics.

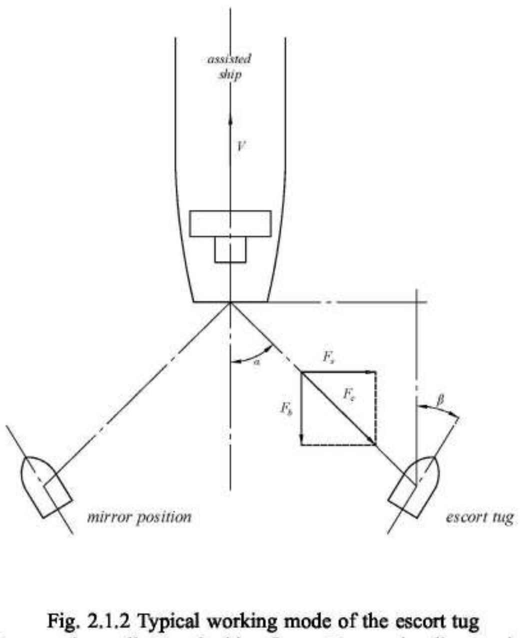


Fig. 2.1.2 Typical working mode of the escort tug
F_s = steering pull; F_b = braking force; F_t = towing line tension;
α = towing line angle; β = oblique angle;
V = speed of the assisted ship

Escort service means steering, braking and otherwise controlling the assisted ship.

Escort characteristics:

maximum steering pull of the tug F_s, in t, at the escort test speed V, in knots, (refer to Fig. 2.1.2);

manoeuvring time t, in s.

Escort tug means a tug which in addition to towing and ship handling operations is intended for escort services.

2.1.3 Technical documentation.

2.1.3.1 Technical documentation to be submitted to the Register for approval shall include the following:

.1 towing arrangement plan required for escort service including towing line path and minimum breaking strength of towing line components and strength of appropriate structures;

.2 preliminary calculation of maximum steering pull of the tug at the escort test speed of 8 and/or 10 knots including propulsion components of the escort tug for balancing of oblique angular position of the tug;

.3 preliminary tug stability calculations for escorting service;

.4 plan of full scale trials.

2.2 TECHNICAL REQUIREMENTS

2.2.1 Arrangement and design.

2.2.1.1 A bulwark shall be fitted all around the exposed weather deck.

2.2.1.2 The towing winch intended for escort service shall be fitted with a load reducing system in order to prevent overload caused by dynamic oscillation in the towing line, and shall be capable of paying out the towing line if the pull exceeds 50 per cent of the breaking strength of the towing line.

2.2.1.3 The towing line components shall have a minimum breaking strength of at least 2,2 times the maximum towing pull as measured during the full scale trials (refer to 2.3).

2.2.1.4 In case of escort service of oil tankers and/or oil recovery vessels, supply vessels, ships intended for the carriage of explosives and inflammable cargoes, the requirements of 11.1.3, Part VIII "Systems and Piping" shall be complied with.

2.2.2 Stability.

2.2.2.1 In addition to the requirements for tugs set forth in 3.7, Part IV "Stability", stability of the escort tug shall comply with the criteria specified in 2.2.2.1.1 to 2.2.2.1.5.

2.2.2.1.1 The ratio between the righting and heeling areas between equilibrium and 20° angle of heel obtained when the maximum steering pull F_s is applied from the tug (refer to Fig. 2.1.2) shall be not less than 1,25.

2.2.2.1.2 The ratio between the righting area and the heeling area due to the maximum steering pull between 0° heel and the angle of flooding or 40° angle of heel, whichever is less, shall be not less than 1,4.

2.2.2.1.3 The angle of heel of the escort tug under the effect of maximum working heeling moment, due to the towing line jerk under rolling shall not exceed the angle corresponding to the maximum of the righting lever curve θ_{max} or the angle of flooding θ_f, whichever is less.

The following requirement shall be complied with (refer to Fig. 2.2.2.1.3):

$$K_3 = \sqrt{\frac{b+c}{a+c}} \geqslant 1{,}0 \qquad (2.2.2.1.3\text{-}1)$$

where a = the area formed by the righting lever curve, the straight line corresponding to the lever $l + l_h$, and the angle of heel $\theta_1 - \theta_{2r}$;
b = the area formed from above by the righting lever curve, from below — by the straight line corresponding to the lever $l + l_h$, and from the right — by the angle corresponding to the maximum of the righting lever curve θ_{max} or the angle of flooding θ_f, whichever is less;
c = the area formed from the left by the righting lever curve, from above — by the straight line corresponding to the lever $l + l_h$, from the right — by the angle corresponding to the maximum of the righting lever curve θ_{max} or the angle of flooding θ_f whichever is less.

When determining the angle of flooding θ_f, the definition of the angle of flooding given in 1.2, Part IV "Stability" shall be considered.

The heeling lever l_h characterizing the effect of towing line jerk, in m, is determined by the formula

$$l_h = 0{,}2\left(1 + 2\frac{d}{B}\right) \frac{b^2}{(1+c^2)(1+c^2+b^2)} \frac{57{,}3}{(\theta_{2r} - \theta_1 + \theta_{\lim})} \qquad (2.2.2.1.3\text{-}2)$$

where d, B = the draft and breadth of the tug respectively;
c, b are calculated in accordance with 3.7.2.2, Part IV "Stability";
$\theta_{\lim} = \theta_{max}$ or θ_f, whichever is less.

2.2.2.1.4 The angle of dynamic heel of the tug which may occur during escort service in case of sudden failure of the main propulsion plant shall not exceed the angle corresponding to the maximum of the righting lever curve θ_{max} or the angle of flooding θ_f, whichever is less.

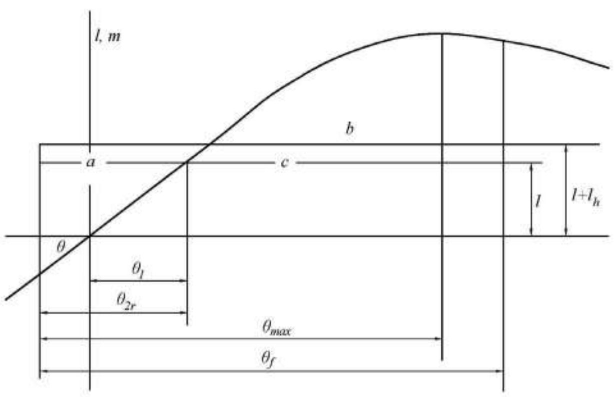


Fig. 2.2.2.1.3

2.2.2.1.5 At the design stage, the value of the maximum steering pull and the angle of heel under its effect may be determined based on the model tests results or by means of calculations. On completion of the ship's construction, the values of the maximum steering pull and the maximum possible angle of heel of the tug shall be ascertained based on the results of full scale trials or numerical simulation carried out in accordance with the procedure approved by the Register.

2.3 FULL SCALE TRIALS

2.3.1 Plan of full scale trials.

2.3.1.1 Prior to the full scale trials the plan of the trials, the approved Information on Stability, as well as preliminary calculations of the ship's escort characteristics and the tug's stability during escort service shall be submitted to surveyor to the Register.

2.3.1.2 The plan of full scale trials shall stipulate determination of the tug's maximum transverse steering force at the speed of the assisted ship of 8 and/or 10 knots, the maximum angle of static heel at the specified modes, as well as the tug's manoeuvring time (refer to Fig. 2.1.2).

2.3.1.3 The plan shall include a list of measuring instruments, description of mandatory manoeuvres, a towing arrangement scheme for expected escort modes, design loads of strong points of the tug, as well as data of the safe working load of the strong points of the assisted ship.

2.3.2 Procedure of trials.

2.3.2.1 Full scale trials shall be carried out on:

.1 the first ship out of the series of ships, then every fifth ship of the series (i.e. sixth, eleventh, etc.) provided their propulsion plant is identical;

.2 every ship of non-series construction.

2.3.2.2 The trials shall be carried out in favourable weather (recommended limitation of wind force is 10 m/s, sea state 2), with the operating load of the tug equal to 50 — 10 per cent of provisions. Current velocity in the area of the trials (if any) shall be measured both upstream and down stream.

2.3.2.3 Displacement or powed of the assisted ship shall be sufficient to maintain the heading and speed with the help of the autopilot during the necessary tug manoeuvring.

2.3.2.4 The following data shall be recorded continuously in real time mode during trials for later analysis:

.1 position of the assisted ship in relation to the escort tug;

.2 towing line tension;

.3 escort test speed;

.4 angle of the tug heel during escort service;

.5 length and angle of the towing line from the centerline of the assisted ship;

.6 manoeuvring time from maintained oblique position of the tug on one side of the assisted ship to mirror position on the other side at the maximum tension value of towing line and the maximum towing line angle from the centerline of the assisted ship (but not more than **60**°);

.7 angle of heel due to sudden loss of thrust.

2.4 REPORTING

2.4.1 Report in tabular form on the results of the tug's trials to determine the escort characteristics and including records of the parameters measured in real time mode shall be agreed with the surveyor to the Register attending the trials and be forwarded to the Register Head Office for consideration. The Report shall contain calculation of the steering pull value taking into account the time of the tug's transfer to the mirror position. The Report shall be accompanied with the escort tug's stability calculation based on results of full scale trials.

2.4.2 Results of full scale trials are documented in the Act issued by surveyor to the Register.

2.4.3 Upon satisfactory results of full scale trials and consideration of stability calculation specified in **2.4.1**, in the Classification Certificate issued for the tug the descriptive notation **Escort tug** is added to the character of classification, and in the column "Other characteristics" the following entry shall be made: "During escort service the maximum steering pull is equal to .... t, with the escort test speed 8 (or 10) knots and the minimum manoeuvring time ....s". In case the measurements were taken at two values of escort test speed (8 and 10 knots), the data of both speeds shall be recorded.

3 REQUIREMENTS FOR THE EQUIPMENT OF SHIPS IN COMPLIANCE WITH THE DISTINGUISHING MARKS ECO AND ECO-S IN THE CLASS NOTATION

3.1 GENERAL

3.1.1 Scope of application.

The requirements for the equipment of ships in compliance with the distinguishing marks **ECO** and **ECO-S** in the class notation have been developed taking into account the following international instruments as amended:

.1 Annexes I, II, IV, V, VI to MARPOL 73/78;

.2 provisions of the International Convention on the Control of Harmful Anti-Fouling Systems on Ships, 2001;

.3 provisions of the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004;

.4 Guidelines for On-Board Exhaust GAS-SO_x Cleaning System (IMO resolution MEPC.184(59));

.5 Code on Intact Stability for All Types of Ships Covered by IMO Instruments (IMO resolution A.749(18));

.6 provisions of IACS Unified Requirement L5 "Onboard computers for stability calculations" (Rev. 1, Feb. 2005);

.7 IMO Guidelines on Ship Recycling, 2004 (IMO resolution A.962(23));

.8 IMO Standards for Vapour Emission Control Systems (MSC/Circ.585);

.9 provisions of Directive 99/32/EU with amendments to Directive 2005/33/EU;

.10 provisions of the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer;

.11 Standard Specification for Shipboard Incinerators (IMO resolution MEPC.76(40));

.12 revised Guidelines and Specifications for Pollution Prevention Equipment for Machinery Space Bilges of Ships (IMO resolution MEPC.107(49));

.13 revised Guidelines and Specifications for Oil Discharge Monitoring and Control Systems for Oil Tankers (IMO resolution MEPC.108(49)).

The requirements of the present Section are applied during survey of ships for assigning the distinguishing marks **ECO** and **ECO-S** in the class notation (refer to 3.2.1).

3.1.2 Terms. Definitions.

Ballast water means water with its suspended matter taken on board a ship to control trim, list, draught, stability or stresses of the ship.

Noxious liquid substance (NLS) means any substance indicated in the Pollution Category column of Chapters 17 and 18 of the International Bulk Chemical Code (IBC Code).

Emission to air means any emission to air from ships subject to control by Annex VI to MARPOL 73/78.

Attained Energy Efficiency Design Index (Attained EEDI) means the EEDI value achieved by an individual ship in compliance with regulation 20 of chapter 4 in Annex VI to MARPOL 73/78.

Segregated ballast means the ballast water introduced into a tank which is completely separated from the cargo oil and fuel oil system and which is permanently allocated to the carriage of ballast or to the carriage of ballast or cargoes other than oil or noxious liquid substances.

Bilge water means water accumulated in the bilge of ship's machinery spaces which may be contaminated with oil.

Garbage means garbage generated during normal operation of the ship, sorted, stored and disposed of/ incinerated in accordance with the provisions of Annex V to MARPOL 73/78.

NLS tanker means a ship constructed or adapted to carry a cargo of noxious liquid substances in bulk and includes an "oil tanker" as defined in Annex I to MARPOL 73/78 when certified to carry a cargo or part cargo of noxious liquid substances.

Oil residues mean oil residues generated during normal operation of the ship and include the following:

used lubricating and hydraulic oils;

fuel oil and lubricating oil leaked from the ship's machinery and systems;

sludge from fuel oil and lubricating oil separators, from bilge separators.

Oil means petroleum in any form including crude oil, fuel oil, sludge, oil refuse and refined products (other then those petrochemicals which are subject to the provisions of Annex II to MARPOL 73/78) and, without limiting the generality of the foregoing, includes the substances listed in appendix I to Annex I to MARPOL 73/78.

New ship (for the purpose of application of the requirements for energy efficiency) means a ship:

for which the building contract is placed on or after 1 January 2013; or

in the absence of a building contract, the keel of which is laid or which is at a similar stage of construction on or after 1 July 2013; or

the delivery of which is on or after 1 July 2015.

Passenger ship means a ship that carries more than 12 passengers.

Anti-fouling systems mean coatings, paints, surface treatment and devices that are used on a ship to control or prevent attachment of unwanted organisms.

Fire-fighting systems mean shipboard fixed fire-fighting systems containing fire-fighting substances with different ozone depleting potential (ODP) and global warming potential (GWP) values.

S O$_x$ E m i s s i o n C o n t r o l A r e a s mean areas where emission of sulphur oxides is limited as defined in Annex VI to MARPOL 73/78 and Directive 99/32/EU, as amended.

D i s c h a r g e t o s e a means any discharge from ships to sea of harmful substances or effluents containing such substances including any escape, disposal, spilling, leaking, pumping, emitting or emptying.

B i l g e s e p a r a t o r means any combination of a separator, filter or coalescer, and also a single unit designed to produce an effluent with oil content not exceeding 15 ppm or 5 ppm (whatever is applicable).

B i l g e a l a r m means a device giving off a signal whenever the oil content in the effluent exceeds 15 ppm or 5 ppm (whatever is applicable).

B a l l a s t w a t e r s y s t e m means a system comprising tanks for ballast water with associated piping, pumps and ballast water treatment system, where provided.

S e w a g e s y s t e m means a system comprising the following equipment:

sewage holding tank with associated piping; or

sewage treatment plant and sewage holding tank;

discharge pipeline with pumps and standard discharge connectors.

S e w a g e means sewage generated during normal operation of the ship and includes drainage as defined in Annex IV to MARPOL 73/78.

R e q u i r e d E n e r g y E f f i c i e n c y D e s i g n I n d e x (R e q u i r e d E E D I) means the maximum value of Attained EEDI that is allowed by regulation **21** of chapter 4 in Annex VI to MARPOL 73/78 for the specific ship type and size.

C h e m i c a l t a n k e r means a ship constructed or adapted for the carriage in bulk of any liquid product listed in Chapter 17 of the IBC Code.

S a n i t a r y a n d d o m e s t i c w a s t e w a t e r s mean drainage from wash basins, showers, laundries, wash tubes and scuppers, drainage from sinks and equipment of galleys and spaces annexed to galleys.

R e f r i g e r a t i o n s y s t e m s means shipboard systems (cargo refrigeration plants, air conditioning and refrigeration systems) containing refrigerants with different ozone depleting potential (ODP) and global warming potential (GWP) values.

3.2 CLASSIFICATION

3.2.1 Application.

The requirements of the present Section apply to the equipment and systems for prevention of pollution from emissions to air and discharges to sea and are aimed at prevention of environmental pollution in case of emergency.

Ships complying with the requirements of the present Section may be assigned the following distinguishing marks in the class notation:

ECO — the distinguishing mark in the class notation, which identifies compliance with the basic requirements for controlling and limiting operational emissions and discharges as well as requirements for prevention of oill and NLS spills during cargo operations and bunkering (the requirements are specified in 3.5);

ECO-S — the distinguishing mark in the class notation, which identifies compliance with more stringent requirements than those for assignment of the distinguishing mark **ECO** in the class notation (the requirements are specified in 3.6).

It is recommended to assign the above distinguishing marks in the class notation to the following ships:

ECO — to newbuildings and existing ships;

ECO-S — to newbuildings, existing passenger and coastal ships.

3.2.2 Requirements for ships with the distinguishing marks ECO and ECO-S in the class notation.

T a b l e 3.2.2

Requirements	Distinguishing marks in the class notation	
	ECO	**ECO-S**
The following requirements shall be met on ships regarding prevention of air pollution:		
3.5.2.2 Prevention of pollution by emission from marine diesel engines	×	×
3.6.2.2 Prevention of pollution by emission from marine diesel engines	—	×
3.5.2.3 Prevention of pollution by emission from boilers and inert gas generators	×	×
3.6.2.3 Prevention of pollution by emission from boilers and inert gas generators	—	×
3.5.2.4 Prevention of pollution by refrigerant emission	×	×
3.6.2.4 Prevention of pollution by refrigerant emission	—	×
3.5.2.5 Prevention of pollution by fire extinguishing media emission	×	×
3.6.2.5 Prevention of pollution by fire extinguishing media emission	—	×
3.5.2.6 and **3.6.2.6** Prevention of pollution by volatile organic compounds emission	×	×
3.5.2.7 and **3.6.2.7** Prevention of pollution by emissions from shipboard incinerators.	×	×
3.5.2.8 Energy efficiency of ship	×	×
3.6.2.8 Energy efficiency of ship	×	×
The following requirements shall be met on ships regarding prevention of pollution of the marine environment:		
3.5.3.2 Discharge of cargo residues.	×	×
3.6.3.2 Discharge of cargo residues.	—	×
3.5.3.3 Structural measures and equipment for prevention of oil spills during cargo operations and bunkering.	×	×
3.6.3.3 Structural measures and equipment for prevention of oil spills during cargo operations and bunkering.	—	×
3.5.3.4 and **3.6.3.4** Ballast water management.	×	×
3.5.3.5 Prevention of pollution at oil contaminated water discharge	×	×
3.6.3.5 Prevention of pollution at oil contaminated water discharge	—	×
3.5.3.6 Prevention of pollution by garbage	×	×
3.6.3.6 Prevention of pollution by garbage	—	×
3.5.3.7 Prevention of pollution by sewage	×	×

Table 3.2.2 — *continued*

Requirements	Distinguishing marks in the class notation	
	ECO	ECO-S
3.6.3.7 Prevention of pollution by sewage	—	×
3.5.3.8 and 3.6.3.8 Control of harmful anti-fouling systems	×	×
3.5.3.9 and 3.6.3.9 Prevention of lubricating oil and hydraulic oil leakages into seawater	×	×
3.5.3.10 Prevention of pollution in case of the hull damage	×	×
3.6.3.10 Prevention of pollution in case of the hull damage	—	×
The following requirements shall be met on ships regarding prevention of pollution at ship recycling:		
3.5.4 and 3.6.5 Prevention of pollution at ship recycling	×	×

3.2.3 Any ship shall have **AUT1** or **AUT2** distinguishing automation mark of the machinery installation in the class notation.

3.2.4 Assignment of the distinguishing marks in the class notation to oil tankers of less than 150 gross tonnage, to other ships of less than 400 gross tonnage and to floating facilities for oil storage and production is subject to special consideration by the Register in each particular case.

3.3 APPLICATION OF INTERNATIONAL INSTRUMENTS' REQUIREMENTS

3.3.1 The requirements of the present Section are based on international instruments, the main of which are specified in 3.1. At the same time, some provisions of the requirements of the present Section are more stringent than the requirements of the relevant international instruments.

3.3.2 Required compliance of the ship's systems and equipment with international instruments.

Table 3.3.2

Ship's systems and equipment	International instrument
15 ppm bilge separators	IMO resolution MEPC.107(49)
15 ppm bilge alarms	IMO resolution MEPC.107(49)
Oil discharge monitoring and control systems	IMO resolution MEPC.108(49), as amended
Oil/water interface detectors	IMO resolution MEPC.5(XIII)
Shipboard incinerators	Regulation 16 of Annex VI to MARPOL 73/78, IMO resolution MEPC.76(40) or MEPC.244(66)
Sewage treatment plants	IMO resolution MEPC.2(VI), MEPC159(55)
Cargo vapour collection systems of oil tankers	Regulation 15 of Annex VI to MARPOL 73/78, MSC/CIRC.585
Marine diesel engines	Regulation 13 of Annex VI to MARPOL 73/78, NO_x Technical Code
Exhaust gas cleaning systems to reduce the emission of sulphur oxides (SO_x)	Regulation 14 of Annex VI to MARPOL 73/78, IMO resolution MEPC.184(59)

3.3.3 International regulations and standards for use of fuel oil on ships, bunkering, sampling and testing of fuel oil.

Table 3.3.3

Required processes, specifications	International instrument
Sampling of fuel oil	IMO resolution MEPC.182(59), GOST 2517-85
Standard marine fuel oil	ISO 8217
Bunkering of ships	Regulation 18 of Annex VI to MARPOL 73/78
Fuel oil sulphur content test	ISO 8754

3.4 CERTIFICATES AND TECHNICAL DOCUMENTATION REQUIRED FOR ASSIGNING THE DISTINGUISHING MARKS ECO OR ECO-S IN THE CLASS NOTATION

3.4.1 Air Pollution Prevention Certificates:

.1 International Air Pollution Prevention Certificate (IAPP) with Supplement issued by any Administration or under the authorization thereof; or

International Air Pollution Prevention Certificate (form 2.4.6) with Supplement (form 2.4.23), issued in compliance with 1.11, Part III "Survey of Ships in Compliance with International Conventions, Codes and Resolutions" of the Guidelines on Technical Supervision of Ships in Service; or

Pollution From Ships Prevention Certificate (form 2.4.18rf).

.2 Engine International Air Pollution Prevention Certificate (EIAPP), issued by any Administration or under the authorization thereof; or

Engine International Air Pollution Prevention Certificate (form 2.4.40) with Supplement (form 2.4.41), issued in compliance with 1.11, Part III "Survey of Ships in Compliance with International Conventions, Codes and Resolutions" of the Guidelines on Technical Supervision of Ships in Service;

.3 SO_x Emission Compliance Certificate (SECC) issued by any Administration or under the authorization thereof; or

SO_x Emission Compliance Certificate (form 2.4.42), issued by the Register under the authorization of any Administration;

.4 International Energy Efficiency Certificate (IIEC) issued by any Administration or under the authorization thereof; or

International Energy Efficiency Certificate (form 2.4.3) with Supplement (form 2.4.3.1), issued in compliance with 1.11, Part III "Survey of Ships in Compliance with International Conventions, Codes and Resolutions" of the Guidelines on Technical Supervision for Ships in Service; or

Energy Efficiency Certificate (form 2.4.3rf) with Supplement (form 2.4.3.1rf).

3.4.2 **Operating procedures and ship's technical documentation in respect of air pollution prevention:**

.1 approved Technical File of the engine on the NO_x emission for each engine subject to survey in accordance with the NO_x Technical Code, including the engine fitted with NO_x-reducing device as an engine component;

.2 approved EGCS — SO_x Technical Manual (ETM) (where applicable);

.3 drawings of any exhaust gas cleaning system which shall be approved in compliance with the IMO Guidelines ;

.4 approved Onboard Monitoring Manual (OMM) (where applicable);

.5 approved SO_x Emission Compliance Plan (SECP) (where applicable);

.6 Record Book of SO_x-Reducing Device Parameters;

.7 approved documentation on the ship's fuel oil system confirming possibility of ready change over to low-sulphur content fuel oil when approaching SO_x emission control areas established under Annex VI to MARPOL 73/78 or Directive 99/32/EU accordingly (where applicable);

.8 procedure for preparing the ship's fuel oil system for operation in the SO_x emission control area (SECA) (where applicable);

.9 Fuel Oil Management Plan, Fuel Oil Record Book;

.10 incinerator systems diagram;

.11 refrigerating operations management procedure;

.12 refrigerating systems diagrams, list of refrigerants used;

.13 fire-fighting systems diagrams, list of fire extinguishing media used in these systems;

.14 Volatile Organic Compound (VOC) Management Plan;

.15 Energy Efficiency Design Index (EEDI) Technical File (where applicable);

.16 Ship Energy Efficiency Management Plan (SEEMP).

3.4.3 **Marine Environment Pollution Prevention Certificates:**

.1 International Oil Pollution Prevention Certificate (IOPP) issued by any Administration or under the authorization thereof; or

International Oil Pollution Prevention Certificate (form 2.4.5) with Supplement (forms 2.4.20 or 2.4.26) issued in compliance with 1.11, Part III "Survey of Ships in Compliance with International Conventions, Codes and Resolutions" of the Guidelines on Technical Supervision for Ships in Service; or

Pollution from Ships Prevention Certificate (form 2.4.18rf);

.2 International Sewage Pollution Prevention Certificate issued by any Administration or under the authorization thereof; or

International Sewage Pollution Prevention Certificate (form 2.4.9) issued in compliance with 1.11 Part III "Survey of Ships in Compliance with International Conventions, Codes ad Resolutions" of the Guidelines on Technical Supervision for Ships in Service; or

Pollution from Ships Prevention Certificate (form 2.4.18rf);

.3 Certificate of Compliance of Equipment and Arrangements of the Ship with the Requirements of Annex V to MARPOL 73/78 (form 2.4.15) (where applicable); or

Pollution from Ships Prevention Certificate (form 2.4.18rf);

.4 International Anti-Fouling System Certificate issued by any Administration or under the authorization thereof; or

International Anti-Fouling System Certificate (forms 2.4.30 or 2.4.30ec) with the Records of Anti-Fouling Systems (forms 2.4.31 or 2.4.3ec) respectively, issued by Register under the authorization of Administrations; or

Statement of Compliance of Anti-Fouling System (form 2.4.30.1) with the Record of Anti-Fouling System (form 2.4.31.1), where applicable; or

Declaration on Compliance of Anti-Fouling System with AFS-Convention, if applicable (refer to 3.5.3.8.3);

.5 International Ballast Water Management Certificate issued by any Administration or under the authorization thereof (with due regard to IMO circular BWM.2/Circ.40); or

International Ballast Water Management Certificate (form 2.5.4), issued in compliance with 1.11, Part III "Survey of Ships in Compliance with International Conventions, Codes and Resolutions" of the Guidelines on Technical Supervision for Ships in Service;

.6 Statement of compliance to IMO resolution on ship recycling "Green passport" (form 2.4.8) with Supplement (form 2.4.8.1).

3.4.4 **Operating procedures and ship's technical documentation in respect of marine environment pollution prevention:**

.1 ship's general arrangement plan and tanks plan;

.2 approved documentation confirming compliance of the oil tanker with the requirements for double hull construction in accordance with regulation 19 of Annex I to MARPOL 73/78;

.3 approved documentation confirming compliance of the ship with the requirements for protective location of fuel oil tanks as defined in regulation 12A of Annex I to MARPOL 73/78 (refer to 3.5.3.10.5 to 3.5.3.10.7 and 3.6.3.10.2);

.4 approved Shipboard Oil Pollution Emergency Plan or Shipboard Marine Pollution Emergency Plan (for Oil and Noxious Liquid Substances) considering regulation 37.4 of Annex I to MARPOL 73/78 in relation to fast access to computerized shore-based software for calculation of damage stability and residual structural strength, as well as Oil Record Book, Parts I and II (regulations 17 and 36 of Annex I to MARPOL 73/78);

.5 approved Shipboard Marine Pollution Emergency Plan for Noxious Liquid Substances (regulation 17 of Annex II to MARPOL 73/78), approved Procedures and Arrangement Manual (regulation 14 of Annex II to MARPOL 73/78) and Cargo Record Book (regulation 15 of Annex II to MARPOL 73/78);

.6 approved Transfer of Oil Cargo between Oil Tankers at Sea (STS Operations) Plan (for oil tankers, where available);

.7 approved Ballast Water Management Plan;

.8 approved Ship's Guidelines for Safe Water Ballast Exchange at Sea (where applicable);

.9 Ballast Water Record Book;

.10 approved ship's software for planning water ballast exchange at sea (where applicable in compliance with 3.5.3.4.2);

.11 Biofouling Management Plan and Biofouling Record Book in compliance with IMO resolution MEPC.207(62);

.12 approved ship's software for calculation of intact trim, stability and strength as well as damage trim and stability;

.13 Sewage Management Plan and Sewage Record Book;

.14 sewage system diagram and sanitary and domestic waste waters system diagram;

.15 Record Book of Detection and Elimination of Petroleum Products (Fuel oil, Hydraulic oil, etc) Operating Leakages to be avoid;

.16 diagrams of manifolds in cargo areas, as well as branch pipes and flanges for fuel oil and oil bunkering, oil residues and oily water discharge indicating the trays and appliances for prevention of spillage of Oil and Noxious Liquid Substances carried in bulk;

.17 diagrams and drawings of fuel oil system, bilge system, oil discharge, monitoring and control system for ballast and flushing water, ballast water system;

.18 Garbage Management Plans, placards and Garbage Record Book, diagrams and drawing of equipment for the prevention of pollution by garbage.

3.5 TECHNICAL REQUIREMENTS FOR ASSIGNING THE DISTINGUISHING MARK ECO IN THE CLASS NOTATION

3.5.1 Introduction.

3.5.1.1 The provisions of the present Chapter cover the requirements on emissions to air from sources of power, oil tanker cargo systems and service systems onboard, as well as requirements for discharges to sea from sources of power, from ship's systems and equipment of machinery spaces and from cargo areas of oil tankers, chemical tankers and NLS tankers, from sewage systems, anti-fouling and ballast systems, as well as the requirements for the prevention of pollution by garbage.

3.5.1.2 The required documentation is specified in 3.4.

3.5.2 Prevention of air pollution.

3.5.2.1 General.

3.5.2.1.1 Fuel oil supplied to the ship shall not contain inorganic acids or chemical wastes that can endanger a ship, bring harm to the crew or that can add to air pollution.

3.5.2.1.2 Fuel oil shall be controlled in accordance with Fuel Oil Management Plan, Fuel Oil Record Book.

Quality of ordered fuel oil and quality of received fuel oil according to bunker delivery note shall be documented in Fuel Oil Record Book (refer to regulations 18.3 and 18.4 of Annex VI to MARPOL 73/78, as well as Directive 99/32/EU, as amended).

Fuel Oil Management Plan shall comprise adequate procedures for replacement of fuel oil in order to make sure that fuel oil burnt in the engine in the SO_x emission control area is of the required quality. Relevant ship's log shall contain evidence that the fuel oil of the required quality was used in relevant areas.

3.5.2.1.3 SECP shall be readily available in all ships using exhaust gas cleaning system to reduce SOx emission to confirm compliance with the requirements of regulations 14.1 and 4.14 of Annex VI to MARPOL 73/78.

This Plan shall list all ship's plants for burning fuel oil, which comply with the operating requirements specified in the above regulations by adoption of the approved system specified above.

3.5.2.1.4 Bunker delivery note shall be accompanied by sample of supplied fuel oil properly sealed and signed by representatives of the bunkering company, ship master or ship officer responsible for bunkering operations. Bunker delivery note shall be kept onboard for three years. Fuel oil sample shall be stored under ship's officers control until the end of consumption but not less than 12 months from the date of supply.

This note shall confirm that a fuel oil is supplied in accordance with regulations 14 and 18 of Annex VI to MARPOL 73/78 taking into account 3.5.2.2.7, i.e. sulphur content in the supplied fuel oil complies with the applicable requirements and there are no inorganic acids and chemical wastes in this fuel oil.

For the purpose of cross-reference the number of sample shall be stated in the note.

3.5.2.1.5 Sampling equipment and testing procedures shall comply with provisions of documents specified in 3.3.3.

In order to fulfill the requirements of IMO resolution MEPC.182(59) in respect of method and place of fuel oil sampling the ship shall be fitted with the sampling device of approved structure (irrespective whether the fuel oil supplier has a sampling device for installation on the inlet header of receiving ship or not).

3.5.2.2 Prevention of pollution by emission from marine diesel engines.

3.5.2.2.1 NO_x emission restrictions are applied to engines permanently fitted onboard of power output more than 130 kW, except engines that are part of any equipment used in emergency solely onboard the ships where they are installed and engines on lifeboats.

3.5.2.2.2 Level of emission from engines on all ships shall comply with Annex VI to MARPOL 73/78.

3.5.2.2.3 Appropriate certificates shall be issued to marine engines of power more than 130 kW (except emergency ones and those for lifeboats) and to exhaust gas cleaning systems to reduce SO_x emission (if applicable) in accordance with **3.4**.1.

3.5.2.2.4 If the exhaust gas cleaning system is used to reduce NO_x emission, the engine and the above system for which it is installed are treated as a single whole. When for NO_x reduction a selective catalytic reduction (SCR) system is used, the requirements of IMO resolution MEPC.198(**62**), as amended, shall be met.

3.5.2.2.5 Measurements of NO_x emission level from diesel engines with exhaust gas cleaning system to reduce NO_x emission or without it shall comply with methods specified in the NO_x Technical Code. Measurements and tests shall be performed and documented in accordance with the provisions of the Guidelines on Marine Diesel Engines Survey in Compliance with the Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines.

3.5.2.2.6 Compliance with SO_x emission restrictions is mainly achieved by use of low-sulphur content fuel oil. Alternatively, an exhaust gas cleaning system may be used to reduce SO_x emission to attain the required level of SO_x emission. The maximum sulphur content in fuel oil supplied to the ship is **3**,0 per cent. When an exhaust gas cleaning system is used, the SO_2 (ppm)/CO_2 (% v/v) ratio shall not exceed 128,0.

3.5.2.2.7 If a ship operates in SOx emission control area (including ports) the sulphur content in fuel oil shall not exceed 1,00 per sent. When an exhaust gas cleaning system is used, the SO_2 (ppm)/CO_2 (% v/v) ratio shall not exceed **43**,**3**.

3.5.2.2.8 During operation of ships in the territorial seas, coastal zones and EU ports the sulphur content in fuel oil shall not exceed values specified in EU Council Directive 1999/**32**/EU, as amended (articles **3** and **4**).

3.5.2.2.9 During operation of passenger ships engaged on the regular voyages to/from the EU ports the sulphur content in fuel oil shall not exceed values specified in Directive 2005/**33**/EU (article **4a**).

3.5.2.2.10 Transition from one type of fuel oil to another while coming in and out of the SO_x emission control areas specified in Annex VI to MARPOL 73/78, as well as while coming in and out of the EU territorial waters including mooring and anchoring in the EU ports shall be registered in the ship's log.

3.5.2.2.11 During survey of engines fitted with the exhaust gas cleaning systems to reduce SO_x emission, the compliance with SO_x emission norms specified in the Guidelines for On-Board Exhaust GAS-SO_x Cleaning System (IMO resolution MEPC.184(59)) shall be confirmed.

3.5.2.3 Prevention of pollution by emission from boilers and inert gas generators.

3.5.2.3.1 Compliance with restrictions of SO_x emission from boilers and inert gas generators is mainly achieved by use of low-sulphur content fuel oil with sulphur content complying with **3**.5.2.2.7 to **3**.5.2.2.10.

3.5.2.3.2 Alternatively, an exhaust gas cleaning system may be used to reduce SO_x emission to reach the required level of SO_x emission. The use of such system is subject to special consideration by the Register in each particular case.

3.5.2.4 Prevention of pollution by refrigerant emission.

3.5.2.4.1 The requirements of the present Section for prevention of pollution by refrigerant emission are applied to cargo refrigerating plants, air conditioning plants and refrigerating systems of all ships.

The said requirements are not applied to autonomous home air-conditioners, refrigerators and freezers permanently sealed and having no connections for refrigerant charging onboard.

3.5.2.4.2 In accordance with provisions of the Montreal Protocol 1987 criteria for refrigerant emission are limited by requirements relative to qualities of used refrigerants in relation to their ozone depleting potential (ODP) and global warming potential (GWP).

3.5.2.4.3 It is not allowed to use ozone-depleting substances on ships.

The following substances may be used as refrigerants onboard:

natural refrigerants (such as, ammonia (NH_3) or carbonic acid (CO_2));

hydro fluorocarbon (HFC) with ODP = 0 and GWP < 3500.

3.5.2.4.4 The Refrigerant Management Procedure shall be implemented on board the ships to control presence of leaks which shall contain as a minimum the following issues:

operation of refrigerating plants to prevent/minimize possible leaks;

periodicity of inspections of refrigerating plants aimed at finding leaks and keeping records of their quantity;

performing corrective actions if leaks exceed norms, operating limitations to prevent such leaks.

Corrective actions shall be performed before the quantity of leaks reaches 10 per cent of the total quantity of refrigerant in each system.

3.5.2.4.5 In order to regenerate a refrigerant, compressors shall be able to discharge refrigerant from the system into the relevant receiver of the liquid refrigerant. Additionally, regenerating units shall be fitted to discharge refrigerant from the system into the existing refrigerant receivers or appropriate receivers.

3.5.2.4.6 When different types of refrigerants are used, measures shall be provided to prevent mixing of such substances.

3.5.2.4.7 In order to make sure there are no emissions to air or that they are reduced to minimum, refrigerants in the refrigerating systems shall be controlled by appropriate method to discover all types of leaks, including those that are usually not discovered by the automatic leak detection system.

One of the following methods or combination thereof may be used:

leak detection system appropriate for the used refrigerant with signaling if refrigerant is found outside refrigerating system;

measuring of refrigerant level in the refrigerating system with low level signaling;

registering refrigerant level in special journal at certain intervals (once in a week as a minimum) to find out minor leaks.

3.5.2.5 Prevention of pollution by fire extinguishing media emission.

3.5.2.5.1 Natural fire extinguishing media (such as argon, nitrogen, CO_2) used in fixed fire extinguishing systems are not considered as ozone depleting substances.

3.5.2.5.2 When other fire extinguishing media (for instance, hydrofluorocarbons (HFC) are used in fixed fire extinguishing systems, the madia shall have the following properties: GWP < 4000, ODP = 0.

3.5.2.6 Prevention of pollution by volatile organic compounds emission.

3.5.2.6.1 In order to prevent emission of VOC from oil tankers carrying crude oil, petroleum products, as well as from chemical tankers carrying chemical cargoes with flashpoint < 60°C, standards for cargo vapour discharge systems shall be applied according to MSC/Circ.585.

3.5.2.6.2 Approved technical documentation for the cargo vapour discharge system including principal diagram of the pipeline for vapour collection on oil tanker with indication of location and purpose of all control and safety arrangements as well as cargo transfer instruction shall be available onboard. This instruction shall contain information on the maximum permissible speed of cargo transfer, maximum pressure drop in the ship vapour collection system at different speeds of loading, operation threshold of each high-sped or vacuum valve etc.

3.5.2.6.3 In Appendix to the International Air Pollution Prevention (IAPP) Certificate there shall be a note on the presence of cargo vapour collection system fitted and approved in accordance with MSC/Circ.585.

3.5.2.6.4 An approved VOC Management Plan shall be available on board the ship.

3.5.2.7 Prevention of pollution by emission from shipboard incinerators.

3.5.2.7.1 Shipboard incinerators shall be type-approved in accordance with IMO resolution MEPC.76(40)) or MEPC.244(66), as applicable.

3.5.2.7.2 Approved diagrams of the incinerator systems, the copy of Incinerator Type Approval Certificate as well as incinerator operational manual shall be available on board the ship.

3.5.2.7.3 In the Certificates (Supplements) given in **3.4.1.1** and **3.4.3.3**, Certificate shall contain notes on shipboard incinerator corresponding to IMO resolution MEPC.76(40) or MEPC.244(66), as applicable.

3.5.2.7.4 Operation of incinerators shall be in accordance with regulation **16** of Annex VI to MARPOL 73/78 and the approved Garbage Management Plan, and be recorded in the Garbage Record Book specified in regulations **10.2** и **10.3** of Annex V to MARPOL 73/78, respectively.

3.5.2.8 Energy efficiency.

3.5.2.8.1 New ship of 400 gross tonnage and above shall be constructed and operated in compliance with chapter 4 in Annex VI to MARPOL 73/78 (IMO resolution MEPC.**203**(**62**)) in terms of energy efficiency depending on the ship type and propulsion plant.

3.5.2.8.2 Each (new and existing) ship of 400 gross tonnage and above, except platforms (including floating offshore oil-and-gas production units), mobile offshore drilling units irrespective of propulsion plants and any non-self-propelled ship, shall keep on board and implement Ship Energy Efficiency Management Plans (SEEMP).

3.5.3 Prevention of marine environment pollution.

3.5.3.1 General.

Compliance with the requirements shall be confirmed in accordance with **3.2** to **3.4**.

3.5.3.2 Discharge of contaminated water and water polluted with noxious liquid substances from cargo areas of ships.

3.5.3.2.1 Discharge criteria apply to tankers carrying crude oil, petroleum products or noxious substances in bulk.

3.5.3.2.2 Discharge of contaminated ballast water or washing water from the area of cargo tanks of oil tankers shall be carried out by the system of automatic measuring, record and control of discharge of ballast and washing water. Discharge criteria shall be in compliance with Annex I to MARPOL 73/78.

3.5.3.2.3 Each tanker designed for the carriage of noxious substances in bulk shall be equipped with pumps and pipelines, providing stripping of each tank carrying cargoes with pollution categories X, Y and Z, in the way that the quantity of residues in the tank and associated piping does not exceed 75 l in accordance with Annex II to MARPOL 73/78. Discharge of contaminated water to sea shall be carried out by means specified in Annex II to MARPOL 73/78.

3.5.3.2.4 The above discharges and discharge to shore reception facilities shall be documented in the Oil Record Book, or Cargo Record Book, for oil tankers and chemical tankers, respectively.

3.5.3.3 Structural measures and equipment for prevention of oil spills during cargo operations and bunkering.

3.5.3.3.1 Oil tankers, chemical tankers and NLS tankers shall have fitted and implemented means and arrangements to reduce the possibility of oil or NLS spill on deck reaching the sea.

3.5.3.3.2 To keep cargo spills within the cargo area, provision shall be made for a permanent continuous coaming on the cargo deck extending from side to side and from a point 0,2*L* forward of amidships to the aft end of the cargo deck with the minimum heights given in Table 3.5.3.3.2:

Table 3.5.3.3.2

Minimum heights of continuous coaming		
Ships of 100000 t deadweight and over	0,2*L* forward of amidships	0,25 m
	Aft end of cargo deck	0,40 m
Ships of less than 100000 t deadweight	0,2*L* forward of amidships	0,10 m
	Aft end of cargo deck	0,25 m

3.5.3.3.3 To collect possible oil spills during cargo operations the main deck in the cargo area shall be fitted with a deck scupper system for collection of the spilled cargo with its accumulation in the holding tank or a slop tank. The deck scupper system may be arranged either with a manually operated valve or with automatic scuppers.

The drainage shall be used during cargo operations where cargo spills may occur, and shall not be used under normal conditions when at sea. When at sea, deck scupper system shall preclude free surface effect with negative impact on the ship's stability.

3.5.3.3.4 On oil tankers, chemical tankers and NLS tankers the points where cargo hoses are connected to cargo manifolds shall be fitted with spill trays with arrangement for spills collection to the holding or slop tank.

The trays shall have the following minimum dimensions:

tray length shall be so that the cargo manifold doesn't extend beyond forward and aft ends of the tray;

width — at least 1,8 m, at that the spill tray extends at least 1,2 m outboard of the end of the manifold flange;

minimum depth — 0,3 m.

3.5.3.3.5 Oil tankers, chemical tankers and NLS tankers shall be fitted with means to adequately support hoses in way of ship's side abreast of manifolds. The support shall preferably be arranged as a horizontal curved plate or pipe section.

3.5.3.3.6 Oil tankers, chemical tankers and NLS tankers shall be fitted with a closed sounding system with high and maximum level alarms. Alternatively, a high level alarm may be accepted in combination with a closed sounding system, provided the alarm is independent from the sounding system.

3.5.3.3.7 Fuel oil, lubricating oil and other petroleum products bunker tanks on all ships shall be fitted with high level alarm to prevent overfilling.

3.5.3.3.8 Locations on the open deck in the area of fuel and lubricating oil pipes, standard connections for oil residues discharge (located outside the bunkering station areas), vent and overflow pipes, other areas where petroleum products and NLS spill may occur shall be fitted with spill trays or restricted by sufficient coamings to prevent their escape to sea.

Oil and fuel bunkering stations shall be fitted with deck scupper system for collection of spill with its accumulation in the relevant holding tank.

3.5.3.3.9 Any oil tanker involved in STS operations shall carry on board an approved plan how to conduct STS operations (STS Operations Plan) in compliance with IMO resolution MEPC.186(59).

3.5.3.4 Ballast water management.

3.5.3.4.1 Ballast water management shall meet the requirements of D-1 or D-2 standard in compliance with regulation B-3 of the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004, as amended.

3.5.3.4.2 All ships where the ballast water management is carried out in compliance with the ballast water exchange standard D-1, shall be provided with the Ballast Water Management Plan according to the Instruction for the Development of Ballast Water Management Plans developed for each ship and approved by the Register.

If the planning of ballast water exchange by the crew is provided for, the ship shall be additionally provided with special software programs for ballast water exchange planning.

3.5.3.4.3 Ballast system used during ballast water exchange at sea shall comply with the requirements of 8.7, Part VIII "Systems and Piping".

3.5.3.4.4 All ships where the ballast water management is carried out in compliance with the ballast water exchange standard D-2 shall be fitted with ballast water control systems approved by the Administration. A copy of Type Approval Certificate for this system issued by Register under the authorization of the Administration shall be permanently available on board the ship.

3.5.3.4.5 Being so authorized by the Administration, the ship shall be provided with an International Ballast Water Management Certificate (issued based on the IMO circular BWM.2/Circ.40) or a Ballast Water Management Certificate (form 2.5.4), issued in compliance with 1.11, Part III "Survey of Ships in Compliance with International Conventions, Codes ad Resolutions" of the Guidelines on Technical Supervision for Ships in Service.

3.5.3.5 Prevention of pollution at oil contaminated and bilge water discharge.

3.5.3.5.1 The requirements for filtering equipment and for discharge of oily bilge water in compliance with regulations 14 and 15 of Annex I to MARPOL shall apply to all ships as specified thereof.

3.5.3.5.2 In addition to the requirements of Annex I to MARPOL 73/78, each ship shall be fitted with the oil contaminated bilge water holding tank of sufficient capacity agreed with the Register for bilge water storage and disposal to reception facilities.

3.5.3.6 Prevention of pollution by garbage.

3.5.3.6.1 The requirements to garbage management and the availability of Garbage Management Plans and placards shall apply to all ships in compliance with Annex V to MARPOL 73/78 regardless the ship gross tonnage and permissible number of persons on board.

3.5.3.6.2 A ship shall be equipped with the marked containers with tight covers for garbage, collection and storage prior to its discharge to the sea in the allowed areas in accordance with the regulations 3 to 6 of Annex V to MARPOL 73/78 or prior to its incineration in the ship incinerators or discharge to shore reception facilities.

3.5.3.7 Prevention of pollution by sewage.

3.5.3.7.1 A ship shall be provided with a Certificate specified in 3.4.3.2.

3.5.3.7.2 All ships shall be fitted with a sewage holding tank and sewage treatment plant of sufficient capacity having a Certificate of Type Approval in compliance with IMO resolution MEPC.159(55) or MEPC.227(64), as applicable.

The above holding tank of sufficient capacity shall be fitted with the effective visual indication means of its capacity with visual and audible alarm activated at its filling by 80 per cent filling of the tank.

3.5.3.7.3 All ships shall be fitted with pipelines with a standard discharge connection in accordance with regulation 10 of Annex IV to MARPOL 73/78 for sewage discharge to reception facilities.

3.5.3.7.4 All ships shall be provided with calculations of the rate of discharge of untreated sewage approved by the Register upon authorization of the Administration. These calculations shall be drawn up according to Recommendation on Standards for the Rate of Discharge of Untreated Sewage from ships in compliance with IMO resolution MEPC.157(55).

3.5.3.7.5 All sewage discharges, whether to sea or to shore-based reception facilities shall be recorded in the appropriate record book with indication of date, location and quantity of sewage discharged. In cases where untreated sewage is discharged to sea, the record shall include information on the ship's speed which shall correspond to the approved rate of discharge and the distance to the nearest shore (more 12 nautical miles[1]) at the moment of discharge.

3.5.3.8 Anti-fouling systems

3.5.3.8.1 Anti-fouling systems (coatings) containing organo-tin compounds (Tributiltin (TBT)) as the active ingredients are not permitted.

3.5.3.8.2 Ships of 400 gross tonnage and upwards shall carry one of Certificates, Statement or Declaration of Compliance of Anti-Fouling System with the International Convention on the Control of Harmful Anti-Fouling Systems of Ships, 2001 (AFS-Convention).

3.5.3.8.3 Ships having a length of 24 m (IC66) and more but of less than 400 gross tonnage shall carry declarations on compliance of their anti-fouling systems with AFS-Convention in accordance with form of Addenda 2 to Annex 4 to AFS Convention or with Annex III of EU Regulation 782/2003 (Regulation 5 of Annex 4 to AFS-Convention).

3.5.3.9 Prevention of lubricating oil and hydraulic oil leakages into seawater.

3.5.3.9.1 Requirements for prevention of leakages of lubricating oil and hydraulic oil into seawater shall be applied in the following cases:

if oil-lubricated stern tube bearings and sealing arrangements are provided;

if there is a possibility that lubricating oil will spill into the seawater from the lubricating oil system of the steering gear bearing;

if seawater cooled engines are provided;

if there is a probability that oil from the hydraulic system will spill into the seawater.

3.5.3.9.2 Occurrence of lubricating oil and hydraulic oil operating leakages into seawater shall be continuously monitored. If evidence of leakage is found, corrective actions shall be initiated and recorded in the ship's log. For this purpose all the insignificant oil leaks shall be monitored by the approved manual or automatic methods.

3.5.3.9.3 In case of oil-lubricated stern tube bearings and/or sealing arrangements, the above requirements shall be considered in addition to the requirements for oil level indicators and low level alarm of lubricating oil tanks as well as environmental safety of stern tube arrangements (refer to 5.6.4 and 5.7, Part VII "Machinery Installations").

3.5.3.10 Prevention of pollution in case of the hull damage.

3.5.3.10.1 The ship with the descriptive notations **Oil tanker** or **Oil/ore carrier** or **Chemical tanker** in the class notation shall be provided with double hull and double bottom in the cargo area in accordance with regulation 19 of Annex I to MARPOL 73/78.

3.5.3.10.2 Requirements to the damage trim and stability characteristics specified in 3.3, Part V "Subdivision" shall be used during flooding of any compartment, if provisions of 3.4 of the above Part do not specify more rigid requirements.

3.5.3.10.3 Any ship shall be fitted with the onboard software to calculate intact trim, stability and strength and to calculate damaged ship trim and stability.

3.5.3.10.4 Oil tankers of 600 t deadweight and over, as well as other ships, with an aggregate fuel oil tanks capacity 600 m^3 and over shall have prompt access to computerized, shore-based damage stability and residual structural strength calculation programs in accordance with regulation 37.4 of Annex I to MARPOL 73/78.

[1]Hereinafter a nautical mile is equal to 1852 m.

3.5.3.10.5 Ships having an aggregate fuel oil tanks capacity 600 m^3 and over shall have double hull and double bottom to protect fuel oil tanks in accordance with regulation 12A of Annex I to MARPOL 73/78, irrespective of capacity of each fuel oil tank.

3.5.3.10.6 Location of suction wells in fuel oil tanks shall comply with the requirements of regulation 12A.10 of Annex I to MARPOL 73/78.

3.5.3.10.7 The valves for fuel oil pipelines located at a distance less than h from the ship's bottom shall be arranged at a distance of not less than $h/2$ from the ship's bottom (refer to Fig. 3.5.3.10.7).

3.5.3.11 Segregated ballast tanks.

3.5.3.11.1 Segregated ballast tanks shall be provided on ships with the descriptive notation **Oil tanker** or **Oil/ore carrier** or **Chemical tanker** in the class notation.

3.5.3.11.2 The capacity of the segregated ballast tanks shall be so determined that the ship may operate safely on ballast voyages without recourse to the use of cargo tanks for water ballast.

3.5.4 Prevention of pollution at ship recycling.

3.5.4.1 All ships shall have a Statement of Compliance to IMO resolution on Ship Recycling "Green Passport" (form 2.4.8) with Supplement (form 2.4.8-1) according to the Guidelines on Ship Recycling (refer to IMO resolution A.962(23)), with additions or amendments thereto currently adopted.

3.5.4.2 The above Statement with Supplement shall be permanently available on board throughout the ship's operating life. The shipowner shall continuously update the Supplement and include thereto all major ship's structure and equipment changes to maintain the information of the Supplement (form 2.4.8-1) actual.

3.5.5 Environmental responsibilities.

All ships shall have a responsible environmental officer onboard.

This officer shall be responsible for the following:

checking the compliance with the environment pollution prevention requirements;

monitoring the implementation of the relevant procedures;

maintaining the relevant ships' logs;

education and training of personnel in the relevant environmental practices.

The responsible environmental officer may delegate authorities to other crew members remaining responsible for the organization of environment protection measures on board the ship.

3.6 TECHNICAL REQUIREMENTS FOR ASSIGNING THE DISTINGUISHING MARK ECO-S IN THE CLASS NOTATION

3.6.1 Introduction.

3.6.1.1 The provisions of the present Chapter cover the requirements for emissions to air from sources of power, cargo systems of oil tankers and service systems on board the ship, as well as the requirements for discharges to sea from sources of power, shipboard systems and equipment of machinery spaces, from cargo areas of oil tankers, chemical tankers and NLS tankers, from sewage systems, anti-fouling systems and ballast systems of the ship, as well as the requirements for prevention of pollution by garbage.

3.6.1.2 Requirements for assigning the distinguishing mark **ECO-S** in the class notation are more stringent as regards prevention of air and marine environment pollution as compared to the requirements for assigning the distinguishing mark **ECO** in the class notation.

3.6.1.3 The required documentation is listed in 3.4.3.

3.6.2 Prevention of air pollution.

3.6.2.1 General.

3.6.2.1.1 Compliance with the requirements shall be confirmed in accordance with 3.2 to 3.4.

3.6.2.1.2 Fuel oil to be used onboard shall comply with the requirements of 3.5.2.2.7 to 3.5.2.2.10 and 3.6.2.2.4.

3.6.2.2 Prevention of pollution by emission from marine diesel engines.

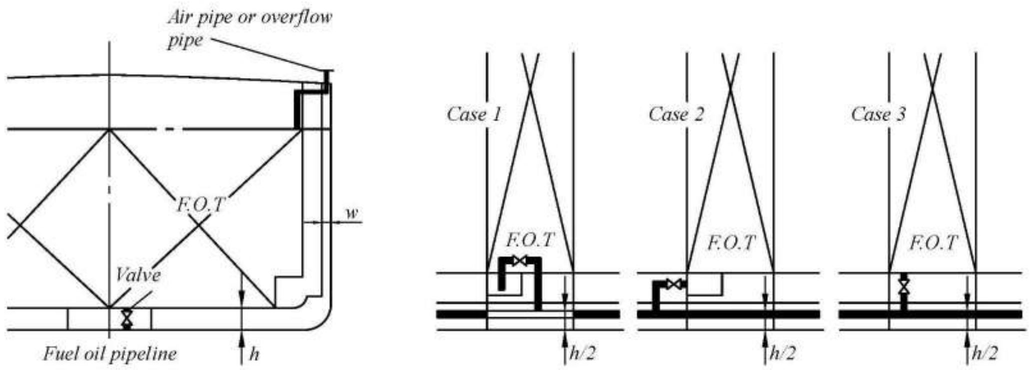


Fig. 3.5.3.10.7

Symbols:

h = the minimum distance of fuel oil tanks location from the moulded line of the bottom shell plating, in m;
w = the minimum distance of fuel oil tanks location from the moulded line of the side shell plating, in m;
F.O.T. = fuel oil tank.

3.6.2.2.1 NO_x eemission restrictions are applied to engines permanently fitted onboard of power output more than 130 kW, except engines that are part of any equipment used in emergency solely onboard the ships where they are installed and engines on lifeboats.

3.6.2.2.2 Level of emission from engines on all ships shall not exceed the following maximum values proceeding from nominal r.p.m. of engines:

13,4 g/Kw·h when $n < 130$ rpm;

$(44\ n^{(-0,23)} - 1,0)$ g/Kw·h when $n \geqslant 130$ rpm but < 2000 rpm;

6,7 g/Kw·h when $n \geqslant 2000$ rpm.

3.6.2.2.3 The exhaust gas cleaning system to reduce NO_x emission (if fitted) shall comply with the requirements of 3.5.2.2.4.

3.6.2.2.4 If a ship operates in SO_x emission control area (including ports) the sulphur content in fuel oil shall not exceed 0,10 per cent. Transition from one type of fuel oil to another while coming in and out of the port or while coming in and out of the SO_x emission control area specified in Annex VI to MARPOL 73/78 shall be registered in the ship's log. When an exhaust gas cleaning system is used, the SO_2 (ppm)/CO_2 (5% v/v) ratio shall not exceed 4.3.

3.6.2.2.5 For engines fitted with the exhaust gas cleaning systems to reduce SO_x emission, the compliance with SO_x emission norms specified in the Guidelines for On-Board Exhaust GAS-SO_x Cleaning System (IMO resolution MEPC.184(59)) shall be confirmed during survey by the Register or other classification society.

3.6.2.3 Prevention of pollution by emission from boilers and inert gas generators.

3.6.2.3.1 Compliance with restrictions of SO_x emission from boilers and inert gas generators is mainly achieved by use of low-sulphur content fuel oil with sulphur content complying with 3.6.2.2.4 to 3.6.2.2.5.

3.6.2.3.2 Alternatively, an exhaust gas cleaning system may be used to reduce SO_x emission to reach the required level of SO_x emission. The use of such system is subject to special consideration by the Register in each particular case.

3.6.2.4 Prevention of pollution by refrigerant emission.

3.6.2.4.1 The requirements of the present Section for prevention of pollution by refrigerant emission shall comply with the requirements of 3.5.2.4.

3.6.2.4.2 The following substances may be used as refrigerants onboard:

natural refrigerants (such as, ammonia (NH_3) or carbonic acid (CO_2));

hydrofluorocarbon (HFC) with ODP = 0 and GWP<1890.

3.6.2.4.3 Structural and operational requirements shall comply with 3.5.2.4.4 to 3.5.2.4.8.

3.6.2.5 Prevention of pollution by fire extinguishing media emission.

3.6.2.5.1 Natural fire extinguishing media (such as argon, nitrogen, CO_2) used in fixed fire extinguishing systems are not considered as ozone depleting substances.

3.6.2.5.2 When other fire extinguishing media (for instance, hydrofluorocarbons (HFC) are used in fixed fire extinguishing systems, the madia shall have the following properties: GWP < 1650, ODP = 0.

3.6.2.6 Prevention of pollution by volatile organic compounds emission.

In order to prevent emission of VOC from oil tankers carrying crude oil, petroleum products or chemical cargoes with flashpoint < 60 °C, the requirements of 3.5.2.6 shall be applied.

3.6.2.7 Prevention of pollution by emission from shipboard incinerators.

Shipboard incinerator shall comply with the requirements of 3.5.2.7.

3.6.2.8 Energy efficiency.

3.6.2.8.1 Energy efficiency shall be provided in compliance with the requirements in 3.5.2.8.

3.6.3 Prevention of marine environment pollution.

3.6.3.1 General.

Compliance with the requirements shall be confirmed in accordance with 3.2 to 3.4.

3.6.3.2 Discharge of cargo residues.

3.6.3.2.1 Discharge criteria for cargo residues for tankers carrying crude oil, petroleum products or noxious substances in bulk are specified in 3.5.3.2.

3.6.3.2.2 Each tanker designed for the carriage of noxious substances in bulk shall be equipped with pumps and pipelines, providing stripping of each tank carrying cargoes with pollution categories X, Y and Z, in the way that the quantity of residues in the tank and associated piping does not exceed 50 l in accordance with Annex II to MARPOL 73/78. Discharge of contaminated water to sea shall be carried out by means specified in Annex II to MARPOL 73/78.

3.6.3.2.3 Cargo tanks shall have smooth inner surfaces and be equipped with cargo wells for efficient stripping. Horizontal framing shall be avoided as far as practicable. Corrugated bulkheads may be allowed with the maximum horizontal angle of corrugations of 65°.

3.6.3.2.4 A washing system with the cleaning machines so arranged that all the surfaces of each tank be washed is obligatory.

3.6.3.3 Structural measures and equipment for prevention of oil spills during cargo operations and bunkering.

3.6.3.3.1 Oil tankers, chemical tankers and NLS tankers shall have fitted and implemented means and arrangements to reduce the possibility of oil or NLS spill on deck reaching the sea according to 3.5.3.3.2.

3.6.3.3.2 To collect possible oil spills during cargo operations the main deck in the cargo area shall be fitted with a deck scupper system for collection of the spilled cargo according to 3.5.3.3.3.

3.6.3.3.3 On oil tankers, chemical tankers and NLS tankers where cargo hoses are connected to cargo manifolds, the provision shall be made for spill trays with arrangements for spills collection to the tank according to **3.5.3.3.4**.

3.6.3.3.4 In the drainage collecting system, shutoff valves shall be provided to stop the drainage into collecting tanks.

3.6.3.3.5 Oil tankers, chemical tankers and NLS tankers shall be fitted with means to support hoses according to **3.5.3.3.5**.

3.6.3.3.6 Oil tankers, chemical tankers and NLS tankers shall be fitted with a closed sounding system with high and maximum level alarms.

3.6.3.3.7 Equipment of tanks for fuel oil, lubricating oil and other petroleum products bunkering in all ships, as well as equipment of bunkering stations, vent and overflow pipes and other areas where petroleum products spills may occur shall comply with the requirements of **3.5.3.3.7** and **3.5.3.3.8**.

3.6.3.3.8 Spill trays to collect petroleum products in case of overflow and spillage during bunkering shall be fitted with the closed system for collecting petroleum products to the holding tank or slop tank.

3.6.3.4 Ballast water management.

The requirements of **3.5.3.4** are applicable.

3.6.3.5 Prevention of pollution at oil contaminated water discharge.

3.6.3.5.1 Oil contaminated water discharge requirements apply to all ships according to regulations **15** and **34** of Annex I to MARPOL 73/78.

3.6.3.5.2 The maximum oil content at the outlet of bilge separators fitted onboard shall not exceed 5 ppm.

3.6.3.5.3 The above separators in all cases shall be fitted with 5 ppm bilge alarm and automatic shut-off valve.

3.6.3.5.4 Each ship shall be fitted with the bilge water holding tank of sufficient capacity agreed with the Register for bilge water disposal to reception facilities. Bilge water shall be collected to the above holding tank from all bilge wells of machinery spaces.

3.6.3.6 Prevention of pollution by garbage.

3.6.3.6.1 Prevention of pollution by garbage shall comply with the requirements of **3.5.3.6**.

3.6.3.6.2 A ship having the descriptive notation **Passenger ship** in the class notation shall be fitted with the following equipment:

marked containers for garbage in accordance with the requirements **3.5.3.6**;

food wastes comminutors shall provide for comminution to particles not exceeding 25 mm in size;

incinerators shall be type approved according to IMO resolution MEPC.76(40) or MEPC.244(**66**), as applicable, to provide full solid domestic waste incineration when allowed.

3.6.3.7 Prevention of pollution by sewage.

3.6.3.7.1 Prevention of pollution by sewage shall be in accordance with **3.5.3.7** (except for **3.5.3.7.2**) and **3.6.3.7.2** to **3.6.3.7.4**.

3.6.3.7.2 A ship shall be fitted with the sewage treatment plant being of a type approved in compliance with IMO resolution MEPC.**159**(55) or MEPC.227(**64**), as applicable, as well as sewage holding tank being equipped as specified in **3.5.3.7.2**.

3.6.3.7.3 Ships having the descriptive notation **Passenger ship** in the class notation shall have a sewage holding tank of sufficient capacity to allow storage of both sewage ("black water") and sanitary and domestic waste waters ("grey water") while the ship is in the area where discharge is prohibited. The holding tank shall be fitted as specified in **3.5.3.7.2**.

3.6.3.7.4 The sewage treatment plant of ships having the descriptive notation **Passenger ship** in the class notation shall be capable to treat both sewage ("black water") and sanitary and domestic waste waters ("grey water"). When the ship is operated in Special areas defined in compliance with the amendments to Annex IV to MARPOL 73/78 in IMO resolution MEPC.200(**62**), the above plant shall have a Certificate of type approval for sewage treatment plants in compliance with IMO resolution MEPC.227(**64**).

3.6.3.8 Control of harmful anti-fouling systems.

The requirements of **3.5.3.8** are applicable.

3.6.3.9 Prevention of lubricating oil and hydraulic oil leakages into seawater.

The requirements of **3.5.3.9** are applicable.

3.6.3.10 Prevention of pollution in case of the hull damage.

3.6.3.10.1 The requirements of **3.5.3.10** are applicable considering the requirements of **3.6.3.10.2**.

3.6.3.10.2 Ships having individual fuel oil tank or oil residues tank capacity exceeding **30** m^3 shall have double bottom to protect fuel oil tanks and oil residues tanks located in accordance with regulation **12A.6** of Annex I to MARPOL 73/78, even if the aggregate capacity of fuel oil tanks is less than **600** m^3.

3.6.3.11 Segregated ballast tanks.

Requirements of **3.5.3.11** are applicable.

3.6.4 Additional technical means.

3.6.4.1 In case of failure of essential machinery of the ship's propulsion plant responsible for maintaining the ship's manoeuvrability in case of emergency, alternative means shall be provided to keep the ship's manoeuvrability.

The following means may be used as alternative (as far as applicable):

two- and multi-shaft propulsion plants;

stem tube arrangements with the possibility of their repair without ship docking and using environmentally friendly media for lubrication and stem tube bearing cooling;

auxiliary retractable azimuth thrusters to keep the ship's speed and course in case of main propulsion plant damage;

four-blade propellers with detachable blades to ensure propulsion in case of damage to a blade where the opposite blade is removed;

"Power take-in" system to transmit the power from an auxiliary electric power plant to the propeller in case of main engine failure;

thrusters in case of main steering gear damage.

The alternative means to preserve the ship manoeuvrability is subject to special consideration by the Register in each particular case.

3.6.4.2 In addition to the navigational equipment and systems complying with the basic (main applicable) requirements of Part V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships, a ship shall be fitted with an automatic ground collision avoidance system, and the information on the ship's maneuvering characteristics shall be available on the navigation bridge.

3.6.5 Prevention of pollution at ship recycling.

The requirements of **3**.5.4 are applicable.

3.6.6 Environmental responsibilities.

The requirements of **3**.5.5 are applicable.

3.7 RECORDS

3.7.1 As a result of applying the requirements of the present Section, the following records will be issued:

.1 Classification Certificate (form **3.1.2**) with the distinguishing marks **ECO** or **ECO-S** in the class notation;

.2 Report on Survey of the Ship (form **6.3.10**).

4 REQUIREMENTS FOR THE EQUIPMENT OF SHIPS IN COMPLIANCE WITH THE DISTINGUISHING MARK ANTI-ICE IN THE CLASS NOTATION

4.1 GENERAL

4.1.1 Scope of application.

4.1.1.1 The requirements for the equipment of ships and FOP in compliance with the distinguishing mark **ANTI-ICE** in the class notation apply to ships and FOP (hereinafter for this Section referred to as "the ships") the design and equipment of which provide effective icing protection. These requirements are additional to the requirements of Part I "Classification", Part III "Equipment, Arrangements and Outfit", Part VIII "Systems and Piping" and Part XI "Electrical Equipment" of the Rules for the Classification and Construction of Sea-Going Ships, as well as Part II "Life-Saving Appliances", Part III "Signal Means", Part IV "Radio Equipment" and Part V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships.

4.1.1.2 Ships complying with the requirements of the present Section may be assigned with the distinguishing mark **ANTI-ICE** added to the character of classification.

4.1.1.3 The distinguishing mark **ANTI-ICE** in the class notation may be assigned to ships under construction and in service.

4.1.2 Definitions and explanations.

For the purpose of the present Section the following definitions and explanations have been adopted.

De-icing is removal of ice appearing on the ship's hull, structures and equipment.

Icing protection is a set of design and organizational measures aimed at reduction of the ship's icing and reduction of labour input into ice removal during operation of the ship.

Icing is a process of ice accretion on the ship's hull, structures and equipment due to sea water splashes or freezing of moisture condensating on the hull from the atmosphere.

Anti-icing is prevention of ice formation on the ship's structures and equipment by means of their heating or relevant covering.

Icing Protection Manual is a document describing actions of the ship's crew to provide icing protection. The scope of the Manual and contents of the information contained therein depend on the ship's type, purpose and area of navigation; they shall be chosen in the most efficient way and agreed with the Register.

4.1.3 Technical documentation.

4.1.3.1 The following technical documentation shall be submitted to the Register for approval to assign the distinguishing mark **ANTI-ICE** in the class notation:

.1 arrangement plan of anti-icing means with indication of their heating capacity;

.2 calculation of heating capacity of anti-icing systems equipment;

.3 electrical single-line diagram of anti-icing systems with heating cables (if any);

.4 circuit diagram of steam and/or thermal liquids anti-icing systems (if any);

.5 arrangement diagram of de-icing means;

.6 test program for anti-icing systems.

4.1.3.2 The following documents approved by the Register shall be kept onboard:

.1 Icing Protection Manual;

.2 Information on Stability including loading cases considering icing.

4.2 TECHNICAL REQUIREMENTS FOR ASSIGNING THE DISTINGUISHING MARK ANTI-ICE IN THE CLASS NOTATION

4.2.1 General.

4.2.1.1 Ships with the distinguishing mark **ANTI-ICE** in the class notation shall, as a rule, be fitted with a tank of a shape providing effective water flow under all operating loading cases.

Assignment of the distinguishing mark **ANTI-ICE** in the class notation to flush deck ships is subject to special consideration by the Register in each particular case.

4.2.1.2 The following anti-icing means may be used:

.1 heating of structures and equipment by means of steam, thermal liquid or heating cables;

.2 use of permanent (awnings, casings) or removable (covers) protective covers.

4.2.1.3 Besides heating of structures the following de-icing means may be used:

.1 washing and firing of ice by means of hot water or steam;

.2 anti-icing liquids;

.3 manual mechanical means including pneumatic instrument.

4.2.1.4 The use of alternative de-icing means (inflatable elastic tanks, ultrasonic and impulse means, de-icing coatings etc.) is subject to special consideration by the Register in each particular case.

4.2.1.5 If steam systems are used for anti-icing the requirements of Section **18**, Part VIII "Systems and Piping" shall be complied with.

4.2.1.6 If thermal liquid systems are used for anti-icing the requirements of Section **20**, Part VIII "Systems and Piping" shall be complied with.

4.2.1.7 If systems with heating cables are used for anti-icing the requirements of **15.4**, Part XI "Electrical Equipment" shall be complied with.

4.2.2 Stability and subdivision.

4.2.2.1 Ships with the distinguishing mark **ANTI-ICE** in the class notation shall comply with the requirements of Parts IV "Stability" and V "Subdivision".

4.2.3 Equipment, arrangements and outfit.

4.2.3.1 Platforms of outer ladders as well as platforms for servicing arrangements and equipment fitted on open decks shall have a grid structure or be equipped with heating elements.

4.2.3.2 Outer ladders located on the escape routes to life-saving appliances as well as muster stations to life-saving appliances (including guard rails) shall be equipped with anti-icing means.

4.2.3.3 Coamings of outer doors leading to the accomodation superstructure spaces and to spaces providing the ship's operation in accordance with its main purpose shall be heated.

Decks in areas of exit from the said spaces shall be equipped with anti-icing means.

4.2.3.4 A passage from the accomodation superstructure spaces to the equipment fitted in the fore part of the ship shall be provided on tankers, including chemical tankers and gas carriers. This passage shall be provided with anti-icing means.

4.2.3.5 Application of anti-icing means to the perched fore structures (masts, foundations of cargo-handling gear, etc.) is subject to special consideration by the Register in each particular case.

4.2.3.6 Side scuttles in the wheelhouse providing the arc of visibility required by **3.2**, Part V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships according to the ship's class shall be heated.

Windshield wipers on the said side scuttles (if any) shall be heated as well.

4.2.3.7 Shell doors, cargo doors and other closing appliances in the fore part of the ship providing the ship's operation in accordance with its main purpose shall be fitted with means for effective ice removal or other means to provide working capacity of the said appliances in case of icing (for example, with ice-breaking hydraulic cylinders).

4.2.3.8 Design of seals of cargo hatches, shell doors and other closing appliances providing the ship's operation in accordance with its main purpose shall preclude freezing of condensate inside seals.

4.2.3.9 Anti-icing shall be provided for the following arrangements and equipment:

.1 anchor and mooring equipment including (but not limited to) winches, capstans, windlasses, chain stoppers, drums, control panels;

.2 arrangements for emergency towing of tankers, including chemical tankers and gas carriers;

.3 hook releasing devices of lifeboats;

.4 launching appliances of survival craft (falls on drums, sheaves, winches of launching appliances, winch breaks and other elements engaged in launching);

.5 liferafts, including hydrostatic releasing devices.

The Register may require taking measures to prevent icing of additional equipment and arrangements in accordance with the ship's main purpose.

4.2.3.10 Lifeboats shall be of enclosed type and be equipped with the relevant heating elements to prevent icing and blocking of access hatches and/or doors.

4.2.3.11 Proper locations shall be provided on board for at-sea storage of removable covers used to prevent icing of equipment and fittings.

4.2.3.12 In addition to the emergency outfit specified in Section **9**, Part III "Equipment, Arrangements and Outfit", ships with the distinguishing mark **ANTI-ICE** in the class notation shall have the necessary de-icing outfit (crowbars, ice-axes, axes, shovels, spades) kept in places of permanent storage and having the relevant marking.

4.2.4 Systems and piping.

4.2.4.1 Sufficient number of scuppers and freeing ports shall be provided for the effective water flow from open decks. Scuppers and freeing ports shall be located so as to preclude water stagnation on decks under all operating loading cases.

4.2.4.2 Air heads of ballast tanks and fresh water tanks shall be fitted with the relevant heating devices.

4.2.4.3 Design of air intakes of main, auxiliary and emergency power plants as well as of ventilation of spaces, which are of great importance for the ship's safety, shall preclude their icing that may cause air duct blockage.

4.2.4.4 Measures shall be taken to preclude freezing of liquid in the pipelines of fire extinguishing systems by means of their effective drying or heating.

Fire hydrants, monitors, fittings and other equipment of fire extinguishing systems fitted on open decks shall be protected from icing by means of heating or removable covers.

Cut-off valve of water and foam fire extinguishing systems shall be fitted in enclosed heated spaces or shall be heated.

4.2.4.5 Hot water or steam supply shall be provided for de-icing on open decks.

4.2.4.6 In addition to **4.2.4.1** to **4.2.4.5** the following items shall be heated on tankers, including chemical tankers and gas carriers:

.1 ventilation valves and pressure/vacuum valves (P/V valves) of cargo tanks and secondary barriers;

.2 level, pressure, temperature gauges and gas analysers in cargo tanks located on open decks, if necessary;

.3 inert gas system elements containing water and located on open decks;

.4 emergency shut-down system (ESD) on gas carriers.

4.2.4.7 Drives of remotely operated fittings of tankers, including chemical tankers and gas carriers, fitted on open decks shall be equipped with anti-icing devices.

4.2.4.8 Pipelines equipped with electrical heating shall comply with the requirements of 5.**8**, Part VIII "Systems and Piping".

4.2.5 Electrical equipment, signal means, radio and navigational equipment.

4.2.5.1 The following electrical equipment, signal means, radio and navigational equipment located on open decks shall be designed so that to prevent icing or shall be heated:

.1 aerials of radio and navigational equipment (excluding rod aerials), aerial matching devices (if fitted on open decks);

.2 navigation lights;

.3 whistles;

.4 COSPAS-SARSAT satellite emergency position-indicating radio beacons;

.5 main and emergency lighting of open decks;

.6 TV cameras used during operation of the ship in accordance with its main purpose;

.7 aerials of telemetric and dynamic positioning systems.

4.2.5.2 If consumers, which according to 9.3.**1**, Part XI "Electrical Equipment" shall be fed from the emergency source of electrical power, are fitted with electrical heating, their heating elements shall be also fed from the emergency source of electrical power.

4.3 TESTS

4.3.1 Prior to tests the following shall be submitted to the Register surveyor:

.1 test program approved by the Register;

.2 Icing Protection Manual approved by the Register.

4.3.2 Anti-icing systems shall be tested in the scope of the approved program including demonstration of their operation for the purpose specified and measurement of their heating capacity.

4.4 RECORDS

4.4.1 As a result of applying the Requirements for the Equipment of Ships in Compliance with the Distinguishing Mark **ANTI-ICE** in the Class **N**otation the following records will be issued:

.1 Classification Certificate (form 3.**1**.**2**) with the distinguishing mark **ANTI-ICE** in the class notation;

.2 Report on Survey of the Ship (form **6**.3.**10**).

5 REQUIREMENTS FOR THE EQUIPMENT OF OIL TANKERS FOR CARGO OPERATIONS WITH OFFSHORE TERMINALS

5.1 GENERAL

5.1.1 Scope of application.

5.1.1.1 The requirements for the equipment of oil tankers for cargo operations with offshore terminals are additional to those of Part I "Classification", Part III "Equipment, Arrangements, and Outfit", Part VI "Fire Protection", Part VIII "Systems and Piping", Part IX "Machinery", Part XI "Electrical Equipment" and Part XV "Automation".

5.1.1.2 A distinguishing mark **BLS-SPM** may be added to the character of classification of ships equipped with the bow loading system and complying with the requirements of the present Section in the full scope.

A distinguishing mark **BLS** may be added to the character of classification of ships equipped with the bow loading system and complying with the requirements of the present Section except for 5.6.2 to 5.6.9 and 5.6.12 to 5.6.14.

A distinguishing mark **SPM** may be added to the character of classification of ships which are not equipped with the bow loading system but complying with the requirements in 5.6.2 to 5.6.9 and 5.6.12 to 5.6.14.A distinguishing The mark **SPM** may be also added to the character of classification of ships carrying liquefied gas in bulk.

5.1.1.3 Distinguishing marks **BLS-SPM**, **BLS** and **SPM** may be assigned to ships under construction and in service.

5.1.2 Definitions.

S i n g l e P o i n t M o o r i n g (S P M) is a floating or stationary offshore structure intended for mooring the oil tankers or floating offshore oil-and-gas production units and for offloading at sea or at anchorage.

O f f s h o r e t e r m i n a l is a ship or offshore structure which is used for mooring of the oil tanker for loading the cargo.

B o w l o a d i n g c o u p l e r is a device of special design which is a part of the bow loading system and which is used to connect the cargo hose of the offshore terminal to the ship cargo system.

B o w l o a d i n g s y s t e m (B L S) is a set of ship equipment located in the fore end of a ship and intended for loading the cargo to the ship from offshore terminals.

5.1.3 Technical documentation.

5.1.3.1 The following technical documentation (where applicable) shall be submitted to the Register to assign distinguishing marks **BLS-SPM**, **BLS** or **SPM** in the class notation:

.1 BLS general arrangement plan with an indication of the cargo system and mooring equipment including: bow loading coupler, guide roller, chain stopper, traction winch, hawse storage reel, BLS hull structures, control stations;

.2 description and drawings of the bow loading coupler;

.3 calculation and drawings of hull strengthenings for bow hawses and chain stoppers;

.4 fire protection diagram for BLS area;

.5 diagram and calculation of ventilation of BLS special spaces;

.6 drawings of BLS components and assembly units, which surfaces shall be protected by the materials precluding spark formation;

.7 drawings of electrical equipment layout and cable laying in BLS spaces;

.8 BLS circuit diagrams;

.9 BLS connection circuit diagrams;

.10 diagrams of BLS hydraulic system;

.11 BLS operating manual;

.12 BLS test program.

5.1.3.2 The Register may require additional documents to those listed in 5.1.3.1 proceeding from BLS design features.

5.2 SHIP STRUCTURE

5.2.1 Oil tankers equipped with BLS shall be fitted with CPP and thrusters or active means of ship's steering (AMSS) to enable sufficient maneuverability and ship stabilization during cargo operations.

5.2.2 Ships equipped with the dynamic positioning system shall be fitted with the devices for surveillance, verification, manual correction of the automated thrusters and automated propulsion system.

5.3 SHIP'S SPACES

5.3.1 Spaces where bow loading coupler and disconnecting couplings of the cargo pipeline are located, as well as the areas within the radius of 3 m from them are considered as hazardous zone 1 in accordance with 19.2.3, Part XI "Electrical Equipment".

5.3.2 Spaces adjacent to hazardous spaces and zones shall not open thereto and shall be equipped with the ventilation system providing at least 8 air changes per hour.

5.3.3 A space accommodating the bow loading coupler shall be provided with natural ventilation.

5.4 OPENINGS AND THEIR CLOSING APPLIANCES

5.4.1 Entrances, air inlets and other openings to machinery, service spaces and control stations shall not be faced to bow loading couplers and shall be located at a distance of at least 10 m from them.

5.4.2 Doors closing BLS shall comply with the requirements of 7.4, Part III "Equipment, Arrangements and Outfit".

5.4.3 Doors closing BLS, when in the open position, shall be protected from the contact with the metal parts of the equipment taken from the terminal by hardwood or equivalent electric insulating materials and by materials precluding spark formation.

5.4.4 When securing the BLS door there shall be no friction of spark-forming metals.

5.5 ANCHOR ARRANGEMENT

5.5.1 For the anchor arrangement of oil tankers fitted with BLS, design or procedural measures shall be taken to prevent its operation during loading the cargo through BLS.

5.6 MOORING ARRANGEMENT

5.6.1 Ships intended for operation with single point mooring (SPM) and having distinguishing marks BLS-SPM or SPM in the class notation shall be equipped with the mooring arrangement complying with the requirements of 5.6.2 to 5.6.9, 5.6.12 to 5.6.14.

5.6.2 The choice of the breaking strength of the mooring line shall be confirmed by the calculation and shall be subject to special consideration by the Register in each case.

Mooring lines shall comply with the requirements of 4.2, Part III "Equipment, Arrangements and Outfit".

Two mooring lines shall be used for mooring of ships of 150000 t deadweight and above. Each mooring line shall end with a chafing chain of 8 m in length and 76 mm in diameter.

The chain used for the chafing chain shall meet the requirements of 3.6, Part XIII "Materials" and shall be taken as follows:

Grade 3 for ships having a deadweight of up to 350000 t;

Grade R4 for ships of 350000 t deadweight and above.

5.6.3 The ship shall be equipped with one or two bow chain stoppers for the chain of 76 mm in diameter and one or two bow fairleads of at least 600 × 450 mm according to Table 5.6.3.

Table 5.6.3

Ship deadweight, in t	Number of bow chain stoppers	Number of bow fairleads	Safe working load (SWL), in kN
⩽100000	1	1	2000
>100000 and <150000	1	1	2500
⩾150000	2	2	3500

5.6.4 Bow chain stopper shall be capable of holding the chain of 76 mm in diameter in closed position and shall be designed so that in the open position the said segment of chain and its connection details would freely pass through. The upper yield stress of bow stopper material shall be determined based on the load of at least 2,0 SWL.

5.6.5 Bow chain stoppers shall be located between 2.7 and 3.7 m inboard from the bow fairleads, provided the bow fairlead, stopper and vertical roller (if any) or the winch drum or capstan drum shall be aligned.

5.6.6 In way of the chain stopper location the deck shall be sufficiently strengthened to withstand horizontal loads equal to 2,0 SWL.

5.6.7 The chain stopper shall remain in the closed position when the driving energy disappears. The chain stopper shall be manually driven to be opened.

5.6.8 A single bow fairlead shall be located at the ship centerline. Where two fairleads are fitted they shall be arranged symmetrically on each side of ship's centerline at a distance of 2 to 3 m between them.

The fairlead shall be oval or round in shape, the radius of fairlead rounding shall be at least 3,5 of the chain diameters.

The upper yield stress of fairlead material shall be determined based on the load of at least 2,0 SWL as specified in 5.6.3.

Hull strengthenings in way of the bow fairlead shall be calculated to take up the load equal to 2,0 SWL directed at an angle of ± 45° in the horizontal plane and ±15° in the vertical plane from the fairlead axis.

5.6.9 The arrangement components which are in contact with the chafing chain shall be protected by materials precluding spark formation.

5.6.10 BLS mooring machinery shall comply with the requirements of 1.2, 6.1, 6.4, Part IX "Machinery".

5.6.11 BLS traction winch shall be fitted with a manual drive of drum for release of the hawser when the driving energy disappears.

5.6.12 Where a chain stopper is provided, the braking force of the automatic brake of BLS mooring machinery as required in 6.4.3.1, Part IX "Machinery" may be reduced to the value enabling paying out of the hawser with the constant tension equal to the rated pull of the drive.

5.6.13 The pull at a reel of the mooring winch or capstan used for BLS operation with SPM shall be at least 147 kN.

5.6.14 Where SPM pick-up rope is kept onboard, the winch storage drum used to stow the SPM pick-up rope shall be sufficient size to accommodate the rope of 150 m in length and of 80 mm in diameter.

5.7 SPECIAL ARRANGEMENT

5.7.1 Where a ship with BLS is provided with a special emergency towing arrangement it shall comply with the requirements of 5.6.9 in addition to those specified in 5.7, Part III "Equipment, Arrangements and Outfit".

5.8 SYSTEMS AND PIPING

5.8.1 Cargo system.

5.8.1.1 Cargo piping shall comply with the requirements of 9.2.3 to 9.2.7; 9.3.7, 9.5, Part VIII "Systems and Piping", considering the following:

.1 other facilities to ensure galvanic intrinsic safety may be used instead of those specified in 9.3.7, Part VIII "Systems and Piping" which is subject to special consideration by the Register;

.2 BLS piping shall be self-draining with a drainage to the cargo tank;

.3 provision shall be made for a tray of sufficient capacity with a drainage system for ships having in way of bow loading coupler a spraying system precluding cargo spills propagation.

5.8.1.2 Remote-controlled valves shall comply with the requirements of 4.1.1.2 to 4.1.1.5, Part VIII "Systems and Piping".

5.8.2 Hydraulic systems.

5.8.2.1 Hydraulic systems shall comply with the requirements of 7.3, Part IX "Machinery".

5.8.2.2 Hydraulic accumulators shall be located in the space not communicating with the hazardous spaces as specified in 5.3.1.

5.8.2.3 Hydraulic accumulators shall be provided with devices capable of being manually activated when driving energy disappears.

5.8.2.4 Design of the hydraulic drive of the bow loading coupler and chain stopper shall prevent its opening when driving energy disappears.

5.8.2.5 The possibility of manual disconnection of bow loading coupler from the terminal cargo hose in case of hydraulic system failure shall be provided from the local station.

5.9 SOUNDING ARRANGEMENTS AND AUTOMATION

5.9.1 Cargo control during BLS operation shall be realized from BLS control station that may be located either in the wheelhouse or in a specially equipped room in the fore part of the ship.

The control station shall be equipped with all necessary monitoring and control instruments to carry out all operations for ship positioning and monitoring of the ship mooring and loading parameters.

Where the BLS control station is located in the fore part of the ship, the requirements of 5.10.2 and 5.12 shall be met.

5.9.2 To provide ship positioning the BLS control station shall be equipped with the following:

.1 control system for the controllable pitch propellers of the main propulsion plant (if any);

.2 thrusters control system;

.3 main engine(s) emergency shutdown arrangement;

.4 steering gear(s) control system;

.5 radar display;

.6 log display;

.7 device for monitoring of dynamic positioning system parameters (if any).

5.9.3 To provide monitoring of ship mooring parameters the BLS control station shall be equipped with the following:

.1 devices for indication and logging by recording device (if any) of hawser and cargo hose tension with actuation of alarm for maximum value;

.2 devices for indication and logging by recording device (if any) of chain tension in chain stopper.

5.9.4 To provide monitoring of ship loading parameters the BLS control station shall be equipped with the following:

.1 device for indication of bow loading coupler position;

.2 device for cargo system valves position indication;

.3 device for cargo tanks level indication and high level alarm;

.4 device for cargo pipe pressure indication at BLS inlet;

.5 device for signal transmission from ship to terminal for cargo pump stop and cargo valve closing on the terminal.

5.9.5 Bow loading coupler, chain stopper, cargo system valves shall be provided with position indicators (open-closed).

5.9.6 BLS control system shall provide blocking of the bow loading coupler inlet valve from being opened until receiving a confirmation that the following actions have been carried out:

.1 terminal cargo hose is properly connected to the bow loading coupler;

.2 sufficient number of ship cargo system valves and BLS cut-off valve are opened, oil tanker is ready for loading the cargo.

5.9.7 BLS control system shall provide blocking of the bow loading coupler inlet valve from being opened in case of BLS mooring arrangement blackout or failure.

5.9.8 Quick-acting emergency shutdown system (ESD) shall be provided for the bow loading coupler. ESD shall provide two operating modes:

.1 first emergency shutdown mode (ESD-**1**) which shall provide the following:

giving a signal for cargo pump stop on the terminal;

closing the bow loading coupler inlet valve and the terminal discharge valve upon receipt of a signal of emergency pressure drop at ship cargo system inlet;

.2 second emergency shutdown mode (ESD-2) which shall provide the following:

giving a signal for cargo pump stop on the terminal;

closing the terminal discharge valve, the bow loading coupler inlet valve and the BLS cut-off valve upon receipt of a signal of emergency pressure drop at ship cargo system inlet;

disconnection of bow loading coupler;

opening of chain stopper.

ESD-**1** and ESD-2 commands shall be given from the BLS control station by means of appropriate controls (buttons, switches). After issuing the command the execution of all the above mentioned functions shall be performed sequentially in automatic mode.

Where ESD-**1** mode is deactivated before the above mentioned sequence of operations has been carried out, the operations shall be completed automatically. In this case the bow loading coupler inlet valve and the BLS cut-off valve shall be fully closed.

Where ESD-2 mode is deactivated before the above mentioned sequence of operations has been carried out, the operations shall be immediately interrupted except for the bow loading coupler inlet valve and the BLS cut-off valve which shall be fully closed.

Controls for activation of ESD-**1** and ESD-2 modes shall be protected from unauthorized use.

5.9.9 Additionally to automatic system specified in 5.9.7, provision shall be made for back-up manual system of emergency disconnection of bow loading coupler by means of which the independent operations for releasing the chain stopper and the locking arrangement of the bow loading coupler shall be provided.

5.9.10 The sequence and time of cargo operations in the emergency disconnection mode shall ensure minimum cargo leakage and preclude the hydraulic shock in the cargo pipeline.

The time of closing of the bow loading coupler inlet valve and the BLS cut-off valve shall be at least 25 s both in automatic and manual modes. The shorter time of closing shall be proved by the calculation confirming the absence of possibility of hydraulic shock in the cargo pipeline.

5.10 FIRE PROTECTION

5.10.1 Boundaries of spaces where BLS cargo system equipment is located shall comply with the requirements of 2.4, Part VI "Fire Protection".

5.10.2 BLS control station in the fore part of the ship shall comply with the following requirements:

.1 BLS control station shall be of "A-**60**" class boundaries;

.2 maintenance of surplus pressure shall be provided in the space;

.3 an emergency exit from the space shall be provided.

5.10.3 Fire-fighting equipment and systems shall comply with the requirements of Section **3**, Part VI "Fire Protection".

5.10.4 The area where BLS cargo and mooring arrangements are located shall be protected by the foam fire extinguishing system independent from the main system.

5.11 ELECTRICAL EQUIPMENT

5.11.1 Electrical equipment shall comply with the requirements of Part XI "Electrical Equipment".

5.11.2 Electrical equipment fitted in the hazardous areas shall comply with the requirements 2.**9**, 2.**10**, **19**.2.**3** and **19**.2.4, Part XI "Electrical Equipment".

5.11.3 Lighting of the loading area and the boundary along it shall provide efficient visual monitoring of the mooring arrangement, cargo hose connection, cargo hose and water surface around.

5.12 COMMUNICATIONS

5.12.1 Where the BLS control station is located in the fore part of the ship, provision shall be made for two-way internal communications between the wheelhouse and the cargo control room in accordance with **3.3**.2, Part VII "Machinery Installations" and 7.2, Part XI "Electrical Equipment".

5.12.2 Two-way communications shall be provided between the BLS control station and the terminal.

5.12.3 Emergency communications shall be provided between the BLS control station and the terminal.

5.12.4 Provision shall be made for direct and indirect means enabling to check communications between the

BLS control station and the terminal in case of failures and faults during cargo operations.

5.13 TESTS

5.13.1 All BLS systems and components shall be tested after their installation onboard in accordance with the programs approved by the Register.

5.13.2 The first cargo operation on the prototype ship of the series using BLS shall be carried out in the presence of the surveyor to the Register. At that the BLS operation for the purpose specified shall be checked in accordance with the operating manual.

Whether the surveyor to the Register shall attend the first cargo operations on board the other ships of the series shall be determined proceeding from the BLS tests on board the prototype ship.

5.14 RECORDS

5.14.1 The following records are issued on the basis of application of the requirements of the present Section:

.1 Classification Certificate (form **3.1.2**) with the distinguishing mark **BLS-SPM**, **BLS** or **SPM** in the class notation;

.2 Report on Survey of the ship (form 6.**3.10**).

6 REQUIREMENTS FOR HELICOPTER FACILITIES

6.1 GENERAL

6.1.1 Application.

6.1.1.1 Requirements for helicopter facilities are additional to those of Part I "Classification", Part II "Hull", Part III "Equipment, Arrangements and Outfit", Part VI "Fire Protection", Part VIII "Systems and Piping", Part XI "Electrical Equipment" of the Rules for the Classification and Construction of Sea-Going Ships and Part IV "Radio Equipment" of the Rules for the Equipment of Sea-Going Ships.

6.1.1.2 Ships and fixed offshore platforms (hereinafter referred to as "ships" for the present Section) complying with the requirements of the present Section may be assigned with the following distinguishing marks added to the character of classification:

.1 HELIDECK — for ships fitted with helidecks and complying with the requirements specified in **6.2**, **6.3**, **6.4.1**, **6.6** and **6.7**;

.2 HELIDECK-F — for ships fitted with the helicopter refuelling facilities and complying with the requirements specified in **6.4.2** (as applicable), **6.5.1** and 6.5.2 (as applicable) in addition to those of **6.1.1.2.1**;

.3 HELIDECK-H — for ships fitted with a hangar and complying with the requirements of the present Section in a full scope.

6.1.1.3 Distinguishing marks **HELIDECK**, **HELIDECK-F** or **HELIDECK-H** may be assigned to ships under construction and in service.

6.1.1.4 Ships shall also meet the requirements of International Civil Aviation Organization (ICAO) and the Flag State (if any) for ensuring safe operation of helicopters which shall be confirmed by the relevant statement or certificate issued by the appropriate Civil Aviation Authority.

6.1.2 Definitions.

Hangar is a purpose-built space for helicopter storage and/or maintenance and repair.

Helideck is a purpose-built helicopter take-off and landing area including all structures, fire-fighting appliances and other equipment necessary for the safe operation of helicopters.

Helicopter facility is a complex of technical means including a helideck, helicopter refuelling facilities and compressed gas or special liquid filling facilities (if any), as well as hangars and spaces where helicopter maintenance facilities are located (if any).

Final approach and take-off area (FATO) is a defined area over which the final phase of the approach manoeuvre to hover or landing of the helicopter is intended to be completed and from which the take-off manoeuvre is commenced.

Touchdown and lift-off area (TLOF) is a dynamic load-bearing area on which a helicopter may touchdown or lift off. For a helideck it is presumed that the FATO and the TLOF will be coincidental.

6.1.3 Technical documentation.

6.1.3.1 The following technical documentation shall be submitted to the Register for approval (as applicable) to assign distinguishing marks **HELIDECK**, **HELI-DECK-F** or **HELIDECK-H** in the class notation:

.1 helideck and hangar deck plans with indication of design loads;

.2 scantlings determination of helideck and hangar deck, as well as of deck- and bulkhead stiffeners in way of helicopter tie-down points;

.3 general arrangement plan of a helicopter facility elements with indication of escape routes, tie-down points, location of fire-fighting equipment and life-saving appliances, arrangement plan and specification of lighting and illumination means;

.4 drawing of helideck safety net;

.5 diagram of power driving gear for the helideck safety net hoisting and lowering, if any;

.6 diagram of helideck drainage system;

.7 diagram of fuel oil loading, transfer, storage and helicopter refuelling system;

.8 diagram of off-grade aviation fuel collection, storage and defueling system;

.9 diagram of nitrogen system for aviation fuel;

.10 electric diagram of main and emergency lighting in the spaces of helicopter facility arrangement;

.11 circuit diagram of helideck lighting and illumination means;

.12 drawings of electrical equipment layout and cable laying on the helideck, in hangar and in other spaces of helicopter facility arrangement;

.13 documentation on helideck and hangar deck covering;

.14 helicopter facility test program;

.15 diagram of obstacle restriction and removal approved by the Flag State Civil Aviation Authority (to be submitted for information);

.16 drawing of helideck and obstacle marking (colour, dimensions and configuration of marks shall be indicated), approved by the Flag State Civil Aviation Authority (to be submitted for information).

6.1.3.2 Helicopter facility operation manual containing equipment description, a checklist of inspections, guidance for the safe operation and equipment maintenance procedures shall be provided on board. This operation manual shall also contain the procedures and precautions to be followed during helicopter refuelling operations developed in accordance with the recognized safe practices.

For mobile offshore drilling units (MODU) and fixed offshore platforms (FOP) this operation manual can be included in the operating manual to be developed in compliance with the requirements of Chapter 14 of the Code for the Construction and Equipment of Mobile Offshore Drilling Units, 2009.

6.1.3.3 The Register may require additional documents to those listed in **6.1.3.1** proceeding from the ship design features.

6.2 HELIDECK DESIGN

6.2.1 Helideck arrangement with regard to provision of horizontal and vertical sectors for helicopter approach, landing and take-off shall comply with the requirements of ICAO and the Flag State (if any).

6.2.2 Helideck arrangement shall provide:

.1 free helicopter approach to helideck;

.2 safety of helicopter take-off and landing operations and maintenance personnel;

.3 helideck location at a maximum possible distance from the ship's hazardous spaces and areas.

6.2.3 Helideck may have any configuration in plan view, generally, circle or regular polygon. In any case FATO shall be of sufficient size to contain an area within which can be drawn a circle of diameter not less than D of the largest helicopter the helideck is intended to serve, where D is the largest dimension of the helicopter when the main and tail rotors are turning.

6.2.4 If the helideck forms the ceiling of a deckhouse or superstructure it shall be of "A-60" class.

6.2.5 Helideck shall be made of steel. Aluminum alloys may be used provided the following:

.1 a helideck, irrespective of its type and location, shall be subject to a survey in case of fire on the helideck or in close proximity;

.2 if a helideck is located above the deckhouse or similar structure, the following conditions shall be additionally satisfied:

.2.1 the deckhouse top and bulkheads below the helideck shall have no openings;

.2.2 windows below the helideck shall be provided with steel covers.

.3 surfaces of the steel and aluminium alloy structures contacting at the point of connection and exposed to sea water shall be separated by gaskets made of non-absorbent electrically insulating material. Bolts, nuts and washers connecting the steel and aluminium structures shall be made of stainless steel. Bolts shall be installed in the bushes made of non-absorbent electrically insulating material which structure shall exclude the contact of aluminium alloy and steel. The aluminium alloy structure insulated from the steel structure shall be grounded to the ship's hull;

.4 bimetal materials shall be approved by the Register, and certificates shall be issued for them by the Register.

6.2.6 Helideck on FOP shall be sloping or prominent for drainage to avoid accumulation of rain water and fuel spills on FATO surface. Inclination of these sloping or prominent surfaces shall be about 1:100. Sagging of helideck surface induced by helicopter at rest shall not lead to accumulation of fuel spills on FATO surface.

6.2.7 Helidecks and helicopter refuelling areas shall be clearly marked and provided with coamings and/or gutters to prevent fuel oil leakage from spreading.

6.2.8 Design of the helideck being the upper deck or superstructure or deckhouse shall comply with the following requirements:

.1 deck longitudinals shall be installed parallel to the helicopter axis at the take-off and landing;

.2 thickness of deck plating, section modulus and web cross-sectional area of longitudinals and beams shall be determined according to 3.2.4.1 – 3.2.4.3, Part II "Hull" at Q determined as per Formula (3.2.3.4) of Part II "Hull" and l_a and l_b equal to 0,3 m. In Formula (3.2.3.4) Q_0 shall be taken equal to the maximum take-off weight of the helicopter, $k_d = 3$, $n_0 = 2$, $n = 1$;

.3 scantlings of deep members and pillars as well as thickness of deck plating for the helicopter having skid instead of wheels shall be determined by direct calculation.

6.2.9 Helideck not being a part of the upper deck or superstructure or deckhouse shall comply with the following requirements:

.1 the plating thickness, section modulus and web cross-sectional area of longitudinals and beams shall be determined according to **6.2.8** of this Part and **2.12** of Part II "Hull" both for the short superstructure deck or deckhouse of the relevant tier;

.2 dimensions of stanchions and struts shall be determined according to **2.9** of Part II "Hull" as for the pillars;

.3 dimensions of beams, stanchions and struts shall be determined with due regard to inertia force from the deck structure weight. Accelerations for determination of inertia forces shall be determined as per 1.3.3.1 and 1.3.4.4 of Part II "Hull";

.4 when the deck projects out of the sheer line, the requirements thereto are subject to special consideration of the Register;

.5 aluminium alloys may be used. Strength and stability of helidecks from aluminium alloys may be determined by the model tests to be conducted in the presence of the Register representative according to the approved program.

6.3 EQUIPMENT OF HELIDECKS

6.3.1 The helideck surface shall be smooth, no steps or recesses in FATO are generally allowed. 'As an exception, the steps on the FATO perimeter line (outside the helideck white perimeter line) shall not exceed 250 mm in height, and within the FATO (within the helideck white perimeter line) shall not exceed 25 mm in height. Objects the function of which requires that they be located on the helideck within the FATO shall only be present provided they do not cause a hazard to helicopter operations.

'As an exception, for ships which keels are laid before 1 January 2012, the steps within the FATO of height not exceeding **60** mm with the edge slop **1/3** are allowed.

6.3.2 The helideck, including its marking, and hangar deck shall have a skid-resistant surface.

6.3.3 For helicopter operation in winter period easily detachable rope net, rather of natural fiber (sisal), diameter of 20 mm and maximum mesh dimensions 200 × 200 mm, shall be provided along the perimeter of the FATO.

Recommended dimensions of the net, depending on the overall helicopter length, are determined by sufficiency to cover the landing area:

6 × 6 m at helicopter length less than 15 m;

12 × 12 m at helicopter length from 15 to 20 m;

15 × 15 m at helicopter length more than 20 m.

The net shall be reliably secured to the deck along the FATO perimeter and fixed to it in any 1,5 m and shall be tightened with a load not less than 2225 N.

The dismounted net shall be kept onboard.

6.3.4 Outboard edges of the helideck shall be provided with fixed or hinged safety net of at least 1,5 m in width, made of fire-resistant flexible material.

For MODU and FOP, as well as for sea-going ships, which keels are laid before 1 January 2012, outboard edge of the fixed safety net shall not rise above the plane of FATO more than 0,25 m, and the net shall be inclined upwards at an angle of at least 10°.

For MODU and FOP, as well as for sea-going ships, which keels are laid on and after 1 January 2012, outboard edge of the fixed safety net shall not rise above the plane of FATO, and the net shall be inclined upwards at an angle of at least 10°.

Hinged safety net in tumble position shall comply with the same requirements.

The safety net shall be strong enough to withstand, without damage, a 75 kg mass being dropped, and the net shall provide hammock effect for person falling into it rather than the trampoline effect produced by some rigid materials.

6.3.5 In addition to the requirements of **6.3.4** the hinged safety net shall comply with the following requirements:

.1 safety net shall be reliably secured in a hoist position;

.2 safety net shall be reliably fixed in a hinged position so as to prevent its hoist due to the effect of airflow from the helicopter rotor;

.3 safety net hoisting and lowering shall be performed so as to minimize the risk of personnel falling overboard during the operations;

4. any failure of power driving gear for safety net hoisting shall not prevent from its lowering by hand.

6.3.6 To minimize the risk of personnel or equipment sliding from the helideck, the outboard edges of the helideck shall have coamings of recommended height of 50 mm. The coamings shall also meet the requirements of **6**.2.7.

6.3.7 The helideck in way of helicopter parking place and maintenance areas, as well as the hangar (if any) shall be equipped with the tie-down points and means for fastening of helicopter maintenance facilities (if any), flush type is preferable. Connection dimensions, arrangement plan and design forces of tie-down points shall be selected for fastening of one or several types of helicopter taking into account the requirements of **6.3**.1.

6.3.8 Where handrails associated with access/escape points exceed the elevation of the FATO by more than 0,25 m, they shall be made collapsible and removable. They shall be collapsed or removed whilst helicopter manoeuvres are in progress.

6.4 FIRE PROTECTION

6.4.1 Fire protection of helidecks.

6.4.1.1 The helideck shall be provided with both main and emergency means of escape and access for fire-fighting and rescue personnel. These shall be located as far apart from each other as practicable, and preferably on the opposite sides of the helideck.

If more than 50 per cent of the helideck area is projected from the main ship structure, it is recommended to arrange two entrances to helideck within the range of such overhanging parts that is providing at least one exit from helideck to windward side in case of fire.

6.4.1.2 Helideck shall be protected by a fixed foam fire extinguishing system according to item 20 of Table 3.1.2.1 of Part VI "Fire Protection".

The minimum capacity of the foam production system depends upon the size of the area to be protected and the foam consumption rate, the minimum foam application rate shall be not less than **6** l/m^2 within a circle having a diameter equal to at least the *D*-value.

'Amount of foam concentrate shall provide a minimum of 5 min discharge capability of a circle having a diameter equal to the *D*-value.

Foam delivery at the minimum application rate shall start within **30** s of system activation.

The foam concentrate shall be suitable for use with seawater and meet the requirements not interior to those, which are adopted by ICAO.

The location and characteristics of the equipment of the foam fire extinguishing system shall provide extinguishing of fire on helicopter high-level units.

It is recommended to provide additionally 100 per cent reserve of foam concentrate for supply of its calculated value in case of helicopter landing after partial use of foam concentrate in testing, drills or fire extinction.

6.4.1.3 The number and position of fire hydrants shall be such that at least two jets of water may reach any part of the helideck.

6.4.1.4 In close proximity to the helideck the following fire-fighting outfit shall be provided and stored near the means of access to that helideck:

.1 at least two dry powder fire extinguishers having a total capacity not less than 45 kg;

.2 carbon dioxide fire extinguishers having a total capacity not less than 18 kg or equivalent; fire extinguishers shall be equipped with flexible nozzles for extinguishing a fire in the upper part of a helicopter;

.3 at least two nozzles of an approved dual-purpose type with hoses sufficient to reach any part of the helideck;

.4 at least two sets of fireman's outfits in addition to those required by item 10 of Table 5.1.2, Part VI "Fire Protection";

.5 at least the following equipment stored to provide its immediate use and protection from weather exposure:

adjustable wrench;
blanket (fire-resistant);
cutter for bolts with at least 60 cm handle;
hook, grab or salving;
hacksaw, heavy duty, complete with 6 spare blades;
ladder;
lifeline of 5 mm in diameter and 15 m in length;
pliers, side-cutting;
set of assorted screwdrivers;
harness knife complete with sheath;
crowbar;
3 pairs of fireproof gloves (recommended);
rescue axe of non-blocking type (recommended);
universal shears or equivalent cutting tool (recommended).

6.4.1.5 Drainage facilities in way of helidecks shall be constructed of steel or other arrangements providing equivalent fire safety; lead directly overboard independent of any other system; and designed so that drainage does not fall onto any part of the unit.

6.4.2 Fire protection of hangars and spaces where helicopter refuelling and maintenance facilities are located.

6.4.2.1 Structural fire protection, fixed fire extinguishing systems and fire detection and alarm systems and fire-fighting outfit for hangars and spaces where helicopter refuelling and maintenance facilities are located shall be similar to those of category A machinery spaces.

6.4.2.2 The boundary structures of hangars and spaces where helicopter refuelling and maintenance facilities are located shall be made of steel.

6.4.2.3 Refuelling station for helicopters shall meet the following requirements:

.1 the boundaries and means of closing openings at the station shall secure gas tightness thereof. Doors leading to the station shall be of steel;

.2 deck covering shall preclude spark formation. Arrangements and machinery shall be so arranged and located as to exclude the possibility of spark formation;

.3 pipelines and cables passing through the boundaries of the station shall not cause loss of its gas tightness;

.4 storage tank fuel pumps shall be provided with means which permit remote shutdown from a safe location in the event of a fire. Where a gravity-fuelling system is installed, equivalent closing arrangements shall be provided to isolate the fuel source;

.5 where several fuel tanks are fitted, the fuel system design shall provide for fuel supply to the helicopter being refuelled only from one tank at a time;

.6 provision shall be made for the arrangement whereby a fuel spillage may be collected and drained into an off-grade fuel tank;

.7 fuel oil piping shall be of steel or equivalent material, as short as possible, and protected against damage;

.8 the refuelling facility shall incorporate a metering device to record the quantity of supplied fuel, a flexible hose with a nozzle fitted with a self-closing valve and a device to prevent over-pressurization of the fuel system.

6.4.2.4 The number and position of the hydrants shall be such that at least three jets of water may reach any part of the hangar.

6.4.2.5 "NO SMOKING" signs shall be displayed at appropriate locations in hangars and spaces where helicopter refuelling and maintenance facilities are located.

6.4.2.6 Storage of flammable liquids and materials, paint materials, lubricating oils, hydraulic liquids and any types of fuel in hangar is not allowed.

6.5 SYSTEMS AND PIPING

6.5.1 Helicopter refuelling systems.

6.5.1.1 Shipboard helicopter refuelling system shall provide bunkering, long-term storage, safety of fuel quality and continuous operation in expected operation conditions.

6.5.1.2 All the equipment used in refuelling operations shall be effectively earthed. All the equipment, arrangements, machinery and deck coverings shall be manufactured and installed so as to prevent spark formation.

6.5.1.3 Tanks used for storage of helicopter fuel shall be located on the open deck in specially designed area, which shall be:

.1 as remote as practicable from accommodation and machinery spaces, escape routes and embarkation stations, as well as from locations containing sources of ignition;

.2 isolated from areas containing sources of vapour ignition;

.3 the fuel storage area shall be provided with arrangements whereby fuel spillage may be collected and drained to off-grade fuel tank;

.4 where tanks for storage of helicopter fuel and off-grade fuel tanks are located in enclosed spaces, such tanks shall be surrounded by cofferdams filled with inert gas;

.5 in cofferdams referred to in **6.5.1**.3.5 the length of oil fuel line and the number of its detachable joints shall be kept to a minimum, and its valves shall be located in easily accessible places, generally, on the open deck;

.6 cofferdams referred to in **6.5.1.3.4** shall not be connected to any piping system serving other spaces.

6.5.1.4 Provision shall be made for fuel jettisoning from tanks of the helicopter located on the helideck or in hangar to the off-grade fuel tank. Provision shall be made for off-grade fuel delivery to the shore or ship's tanks.

6.5.1.5 Tanks used for storage of helicopter fuel and associated equipment shall be protected against physical damage and from a fire in an adjacent space or area. Tanks shall be protected against direct sunrays.

6.5.1.6 When equipping tanks for the storage of helicopter fuel with facilities for their emergency jettisoning precautions shall be taken to prevent the tank jettisoned from impact against ship's structures. The tanks shall be as remote as practicable from survival craft muster and embarkation stations and survival craft launching stations.

6.5.1.7 The fuel tanks shall be made of materials which resist attacks by corrosion and helicopter fuel.

Fuel may be stored both in transported and fixed tanks.

Tanks shall be efficiently secured, closed and bonded. The tanks shall be readily accessible for inspection.

Tanks and piping for anti-crystallization fluids shall be made of stainless steels.

6.5.1.8 Each fuel oil tank shall be fitted with filling, outlet, sounding and air pipes. The end of a filling pipe shall not be more than 300 mm above a tank bottom. It is recommended to use closed-type flow-meters. The sounding pipe shall end 30 to 50 mm above a tank bottom and shall be laid to the open deck.

6.5.1.9 Air pipes of fuel oil tanks shall be laid to a height of at least **2,4** m above the open deck. Open ends of air pipes shall be spaced at a distance of at least **10** m from air in-takes and openings of enclosed spaces with ignition sources, and from a deck machinery and equipment, which may present an ignition hazard, and shall be fitted with flame-arresting meshes or other fittings approved by the Register.

6.5.1.10 A fuel oil pump shall take in fuel oil simultaneously from one tank only. Pipelines shall be made of steel or equivalent material, shall be short (where possible) and shall be protected against damages.

6.5.1.11 Fuel oil pumps shall be provided with shutdown means positioned in a remote safe place. Service tanks shall be provided with quick-closing valves driven from outside the tank area.

6.5.1.12 All pipelines and equipment of the system for bunkering, storage and fuelling shall be electrically continuous and shall be earthed to the ship hull.

6.5.1.13 Fuel pipelines shall have no stagnant sections. Where it is structurally impossible to avoid stagnant sections, provision shall be made for pipe drainage by means of nitrogen purging or another way of pipeline emptying. The lower parts of piping system shall be provided with drain cocks to remove sediment to off-grade fuel tank.

6.5.1.14 Helicopter refuelling system shall be so designed as to provide free access for its maintenance, fuel sampling and repair.

6.5.1.15 Shipboard helicopter refuelling system shall comply with the requirements actual in the Civil Aviation of Flag State in part of bunkering, storage, cleaning, quality control and fuel filling. Refuelling facilities shall be certified (approved) for compliance with the requirements of the Flag State aviation regulations.

6.5.2 Ventilation system of hangars and spaces where helicopter refuelling and maintenance facilities are located.

6.5.2.1 Hangars and spaces where helicopter refuelling and maintenance facilities are located shall be provided with mechanical exhaust ventilation sufficient to give at least **10** air changes per hour. Fans shall be of flameproof design and shall meet the requirements of 5.3.3, Part IX "Machinery" and **19.3.4**, Part XI "Electrical Equipment".

6.6 ELECTRICAL EQUIPMENT

6.6.1 Electrical equipment and electric wiring of hangars and spaces where helicopter refuelling and maintenance facilities are located shall comply with the requirements of **2.9**, Part XI "Electrical Equipment".

6.6.2 Lighting and illumination means for helidecks shall comply with the requirements of **6.9**, Part XI "Electrical Equipment" of the Rules for the Classification and Construction of Sea-Going Ships and the Flag State Civil Aviation requirements.

6.7 COMMUNICATIONS

6.7.1 To ensure helicopter operation the ship shall be equipped with necessary radio and meteorological equipment in compliance with the Flag State Civil Aviation requirements.

6.8 TESTS

6.8.1 All systems and components of the helicopter facility when installed onboard shall be tested according to the programs approved by the Register.

6.8.2 Upon request of the Flag State Civil Aviation flight trials and/or test flights may be performed on ships in compliance with the Flag State regulatory documents.

6.9 RECORDS

6.9.1 As a result of applying the requirements of the present Section the following records will be issued:

.1 Classification Certificate (form 3.1.2) with the distinguishing mark **HELIDECK**, **HELIDECK-F** or **HELIDECK-H** in the class notation;

.2 Report on Survey of the Ship (form 6.3.10).

7 REQUIREMENTS FOR SHIP EQUIPMENT TO ENSURE LONG-TERM OPERATION AT LOW TEMPERATURE

7.1 GENERAL

7.1.1 Application.

7.1.1.1 The requirements for ship equipment and FOP (hereinafter for this Section referred to as "the ships") to ensure long-term operation at low temperature apply to ships intended for operation in cold climatic conditions, including the Gulf of Saint Lawrence, northern part of the Baltic Sea, the Arctic Ocean and Antarctic Seas, and are additional to the requirements of Part I "Classification", Part II "Hull", Part III "Equipment, Arrangements and Outfit", Part VII "Machinery Installations", Part VIII "Systems and Piping", Part IX "Machinery", Part XI "Electrical Equipment" and Part XIII "Materials" of the Rules for the Classification and Construction of Sea-Going Ships, Part II "Life-Saving Appliances", Part III "Signal Means", Part IV 'Radio Equipment" and Part V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships, as well as the Rules for the Cargo Handling Gear of Sea-Going Ships.

7.1.1.2 For ships complying with the requirements of the present Section a distinguishing mark **WINTERIZATION(DAT)** may be added to the character of classification at the shipowner's request. Design ambient temperature shall be indicated in brackets, for example: **WINTERIZATION(−40)**.

7.1.1.3 The necessary conditions for assigning the distinguishing mark **WINTERIZATION(DAT)** are as follows:

.1 availability of ice class not less than **Arc4** in compliance with **2.2.3**, Part I "Classification". At shipowner's request the distinguishing mark **WINTERIZATION(DAT)** may be assigned to ships of ice class **Ice3** and below, in this case the extent of compliance with the requirements of the present Section shall be subject to special consideration by the Register;

.2 availability of the distinguishing mark **ANTI-ICE** for ships fitted with equipment for icing protection in compliance with Section **4**;

.3 availability of the distinguishing mark for ships of high ecological safety not less than **ECO** or **ECO-S** in compliance with Section **3**.

7.1.1.4 The distinguishing mark **WINTERIZATION(DAT)** may be assigned to ships under construction and in service.

7.1.2 Definitions, explanations and abbreviations.

For the purpose of the present Section the following definitions, explanations and abbreviations have been adopted.

Accommodation spaces are spaces complying with the requirements of **1.5.2**, Part VI "Fire Protection".

Pollutant means any substance, which falls within the limits for marine disposal in compliance with MARPOL 73/78.

Enclosed space is a space with a direct access to the open deck which is fitted with an appropriate closure.

IBC Code — International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk;

LSA Code — International Life-Saving Appliances Code;

MARPOL 73/78 — International Convention for the Prevention of Pollution from Ships, 1973 and Protocol, 1978 thereto.

Open space is a space with a direct access to the open deck which is not fitted with closure or shall be kept open for long periods as regards operational conditions of equipment installed in this space.

Design ambient temperature (DAT) is the minimum average daily air temperature, in °C, which can take place during a five-year period of ship operation on the routs passing in the most unfavourable waters as regards cooling conditions.

Design temperature of the structure is the temperature, in °C, assumed for choosing of construction material. When the Rules or this Section contain no additional provisions, the design ambient temperature is assumed as a design temperature of the structure.

Test temperature is the test temperature of machinery, equipment or materials to confirm their fitness for use at design ambient temperature. Unless otherwise specified in the present Section, the test temperature shall be assumed **10** °C below the design ambient temperature.

Working liquids mean fuel and lubricating materials, and hydraulic oils necessary for normal operation of a ship and its equipment, as well as oil residues.

7.1.3 Technical documentation.

7.1.3.1 The following technical documentation shall be submitted to the Register for approval to assign the distinguishing mark **WINTERIZATION(DAT)** in the class notation:

.1 Manual on operation of ship at low temperature (Winterization Manual);

.2 one line diagrams of electric heating systems (electric heating appliances, systems utilizing heating cables);

.3 certificates for machinery, equipment, arrangements, outfit, foam concentrate, hydraulic liquids and lubricating oils, specified in the present Section, confirming suitability of their use at design ambient temperature;

.4 test programs for the equipment intended for prolonged exposure to low service temperatures, specified in the present Section.

7.1.3.2 The following documents approved by the Register shall be available on board the ship:

.1 Manual on operation of ship at low temperature (Winterization Manual);

.2 Information on Stability including loading cases considering icing;

.3 Information on Damage Trim and Stability;

.4 Ice Ship Safety Certificate (Ice Passport).

7.1.3.3 Technical documentation on products to be submitted for approval in addition to the Rules requirements is specified in the relevant Chapters of the present Section.

7.2 DESIGN TEMPERATURES

7.2.1 Design ambient temperature value is established by the shipowner according to the ship purpose and service conditions.

7.2.2 The following standard values of design ambient temperature are stipulated by the present Section: −30 °C (the distinguishing mark **WINTERIZATION(−30)**); −40 °C (the distinguishing mark **WINTERIZATION(−40)**); −50 °C (the distinguishing mark **WINTERIZATION(−50)**).

7.2.3 Application of the present Section requirements to ships intended for operation at design ambient temperature below −50 °C is subject to special consideration by the Register.

7.2.4 Design ambient temperature shall not be assumed above the temperature specified in **1.2.3.3** of Part II "Hull" for the appropriate ice class without special consideration by the Register.

7.2.5 Design temperature of hull structures shall be assumed according to **1.2.3.4** of Part II "Hull". In this case, design ambient temperature shall be assumed as the value of T_A.

7.2.6 For equipment and machinery installed on the open decks, as well as in the open spaces, the design ambient temperature shall be assumed as design temperature of structures. For equipment and machinery installed in unheated enclosed spaces exposed to the environment and adjoining unheated adjacent enclosed spaces the design ambient temperature shall be assumed as the design temperature. For equipment and machinery installed in unheated enclosed spaces exposed to the environment and adjoining heated adjacent enclosed spaces the temperature of 20 °C above the design ambient temperature shall be assumed as the design temperature of structure.

7.3 GENERAL REQUIREMENTS FOR SHIP DESIGN

7.3.1 Cargo and slop tanks (if any) of oil tankers (regardless of deadweight) shall be protected throughout the length by ballast tanks or compartments not intended for carriage of pollutants in compliance with regulation 19 of Annex I to MARPOL 73/78.

Location of cargo and slop tanks (if any) of chemical tankers relative to shell plating shall comply with the requirements of regulation 2.6 of the IBC Code depending on the ship's type. Therewith, for carriage of selected vegetable oils onboard the type 3 chemical tankers the requirements of regulation 4.1.3 of Annex II to MARPOL 73/78 shall be met. Other type 3 chemical tankers, as well as tankers intended for carriage of hazardous substances in bulk shall be fitted with cargo and slop tanks located at least at 760 mm distance from the shell plating.

7.3.2 Ship having any fuel oil tank with a capacity exceeding 30 m^3 shall have a double-hull construction to protect such tanks located in compliance with paragraphs 6 and 7 of regulation 12A, Annex I to MARPOL 73/78 regardless the total capacity of fuel oil tanks on board.

7.3.3 On all ships, the tanks intended for storage of working liquids except fuel shall be located at least at 760 mm distance from the shell plating, except the tanks with individual capacity of 30 m^3 and below.

7.3.4 Navigation bridge wings shall be closed.

Angles of view shall meet the requirements of 3.2, Part V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships. Bridge front, rear and side windows (including wings) shall be inclined from the vertical plane top out, at an angle of not less 10° and not more than 25°.

7.3.5 Exit from corridors of accommodations to the open deck shall be arranged through the heated companions.

7.3.6 A heated deckhouse shall be provided as a shelter for crew while performing the following functions: observation of the environment during the ship's movement or using guards whilst in a port.

7.3.6 When the ship is equipped for movement in the notch of an icebreaker, the adequate hull strengthening of the fore end shall be provided. Calculations of strengthening shall be submitted to the Register for consideration.

Where necessary, the appropriate arrangements for lifting the anchors from the hawse pipes, as well as the device for their fastening to the deck shall be provided.

7.4 EQUIPMENT, ARRANGEMENTS AND OUTFIT

7.4.1 Anchor arrangement.

7.4.1.1 Materials for manufacture of anchor shall meet the requirements of Section 8, Part XIII "Materials".

7.4.1.2 Materials for manufacture of anchor chain shall meet the requirements of **7.12.7**.

7.4.1.3 Materials of castings for manufacture of anchor hawse pipe shall meet the requirements of **7.12.4**.

The Register certificates issued for anchor hawse pipes to be installed onboard the ships with distinguishing marks **WINTERIZATION(−40)** and **WINTERIZATION(−50)** shall contain an indication whether it is allowed to use them at appropriate design ambient temperature.

7.4.1.4 Anchor stoppers shall meet the requirements of **3.6.1**, Part III "Equipment, Arrangements and Outfit".

The Register certificates issued for anchor stoppers to be installed onboard the ships with distinguishing marks **WINTERIZATION(−40)** and **WINTERIZATION(−50)** shall contain an indication whether it is allowed to use them at appropriate design ambient temperature.

7.4.2 Mooring appliances.

7.4.2.1 Materials of castings for manufacture of mooring bollards, fairleaders and other mooring appliances shall meet the requirements of **7.12.4**.

The Register certificates issued for mooring appliances to be installed onboard the ships with distinguishing marks **WINTERIZATION(−40)** and **WINTERIZATION(−50)** shall contain an indication whether it is allowed to use them at appropriate design ambient temperature.

7.4.2.2 Chain stoppers for single-point mooring to offshore terminals shall meet the requirements of **7.4.1.4**.

7.4.3 Towing arrangement.

7.4.3.1 Materials of castings for manufacture of bitts, towing bollards, fairleaders, chocks, roller and other towing arrangement shall meet the requirements of **7.12.4**.

The Register certificates issued for mooring appliances to be installed onboard the ships with distinguishing marks **WINTERIZATION(−40)** and **WINTERIZATION(−50)** shall contain an indication whether it is allowed to use them at appropriate design ambient temperature.

7.4.3.2 Chains of emergency towing arrangement shall meet the requirements of **7.12.7**.

7.4.4 Side scuttles.

7.4.4.1 Side scuttles of wheelhouse and cargo control room shall be provided with heating in compliance with **4.2.3.6** of the present Part.

7.4.4.2 Onboard the ships with distinguishing marks **WINTERIZATION(−40)** and **WINTERIZATION(−50)** the side scuttles with double glass shall be installed in accommodation spaces.

7.4.4.3 When the cargo deck is viewed through the side scuttles of master's cabin, at least one of these side scuttles shall be provided with heating.

7.4.4.4 External access or other equivalent means for cleaning of side scuttles of navigation bridge and cargo control room shall be provided.

7.4.5 Hatchways, shell doors, cargo doors.

7.4.5.1 Materials for manufacture of cargo hatch covers and hatchways of cargo tanks, shell doors, cargo doors, including seals shall meet the requirements of **7.12.1** to **7.12.6**.

7.4.5.2 Hydraulic liquids and lubricating oils shall be suitable for use at design ambient temperature.

7.4.5.3 The Register certificates issued for cargo hatch covers and cargo tanks, shell doors, cargo doors to be installed onboard the ships with distinguishing marks **WINTERIZATION(−40)** and **WINTERIZATION (−50)** shall contain an indication whether it is allowed to use them at appropriate design ambient temperature.

See circular 872

7.5 STABILITY AND SUBDIVISION

7.5.1 The requirements of Parts IV "Stability" and V "Subdivision" shall be met.

7.5.2 The ship shall be provided with a reliable draught measurement system whereby the forward and aft draughts can be easily determined.

7.6 MACHINERY INSTALLATIONS

7.6.1 Propulsion plants of ice class ships with distinguishing marks **WINTERIZATION(−30)**, **WINTERIZATION(−40)** and **WINTERIZATION(−50)** shall be capable of maintaining rated power and required rated torque at propeller shafts in a range of rotation speed corresponding to the appropriate operating conditions and modes in accordance with the assigned ice class.

7.6.2 Means shall be provided to ensure that machinery may be brought into operation from the dead ship condition without external aid, as well as storage and supply of fuel to the emergency diesel-generator having the following characteristics:

.1 winter diesel fuel with pour point temperature not exceeding −45 °C onboard the ships with a distinguishing mark **WINTERIZATION(−40)**;

.2 arctic diesel fuel with pour point temperature not exceeding −55 °C onboard the ships with a distinguishing mark **WINTERIZATION(−50)**.

7.6.3 Based on their design, the machinery, shafting, boilers and other pressure vessels, as well as pipelines of systems and fittings, shall remain operative during the ship stay at design ambient temperature.

7.6.4 Onboard the ships with distinguishing marks **WINTERIZATION(−40)** and **WINTERIZATION(−50)** air supply to main engines shall not lead to overcooling of machinery space. Technical means shall be provided to exclude increase of mechanical load on cylinders and pistons and bearings of main engines due to the harmful effect of reduced temperatures of scavenging air.

7.6.5 When environmentally hazardous refrigerants are used, the sterntube seals shall be so designed as to prevent leakage out of the seal housing when operated within the specified modes. Permissible leakage of non-toxic and biologically neutral refrigerants are not considered as pollution from ships.

7.6.6 Technical means shall be provided for complete shaft line turning during the ship stay in close floating ice.

7.6.7 In general, at least two auxiliary boilers shall be provided onboard the ships with distinguishing marks **WINTERIZATION(−40)** and **WINTERIZATION(−50)**.

7.6.8 In general, steel four-bladed propellers with detachable blades shall be used.

7.6.9 Ships shall be provided with technical means for replacing defective blades afloat.

7.7 SYSTEMS AND PIPING

7.7.1 Fittings, formed components, expansion joints.

7.7.1.1 Materials for manufacture of fittings, expansion joints and formed components of pipelines to be installed on the open decks, as well as in the open unheated spaces shall meet the requirements of **7.12.1** to **7.12.6**.

7.7.1.2 The **R**egister certificate issued for fittings, expansion joints and formed components of pipelines to be installed onboard the ships with distinguishing marks **WINTERIZATION(−40)** and **WINTERIZATION(−50)** and installed on the open decks, as well as in the open unheated spaces shall contain an indication whether it is allowed to use them at appropriate design ambient temperature.

7.7.1.3 Side fittings installed above the load waterline shall meet the requirements of **4.3.1.2** of "Systems and Piping".

7.7.2 Ballast **and** sewage systems.

7.7.2.1 Ballast system shall meet the requirements of 8.3.2, Part VIII "Systems and Piping".

7.7.2.2 Discharge pipeline of ballast system shall be provided with heating.

7.7.2.3 Where submerged electrically-driven ballast pumps are used, their serviceability at design ambient temperature shall be ensured and documented; and the relevant information shall be introduced into the certificates issued by the **R**egister.

7.7.2.4 Hydraulic liquids used as working media for ballast pumps driving and remotely controlled fittings shall be suitable for use at design ambient temperature.

7.7.2.5 Sewage holding tanks and pipelines leading thereto shall be located in heated spaces or provided with heating.

7.7.3 Fire extinguishing systems.

7.7.3.1 All fire pumps, including emergency fire pump, shall be placed in spaces with positive temperature.

7.7.3.2 Design of water fire main system and foam fire extinguishing system shall meet the requirements of **3.2** and **3.7**, Part VI "Fire Protection" considering the requirements of **4.2.4.4**.

7.7.3.3 A foam concentrate for foam fire extinguishing system shall be approved by the **R**egister and be stored in the space with positive temperature.

7.7.3.4 Air-foam nozzles intended for installation onboard the ships with distinguishing marks **WINTERIZATION(−40)** and **WINTERIZATION(−50)** shall work properly at required design ambient temperature and shall have the relevant **R**egister approval.

7.7.3.5 Fire hoses shall meet the requirements of 5.1.4, Part VI "Fire Protection" They shall be approved by the **R**egister and be suitable for operation at design ambient temperature.

7.7.4 Systems **of tankers and combination carriers.**

7.7.4.1 Cargo system.

7.7.4.1.1 Where submerged electrically-driven ballast pumps are used, their serviceability at design ambient temperature shall be ensured and documented and the relevant information shall be introduced into the certificates issued by the **R**egister.

7.7.4.1.2 Hydraulic liquids used as working media for ballast pumps driving and remotely controlled fittings shall be suitable for use at design ambient temperature.

7.7.4.1.3 The **R**egister certificates issued for cargo hoses of oil and chemical tankers shall contain an indication whether it is allowed to use them at design ambient temperature.

7.7.4.2 Bow loading system.

7.7.4.2.1 Materials of components of the bow loading system shall meet the requirements of **7.12.1** to **7.12.6**.

7.7.4.2.2 Hydraulic liquids and lubricating oils shall be suitable for use at design ambient temperature.

7.7.4.2.3 The **R**egister certificates issued for bow loading system to be installed onboard the ships with distinguishing marks **WINTERIZATION(−40)** and **WINTERIZATION(−50)** shall contain an indication whether it is allowed to use it at appropriate design ambient temperature.

7.7.4.3 Inert gas system.

7.7.4.3.1 Sea water supply pipeline for deck water seal, a gas scrubber and other equipment of inert gas system shall be fitted with heating.

7.7.5 Ventilation system.

7.7.5.1 In addition to the requirements of Section **12**, Part VIII "Systems and Piping" the ventilation system shall meet the requirements of **4.2.4.3**.

7.8 DECK MACHINERY

7.8.1 Materials used for manufacture of deck machinery components shall comply with the requirements of **7.12.1** to **7.12.6**.

7.8.2 The Register certificates issued for deck machinery intended for installation onboard the ships with distinguishing marks **WINTERIZATION(−40)** and **WINTERIZATION(−50)** shall contain an indication whether it is allowed to use it at appropriate design ambient temperature.

7.8.3 Hydraulic liquids and lubricating oils shall be suitable for use at design ambient temperature.

7.9 LIFE-SAVING APPLIANCES

7.9.1 General requirements for life-saving appliances.

7.9.1.1 Life-saving appliances shall comply with the requirements of Part II "Life-Saving Appliances" of the Rules for the Equipment of Sea-Going Ships; at that, they shall be in the operating condition when stored at design ambient temperature.

7.9.1.2 The Register certificates issued for life-saving appliances intended for ships with distinguishing marks **WINTERIZATION(−40)** and **WINTERIZATION(−50)** shall contain an indication whether it is allowed to use them at appropriate design ambient temperature.

See circular 872

7.9.1.3 Life-saving appliances intended for ships with distinguishing marks **WINTERIZATION(−40)** and **WINTERIZATION(−50)** shall be marked **W(−40)** and **W(−50)** accordingly.

7.9.2 Lifeboats.

7.9.2.1 Lifeboats shall be of an enclosed type and shall comply with the following additional requirements with regard to Section 6, Part II "Life-Saving Appliances" of the Rules for the Equipment of Sea-Going Ships:

.1 a lifeboat shall provide accommodation for a specified number of persons in warm clothes with personal survival kits stipulated by **7.9.6.2**;

.2 a lifeboat keel shall be provided with additional strip of steel or other equivalent material to protect the keel from contact with ice; adequate protection is allowed;

.3 a lifeboat engine shall be equipped with a means for its cold start at design ambient temperature within 2 min from the start; a starter shall be driven from two independent sources of power;

.4 cooling system of a lifeboat engine shall ensure its operation at design ambient temperature;

.5 a lifeboat propeller shall be properly protected from damage by ice;

.6 lifeboat engine fuel oil and oils used shall provide engine safe operation at design ambient temperature;

.7 a lifeboat cockpit shall be electrically heated;

.8 lifeboat scuttles which provide the required visibility from a control station shall be heated;

.9 a lifeboat shall be fitted with a fixed two-way VHF radiotelephone apparatus in compliance with the requirements of **12.2**, Part IV "Radio Equipment" of the Rules for the Equipment of Sea-Going Ships; apparatus shall be operable at appropriate design ambient temperature;

.10 drinking water shall be stored in containers that allow for expansion due to freezing;

.11 a lifeboat shall be additionally supplied with a food ration in the quantity equal to **30** per cent of the ration required by the LSA Code to account for high rates of energy expenditure under cold conditions;

.12 a lifeboat on-load release mechanism shall be provided with heating or other measures ensuring safe actuation of a release mechanism at design ambient temperature shall be taken; See circular 872

.13 a suitable icing removal mallet or another tool for ice accretion removal complying with the requirements of **4.2.3.12** shall be available in the vicinity of a lifeboat.

7.9.3 Rescue boats.

7.9.3.1 Rescue boats shall comply with the following additional requirements with regard to Section 6, Part II "Life-Saving Appliances" of the Rules for the Equipment of Sea-Going Ships:

.1 only rigid rescue boats shall be used;

.2 safe starting of the engine at design ambient temperature shall be provided;

.3 rescue boat engine fuel oil and oils used shall provide engine safe operation at design ambient temperature;

.4 a rescue boat shall be fitted with a fixed two-way VHF radiotelephone apparatus in compliance with the requirements of **12.2**, Part IV "Radio Equipment" of the Rules for the Equipment of Sea-Going Ships; apparatus shall be operable at appropriate design ambient temperature.

7.9.4 Liferafts.

7.9.4.1 Liferafts shall comply with the following additional requirements with regard to Section 6, Part II "Life-Saving Appliances" of the Rules for the Equipment of Sea-Going Ships:

.1 inflation of a liferaft shall be completed within **3** min at design ambient temperature;

.2 containers of inflatable liferafts and hydrostatic release units shall be provided with heating or other measures to ensure ease launching, inflation and release of liferafts at design ambient temperature shall be taken;

.3 a manual inflation pump that is proven to be effective at design ambient temperature shall be stored in a heated space in the vicinity of the inflatable liferaft;

.4 liferafts shall be additionally supplied with a food ration in the quantity equal to 30 per cent of the ration required by the LSA Code to account for high rates of energy expenditure under cold conditions;

.5 a suitable icing removal mallet or another tool for ice accretion removal complying with the requirements of 4.2.3.12 shall be available in the vicinity of the liferafts.

7.9.5 Launching appliances of lifeboats, rescue boats and liferafts.

7.9.5.1 Launching appliances of lifeboats, rescue boats and liferafts shall comply with the following additional requirements with regard to Section 6, Part II "Life-Saving Appliances" of the Rules for the Equipment of Sea-Going Ships:

.1 materials used for their manufacture shall comply with the requirements of 7.12.1 to 7.12.6;

.2 hydraulic liquids and lubricating oils used in launching and embarkation appliances shall be suitable for use at design ambient temperature;

.3 electric motors and winches of launching appliances, automatic release hook shall be provided with heating or removable covers; if heating is not provided, a suitable icing removal mallet or another tool for ice accretion removal complying with the requirements of 4.2.3.12 shall be available in the vicinity of the launching appliance;

.4 electric motors, hydraulic drives, winches, brakes and other components of the launching appliance shall be effective at design ambient temperature, their operability shall be confirmed by appropriate testing;

.5 drums with falls, sheaves, winches, winch brakes and other components of the equipment engaged in launching shall be provided with heating or other measures ensuring safe launching of survival craft and rescue boats at design ambient temperature shall be taken.

7.9.6 Group and personal survival kits.

7.9.6.1 In addition to the equipment listed in Section 6, Part II "Life-Saving Appliances" of the Rules for the Equipment of Sea-Going Ships, group and personal survival kits shall be provided.

Personal survival kits (PSK) complying with the requirements of 7.9.6.2 shall be carried onboard the ship with a distinguishing mark **WINTERIZATION(DAT)** in the class notation whenever a voyage is expected to encounter mean daily temperatures below 0 °C.

Group survival kits (GSK) complying with the requirements of 7.9.6.4 shall be carried onboard the ship with a distinguishing mark **WINTERIZATION(DAT)** in the class notation whenever a voyage is expected to encounter ice conditions which may prevent the launching and operation of survival craft.

Sufficient number of group and personal survival kits (as applicable) shall be carried to cover at least 110 per cent of the rated complement of the ship.

7.9.6.2 A personal survival kit shall be stored so that it may be easily retrieved in an emergency situation (in cabins or in dedicated lockers near muster and embarkation stations).

A personal survival kit shall consist of the following items:

.1 clothing:

head protection — 1 (vacuum packed);

neck and face protection — 1 (vacuum packed);

hand protection — mitts — 1 pair (vacuum packed);

hand protection — gloves — 1 pair (vacuum packed), if they are not permanently attached to thermal protective aid;

foot protection — socks — 1 pair (vacuum packed);

foot protection — boots — 1 pair;

personal thermal protective aid complying with the requirements of 6.6, Part II "Life-Saving Appliances" of the Rules for the Equipment of Sea-Going Ships — 1;

approved immersion suit — 1 (not required, if an immersion suit is provided for every person onboard in compliance with 4.2.3.2 of Part II "Life-Saving Appliances" of the Rules for the Equipment of Sea-Going Ships);

thermal underwear — 1 set (vacuum packed);

.2 miscellaneous:

handwarmers for 240 h;

sunglasses — 1;

survival candle — 1;

matches —2 boxes;

whistle — 1;

drinking mug — 1;

pen knife — 1;

handbook (Arctic Survival) — 1;

carrying bag — 1.

Personal survival kits shall not be opened and used for training purposes and the following notice written in English or the language understood by the crew shall be displayed wherever they are stored:

"CREW MEMBERS AND PASSENGERS ARE REMINDED THAT THEIR PERSONAL SURVIVAL KIT IS FOR EMERGENCY SURVIVAL USE ONLY. NEVER REMOVE ITEMS OR SURVIVAL CLOTHING OR TOOLS FROM THE PERSONAL SURVIVAL KIT CARRYING BAG — YOUR LIFE MAY DEPEND ON IT".

7.9.6.3 In addition to the equipment listed in 7.9.6.2, it is recommended to include the following items in a personal survival kit:

impact-heated thermosoles for boots — 1 pair;

thermotowels for local body warming — 1 pack;

disposable diapers — 1 pack.

7.9.6.4 Group survival kit shall be stored in containers so that they may be easily retrieved in emergency; in general, containers shall be located adjacent to survival craft and be stowed on cradles; containers shall be floatable and be designed so that they may be easily moved over the ice.

A group survival kit shall consist of the following items:

.1 group equipment:

tents — **1** per 6 persons;

air mattresses — **1** per 2 persons;

sleeping bags — **1** per 2 persons (vacuum packed);

stove — **1** per tent;

stove fuel — **0**,5 l per person;

fuel paste — 2 tubes per stove;

matches — 2 boxes per tent;

pan (with sealing lid) — **1** per tent;

fortified health drink — 5 packets per person;

flashlight — **1** per tent;

candles and holders — 5 per tent;

snow shovel — **1** per tent;

snow saw — **1** per tent;

snow knife — **1** per tent;

tarpaulin — **1** per tent;

foot protection — boots — **1** pair per person;

GSK container — **1**;

.2 spare personal equipment (**1** set per GSK container):

head protection — **1** (vacuum packed);

neck and face protection — **1** (vacuum packed);

hand protection — mitts — **1** pair (vacuum packed);

hand protection — gloves — **1** pair (vacuum packed);

foot protection — socks — **1** pair (vacuum packed);

foot protection — boots — **1** pair;

personal thermal aid complying with the requirements of 6.6, Part II "Life-Saving Appliances" of the Rules for the Equipment of Sea-Going Ships — **1**;

thermal underwear — 1set (vacuum packed);

handwarmers for **240** h — **1** set;

sunglasses — **1**;

whistle — **1**;

drinking mug — **1**.

7.9.6.5 It is recommended to provide air mattresses included in a group survival kit with a self-inflation system.

7.9.6.6 Where a shot gun or hunting rifle is provided to protect survivors from wildlife, it shall be stored in a secure location readily available in an emergency.

7.10 CARGO GEAR

7.10.1 Cargo handling gear.

7.10 1.1 Materials for manufacture of cargo handling gear elements shall meet the requirements of **3.1** of the Rules for the Cargo Handling Gear of Sea-Going Ships and the requirements of **7.12.1** to **7.12.6**.

Design ambient temperature is assumed as design temperature of the structure.

7.10.1.2 When cargo-handling gear is equipped with operator's cabin it shall be provided with heating and fitted with window wiper.

Control panels of the cranes not fitted with cabins, as well as derricks, shall have heating or relevant shelter.

7.10.1.3 Necessary means for cold start of machinery of cargo handling gear at design ambient temperature shall be provided.

7.10.1.4 For hydraulic and electro-hydraulic cargo handling gear, heating of hydraulic liquid shall be provided.

7.10.1.5 Hydraulic liquids and lubricating oils shall be suitable for use at design ambient temperature.

7.10.1.6 The Register certificates issued for cargo handling gear to be installed onboard the ships with distinguishing marks **WINTERIZATION(−40)** and **WINTERIZATION(−50)** shall contain an indication whether it is allowed to use it at appropriate design ambient temperature.

7.10.2 Devices for cargo securing on open decks.

7.10.2.1 Materials of devices for securing cargo on open decks, including guides for fastening of deck containers shall meet the requirements of **7.12.1** to **7.12.4**.

7.10.2.2 The Register certificates issued for devices for securing cargo on open decks intended for installation onboard the ships with distinguishing marks **WINTERIZATION(−40)** and **WINTERIZATION(−50)** shall contain an indication whether it is allowed to use them at appropriate design ambient temperature.

7.11 ELECTRICAL, RADIO AND NAVIGATIONAL EQUIPMENT

7.11.1 Installation of cables.

7.11.1.1 Cables to be installed on the open decks and in the open unheated spaces shall be tested at following temperatures:

.1 for ships with distinguishing marks **WINTERIZATION(−30)** at temperature of **−40** °C and **WINTERIZATION(−40)** at temperature of **−50** °C;

.2 for ships with distinguishing marks **WINTERIZATION(−50)** at the temperature of **−60** °C;

.3 when design ambient temperature is below **−50** °C the testing temperature shall be **10** °C lower than the design ambient temperature.

7.11.1.2 Cable intended for installation on open decks shall have indications in the Register Certificate/Type Approval Certificate whether it is allowed to use it at appropriate temperatures.

7.11.1.3 Materials for manufacture of cable fastening parts (hangers, cable boxes, pipes) and cable sealing shall meet the requirements of **7.12.1** to **7.12.4**.

7.11.1.4 Means shall be provided to protect cable installed on open decks from mechanical damage at manual ice removal. Cable penetrations through open decks shall be covered by steel enclosures to a height of **0**,5 m from the transition point or equipment (whichever is closer).

7.11.2 Equipment.

7.11.2.1 All electric motors, switchboards and control panels provided on the open decks and in the open unheated spaces shall be equipped with the means of anticondensation heating.

7.11.2.2 All electrical equipment intended for installation on the open decks and in the open unheated spaces shall be tested for cold endurance according to 10.5.4.2, Part IV "Technical Supervision During Manufacture of Products" of the Rules for Technical Supervision During Construction of Ships and Manufacture of Materials and Products for Ships at the temperature in the chamber being 10 °C lower than the design ambient temperature or at the temperature of −40 °C (whichever is lower).

The Register certificates issued for electrical equipment to be installed on the open decks and in the open unheated spaces of ships with a distinguishing mark **WINTERIZATION(−50)** shall contain an indication whether it is allowed to use it at appropriate design ambient temperature.

7.11.2.3 All radio equipment intended for installation on the open decks and in the open unheated spaces shall be tested for cold endurance according to **4.2**, Appendix **1** to Section **15**, Part IV "Technical Supervision during Manufacture of Products" of the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships at the working temperature in the chamber being **10** °C lower than the design ambient temperature or at the temperature of −**40** °C (whichever is lower) and at the limiting temperature in the chamber being **20** °C lower than the design ambient temperature or at the temperature of −60 °C (whichever is lower).

The Register certificates issued for radio equipment to be installed on the open decks and in the open unheated spaces of ships with a distinguishing mark **WINTERIZATION(−50)** shall contain an indication whether it is allowed to use it at appropriate design ambient temperature.

7.11.2.4 All navigational equipment intended for installation on the open decks and in the open unheated spaces shall be tested for cold endurance according to **4.2**, Appendix **1** to Section **16**, Part IV "Technical Supervision during Manufacture of Products" of the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships at the working temperature in the chamber being **10** °C lower than the design ambient temperature or at the temperature of −**40** °C (whichever is lower) and at the limiting temperature in the chamber being **20** °C lower than the design ambient temperature or at the temperature of −60 °C (whichever is lower).

The Register certificates issued for navigational equipment to be installed on the open decks and in the open unheated spaces of ships with a distinguishing mark **WINTERIZATION(−50)** shall contain an indication whether it is allowed to use it at appropriate design ambient temperature.

7.11.2.5 The list of navigational equipment onboard the ships with a distinguishing mark **WINTERIZATION(DAT)** in the class notation shall meet the requirements of **2.2.3**, Part V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships in respect of additional requirements for the icebreakers, ships of ice classes **Arc4** to **Arc9**, as well as ships of all polar classes.

7.11.3 Lighting and signal means.

7.11.3.1 Ships shall be equipped with at least two suitable searchlights which shall be controllable from conning positions.

7.11.3.2 Searchlights specified in **7.11.3.1** shall be installed to provide, as far as is practicable, all-round illumination suitable for mooring, astem manoeuvres and emergency towing.

7.11.3.3 Searchlights specified in **7.11.3.1** shall be designed so as to prevent icing or shall be provided with heating.

7.11.4 Electrical heating appliances.

7.11.4.1 Electrical heating fed from emergency sources of electrical power shall be provided for the following ship spaces:

.1 wheelhouse;

.2 radioroom (if any);

.3 main machinery control room;

.4 cargo control room;

.5 fire extinguishing station;

.6 one of public spaces (for instance, messroom);

.7 hospital;

.8 engineering workshop.

7.11.4.2 Heating appliances capacity fitted in the above spaces shall provide positive temperature in these spaces at design ambient temperature.

7.11.4.3 Emergency sources of electrical power shall ensure supply of the above heating appliances during the time period stated in **9.3.1**, Part XI "Electrical Equipment".

7.11.4.4 Battery compartments shall be heated in compliance with the requirements of **13.3**, Part XI "Electrical Equipment". Heating appliances, where fitted, shall be fed from emergency source of electrical power. Thus, it is allowed to perform heating, when power is supplied only from the emergency source of electrical power, by any means in compliance with the international and national standards for explosive atmosphere.

7.12 MATERIALS

7.12.1 Materials used for hull structures and ship machinery items subject to the technical supervision of the Register in accordance with the relevant Parts of the

Rules shall comply with the requirements of Part XIII "Materials" and with the Register approved standards and/or with the Register agreed specifications.

7.12.2 Steel plates and sections for hull structural members, ship equipment and machinery intended for prolonged exposure to low service temperatures shall be selected toaccordance with **1.2.3**, Part II "Hull" with due regard to the adopted value of design ambient temperature. Proceeding from the selected strength level and service conditions, the requirements for steel are specified in 3.**2**, 3.5, 3.**13**, 3.14 and 3.**17** of Part XIII "Materials".

In particular cases, at the request of the Register, steel for essential hull structures may be used upon receipt of data on crack resistance of the steel. The information received shall be assessed with regard to the requirements of Part XII "Materials" of the Rules for the Classification, Construction and Equipment of Mobile Offshore Drilling Units and Fixed Offshore Platforms.

7.12.2.1 Steel for machinery and equipment foundations installed on the open decks, in open and enclosed unheated spaces shall comply with the requirements of **1.2.3.1**, Part II "Hull" (structural members of category I).

The design temperature of structure shall be assumed according to 7.2.6.

7.12.3 Welded and seamless steel pipes for systems on the open decks and in the open unheated spaces shall comply with the requirements of 3.4 and 3.16, Part XIII "Materials", with the Register approved standards and/or Register agreed specifications.

The material for pipes shall be selected proceeding from the purpose of the systems, with regard to their operating temperature and the requirements of 3.5, Part XIII "Materials" of the Rules, as well as the requirements of Table 2-4, Part IX "Materials and Welding" of the Rules for the Classification and Construction of Gas Carriers for the minimum design temperature of −55 °C.

7.12.4 The material of steel forgings and castings for the components of ship equipment, machinery and fittings installed on the open decks and in the open unheated spaces of ships shall comply with the requirements of 3.7 or 3.8, Part XIII "Materials" accordingly, or with the Register approved standards and/or Register agreed specifications.

The material for pipes shall be selected proceeding from the purpose of the forgings and castings, and with regard to their operating temperature and the requirements of 3.5, Part XIII "Materials".

7.12.5 Grey iron and ductile cast iron of ferritic structure is not permitted for the manufacture of components of ship equipment, machinery and fittings installed on the open decks and in the open unheated spaces of ships with a distinguishing mark **WINTERIZATION(DAT)** in the class notation.

7.12.6 Plastics, gasket and seal materials, as well as materials of organic origin used for ship equipment, machinery and fittings and for systems installed on open the decks and in the open unheated spaces of ships shall comply with the applicable requirements of Section 6, Part XIII "Materials", with the Register approved standards and/or with the Register agreed specifications. In addition, a documentary confirmation of the above materials reliability at design temperature shall be submitted.

7.12.6.1 The underwater hull and sides of at least **1**,0 m above the upper boundary of the ice strake shall have an ice resistant coating (unless clad steel is used for ice strake plating where the appropriate electrochemical protection is provided). The coating supply documentation shall be agreed between the shipowner, the shipyard and the coating manufacturer and shall be submitted to the Register for consideration.

7.12.6.2 The paint coatings of hull structures, machinery and equipment intended for prolonged exposure to low service temperature shall provide required resistance at the design temperature of the structure. The coating supply documentation shall be agreed between the shipowner, the shipyard and the coating manufacturer and shall be submitted to the Register for consideration.

7.12.7 The use of anchor and mooring chain cables of category **1** is not permitted.

The material for anchor and mooring chain cables shall comply with the requirements of 3.6 and Section **7** of Part XIII "Materials", as well as with the Register approved standards and/or with the Register agreed specifications. The maximum impact test temperature is equal to −**20** °C.

The results of steel test at operating temperature shall be submitted to the Register.

7.13 TESTS

7.13.1 Generally, the materials and equipment covered by the present Section are tested by the manufacturer in accordance with the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships.

7.13.2 After completion of construction of prototype ships with ice strengthening category **Arc4** and above, the additional sea trials in ice conditions shall be feasible due to the program developed by the shipowner and agreed with the Register. During the sea trials of prototype ships in ice conditions, provision may be made for checking the operability of anti-icing systems and equipment intended for exposure to low service temperatures.

7.14 RECORDS

7.14.1 As a result of applying the requirements of the present Section the following records will be issued:

.1 Classification Certificate (form 3.1.2) with the distinguishing mark **WINTERIZATION(DAT)** in the class notation;

.2 Report on Survey of the Ship (form 6.3.10).

8 REQUIREMENTS FOR PROPULSION PLANT REDUNDANCY

8.1 SCOPE OF APPLICATION AND MARKS IN THE CLASS NOTATION

8.1.1 Compliance with the requirements of this Section is mandatory for the ships, which are assigned according to the requirements of **2.2.27**, **Part I** "Classification" one of the following distinguishing marks added to the class notation:

.1 RP-1 – when the propulsion plant provides for the redundancy of its components, except the main engine, reduction gear, shafting and propeller; at that a single failure in any component of systems and equipment serving the said components shall not lead to the loss of propulsion, power and ship's steering;

.2 RP-1A – when the propulsion plant provides for the redundancy of its components, except the main engine, reduction gear, shafting and propeller; at that a single failure in any component of the propulsion plant, its auxiliary machinery and systems shall not lead to the loss of propulsion and ship's steering;

.3 RP-1AS – when the propulsion plant provides for the redundancy of its components, as required for **RP-1A**, and at that the main engines or the engines of the alternative propulsion plant are located in independent machinery spaces in such a way that the loss of one compartment due to fire or flooding shall not lead to the loss of propulsion, power and ship's steering;

.4 RP-2 – when the propulsion plant provides for the redundancy of its components and consists of several propulsion plants; at that a single failure in any component of the propulsion plant and steering gear shall not lead to the loss of propulsion, power and ship's steering;

.5 RP-2S – when the propulsion plant provides for the redundancy of its components, as required for **RP-2** and is located in two independent machinery spaces in such a way that the loss of one compartment due to fire or flooding shall not lead to the loss of propulsion, power and ship's steering.

8.1.2 Distinguishing marks **RP-1, RP-1A, RP-1AS, RP-2** or **RP-2S** may be assigned to the ships under construction and in service.

8.2 DEFINITIONS AND EXPLANATIONS

8.2.1 The alternative propulsion plant means the totality of machinery, systems and arrangements producing thrust for the ship's motion in emergency conditions in case of a failure of the main propulsion plant. A standby emergency engine, electric motor or shaft generator applied as a propulsion motors, may be used as the alternative propulsion plant. Total capacity of the alternative propulsion plant shall be at least one eighth of the total capacity of the main propulsion plant.

Auxiliary machinery and systems of the propulsion plant mean all the support systems (fuel system, lubricating oil system, cooling system, compressed air system, hydraulic system, etc.) required for normal operation of the propulsion machinery and propeller.

Main propulsion plant means the totality of machinery, systems and arrangements producing thrust for the ship's motion and comprising propulsion machinery of approximately equal capacity, auxiliary machinery and supporting systems, propellers, as well as all necessary monitoring, control and alarm systems. When the main propulsion plant consists of several engines, each of propulsion engines is considered the main one. When each propulsion plant in two-shaft or more propulsion plant is fully independent, every plant is considered as the main propulsion plant.

Propulsion device/propeller means the machinery (propeller, azimuth thruster, water jet propellers, etc.) converting mechanical energy of the propulsion machinery into thrust for the ship's motion.

Single failure in the propulsion plant means a failure either in an active component (main engine, generator, their local control system, remotely controlled valve, etc.) or in a passive component (pipeline, power cable, manually controlled valve, etc.) not leading to failures of other components.

Power of the propulsion plant means the total power of the propulsion machinery installed onboard the ship. Unless otherwise stated, the capacity of the propulsion plant shall not include the capacity produced by the propulsion machinery but used under normal operating conditions for other purpose than the ship's propulsion (e.g., power of the shaft generator).

Propulsion machinery means the machinery (diesel, turbine, electric motor, etc.) producing mechanical energy for the propeller drive.

Redundancy of the propulsion plant means single or repeated duplication of its components when the propulsion plant is arranged in such a way that a single failure of one of its active or passive components does not lead to the loss of propulsion and ship's steering under the external conditions specified in the **Rules**.

Marine power plant means the totality of machinery, systems and arrangements that provides the ship with all types of energy and may consists of the following components: main propulsion plant, alternative propulsion plant, electrical power plant, auxiliary machinery.

8.3 TECHNICAL DOCUMENTATION

8.3.1 To assign the distinguishing marks **RP-1**, **RP-1A**, **RP-1AS**, **RP-2** or **RP-2S** added to the class notation of the ship, the following documentation shall be submitted to the Register for approval (where applicable):

.1 calculation results demonstrating that a single failure does not lead to the loss of propulsion and ship's steering according to **8.5.3** (for ships with the distinguishing marks **RP-1A**, **RP-1AS**, **RP-2** or **RP-2S**). As an alternative, the results of the model or full-scale tests may be submitted;

.2 qualitative failure analysis for propulsion and steering (in compliance with Section **12**, Part VII "Machinery Installations") or Failure Mode and Effect Analysis (FMEA) of the propulsion plant components based on the failure tree or the equivalent risk analysis agreed with the Register;

.3 torsional vibration calculations in compliance with **3.2.8.5.11**, Part I "Classification"; at that the possibility of long-term operation of the alternative propulsion plant shall be considered separately;

.4 programmes of mooring and sea trials.

8.4 REQUIREMENTS FOR SHIPS WITH DISTINGUISHING MARK RP-1 IN THE CLASS NOTATION

8.4.1 All the components comprising the following auxiliary machinery and systems of the main propulsion plant shall be subject to redundancy:

.1 fuel oil system, including settling tanks, except the fuel oil filling, transfer and separation system;

.2 lubricating oil system of the propulsion machinery, reduction gear, shafting bearings, sterntube bearings, etc., except the oil filling, transfer and separation system;

.3 hydraulic systems providing operation of the propulsion unit couplings, controllable pitch propellers, reverse deflectors of water jet propellers, etc.;

.4 sea water and fresh water cooling systems serving the main propulsion plant;

.5 fuel heating systems in storage tanks serving the main propulsion plant;

.6 starting systems (air, electrical, hydraulic) serving the propulsion plant;

.7 electrical power sources;

.8 ventilation plants, where necessary, for example supplying air for cooling of primary movers;

.9 monitoring, alarm and control systems.

8.4.2 A single failure in the auxiliary pumps and components of the systems indicated in **8.4.1**, including damage of fixed piping, shall not lead to the loss of propulsion and ship's steering. To meet this requirement, the necessary by-pass piping and redundancy of equipment (pumps, heaters, etc.) shall be provided in the systems. In case of a single failure, reduction of the main engine output may be allowed but not exceeding 50 per cent.

8.4.3 Provision shall be made for disconnection of the sections of systems and piping where a failure occurred from the properly functioning sections.

8.4.4 The ship shall be provided with the main and auxiliary steering gears in compliance with **2.9** of Part III "Equipment, Arrangement and Outfit". Control of the main and auxiliary steering gears shall be independent and provided both on the navigation bridge and in the steering gear compartment.

8.5 REQUIREMENTS FOR SHIPS WITH DISTINGUISHING MARK RP-1A IN THE CLASS NOTATION

8.5.1 In addition to the requirements of **8.4**, the ships with distinguishing mark **RP-1**A in the class notation shall meet the requirements of **8.5**.

8.5.2 The main propulsion plant shall consist of two or more propulsion machinery, at that one reduction gear, one propulsion electric motor, one shaftline and one propeller are allowed. One of the propulsion machinery may be the alternative propulsion plant. Therewith, for independent systems serving the redundant machinery, there is no need to comply with the requirements of **8.4.2** regarding the redundancy of each component of the system.

8.5.3 In case of a single failure in the main propulsion plant, the existing propulsion machinery or the alternative propulsion plant shall provide the following under any conditions of ship's loading:

.1 ship's motion at a speed of 6 knots or 50 per cent of the specified speed of ship according to **1.1.3**, **Part** II "Hull", whichever is less, at a sea state 5 as per Beaufort scale;

.2 ship's steering sufficient for obtaining the safe position as regard to stability and maintenance of this position at a sea state **8** as per Beaufort scale;

.3 compliance with the requirements of **8.5.3.1** and **8.5.3.2** for at least **72** h; for ships the maximum duration of which voyage is less than **72** h, the above time may be restricted by the maximum duration of the voyage.

8.5.4 The alternative propulsion plant shall be put into operation not later than in 5 min after a failure in the main propulsion plant.

8.5.5 A single failure leading to the loss of one or more generators may be accepted, provided the Failure Mode and Effect Analysis (FMEA) demonstrates that after a failure sufficient power is produced to provide the ship's propulsion and steering in compliance with the requirements of **8.5.3** without the standby generator putting into operation.

After a failure the electrical power shall be sufficient to start the heaviest consumer without the electrical load imbalance.

At that the standby electrical pumps may not be considered for the electrical load balance while operating the alternative propulsion plant.

8.5.6 The main switchboard shall consist of two sections. In case of a failure in one section, the remaining one shall be capable to supply power to the following consumers:

.1 drives of the alternative propulsion plant and steering gears, including the hinged equipment;

.2 equipment for transmitting propulsive thrust;

.3 propulsion electrical motor, where available;

.4 propeller;

.5 auxiliary machinery and propulsion plant systems;

.6 monitoring, alarm and control systems.

8.5.7 Monitoring, alarm and control systems of the alternative propulsion plant shall be independent of the systems of the main propulsion plant.

8.6 REQUIREMENTS FOR SHIPS WITH DISTINGUISHING MARK RP-1AS IN THE CLASS NOTATION

8.6.1 In addition to the requirements of 8.5, the ships with distinguishing mark **RP-1AS** in the class notation shall meet the requirements of 8.6.

8.6.2 The main propulsion plant shall be fitted with at least two main engines located, at least, in two independent engine rooms according to 8.6.3 and 8.6.4. Non-redundant components of the main propulsion plant (reduction gear, propeller, shaftline, propulsion electric motor) common for several main engines shall be located in an independent space separated from the engine rooms with the main engines by a watertight bulkhead of "A-0" class fire integrity according to 2.7.1.2, Part II "Hull".

8.6.3 The bulkhead separating the engine rooms indicated in 8.6.2 shall be watertight bulkhead of "A-60" class fire integrity according to 2.7.1.2, Part II "Hull".

When the engine rooms are separated by cofferdams, tanks or other compartments, the bulkheads shall be at least of "A-0" class fire integrity but not lower than required for the adjacent spaces and compartments in Section 2, Part VI "Fire Protection".

8.6.4 When the closures are provided in the bulkheads indicated in 8.6.2 and 8.6.3, they shall meet the requirements of 7.12, Part III "Equipment, Arrangements and Outfit". These closures may not be considered as the emergency exits of the engine rooms.

8.7 REQUIREMENTS FOR SHIPS WITH DISTINGUISHING MARK RP-2 IN THE CLASS NOTATION

8.7.1 In addition to the requirements of 8.4 and applicable requirements of 8.5, the ship shall meet the requirements of 8.7.

8.7.2 The ship shall be fitted with at least two independent main propulsion plants.

In case of a single failure in one propulsion plant, at least 50 per cent of the ship propulsion power shall remain available and provide propulsion and ship's steering under any loading conditions.

8.7.3 In case of a single failure in one propulsion plant, the following requirements shall be met:

.1 a failure shall not affect the remaining propulsion plant, if it was operative at the moment of a failure (in particular, the drive power and speed shall not be significantly modified);

.2 the remaining propulsion plant, if not operative at the moment of a failure, shall be kept in hot standby in order to be ready for operation within 45 s after a failure;

.3 safety measures shall be provided for the failed propulsion plant, in particular, interlocking of shafting.

8.7.4 The ship shall be fitted with at least two independent steering gears according to 2.9, Part III "Equipment, Arrangements and Outfit". At that at a single failure of one steering gear, the remaining gear shall remain operative, as well as in case of a failure in the synchronizing system.

The ship's steering shall be provided under the conditions indicated in 8.5.3 even in case when one of the rudders is blocked at the maximum hard-over angle, at that the possibility shall be provided of the rudder shifting to the position parallel to the ship centreline and fixing the rudder in this position.

8.7.5 When only the azimuth thrusters are provided as propellers and devices for the ship control, at least two independently operated propulsion plants shall be provided.

The ship's steering shall be provided under conditions indicated in 8.5.3 even in case when one of the azimuth thrusters is blocked or disconnected, at that the possibility shall be provided of the thruster shifting to the position parallel to the ship centreline and fixing the thruster in this position.

8.8 REQUIREMENTS FOR SHIPS WITH DISTINGUISHING MARK RP-2S IN THE CLASS NOTATION

8.8.1 In addition to the requirements of 8.4, applicable requirements of 8.5 and the requirements of 8.7, the ship shall meet the requirements of 8.8.

8.8.2 The ship shall be fitted with at least two independent propulsion plants (including reduction gear, propeller and shafting) according to 8.7.2 and 8.7.3 and located, as a minimum, in two independent engine rooms.

8.8.3 The longitudinal bulkhead separating the engine rooms indicated in 8.8.2 shall be watertight bulkhead of "A-60" class fire integrity according to 2.7.1.2, Part II "Hull".

When the machinery rooms are separated by the cofferdams, tanks or other compartments, the bulkheads shall be at least of "A-0" class fire integrity but not lower than required for the adjacent spaces and compartments in Section 2, Part VI "Fire Protection".

8.8.4 When closures are provided in the longitudinal bulkhead indicated in 8.8.2, they shall meet the requirements of 7.12, Part III "Equipment, Arrangements and Outfit".

These closures may not be considered as the emergency exits of the machinery rooms.

8.8.5 The ship shall be fitted with at least two independent steering gears in compliance with 8.7.4 located, as a minimum, in two independent steering gear compartments.

8.8.6 The longitudinal bulkhead separating the steering gear compartments shall be watertight bulkhead of at least "A-0" class fire integrity according to 2.7.1.2, Part II "Hull".

8.8.7 The main sources of electrical power shall be located in separate compartments according to 8.8.3 and 8.8.4 that in case of fire or flooding in one compartment, power supply to the consumers indicated in 8.5.6 shall be provided.

8.8.8 The main switchboard shall be divided in two sections according to 8.5.6.

Each section shall be located in a separate compartment. The bulkhead separating the main switchboard compartments shall comply with the requirements of 8.8.3 and 8.8.4.

8.8.9 Automation, monitoring and control systems of the propulsion plants and steering gears shall be located in such a way that the loss of one engine rooms due to fire or flooding may lead to the loss of one propulsion plant or one steering gear only.

Control stations shall be arranged in such a way that in case of fire or flooding in one machinery space or one steering gear compartment the control functions shall be provided.

9 REQUIREMENTS FOR SHIPS EQUIPPED FOR USING GAS FUEL

9.1 GENERAL

9.1.1 Application.

The requirements of the present Section are intended for ships using a mixture of various hydrocarbon gases in compressed or liquefied condition as gas fuel.

When hydrocarbon gases with methane content below 85 per cent are used as fuel in ships it shall be subject to special consideration by the Register. Moreover, using gas fuel with methane content below 85 per cent shall be agreed with the flag state Maritime Administration.

If a ship is a gas carrier, other than the present requirements, it shall comply with the requirements of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) and the Rules for the Classification and Construction for Ships Carrying Liquefied Gases in Bulk.

If a ship is not a gas carrier, the use of gas fuel shall be specially approved by the flag state Maritime Administration.

In addition to these requirements, the ship shall comply with the requirements of the flag state Maritime Administration and the Port State Control.

In addition to sea-going ships, the requirements of the present Section are applicable to other offshore installations subject to the Register technical supervision, oil and gas production units and other offshore installations. Some paragraphs applied to the requirements shall be subject to special consideration by the Register with due regard to national requirements applicable to such installations.

9.1.2 Class **notation.**

Ships fitted for the use of gas fuel in compliance with the present Section are assigned a distinguishing mark GFS (Gas Fuelled Ship) added to the character of classification.

9.1.3 Terms and **definitions.**

In addition to the below mentioned, the definitions given in **1**.2, Part I "Classification" of the Rules for the Classification and Construction for Ships Carrying Liquefied Gases in Bulk are applicable to the requirements of this Section.

Non-hazardous atmosphere means air environment where gas concentration is lower than the level corresponding to activating an alarm on high gas concentration in the air.

Dual fuel engine means a heat engine so designed that both gas and fuel oil may be used as fuel, simultaneously or separately.

Gas safe machinery space means closed gas safe space with gas fuel consumers, explosion safety of which is ensured by installation of gas-containing equipment in gastight enclosures (piping, ducting, partitions) for gas fuel bleed-off, and the inner space of partitions and ducting shall be considered gastight.

Gas-safe space is a space other than a gas-dangerous space.

Gas area means an area where gas-containing systems and equipment are located, including the weather deck spaces above them.

Gas fuel means any hydrocarbon fuel having at the temperature of **37**,8 °C the absolute pressure of saturated vapors according to Reid equal to 0,28 MPa and above.

Gas- dangerous machinery space means closed gas-hazardous space with gas fuel consumers, explosion safety of which in case of gas fuel leakage is ensured by emergency shutdown (ESD) of all machinery and equipment which may be an ignition source.

Gas-dangerous space means a space in the gas area which is not equipped with an approved device to ensure that its atmosphere is at all times maintained in a gas-safe condition. It is subdivided into explosion hazard zones 0, **1** and 2, the boundaries of which are specified in **9**.**9**.2.

Gas-containing systems mean systems intended for storage, feed, supply and discharge of gas to ship consumers.

Master gas fuel valve means an automatic valve installed at gas supply pipeline to each engine located outside machinery space when the equipment for gas fuel combustion is used.

Gas fuel storage tank (GFST) means a tank designed as an initial gas fuel tank for storage on board the ship in liquid or compressed gaseous form.

CNG tank means compressed gas fuel storage tank.

LNG tank means liquefied gas fuel storage tank.

A, B and C type tanks mean independent tanks complying with the requirements to

A, B and C type independent tanks of gas carriers stated in the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk.

Fuel oil means any hydrocarbon fuel in compliance with **1**.**1**.2, Part VII "Machinery Installations".

Enclosed space means any space inside of which, in the absence of mechanical ventilation, natural ventilation is restricted in such a way that any explosive atmosphere is not subject to natural dispersion.

Open space means a space open from one or several sides, in all parts of which an effective natural ventilation is arranged via permanently open openings in the side partitions and in the above located deck.

Semi-enclosed space means a space restricted by decks and bulkheads where natural ventilation is available but its efficiency sufficiently differs from normal one at the weather deck.

Gas fuel storage room means a room where gas fuel storage tanks are located.

Gas fuel consumer means any ship equipment or machinery (engine, boiler, inert gas generator, galley stove, etc.) where gas fuel is used for generation of power or combustion products.

9.1.4 Technical documentation.

In addition to the technical documentation specified in Section **3**, Part I "Classification", the following technical data and ship documents confirming fulfillment of the Rules shall be submitted to the Register:

.1 drawings of fuel tanks arrangement with their distances from side plating and the bottom specified;

.2 drawings of supports and other structures to ensure fastening and limiting shifting of fuel tanks;

.3 calculations of heat emission from the flame which may occur during the fire affecting gas fuel tanks and other equipment and spaces related to gas fuel;

.4 drawings and diagrams of systems and piping for gas fuel specifying such assemblies as compensators, flange joints, stop and control fittings, drawings of quick closing arrangements of gas fuel system, diagrams of gas fuel preparation, heating and pressure control, calculations of stresses in piping containing gas fuel at a temperature below −**110** °C;

.5 drawings of safety and vacuum safety valves of gas fuel storage tanks;

.6 drawings and descriptions of all systems and arrangements for the measurement of cargo amount and characteristics, and for gas detection;

.7 diagrams of gas fuel pressure and temperature control and regulating systems;

.8 drawings and calculations of draining and ballast systems in gas-hazardous spaces;

.9 diagrams and calculations of gas-dangerous spaces ventilation;

.10 diagrams and calculations of gas-freeing system;

.11 circuit diagrams of electric drives and control systems for a fuel preparation plants, ventilation of hazardous spaces and airlocks;

.12 circuit diagrams of electric measurement and alarm systems for equipment related to the use of gas fuel;

.13 general arrangement drawings of electrical equipment related to the use of gas fuel;

.14 drawings of cable laying in hazardous spaces and areas;

.15 drawings of earthing for electrical equipment, cables, piping located in gas-dangerous spaces;

.16 justification of electrical equipment fitness;

.17 ship general arrangement drawings specifying the layout of:

gas fuel storage tanks and any openings in them;

spaces for fuel storage and preparation and any openings to them;

doors, hatches and any other openings into hazardous spaces and areas;

venting pipes and air inlet and outlet locations of a ventilation system of hazardous spaces and areas;

doors, scuttles, companions, ventilation duct outlets locations and other openings in spaces adjacent to hazardous area;

.18 data on the properties of gas fuel intended for the use on board the ship;

.19 analysis of risks related to the use and storage of gas fuel and possible consequences of its leakages as per the procedure agreed with the Register. The analysis shall consider the risks of damage of hull structural members and failure of any equipment after accident related to the use of gas fuel. The results of risk analysis shall be taken into consideration in the Operating manual.

Regarding the LNG tanks, the technical documentation shall be submitted in the extent required for approval of cargo tank for carrying LNG on board the gas carrier in compliance with the requirements of the Rules for the Classification and Construction of Gas Carriers and the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk.

Regarding the CNG tanks, the technical documentation shall be submitted in the extent required for approval of cargo tank for carrying CNG on board the gas carrier in compliance with the Rules for the Classification and Construction of CNG Gas Carriers.

When the standard cylinders are used, the calculation of permissible pressure shall be submitted.

9.2 GENERAL REQUIREMENTS TO SHIP STRUCTURE

9.2.1 All dimensions of hull structure elements, except for those specially mentioned in the present Chapter, shall be determined in accordance with the requirements of the Rules for the Classification and Construction of Sea-going Ships depending on purpose and constructive type of the ship.

9.2.2 Gas fuel storage tanks both in liquefied (LNG) and compressed (CNG) condition may be located directly at the weather deck of the ship or in special enclosed spaces in the ship's hull. In the enclosed spaces liquefied gas fuel shall be stored at the pressure not exceeding 1 MPa.

Membranes ensuring a seal between a deck and gas fuel storage tank shall be provided where the gas fuel storage tank gets through the upper weather deck. Therewith, the space located below the membrane may be considered as an enclosed gas-dangerous space, and the space above the membranes may be considered as an open space.

9.2.3 When located at the weather deck, gas fuel storage tanks shall be arranged at the distance of at least B/5 (one fifth of the ship's breadth) from the outer plating. On board ships not being passenger ships, upon special consideration of the Register, the distance from the outer plating may be reduced for up to less than B/5, but not less than 760 mm.

When located at the weather deck, the gas fuel storage tanks shall be located in the special partition made in the form of semi-closed space with sufficient natural ventilation preventing accumulation of gases in any part of it.

Under the storage tank for liquefied gas fuel a stainless steel tray shall be provided to prevent intrusion of liquefied gas to the deck in case of damage of piping connected to the tank below the possible level of liquefied gas.

Direct contact between the tray and the hull shall be avoided. Insulation shall be sufficient to ensure strength of hull structures in case of leakage.

9.2.4 Access to gas-dangerous spaces for their inspection shall be provided. The access shall be provided:

.1 to the spaces located in the ship's hull — directly from the weather deck through the openings, hatches and manholes with clear dimensions of at least 800 × 800 mm;

.2 to the spaces at the weather deck through the openings or manholes in the vertical walls with clear dimensions of at least 800 × 800 mm.

9.2.5 Gas fuel storage rooms.

9.2.5.1 When type C gas fuel storage tanks are located in special enclosed space, the storage tanks shall be located minimum at the distance of 1/5 of the ship's breadth or 11,5 m, whichever is lesser, from the side shell plating. Furthermore, gas fuel storage tanks shall be located minimum at the distance of 1/15 of ship's breadth or 2 m, whichever is lesser, from the bottom plating. For ships other than passenger ships a tank location closer than B/5 but not less than 760 mm from the ship side may be accepted upon the special consideration of the Register.

9.2.5.2 When the tanks other than type C tanks are used as gas fuel storage tanks, the ship shall have double sides and double bottom in the area of location of the gas fuel storage tanks. Height of double bottom shall be at least 1/15 of the ship's breadth or 2 m, whichever is lesser. Width of double side shall be at least 1/5 of ship's breadth or 11,5 m, whichever is lesser. When the width of double side and double bottom are different, the structure in the junction point shall be equal to those shown at Figs. 2.6-1 and 2.6-2, Part II "Gas Carrier Design" of the Rules for the Classification and Construction of Ships Carrying Liquefied Gases in Bulk.

9.2.5.3 Gas fuel storage rooms shall be gas-tight and access to them shall be located in the Gas-safe area at the weather deck. When the latter is not fulfilled, an air lock shall be provided at the access to the gas fuel storage tank. Air lock shall be formed by two self-closing steel gas-tight doors located at the distance of at least 1,5 m but not greater than 2,5 m from each other. Air lock coaming height shall be at least 300 mm.

9.2.5.4 Gas fuel storage rooms shall not be located adjacent to machinery spaces of category A.

If the machinery spaces are separated from the gas fuel storage room by cofferdams, then an additional fire-resistant insulation to class A-60 standard shall be fitted for one of the bulkheads.

9.2.5.5 When gas fuel storage tanks are double walled, the gas fuel storage room could be arranged as a tight enclosure covering any openings to gas fuel storage tanks and fittings installed on them. Joints of a bulkhead with the outer shell of the gas fuel storage tank shall be tight and fully welded.

9.2.5.6 Bilge system of the gas fuel storage tank rooms shall be made separate and shall not be connected to the bilge system for the rest of the ship spaces.

9.2.6 Gas compressor room and gas fuel pump room.

9.2.6.1 Compressor rooms and gas fuel pump rooms, if arranged, shall be subject to the requirements of **9.2.7** and **9.2.8** for gas fuel storage rooms.

9.2.6.2 Where compressors are driven by shafting passing through a bulkhead or deck, the bulkhead penetration shall be of gastight type.

9.2.7 Machinery spaces.

9.2.7.1 One of two below mentioned methods for provision of safety in the machinery space may be accepted:

engine room is considered gas safe. Furthermore, single failure of gas containing equipment located in such a space shall not result in accumulation of explosive concentration and the requirements of **9.2.7.2** shall be met;

engine room is considered gas dangerous. Furthermore, single failure of gas containing equipment located in such space results in accumulation of explosive concentration, therewith, safety is provided by the emergency shutdown of any ignition sources and the requirements of **9.2.7.3** shall be met.

9.2.7.2 To consider the engine room gas safe the following requirements shall be met:

pipes and equipment with gas fuel shall be installed in tight pipes with inert gas (pipe inside the pipe) or continuously ventilated duct in compliance with the requirements of **9.5.3.2** or **9.5.3.3**;

electrical equipment inside the duct shall be explosion-proof;

when leakage is detected, supply of gas fuel to the equipment shall be stopped, and the piping shall be blown off using the fittings given in **9.5.3.4**. In this case another piping for supplying fuel oil or gas fuel or, in the installations with several main engines, a separate piping for supplying another main engine shall be provided.

9.2.7.3 When the engine room is considered gas dangerous space, the following requirements shall be met to ensure its safety:

piping and equipment containing gas fuel are located directly in the engine room, therewith gas safe and gas dangerous parts of the engine room are separated by a ventilated lock;

gas dangerous part of the engine room shall be continuously actively ventilated in compliance with **9.7.12**;

all electrical equipment inside the gas dangerous part of the engine room is of explosion-proof version;

inside the engine room gas concentration is constantly monitored in accordance with **9.8.4**, and in case of leakage the main gas valve shall be closed, gas supply to the engine room shall be shut down and all the sources of ignition shall be stopped (including the main engine).

9.2.7.4 Use of gas engine rooms specified in **9.2.7.5** is only allowed, when at least one more main engine is available on board ship which is located outside the engine room so protected and the power of which is roughly equal to the power of the engines located in the gas-hazardous engine room. Arrangement of the engines in two fully autonomous gas-hazardous spaces is allowed.

9.2.7.5 Arrangement of boilers, incinerators and other equipment with fuel nozzles in the gas-hazardous spaces is not allowed.

9.2.7.6 Use of gas-dangerous engine rooms specified in **9.2.7.3** is only allowed when gas fuel is applied, the density of which at normal conditions is lower than the air density and the pressure in gas fuel piping shall not exceed **1** MPa.

9.2.7.7 Use of gas-hazardous machinery spaces on gas carriers is only permitted subject to approval of the flag state Maritime Administration.

9.3 DESIGN OF GAS FUEL STORAGE TANKS

9.3.1 General requirements to gas fuel storage tanks

9.3.1.1 Gas fuel storage tanks shall be supported by the hull in a manner which will prevent movement of the tank under static and dynamic loads.

A possibility of contraction and expansion for the structures, forming the cargo tank, under temperature variations without due stresses of the tank and hull structures shall be ensured.

Gas fuel storage tanks with supports shall be designed for a static angle of heel of **30**°.

The supports shall be calculated for the most probable maximum resulting acceleration determined in compliance with **3**.5 of Part IV "Cargo Tanks" of the RS Rules for the Classification and Construction of Ships Carrying Liquefied Gases in Bulk.

9.3.1.2 The design of the gas fuel storage tank attachment to the hull shall provide for special stops which can withstand horizontal forces due to the ship's collision equal to 0,5 and 0,25 of the weight of the tank and cargo in the forward and aft directions respectively; any damages therewith to cargo structures shall be prevented.

9.3.1.3 A structural analysis of gas fuel storage tank structures and tank supports shall be carried out on the assumption that the loads specified in **9.3.1.2** and loads generated due to heel according to **9.3.1.1**, are not superimposed on the forces due to ship's hull deformation in the seas.

9.3.1.4 Provision shall be made for structural measures to prevent potential gas fuel storage tanks shifting relative to the ship's hull under the inertia forces caused by rolling.

9.3.1.5 The design of independent tanks shall provide for antifloating arrangements (keys, stops, etc.) which withstand an upward force caused by an empty tank in a gas fuel storage tank space flooded to the full-load draught; in such a case, a stress in ship's hull structure elements is not exceed yield point.

9.3.1.6 Each gas fuel storage tank (LNG or CNG) shall be provided with a tank isolation shutoff valve capable of being remote operated. The valve shall be located as close to the tank as possible at any piping connected to the tank or directly on the tank.

9.3.1.7 For single fuel (gas only) installations at least two gas fuel storage tanks of approximately equal capacity shall be provided and they shall be located in separate spaces.

9.3.2 Liquefied gas fuel storage tanks.

9.3.2.1 Liquefied gas storage tanks (LNG) shall be designed in compliance with the requirements of Part IV

"Cargo tanks" of the RS Rules for the Classification and Construction of Ships Carrying Liquefied Gases in Bulk for transfer of liquefied gas fuel tanks.

9.3.2.2 Each LNG tank shall be fitted with relief valves in compliance with the requirements to safety valves of cargo tanks set forth in Part VI "Systems and piping" of the Rules for the Classification and Construction of Ships Carrying Liquefied Gases in Bulk.

9.3.2.3 Liquefied gas storage tanks shall be fitted with shut-off valves in compliance with the requirements to safety valves of LNG transportation tanks set forth in the Part VI "Systems and piping" of the Rules for the Classification and Construction of Ships Carrying Liquefied Gases in Bulk.

9.3.2.4 The outlets of venting pipes from the pressure relief valves shall be located at least B/3 or 6 m, whichever is greater, above the weather deck and 6 m above the working area and gangways. Gas outlet pipes shall be designed so that the outgoing gas shall be directed upwards and the possibility of water and snow ingress into the system shall be kept to minimum.

9.3.2.5 All gas outlets shall be located at the distance of at least 10 m from:

the nearest air inlet or openings in the accommodation and service spaces and control posts or from other gas safe spaces;

outlets in the engine room.

9.3.3 Compressed gas storage **tanks.**

9.3.3.1 Compressed gas storage tanks (CNG) shall be designed in compliance with the requirements of Part X "Boilers, heat exchanger and pressure vessels" of the Rules for the Classification and Construction of Seagoing Ships. Standard cylinders, for which it is necessary to make calculation of permitted pressure, and specially designed pressure vessels may be used as compressed gas storage tanks.

9.3.3.2 Each compressed gas storage tank shall be equipped with relief valves complying the requirements for cargo tanks in compliance with Section 2, Part VI Systems and piping" of the Rules for the Classification and Construction of Ships Carrying Liquefied Gases in Bulk.

9.3.3.3 Relief valves of CNG tanks located in the hull or at the weather deck of gas carrier shall be connected with gas outlet piping. Gas outlets from the relief valves shall meet the requirements of 9.3.2.3 and 9.3.2.4.

9.4 GAS FUEL CONSUMERS ON BOARD SHIP

9.4.1 Internal combu**stion engines.**

9.4.1.1 General requirements for Internal Combustion Engines.

9.4.1.1.1 Engine crankcases shall be fitted with explosion relief valves in way of each crankshaft crankthrow. Design and actuating pressures of explosion relief valves shall be specified with due regard to the possible explosion of gas fuel leakage accumulated in the crankcase.

9.4.1.1.2 Crankcase of trunk-piston engines shall be protected as follows:

.1 to prevent accumulation of gas fuel leakage, the ventilation of crankcases shall be provided. Air pipe ends shall be led to safety place and fitted with flame arresters;

.2 detectors of gas fuel leakage or any other equivalent equipment shall be installed.

Device for automatic admission of inert gas is recommended for installation;

.3 mounting of oil mist concentration sensor in the crankcase shall be provided.

9.4.1.1.3 Crankcase of a cross-head type engine shall be equipped with oil mist concentration sensor or temperature control system of the engine bearings. Sub-bearing spaces of the cross-head engine shall be provided with gas fuel leakage detectors or any other equivalent devices.

9.4.1.1.4 When gas fuel is supplied to the cylinders as part of gas or vapour mixture via the common inlet header, the inlet gas or vapour collector shall be fitted with an explosion relief valve or another explosion relief device to ensure its sufficient strength to withstand the explosion.

9.4.1.1.5 Exhaust gas collectors shall be fitted with explosion relief valves or other explosion relief devices, the dimensions of which shall be designed to withstand explosion of gas fuel entering it in case of no ignition in one cylinder.

9.4.1.1.6 Exhaust gas pipes of gas-fuelled engines shall be provided with effective means of blowing off and shall not be combined with exhaust gas piping from other engines, boilers and incinerators. All exhaust gas piping shall be fitted with spark arresters.

9.4.1.1.7 Branch pipes of starting air piping laid to each cylinder shall be equipped with flame arresters. Engine gas collector connection with shipboard gas fuel piping shall ensure the necessary flexibility. The connection of the engine gas collector with the ship gas piping shall provide the necessary flexibility. The connection of the gas fuel supply collector to the gas fuel injection valves shall provide complete coverage by the protection pipes or ducts.

9.4.1.1.8 Lubricating oil system and cooling water system of gas-fuelled engines shall be equipped with the effective gas extraction measures fitted after the outlet of oil and cooling water from the engine. Air pipes for extraction of gas from the said means and from oil daily tanks and cooling tanks shall be extracted to open parts in a safety place.

9.4.1.1.9 Measures for monitoring of fuel combustion shall be provided. Extent of monitoring shall be established and submitted for approval with due regard to the review of failure origin and their consequences for all engine components affecting combustion. The minimum extent of monitoring, type of automatic protection and alarm system are given in the Table **9.4.1.1.9**.

9.4.1.2 Dual fuel internal combustion engines

9.4.1.2.1 When operated on dual fuel, the internal combustion engines shall be fitted with the means for injection of liquid starting oil fuel to each cylinder of the engine. The amount of starting oil fuel fed to each cylinder shall be sufficient to ensure a positive ignition of the gas mixture in every mode of dual fuel engine operation. The engine shall be so designed that to preclude shut off of the starting oil fuel supply prior to or simultaneously with the gas fuel shut-off.

9.4.1.2.2 Start and normal stop of the duel fuel engine, low power and variable duty operation, ship maneuvering, mooring operations and any modes related to the possibility of reducing the engine number of revolutions per minute below the minimum stable speed shall be on oil fuel only. The engines shall be capable of continuous operation by fuel oil only.

9.4.1.2.3 In case of sudden shut-off of the fuel oil to the dual-fuel engine, gas fuel supply shall be shut off simultaneously and the engine shall be stopped. In emergency shut-off of gas fuel supply the engine shall continue operation on fuel oil without stop.

9.4.1.2.4 Dual-fuel engines shall be fitted with the appropriate arrangements to avoid simultaneous supply of gas fuel and full supply of fuel oil.

9.4.1.2.5 Changeover to gas fuel shall only be possible at a power level where the engine demonstrates stable safe operation on dual fuel that shall be determined through testing. Changeover to gas fuel shall be made automatically at obtaining this power by the engine, and when the power is reduced below this power value, the gas fuel supply shall be automatically stopped.

9.4.1.3 Gas fuel internal combustion engines

9.4.1.3.1 The starting sequence of gas fuelled engine shall exclude admission of gas fuel to the cylinders until ignition is activated and the engine has reached the minimum rotation frequency necessary for firing gas and vapour mixture in the cylinder.

9.4.1.3.2 If ignition has not been detected by the engine monitoring system within **10** s after opening of the gas valve, it shall be automatically shut off and the stop procedure shall be activated to eliminate the ignition of any unburned gas and vapour mixture.

9.4.1.3.3 On normal stop, as well as emergency shutdown, gas fuel supply shall be not earlier than closing the gas valves to each cylinder and to the complete engine.

9.4.1.3.4 When restarting after a failed start attempt shall be possible only after the exhaust gas collector is purged and exhaust gas piping system is ventilated with a volume of air at least equal to **3** times the volume of the exhaust gas system before the turbocharger. The above purging may be carried out through running the engine on starting air.

9.4.2 Gas-turbine engines (GTE).

9.4.2.1 Both gas fuel and fuel oil are used to start the turbine and operate it in all modes.

9.4.2.2 Measures shall be provided to prevent availability of liquid fraction in gas fuel entering the gas turbine engine.

9.4.2.3 In case of gas fuel shut-off the gas-turbine engine shall be automatically stopped or transferred to fuel oil operation , and the possibility of repeated supply of gas fuel shall be eliminated by closing of quick-closing valve located as close to the gas-turbine engine as possible.

9.4.2.4 A manual gas fuel shut-off device shall be provided directly at the gas-turbine.

9.4.2.5 All exhaust gas piping shall be fitted with spark arresters and shall not be combined with the exhaust gas piping of other engines, boilers and incinerators.

9.4.3 Boiler installations.

9.4.3.1 Each boiler shall be fitted with a separate uptake. Burner unit of the boiler shall be shaped so that to prevent forming of pockets where gas may be accumulated.

9.4.3.2 Burner unit shall be suitable to burn either fuel oil and gas fuel alone or oil and gas fuel

Table 9.4.1.1.9

Item No.	Monitoring parameter or engine component	Measurement point or monitoring conditions	Parameter limit values (alarm) or fault symptoms	Automatic shut-off of gas fuel supply valves	Indication in main machinery control room
1	Gas fuel injection valves	Each cylinder	Seizing of gas fuel injection valve in open position	×	Constantly
2	Pilot oil fuel injectors or ignition plugs	Each cylinder	Incorrect firing	×	Constantly
3	Exhaust gas temperature	At each cylinder outlet Deviation from average value	Max	×	Constantly
4	Combustion pressure	In each cylinder Deviation from average value	Max	×	Constantly
5	Gas fuel supply pressure	At the engine inlet	Min	×	Constantly

simultaneously. Changeover from gas to oil burning shall not cause change of the boiler operating mode.

Burner unit shall be equipped by the pilot burner operating on fuel oil. Burner units shall have interlocking and non-disconnectable protection specified in 5.3.**2** to 5.3.**4** of Part X "Boilers, heat exchangers and pressure vessels".

9.4.3.3 On the pipe of each gas burner a manually operated shut-off valve shall be fitted.

An installation shall be provided for purging the gas supply piping to the burner by means of inert gas or steam, after the extinguishing of this burner.

9.4.3.4 The controls, regulators, interlocking, protective devices and alarms of the automated burning installations shall comply with the requirements of **4**.3 of Part XV "Automation".

9.4.3.5 The requirements of **9**.5.3 and **9.8.4.4** shall be applicable to gas supply systems and piping.

9.4.3.6 All exhaust gas piping shall be fitted with spark arrestors and shall not be combined with the exhaust gas piping from other engines, boilers and incinerators.

9.4.4 Other gas consumers.

9.4.4.1 Gas fuel for domestic purposes may be used only as an autonomous system complying the requirements of **13.14**, Part VIII "Systems and piping".

9.4.4.2 Use of gas fuel for other purposes, not specified in **9.4.1** — **9.4**.3, for instance, inert gas producing, shall be subject to special consideration of the Register in each particular case.

9.5 FUEL SYSTEM

9.5.1 Gas bunkering stations.

9.5.1.1 Gas bunkering stations shall be so located at open parts of the deck that sufficient natural ventilation is provided. Use of enclosed or semi-enclosed spaces as bunkering stations shall be subject to special consideration of the Register.

9.5.1.2 Measures shall be taken to prevent damage of hull structures due to effect of spilled liquefied gas. For ships using CNG, bunkering stations shall be separated from the control stations and accommodations, guarded by a coaming and equipped with a special drip tray made of stainless steel for leakage accumulation. Leakage draining piping for drip tray discharge shall be provided. Leakage drainage piping shall be located over the ship's side and preferably leads down near the sea. Leakage draining piping may be removable and may be installed for the bunkering period.

9.5.1.3 An operator's work place shall be equipped at the bunkering station and be protected against possible leakage of bunkering fuel. Monitoring of pressure and fuel tank level, overfill alarm and automatic shutdown of intake fittings and the necessary communication means shall be provided at the operator work place; shall also be indicated at this location.

9.5.1.4 Every bunkering line shall be fitted with a local manually-operated and remotely controlled stop valve. It shall be possible to release the remote-operated valve from safe easily-accessible place.

9.5.1.5 The bunkering system shall be so arranged that no gas is discharged to air during filling of storage tanks.

9.5.2 Gas compressors.

9.5.2.1 The fuel gas compressors shall meet the requirements of 5.5, Part IX "Machinery". Gas compressors shall be fitted with accessories and instrumentation necessary for efficient and reliable function. As a minimum, the warning alarms shall be fitted in respect of the following parameters: compressor operation, low gas input pressure and low gas output pressure and excess output pressure build-up.

9.5.2.2 The gas compressors shall be equipped with the emergency stop devices from the following locations:

the cargo control room (relevant for cargo ships);

navigation bridge;

central control room;

fire control station.

9.5.3 System of gas supply to consumers.

9.5.3.1 Gas fuel piping shall not be laid through control stations, accommodation and service spaces. Laying of gas fuel pipelines through other enclosed areas and spaces and inside gas-safe machinery spaces (refer to **9**.2.13 and **9.2.14**) is allowed in compliance with the requirements of **9.5.3.2** or **9**.5.3.3.

Gas fuel piping shall not be laid at the distance below **760** mm from the outer shell.

During the design and calculation of gas fuel supply piping, besides compliance with the requirements of **2**.3, Part VIII "Systems and piping" the possibility shall be considered of fatigue failure of gas piping due to vibrations, as well as due to pulse pressure when supplying gas fuel to compressors.

9.5.3.2 The pipeline represents a piping system with double walls containing gas fuel inside the internal pipe. The following conditions shall be met:

.1 the space between the walls shall be filled with inert gas under pressure exceeding gas fuel pressure;

.2 inert gas pressure shall be constantly monitored by the alarm system;

.3 at the alarm system activation the automatic valves mentioned in **9**.5.3.**4** shall be automatically closed prior to the inert gas pressure drops lower than the pressure of gas fuel, and vent valve stated in **9**.5.3.**4** shall be automatically opened;

.4 the system shall be so arranged that the internal part of gas fuel supply pipeline between the main gas valve and engine be automatically purged with inert gas, when the main gas valve is closed.

9.5.3.3 Gas fuel pipelines shall be installed in the pipe or duct with artificial exhaust ventilation of the space between them, The capacity of exhaust ventilation shall be calculated based on the velocity of gas fuel flow, structure and location of protective pipes or ducts rand provide at least 30 air changes per hour. Therewith, the following conditions shall be met:

.1 the pressure in the space between the external and internal walls of pipelines or ducts shall be kept lower than the atmospheric pressure;

.2 provision shall be made for the gas leakage detector and when this detector or alarm system is activated, the automatic valves specified in **9.5.3.4**, shall be automatically closed before the inert gas pressure is reduced below the fuel gas pressure and the gas exhaust valve indicated in **9.5.3.4** shall be automatically opened;

.3 electrical motors shall be of explosion-proof design and be located outside the pipes or ducts;

.4 when the required air flow is not maintained by the ventilation system, the main gas valve, mentioned in 9.5.3.5, shall be closed automatically. Ventilation shall function every time when gas is supplied through the pipeline;

.5 air intakes of the ventilation system shall be provided with non-return devices. These requirements are not compulsory when gas detectors are fitted in air intakes;

.6 provision shall be made for inertization and degasification of gas fuel pipeline system section located in the engine room.

9.5.3.4 Gas fuel supply system to every consumes shall be fitted with three automatic valves. Two of them shall be installed in succession in the system of gas fuel supply to the engine. The third valve (gas outlet) shall be mounted for gas discharge from the pipe section located between two automatic valves installed in succession to the safe place on the weather deck. The system shall be so constructed that when the pressure in the gas fuel supply pipeline fluctuates from the set values, loss of energy for valve control, violation of the conditions specified in **9.5.3.2** and **9**.5.3.3, as well as stop of engine due to any reason two valves installed in succession shall be closed automatically and the third valve (gas outlet) shall be opened automatically.

As an alternative, one of two valves installed in succession and the ventilation valve may be combined in one body, provided their performance of the above-mentioned functions.

All three valves shall be manually operated.

9.5.3.5 The main gas valve shall be installed outside the engine room and be equipped with remote control to enable its closing from the engine room.

This valve shall be automatically closed in the following cases: leakage of gas fuel;

violation of the conditions stated in **9**.5.3.2 and **9**.5.3.3;

actuation of oil mist concentration sensor in the engine crankcase or in the temperature control system of the engine bearings.

9.5.3.6 Gas lines shall have sufficient structural strength with regard to stresses caused by the mass of the pipelines, internal pressure, loads caused by bends of the ship's hull and possible accelerations during the operation.

9.5.3.7 The structure of protective pipes or ducts of the ventilation system mentioned in **9**.5.3.2 and **9**.5.3.3, shall have strength sufficient to withstand fast increase of internal pressure in case of pipeline break. A number of split connections in protective pipes or ducts shall be minimum.

9.5.3.8 As a rule, gas pipelines shall be connected with complete-penetration butt welds and special means for provision of weld root quality and completely radiographically tested. All butt welds after welding are subject to heat treatment depending on the material. The use of other joints shall be specially considered by the Register in each case.

9.6 FIRE PROTECTION

9.6.1 General

9.6.1.1 Subject to the character of the ship classification and in addition to the requirements of the present Section, fire protection shall meet the requirements of Part VI "Fire Protection".

9.6.2 Structural fire protection

9.6.2.1 Gas fuel tanks located at the weather deck shall be separated from the accommodation, service, cargo and machinery spaces by a special screen made as class A-60 fire structure.

9.6.2.2 Gas fuel tank rooms and ventilation trunks to such spaces shall be separated from accommodation, service, cargo and machinery spaces by class A-**60** fire structures. They may be separated from other spaces of little fire risk by class A-0 fire.

9.6.2.3 Gas pipes led through ro-ro spaces on open deck shall be provided with guards to prevent vehicle collision damage. The fire protection of such piping is subject to special consideration by the Register.

9.6.2.4 When more than one machinery space is arranged on board the ship, they shall be separated by class A-**60** bulkhead.

9.6.2.5 Gas compressor room shall be regarded as a machinery space of category A for fire insulation requirements and shall have relevant fire protection.

9.6.2.6 Gas fuel bunkering room shall be separated from other spaces by class A-6**5**0 structures, except cofferdams of ballast tanks and other spaces of low fire risk which may be separated by class A-0 structures.

9.6.3 Fire water main system.

9.6.3.1 Fire water main system shall be in compliance with the requirements of **3.2**, Part VI "Fire Protection" with due regard for the character of the ship classification.

9.6.3.2 Where fire water main pumps are used as part of the water spray system, the required pump capacity shall be determined for the case of both the fire water main system and the water spray system being in operation.

9.6.3.3 Where gas fuel tanks are installed on the open deck, the fire water mains shall be provided with a shutoff valve to isolate the damaged pipe section with the system remaining operable all the time.

9.6.4 Water spray system

9.6.4.1 A water spray system shall be fitted on board of gas-fuelled ships for cooling and fire prevention and to cover exposed parts of gas storage tank located above deck.

9.6.4.2 The system shall be designed to cover all areas specified in **9.6.4.1** with an application rate as follows:

.1 10 l/min/ per $1m^2$ for horizontal surfaces;

.2 4 l/min/ per $1m^2$ for vertical surfaces.

9.6.4.3 For the purpose of isolating damaged sections, stop valves shall be fitted.

Alternatively, the system may be divided into two sections which shall be independently operated. Control of the sections shall be located in a safe and readily accessible position.

9.6.4.4 Connection to the ship's fire main shall be provided through a stop valve fitted on the open deck in a safe position outside the bunkering station area.

9.6.4.5 Remote start of pumps supplying the drenching system and remote operation of fittings shall be located in a readily accessible position which is not likely to be cut off in case of fire.

9.6.4.6 The nozzles of the drenching system should be of an approved full bore type and they shall be arranged to ensure an effective distribution of water throughout the space being protected.

9.6.5 Dry chemical powder system.

9.6.5.1 To protect the bunkering station area and cover all possible leak points, gas fuelled ships shall be equipped with a dry chemical powder system complying with the requirements of Part VI "Fire Protection". The capacity shall be at least 3,5 kg/s and the power capacity shall be sufficient for a minimum of 45 s discharges.

9.6.6 Fire detection and alarm system.

9.6.6.1 In gas fuel storage spaces and in ventilation ducts leading thereto, a fire detection system of an approved type shall be installed. The system shall ensure clear identification of activated detector and determine its location.

9.6.6.2 A smoke detection system cannot be contemplated as an efficient and quick acting means of fire detection complying with **9.6.6.1** unless other fire detecting equipment is provided additionally.

9.6.7 Fire safety provision.

9.6.7.1 Two portable dry chemical powder fire extinguishers, each of at least 5 kg capacity shall be provided in the vicinity of the bunkering station.

9.6.7.2 Engine room where the gas fuel is heavier than air shall be provided with two dry chemical powder extinguishers of at least 5 kg capacity each, located at the entrance to the rooms.

9.7 VENTILATION OF SPACES

9.7.1 Ventilation ducts opening to spaces classed as hazard zones shall be completely insulated from ventilation ducts opening to gas-safe spaces. Ventilation ducts opening to spaces containing gas compressors and gas fuel storage tanks as well as machinery spaces shall be provided with A-60 class automatic fire dampers.

9.7.2 The design of ventilators serving hazard zones shall be in compliance with the requirements of 5.3.3, Part IX "Machinery". Electric drives of ventilators fitted inside hazard zones shall be intrinsically safe. When fitted inside the ventilation duct, the explosion proofhess of electric drives of ventilators shall be the same as that of the space through which they are led.

9.7.3 Provision shall be made for an alarm to warn of ventilation being shut down in spaces and rooms to be continuously ventilated.

9.7.4 Ventilation system shall ensure the absence of gas pockets in spaces being served.

9.7.5 The inlets of ventilation ducts opening into enclosed hazardous spaces shall draw air from spaces which, in the absence of considered inlets of the said ventilation ducts, would be non-hazardous.

Air inlets for non-hazardous enclosed spaces shall be taken from non-hazard zones at least 1,5 m away from any boundaries of any hazard zone.

Where the inlet duct passes through a more hazardous space, this duct shall have overpressure relative to this space so the air from it would not leak into the duct in case of tightness loss.

9.7.6 Air outlets from non-hazardous spaces shall be located outside hazard zones.

9.7.7 Air outlets from hazardous enclosed spaces shall be located in spaces which, in the absence of the considered outlet, would be of the same of lesser hazard than the ventilated space.

9.7.8 Where spaces classed as non-hazardous have openings to a hazard zone, the openings shall be fitted with an air lock and be maintained at overpressure relative to the external hazard zone. The overpressure ventilation shall be arranged according to the following requirements: on tightness loss, any electrical equipment which is not intrinsically safe shall be de-energized until 5 air changes at least have been made by means of ventilation and the space is pressurized. The pressure in these spaces shall be controlled continuously, and in the event of overpressure ventilation failure or overpressure loss an alarm shall be given and the electrical equipment which is not intrinsically safe shall be de-energized automatically.

9.7.9 Tank rooms shall be provided with an effective mechanical ventilation system of the extraction type, providing a ventilation capacity of at least 30 air changes per hour.

9.7.10 The ventilation system for machinery spaces containing gas consumers and boilers shall be independent of all other ventilation systems.

9.7.11 Hazardous engine rooms (refer to **9.2.7.3**) shall have ventilation with a capacity of at least 30 air changes per hour. The ventilation system shall ensure a good air circulation in all spaces without formation of gas pockets.

The capacity of the ventilation system shall not be reduced by more than 50 per cent in case of a single failure within the system or a service equipment failure. Arrangements are acceptable whereby under normal operation of the system the machinery space is ventilated with at least 15 air changes per hour provided that, if gas is detected in the machinery space, the number of air changes will automatically be increased to 30 air changes per hour.

9.7.12 In gas compressor and pump spaces, the ventilation system shall be of the extraction type, providing a ventilation capacity of at least 30 air changes per hour. The ventilation system shall ensure a good air circulation in all spaces without formation of gas pockets. The capacity of the ventilation system shall not be reduced by more than 50 per cent in case of a single failure within the system or a service equipment failure.

9.7.13 In gas compressor and pump spaces, the ventilation system shall operate as long as the compressors and pumps are in operation. The operation of ventilation shall be permanently controlled, and, in the event of its failure, an alarm shall be given at a manned location. In case of ventilation loss, not less than 5 air changes shall be made in the gas compressor and pump space before energizing the electrical equipment installed therein which is not intrinsically safe.

9.8 MONITORING, CONTROL AND AUTOMATION SYSTEMS

9.8.1 General.

9.8.1.1 The requirements of **2.4**, Part XV "Automation" shall be complied with.

9.8.2 Pressure and Temperature Monitoring.

9.8.2.1 Each gas fuel storage tank shall be provided with devices for remote monitoring from the bridge and local monitoring of gas pressure and temperature. The devices shall be clearly marked with upper and lower range values of allowable working pressure.

Provision shall be made for upper and lower pressure alarms in the tank (where vacuum protection is required by tank design), which shall be activated before safety valve operation.

9.8.2.2 The gas fuel inlet pipe shall be fitted with a device for pressure control between the inlet valve and shore connection.

9.8.2.3 On the gas fuel outlet piping following the pump and on the gas fuel inlet piping following the inlet valve, a device shall be mounted for pressure control.

9.8.2.4 In the drain well of LNG tank storage space, level indicators and temperature indicating devices shall be fitted. As a result of temperature indicating device activation, the main gas valve of the tanks shall be automatically closed. Upper level indicator shall activate an alarm.

9.8.2.5 The LNG tanks the level indicators shall be provided.

9.8.3 Gas fuel storage tank overflow prevention.

9.8.3.1 Each LNG tank shall be provided with means of overflow prevention in compliance with the requirements for cargo tanks of gas carriers specified in 3.1, Part VIII "Instrumentation" of the Rules for the Classification and Construction of Ships Carrying Liquefied Gases in Bulk. Overflow prevention means shall be independent of level indicators mentioned in **9.8.2.4**.

9.8.3.2 Each CNG tank shall be provided with means of overpressure prevention during bunkering with an alarm to be activated when reaching 95 per cent of design pressure.

9.8.4 Gas leaks control in spaces.

9.8.4.1 All enclosed gas-dangerous spaces shall be provided with effective gas detection systems in the areas of its possible accumulation and leakage. The number of detectors to be fitted in each space is subject to special consideration in each case proceeding from the size and configuration of the space. When the gas concentration equal to 20 per cent of the lower explosion limit is reached in the space under control, visual and audible alarm shall be given on the bridge. In ventilation ducts containing gas-fuel pipes, the alarm shall be given when the concentration equal to 30 per cent of the lower explosion limit is reached. In case the concentration equal to 40 per cent of the lower explosion limit is reached, measures (at least those stated in Table **9.8.4.2**) to automatically shutdown gas-fuel supply to the space shall be taken.

9.8.4.2 In the gas-dangerous machinery rooms, two independent systems shall be necessary to control gas supply to the machinery space.

9.8.4.3 In gas-safe machinery spaces at least two detectors of the gas supply control system shall be fitted to activate alarm at reaching 30 per cent of the lower explosion limit.

9.8.4.4 Where gas-fuel leakage is found and in case of system failure, the safety system shall automatically activate regulating functions stated in Table **9.8.4.4**.

Table 9.8.4.4

Parameter	Alarm	Automatic shutdown of main tank valve	Automatic shutdown of gas supply to consumers in machinery room	Notes
Gas detection in tank room above 20% LEL	×			
Gas detection on two detectors[1] in tank room above 40% LEL	×	×		
Fire detection in tank room	×	×		
Bilge well high level tank room	×			
Bilge well low temperature in tank room	×	×		
Gas detection in duct between tank and machinery space containing gas-fuelled consumers above 20 % LEL	×			
Gas detection by two detectors[1] in duct between tank and machinery space above 40 % LEL	×	×[2]		
Gas detection in compressor room above 20 % LEL	×			
Gas detection on two detectors[1] in duct between tank and machinery space containing gas-fuelled consumers above 40% LEL	×	×[2]		
Gas detection in duct inside machinery space containing gas-fuelled consumers above 30% LEL	×			If double pipe fitted in machinery space containing gas-fuelled consumers
Gas detection on two detectors[1] in duct inside machinery space containing gas-fuelled consumers above 40% LEL	×		×[3]	If double pipe fitted in machinery space containing gas-fuelled consumers
Gas detection in machinery space containing gas-fuelled comsumers above 20% LEL				Gas detection only required for ESD protected machinery space containing gas-fuelled consumers
Gas detection by two detectors[1] in machinery space containing gas-fuelled consumers above 40 % LEL	×		×	Gas detection only required for ESD protected machinery space. It shall also disconnect non-certified safe electrical equipment in machinery space.
Loss of ventilation in duct between tank and machinery space[6]	×		×[2,4]	
Loss of ventilation in duct inside machinery space[6]	×		×[3,4]	If double pipe fitted in machinery space.
Loss of ventilation in machinery space containing gas-fuelled consumers	×		×	ESD protected machinery space containing gas-fuelled consumers only.
Fire detection in machinery space containing gas-fuelled consumers	×		×	
Abnormal gas pressure in gas supply pipe	×		×[4]	
Failure of valve control actuating medium	×		×[5]	Time delayed as found necessary
Automatic shutdown of consumer (consumer failure)	×		×[5]	
Emergency shutdown of consumer manually released	×		×	

[1]Two independent gas detectors located close to each other are required for redundancy reasons. If the gas detector is of self monitoring type, installation of a single gas detector is permitted.

[2]If the tank is supplying gas to more than one consumer and the different supply pipes are completely separated and fitted in separate ducts and with the master valves fitted outside of the duct, only the master valve on the supply pipe leading into the duct where gas or loss of ventilation is detected shall close.

[3]If the gas is supplied to more than one consumer and the different supply pipes are completely separated and fitted in separate ducts and with the master valves fitted outside of the duct and outside of the machinery space containing gas-fuelled consumers, only the master valve on the supply pipe leading into the duct where gas or loss of ventilation is detected shall close.

[4]This parameter shall not lead to shutdown of gas supply for single fuel gas consumers, only for dual fuel consumers.

[5]Only when 3 valves specified in 9.5.3.5 operate.

[6]If the duct is protected by inert gas (refer to 9.5.3.2) then loss of inert gas overpressure shall lead to the same actions as indicated in this table.

9.9 ELECTRICAL EQUIPMENT

9.9.1 General

9.9.1.1 Electrical equipment shall be in compliance with Part VII "Electrical Equipment" of the Rules for the Classification and Construction of Ships Carrying Liquefied Gases in Bulk. The classification of dangerous zones shall be in compliance with **9.9**.2.

9.9.2 Classification of dangerous zones, spaces and areas

9.9.2.1 The classification of dangerous zones and spaces in gas-fuelled ships shall be in compliance with IEC 60079-10 and IEC 6092-502. If a dangerous space is not covered by **9.9**.2.2, one shall be guided by the above standards.

9.9.2.2 Zone 0: the internal areas of gas fuel storage tanks, pipes and equipment containing gas, any pipework of pressure-relief or other venting systems for gas fuel storage tanks.

9.9.2.3 Zone 1:

gas fuel storage tank rooms,

gas compressor rooms,

areas on the open deck and semi-enclosed spaces on the open deck within **3** m of any gas tank outlets, gas or vapour outlet from relief valves, bunker manifold outlet, other gas valve, gas pipe flange, gas pump-room ventilation outlets and gas tank openings;

areas on the open deck or semi-enclosed spaces on deck within **1**,5 m of gas compressor and pump room entrances, gas pump and compressor room ventilation inlets and other openings into zone **1** spaces;

areas on the open deck within spillage coamings surrounding gas bunker manifold valves and **3** m beyond these, up to a height of **2**,**4** m above the deck;

enclosed or semi-enclosed spaces in which pipes containing gas are located and ventilation ducts around gas pipes;

gas-hazardous engine rooms are considered non-hazardous areas during normal operation, but changes to zone **1** in the event of gas leakage.

9.9.2.4 Zone 2:

Area at the open deck within **1**,5 m around zone **1**.

9.10 PERSONNEL PROTECTION

9.10.1 Where the equipment of gas system is installed in enclosed spaces of the ship, provision shall be made for at least two sets of safety equipment each permitting personnel to enter and work in spaces filled with natural gas.

9.10.2 A set of safety equipment specified in **9.10.1** shall consist of:

.1 one self-contained air-breathing apparatus not using stored oxygen having a capacity at least of **1200** l of free air;

.2 tight-fitting goggles, gloves, intrinsically safe protective clothing and boots;

.3 steel-cored rescue line with an intrinsically safe belt;

.4 explosion-proof lamp.

9.10.3 For breathing apparatuses specified in **9.10.2.1**, fully charged air bottles with a total free air capacity of at **3600** l for each breathing apparatus shall be provided.

9.10.4 Medical first-aid equipment shall be available on board for persons suffering from burns, frostbites (including cryogenic ones) as well as intoxication with natural gas or products of incomplete fuel burning.

9.10.5 The following service documentation shall be available on board:

.1 bunkering instructions;

.2 purging and gas removal instructions;

.3 instructions for using gas fuel;

.4 instructions describing the crew behaviour in case of emergency which may arise during operations with gas fuel.

9.10.6 A plan of periodic audits and maintenance in connection with using gas as fuel shall be developed on board.

10 REQUIREMENTS TO BALTIC ICE CLASS SHIPS

10.1 GENERAL

10.1.1 Requirements to the Baltic ice class ships comply with the requirements of the Finnish-Swedish Ice Class Rules, 2010 and apply to the ships operating in the Baltic Sea area in winter.

10.2 BALTIC ICE CLASSES

10.2.1 Ships complying with the requirements of the present Section may be assigned to the Baltic ice classes as follows:

.1 ice class **IA Super**: ships with such structure, engine output and other properties that they are normally capable of navigating in difficult ice conditions without the assistance of icebreakers;

.2 ice class **IA**: ships with such structure, engine output and other properties that they are capable of navigating in difficult ice conditions, with the assistance of icebreakers when necessary;

.3 ice class **IB**: ships with such structure, engine output and other properties that they are capable of navigating in moderate ice conditions, with the assistance of icebreakers when necessary;

.4 ice class **1C**: ships with such structure, engine output and other properties that they are capable of navigating in light ice conditions, with the assistance of icebreakers when necessary;

.5 ice class **II**: ships that have a steel hull and that are structurally fit for navigation in the open sea and that, despite not being strengthened for navigation in ice, are capable of navigating in very light ice conditions with their own propulsion machinery;

.6 ice class **III**: суда, ships that do not belong to the ice classes referred to in 10.2.1.1 — 10.2.1.5.

10.3 ICE CLASS DRAUGHT

10.3.1 Upper and lower ice waterlines.

10.3.1.1 The upper ice waterline (UIWL) shall be the envelope of the highest points of the waterlines at which the ship is intended to operate in ice. The line may be a broken line.

The lower ice waterline (LIWL) shall be the envelope of the lowest points of the waterlines at which the ship is intended to operate in ice. The line may be a broken line.

10.3.2 Maximum and minimum draught fore and aft.

10.3.2.1 The maximum and minimum ice class draughts at fore and aft perpendiculars shall be determined in accordance with UIWL and LIWL.

Restrictions on draughts when operating in ice shall be documented and kept on board readily available to the master. The maximum and minimum ice class draughts fore, amidships and aft shall be indicated in the Annex to Classification Certificate (form **3.1.2-1**). if the summer load line in fresh water is anywhere located at a higher level than the UIWL, the ship's sides are to be provided with a warning triangle and with an ice class draught mark at the maximum permissible ice class draught amidships (refer to Appendix), which are also specified in the Annex to Classification Certificate (form **3.1.2-1**).

The draught and trim, limited by the UIWL, must not be exceeded when the ship is navigating in ice. The salinity of the sea water along the intended route shall be taken into account when loading the ship.

The ship shall always be loaded down at least to the LIWL when navigating in ice. Any ballast tank, situated above the LIWL and needed to load down the ship to this water line, shall be equipped with devices to prevent the water from freezing. In determining the LIWL, regard shall be paid to the need for ensuring a reasonable degree of ice-going capability in ballast. The propeller shall be fully submerged, if possible entirely below the ice. The forward draught shall be at least $(2 + 0{,}00025\Delta)h_0$ but need not exceed $4h_0$

where Δ = displacement of the ship, in t, on the maximum ice-class draught according to **10.3**.1.1;

h_0 = level ice thickness, in m, according to **10.5**.2.1.

10.4 ENGINE OUTPUT

10.4.1 Definitions and explanations.

10.4.1.1 The engine output P is the maximum output the propulsion machinery can continuously deliver to the propellers.

The dimensions of the ship and some other parameters are defined below (refer to Fig. **10.4.1.1**):

L — length of the ship between the perpendiculars, in m;

L_{BOW} — length of the bow, in m;

L_{PAR} — length of the parallel midship body, in m;

B — breadth of the ship, in m;

T — draught of the ship, in m;

A_{wf} — area of the waterline of the bow, in m^2;

α — the angle of the waterline at B/4, in deg.;

φ_1 — the rake of the stem at the centerline, in deg. φ_1 = 90° for a ship with a bulbous bow;

φ_2 — the rake of the bow at $B/4$, in deg.;

ψ — flare angle calculated as $\psi = \arctan(\tan\varphi/\sin\alpha)$, in deg., c using angles α and φ. For 10.4.3 flare angle is calculated using $\varphi = \varphi_2$;

D_p — diameter of the propeller, in m;

H_M — thickness of the brash ice in mid channel, in m;

H_F — thickness of the brash ice layer displaced by the bow, in m.

10.4.2 The engine output shall not be less than that determined in 10.4.3.

Irrespective of the engine output determination by Formula (10.4.3-1), The engine output shall not be less than 1000 кВт kW for ice classes **IA**, **IB** and **IC** and not less than 2800 кВт kW for ice class **IA Super**.

10.4.3 The engine output requirement shall be calculated for two draughts. The engine output shall not be less than the greater of these two outputs.

In the calculations the ship's parameters specified in 10.4.1.1 which depend on the draught are to be determined at the appropriate draught, but L and B shall be determined only at the UIWL.

$$P = K_e \frac{(R_{CH}/1000)^{3/2}}{D_P}, \text{ in kW,} \qquad (10.4.3\text{-}1)$$

where K_e = shall be taken according to Table 10.4.3;
R_{CH} = is the ice resistance in Newton of the ship in a channel with brash ice and a consolidated surface layer, in N.

Table 10.4.3

Number of propellers	CP propeller or electric or hydraulic propulsion machinery	FP propeller
1	2,03	2,26
2	1,44	1,60
3	1,18	1,31

$$R_{CH} = C_1 + C_2 + C_3 C_\mu (H_F + H_M)^2 (B + C_\psi H_F) + C_4 L_{PAR} H_F^2 + C_5 \left(\frac{LT}{B^2}\right)^3 \frac{A_{wf}}{L} \qquad (10.4.3\text{-}2)$$

where $C_\mu = 0{,}15\cos\varphi_2 + \sin\psi\sin\alpha$, C_μ shall be taken equal or larger than 0,45;
$C_\psi = 0{,}047\psi - 2{,}115$, and $C_\psi = 0$, if $\psi < 45°$;
$H_F = 0{,}26 + (H_M B)^{0{,}5}$;
H_M = 1,0 m for ice classes **IA** and **IA Super**;
H_M = 0,8 m for ice class **IB**;
H_M = 0,6 m for ice class **IC**;
C_1 = 0 for ice classes **IA**, **IB** and **IC**;

$$C_1 = f_1 \frac{BL_{PAR}}{2(T/B) + 1} + (1 + 0{,}021\varphi_1)(f_2 B + f_3 L_{BOW} + f_4 L_{BOW})$$

for ice class **IA Super**;

f_1 = 23 N/m²;
f_2 = 45,8 N/m;
f_3 = 14,7 N/m;
f_4 = 29 N/m².
C_2 = 0 for ice classes **IA**, **IB** and **IC**;

$$C_2 = (1 + 0{,}063\varphi_1)(g_1 + g_2 B) + g_3\left(1 + 1{,}2\frac{T}{B}\right)\frac{B^2}{\sqrt{L}}$$

for ice class **IA Super**;

g_1 = 1530 N;
g_2 = 170 N/m;
g_3 = 400 N/m^{1,5}.

Value $\left(\frac{LT}{B^2}\right)^3$ in Formula (10.4.3-2) shall not to be taken as less than 5 and shall not be taken as more than 20.

10.4.4 Formula (10.4.3-2) may be used when the conditions given in Table 10.4.4 are fulfilled.

Table 10.4.4

Applicability conditions of Formula (10.4.3-2)

Parameter	Minimum value	Maximum value
α, in deg.	15	55
φ_1, in deg.	25	90
φ_2, in deg.	10	90
L, m	65,0	250,0
B, m	11,0	40,0
T, m	4,0	15,0
L_{BOW}/L	0,15	0,40
L_{PAR}/L	0,25	0,75
D_P/T[1]	0,45	0,75
$A_{wf}/(L \cdot B)$	0,09	0,27

[1]When calculating the parameter D_P/T, T shall be measured at the largest draught amidships.

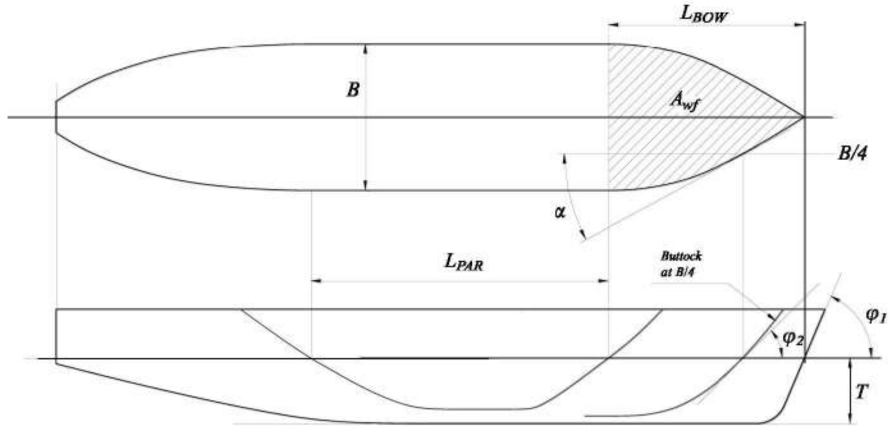


Fig. 10.4.1.1 Determination of the geometric quantities of the hull

The use of K_e or R_{CH} values based on more exact calculations or values based on model tests may be approved. Such an approval will be given on the understanding that it can be revoked if experience of the ship's performance in practice motivates this. The design requirement for ice classes is a minimum speed of 5 knots in the following brash ice channels:

H_M = 0,6 m for ice class **IC**;

H_M = 0,8 m for ice class **IB**;

H_M = 1,0 m for ice class **IA**;

H_M = 1,0 m and a 0,1 m thick consolidated layer of ice for ice class **IA Super**.

10.5 HULL STRUCTURAL DESIGN

10.5.1 General.

The method for determining the hull scantlings is based on certain assumptions concerning the nature of the ice load on the structure. These assumptions are from full scale observations made in the northern Baltic.

It has thus been observed that the local ice pressure on small areas can reach rather high values. This pressure may be well in excess of the normal uniaxial crushing strength of sea ice. The explanation is that the stress field in fact is multiaxial.

Further, it has been observed that the ice pressure on a frame can be higher than on the shell plating at midspacing between frames. The explanation for this is the different flexural stiffness of frames and shell plating. The load distribution is assumed to be as shown in Fig. 10.5.1-1.

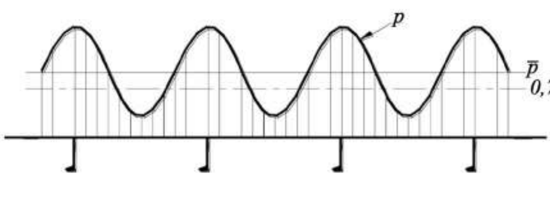


Fig. 10.5.1-1 Ice load distribution on a ship's side

The formulae and values given in this section may be substituted by direct analysis if they are deemed by the administration or the classification society to be invalid or inapplicable for a given structural arrangement or detail. Otherwise, direct analysis is not to be utilized as an alternative to the analytical procedures prescribed by explicit requirements in 10.5.3 — 10.5.5.

Direct analyses shall be carried out using the load patch defined in 10.5.2 (p, h and l_a). The pressure to be used is 1,8p where p is determined according to 10.5.2.2. The load patch shall be applied at locations where the capacity of the structure under the combined effects of bending and shear are minimized. In particular, the structure is to be checked with load centred at the UIWL, 0,5h_0 below the LIWL, and positioned several vertical locations in between. Several horizontal locations shall also be checked, especially the locations centred at the mid-span or -spacing. Further, if the load length l_a cannot be determined directly from the arrangement of the structure, several values of l_a shall be checked using corresponding values for c_a.

The acceptance criterion for designs is that the combined stresses from bending and shear, using the von Mises yield criterion, are lower than the yield point σ_y. When the direct calculation is using beam theory, the allowable shear stress is not to be larger than 0,9τ_y, where $\tau_y = \sigma_y/\sqrt{3}$.

If scantlings derived from these regulations are less than those required by the Register for a not ice strengthened ship, the latter shall be used.

N o t e s : 1. The frame spacings and spans defined in the following text are normally (in compliance with the requirements of the Register normative documents for the ship in question) assumed to be measured along the plate and perpendicular to the axis of the stiffener for plates, along the flange for members with a flange, and along the free edge for flat bar stiffeners. For curved members the span (or spacing) is defined as the chord length between span (or spacing) points. The span points are defined by the intersection between the flange or upper edge of the member and the supporting structural element (stringer, web frame, deck or bulkhead). Fig. 10.5.1-2 illustrates the determination of span and spacing for curved members.

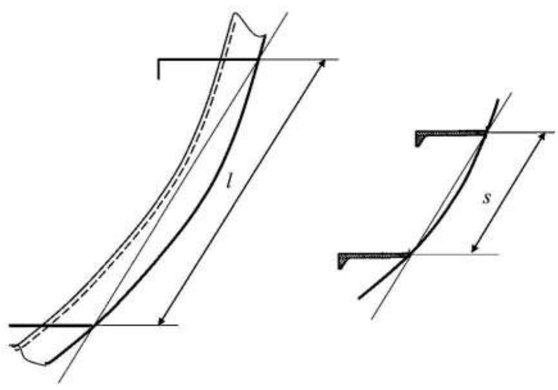


Fig. 10.5.1-2 Definition of the frame span (left) and frame spacing (right) for curved members

2. The effective breadth of the attached plate to be used for calculating the combined section modulus of the stiffener, stringer and web frame and attached plate shall be taken as the applicable requirements of the Register normative documents require. The effective breadth shall in no case be more than what is stated in the applicable requirements of the Register normative documents for the ship in question.

3. The requirements for the section modulus and shear area of the frames, stringers and web frames in 10.5.4 — 10.5.6, are with respect to the effective member cross section. For such cases where the member is not normal to the plating, the section properties shall be calculated in accordance with the applicable requirements of the Register normative documents for the ship in question.

10.5.1.1 Hull regions.

The ship's hull is divided into regions as follows (refer also to Fig. 10.5.1.1).

Bow region: from the stem to a line parallel to and 0,04L aft of the forward borderline of the part of the hull where the waterlines run parallel to the centerline. For ice classes **IA Super** and **IA** the overlap over the borderline need not exceed 6 m, for ice classes **IB** and **IC** this overlap need not exceed 5 m.

Midbody region: from the aft boundary of the bow region to a line parallel to and 0, For ice classes **IA Super** and **IA** the overlap over the borderline need not exceed 6 m, for ice classes **IB** and **IC** this overlap need not exceed 5 m.

Stern region: From the aft boundary of the midbody region to the stern.

L shall be taken as the ship's design length in compliance with the requirements of the Register normative documents.

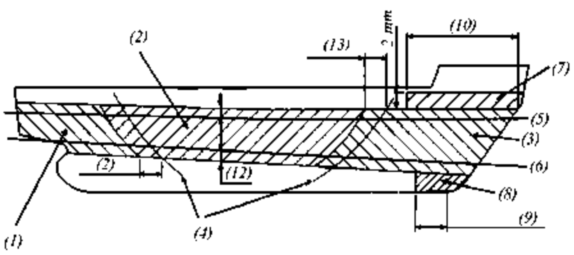


Fig. 10.5.1.1 Ice strengthened regions of the hull:
1 — ice belt, stern region; *2* — ice belt, midbody region;
3 — ice belt, bow region; *4* — border of the part of the side where waterlines are parallel to the centerline;
5 — UIWL; *6* — LIWL;
7 — upper bow ice belt; *8* — fore foot;
9 — 5 frame spacings; 10 — 0,2L;
11 — refer to 10.5.1; *12* — refer to 10.5.3.1;
13 — refer to 10.5.1

10.5.2 Ice load.

10.5.2.1 Height of the ice load area.

An ice-strengthened ship is assumed to operate in open sea conditions corresponding to a level ice thickness not exceeding h_0. The design ice load height h of the area actually under ice pressure at any particular point of time is, however, assumed to be only a fraction of the ice thickness. The values for h_0 and h are given in the following Table:

Ice class	h_0, in m	h, in m
IA Super	1,0	0,35
IA	0,8	0,30
IB	0,6	0,25
IC	0,4	0,22

10.5.2.2 Ice pressure.

The design ice pressure is determined by the following formula:

$$p = c_d c_p c_a p_0, \text{ in MPa,} \qquad (10.5.2.2)$$

where c_d = is a factor which takes account of the influence of the size and engine output of the ship. The factor c_d is taken as maximum 1,0 and is determined by the following formula:

$$c_d = \frac{ak+b}{1000}$$

where $k = \frac{\sqrt{\Delta P}}{1000}$;

a and b are given in the following Table:

	Region			
	bow		midbody and stern	
	$k \leqslant 12$	$k > 12$	$k \leqslant 12$	$k > 12$
a	30	6	8	2
b	230	518	214	286

Δ = displacement of the ship at maximum ice class draught, in t (refer to. 10.3.1);

P = actual continuous engine output of the ship, in kW (refer to 10.4.2);

c_p = factor which takes account of the probability that the design ice pressure occurs in a certain region of the hull for the ice class in question.

The value of c_p is given in the following Table:

Ice class	Region		
	bow	midbody	stern
IA Super	1,0	1,0	0,75
IA	1,0	0,85	0,65
IB	1,0	0,70	0,45
IC	1,0	0,50	0,25

c_a = factor which takes account of the probability that the full length of the area under consideration will be under pressure at the same time. It is calculated by the following formula:

$$c_a = \sqrt{l_0/l_a}\,,\quad 0{,}35 \leqslant c_a \leqslant 1{,}0$$

where l_0 = 0,6 m;

l_a shall be taken as follows:

Structure	Type of framing	l_a, in m
Shell	transverse	Frame spacing
	longitudinal	1,7 frame spacing
Frames	transverse	Frame spacing
	longitudinal	Span of frame
Ice stringer		Span of stringer
Web frame		2 web frame spacing

p_0 = nominal ice pressure; the value 5,6 MPa shall be used.

10.5.3 Shell plating.

10.5.3.1 Vertical extension of ice strengthening for plating (ice belt).

The vertical extension of the ice belt shall be as follows (refer to Fig. **10.5.1.1**):

Ice class	Hull region	Above UIWL	Below LIWL
IA Super	bow	0,60 m	1,20 m
	midbody		
	stern		1,0 m
IA	bow	0,50 m	0,90 m
	midbody		0,75 m
	stern		
IB и IC	bow	0,40 m	0,70 m
	midbody		0,60 m
	stern		

In addition, the following areas shall be strengthened.

Fore foot. For ice class **IA Super**, the shell plating below the ice belt from the stem to a position five main frame spaces abaft the point where the bow profile departs from the keel line shall have at least the thickness required in the ice belt in the midbody region.

Upper bow ice belt. For ice classes **IA Super** and **IA** on ships with an open water service speed equal to or exceeding **18** knots, the shell plate from the upper limit of the ice belt to 2 m above it and from the stem to a position at least **0**,2L abaft the forward perpendicular, shall have at least the thickness required in the ice belt in the midbody region.

A similar strengthening of the bow region is advisable also for a ship with a lower service speed, when it is, e.g. on the basis of the model tests, evident that the ship will have a high bow wave.

Side scuttles shall not be situated in the ice belt. If the weather deck in any part of the ship is situated below the upper limit of the ice belt (e.g. in way of the well of a raised quarter decker), the bulwark shall be given at least the same strength as is required for the shell in the ice belt. The strength of the construction of the freeing ports shall meet the same requirements.

10.5.3.2 Plate thickness in the ice belt.

For transverse framing the thickness of the shell plating shall be determined by the following formula:

$$t = 667s\sqrt{\frac{f_1 p_{PL}}{\sigma_y}} + t_c \text{, in mm.} \quad (\mathbf{10.5.3.2\text{-}1})$$

For longitudinal framing the thickness of the shell plating shall be determined by the following formula:

$$t = 667s\sqrt{\frac{p}{f_2\sigma_y}} + t_c \text{, in mm,} \quad (\mathbf{10.5.3.2\text{-}2})$$

where s = frame spacing, in m;
p_{PL} = 0,75p, in MPa;
p as given in 10.5.2.2;

$f_1 = 1{,}3 - \frac{4{,}2}{(h/s + 1{,}8)^2}$; maximum 1,0;

$f_2 = 0{,}6 + \frac{0{,}4}{(h/s)}$ when $h/s \leqslant 1$;

$f_2 = 1{,}4 - 0{,}4(h/s)$ when $1 \leqslant h/s < 1{,}8$

where h as given in 10.5.2.1;
σ_y = yield stress of the material, in MPa, for which the following values shall be used:
σ_y = 235 MPa for normal-strength hull structural steel;
σ_y = 315 MPa or higher for high-strength hull structural steel.

If steels with different yield stress are used, the actual values may be substituted for the above ones upon agreement with the Register.

t_c = increment for abrasion and corrosion, in mm; normally t_c shall be 2 mm; if a special surface coating, by experience shown capable to withstand the abrasion of ice, is applied and maintained, lower values may be agreed with the Register.

10.5.4 Frames.

10.5.4.1 Vertical extension of ice strengthening for framing.

The vertical extension of the ice strengthening of the framing shall be at least as follows:

Ice class	Hull region	Above UIWL	Below LIWL
IA Super	bow	1,2 m	Down to double bottom or below top of the floors
	midbody		2,0 m
	stern		1,6 m
IA, IB и IC	bow	1,0 m	1,6 m
	midbody		1,3 m
	stern		1,0 m

Where an upper bow ice belt is required (refer to **10.5.3.1**), the ice-strengthened part of the framing shall be extended at least to the top of this ice belt.

Where the ice-strengthening would go beyond a deck or a tanktop (or tank bottom) by no more than **250** mm, it can be terminated at that deck or tanktop (or tank bottom).

10.5.4.2 Transverse frames.

10.5.4.2.1 Section modulus and shear area.

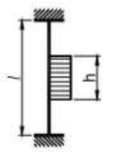
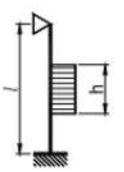
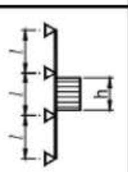
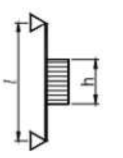
The section modulus of a main or intermediate transverse frame shall be determined by the following formula:

$$Z = \frac{pshl}{m_t \sigma_y}, \text{ in cm}^3. \qquad (10.5.4.2.1\text{-}1)$$

The effective shear area is calculated from the formula

$$A = \frac{\sqrt{3}\, f_3 phs}{2\sigma_y} 10^4, \text{ in cm}^2, \qquad (10.5.4.2.1\text{-}2)$$

where p = ice pressure as given in 10.5.2.2, in MPa;
s = frame spacing, in m;
h = height of load area as given in 10.5.2.1, in m;
l = span of the frame, in m;
$m_t = \frac{7m_0}{7-5h/l}$;
f_3 = factor which takes into account the maximum shear force versus the load location and the shear stress distribution, f_3 = 1,2;
σ_y = yield stress as in 10.5.3.2, in MPa;
m_0 = takes the boundary conditions into account. The values are given in the following Table:

Boundary condition	m_0	Example
	7	Frames in a bulk carrier with top wing tanks
	6	Frames extending from the tank top to a single deck
	5,7	Continuous frames between several decks or stringers
	5	Frames extending between two decks only

The boundary conditions are those for the main and intermediate frames. Load is applied at mid span.

Where less than 15 per cent of the span, l, of the frame is situated within the ice-strengthening zone, ordinary frame scantlings may be used.

10.5.4.2.2 Upper end of transverse framing.

The upper end of the strengthened part of a main frame and of an intermediate ice frame shall be attached to a deck, tanktop (or tank bottom) or an ice stringer (refer to 10.5.5).

Where a frame terminates above a deck or a stringer which is situated at or above the upper limit of the ice belt, the part above the deck or stringer may have the scantlings required by the requirements of the appropriate normative documents of the Register for an non ice-strengthened ship and the upper end of an intermediate frame may be connected to the adjacent frames by a horizontal member having the same scantlings as the main frame.

10.5.4.2.3 Lower end of transverse framing.

The lower end of the strengthened part of a main frame and of an intermediate ice frame shall be attached to a deck, tanktop (or tank bottom) or an ice stringer (refer to 10.5.5).

Where an intermediate frame terminates below a deck, tanktop (or tank bottom) or ice stringer which is situated at or below the lower limit of the ice belt, the lower end may be connected to the adjacent main frames by a horizontal member of the same scantlings as the main frames. Note that the main frames below the lower edge of ice belt must be ice strengthened, refer to 10.5.4.1.

10.5.4.3 Longitudinal frames.

The requirements of the present Section are intended for longitudinal frames with all end conditions.

10.5.4.3.1 Frames with and without brackets.

The section modulus of a longitudinal frame shall be not less than determined by the following formula:

$$Z = \frac{f_4 phl^2}{m\sigma_y} 10^6, \text{ in cm}^3, \qquad (10.5.4.3.1\text{-}1)$$

and effective shear area of a longitudinal frame shall be not less than determined by the following formula:

$$A = \frac{\sqrt{3}\, f_4 f_5 phl}{2\sigma_y} 10^4, \text{ in cm}^2. \qquad (10.5.4.3.1\text{-}2)$$

In calculating the actual shear area of the frames, the shear area of the brackets shall not be taken into account.

In the formulae given above:
f_4 = factor which takes account of the load distribution to adjacent frames: $f_4 = (1 - 0{,}2h/s)$;
f_5 = factor which takes into account the maximum shear force versus load location and the shear stress distribution; f_5 = 2,16;
p = ice pressure as given in 10.5.2.2, in MPa;
h = height of load area as given in 10.5.2.1, in m;
s = frame spacing, in m;
l = total span of frame, in m;
m = boundary condition factor; m = 13,3 for a continuous beam; where the boundary conditions deviate significantly from those of a continuous beam, e.g. in an end field, a smaller boundary factor may be required. For frames without brackets a value m = 11,0 shall be used;
σ_y = yield stress as in 10.5.3.2, in MPa.

10.5.4.4 General on framing.

10.5.4.4.1 The attachment of frames to supporting structures.

Within the ice-strengthened area all frames shall be effectively attached to all the supporting structures. A longitudinal frame shall be attached to all the supporting web frames and bulkheads by brackets. When a transversal frame terminates at a stringer or deck, a bracket or similar construction is to be fitted. When a frame is running through the supporting structure, both sides of the web plate of the frame are to be connected to the structure (by direct welding, collar plate or lug). When a bracket is installed, it has to have at least the same thickness as the web plate of the frame and the edge has to be appropriately stiffened against buckling.

10.5.4.4.2 Support of frames against tripping for ice class **IA Super**, for ice class **IA** in the bow and midbody regions and for ice classes **IB** and **1C** in the bow region of the ice-strengthened area.

All the frames shall be attached to the shell by double continuous weld. No scalloping is allowed.

The web thickness of the frames shall be at least the maximum of the following:

$$\frac{h_w\sqrt{\sigma_y}}{C}$$

where h_w = web height;
C = 805 for profiles; and
C = 282 for flat bars;

2,5 per cent of the frame spacing for transverse frames;

half of the net thickness of the shell plating, $t - t_c$. For the purpose of calculating the web thickness of frames, the required thickness of the shell plating is to be calculated according to 10.5.3.2 using the yield strength σ_y of the frames;

9 mm.

Where there is a deck, tanktop (or tank bottom) or bulkhead in lieu of a frame, the plate thickness of this shall be as above, to a depth corresponding to the height of the adjacent frames.

Frames that are not normal to the plating or the profile is unsymmetrical, and the span exceeds **4**,0 m, shall be supported against tripping by brackets, intercostals, stringers or similar at a distance not exceeding 1,3 m. If the span is less than **4**,0 m, the supports against tripping are required for unsymmetrical profiles and stiffeners the web of which is not normal to plating in the following regions:

all hull regions for ice class **IA Super**;
bow and midbody regionsfor ice class **IA**;
bow region for ice classes **IB** and **1C**.

10.5.5 Ice stringers.

10.5.5.1 Stringers within the ice belt.

The section modulus of a stringer situated within the ice belt (refer to 10.5.3.1), shall be taken not less than determined by the formula

$$Z = \frac{f_5 f_8 p h l^2}{m\sigma_y} 10^6, \text{ in cm}^3. \qquad (10.5.5.1\text{-}1)$$

The effective shear area shall be taken not less than determined by the formula

$$A = \frac{\sqrt{3}\, f_5 f_7 f_8 p h l}{2\sigma_y} 10^4, \text{ in cm}^2, \qquad (10.5.5.1\text{-}2)$$

where p = ice pressure as given in 10.5.2.2, in MPa;
h = height of load area as given in 10.5.2.1, in m.
The product ph shall not be taken as less than 0,15;
l = span of the stringer, in m;
m = boundary condition factor as defined in 10.5.4.3;
f_5 = factor which takes account of the distribution of load to the transverse frames; to be taken as 0,9;
f_7 = safety factor of stringers; to be taken as 1,8;
f_8 = a factor that takes into account the maximum shear force versus load location and the shear stress distribution, ;
σ_y = yield stress as in 10.5.3.2, in MPa.

10.5.5.2 Stringers outside the ice belt.

The section modulus of a stringer situated outside the ice belt but supporting ice-strengthened frames shall be taken not less than determined by the formula

$$Z = \frac{f_9 f_{10} p h l^2}{m\sigma_y}(1 - h_s/l_s)10^6, \text{ in cm}^3. \qquad (10.5.5.2\text{-}1)$$

The effective shear area shall be taken not less than determined by the formula

$$A = \frac{\sqrt{3}\, f_9 f_{10} f_{11} p h l}{2\sigma_y}(1 - h_s/l_s)10^4, \text{ in cm}^2, \qquad (10.5.5.2\text{-}2)$$

where p = ice pressure as given in 10.5.2.2, in MPa;
h = height of load area as given in 10.5.2.1, in m.
The product ph shall not be taken as less than 0,15;
l = span of stringer, in m;
m = boundary condition factor as defined in 10.5.4.3;
l_s = distance to the adjacent ice stringer, in m;
h_s = distance to the ice belt, in m;
f_9 = factor which takes account of the distribution of load to the transverse frames; to be taken as 0,80;
f_{10} = safety factor of stringers; to be taken as 1,8;
f_{11} = factor that takes into account the maximum shear force versus load location and the shear stress distribution, f_{11} = 1,2;
σ_y = yield stress of material as in 10.5.3.2, in MPa.

10.5.5.3 Deck strips.

Narrow deck strips abreast of hatches and serving as ice stringers shall comply with the section modulus and shear area requirements in 10.5.5.1 and 10.5.5.2 respectively. In the case of very long hatches, upon agreement with the Register, the product ph may be taken as less than 0,15 but in no case as less than 0,10.

Regard shall be paid to the deflection of the ship's sides due to ice pressure in way of very long (more than B/2) hatch openings when designing weather deck hatch covers and their fittings.

10.5.6 Web frames.

10.5.6.1 Ice load.

The ice load transferred to a web frame from an ice stringer or from longitudinal framing shall be determined by the following formula:

$$F = f_{12} p h S, \text{ in MN}, \qquad (10.5.6.1)$$

where p = ice pressure as given in 10.5.2.2, in MPa, in calculating c_a, however, l_a shall be taken $2S$.
h = height of load area as given in 10.5.2.1, in m.

The product ph shall not be taken as less than 0,15;
S = distance between web frames, in m;
f_{12} = safety factor of web frames; to be taken as 1,8.
In case the supported stringer is outside the ice belt, the force F shall be multiplied by $(1-h_s/l_s)$ where h_s and l_s shall be taken as defined in 10.5.5.2.

10.5.6.2 Section modulus and shear area.

The section modulus and shear area of web frames shall be calculated by the following formulae.

The effective shear area

$$A = \frac{\sqrt{3}\alpha f_{13} Q 10^4}{2\sigma_y}, \text{ in cm}^2, \qquad (10.5.6.2\text{-}1)$$

where Q = maximum calculated shear force under the ice load F as given in 10.5.6.1;
f_{13} = factor that takes into account the shear force distribution, f_{13} = 1,1;
α = as given in the Table below;
σ_y = yield stress of material as in 10.5.3.2, in MPa.

Section modulus

$$Z = \frac{M}{\sigma_y}\sqrt{\frac{1}{1-(\gamma A/A_a)^2}}\, 10^6, \text{ in cm}^3, \qquad (10.5.6.2\text{-}2)$$

where M = maximum calculated bending moment under the ice load F. M = 0,193Fl;
γ = given in the Table below;
A = required shear area;
A_a = actual cross sectional area of the web frame, $A_a = A_f + A_w$.
Factors α and γ can be obtained from the Table below:

A_f/A_w	0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
α	1,5	1,23	1,16	1,11	1,09	1,07	1,06	1,05	1,05	1,04	1,04
γ	0	0,44	0,62	0,71	0,76	0,80	0,83	0,85	0,87	0,88	0,89

where A_f = actual cross section area of free flange;
A_w = actual effective cross section area of web plate.

10.5.7 Stem.

10.5.7.1 The stem shall be made of rolled, cast or forged steel or of shaped steel plates as shown in Fig. 10.5.7.1.

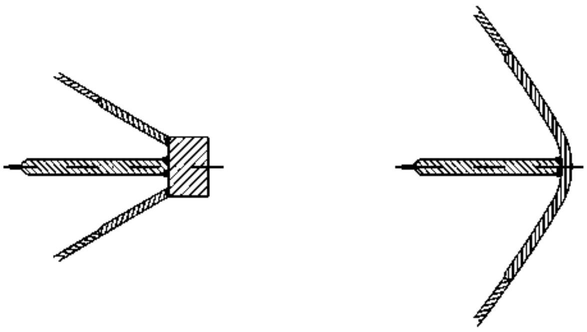


Fig. 10.5.7.1 Examples of suitable stems

The plate thickness of a shaped plate stem given in Fig 10.5.7.1, and in the case of a blunt bow, any part of the shell where $\alpha \geqslant 30°$ and $\psi \geqslant 75°$ (refer to 10.4.1.1 for angle definitions), shall be not less than determined in 10.5.3.2, assuming that

s = spacing of elements supporting the plate, in m;
$p_{PL} = p$, in MPa (refer to 10.5.3.2);
l_a = spacing of vertical supporting elements, in m.

The stem and the part of a blunt bow defined above shall be supported by floors or brackets spaced not more than 0,6 m apart and having a thickness of at least half the plate thickness. The reinforcement of the stem shall extend from the keel to a point 0,75 m above UIWL or, in case an upper bow ice belt is required (refer to 10.5.3.1), to the upper limit of this.

10.5.8 Stern.

The introduction of new propulsion arrangements with azimuthing thrusters or "podded" propellers, which provide an improved manoeuvrability, will result in increased ice loading of the Stern region and the stern area. This fact should be considered in the design of the aft/stern structure.

In order to avoid very high loads on propeller blade tips, the minimum distance between propeller(s) and hull (including stern frame) should not be less than h_0 (refer to 10.5.2.1).

On twin and triple screw ships the ice strengthening of the shell and framing shall be extended to the double bottom for 1,5 m forward and aft of the side propellers.

Shafting and stern tubes of side propellers shall normally be enclosed within plated bossings. If detached struts are used, their design, strength and attachments to the hull shall be approved by the Register.

10.6 RUDDER AND STEERING ARRANGEMENTS

10.6.1 The scantlings of rudder post, rudder stock, pintles, steering engine etc. as well as the capability of the steering engine shall be determined in compliance with the applicable requirements of the Register. The maximum service speed of the ship to be used in these calculations shall, however, not be taken as less than stated below:

for ice class **IASuper** — 20 knots;
for ice class **IA** — 18 knots;
for ice class **IB** — 16 knots;
for ice class **IC** — 14 knots.

If the actual maximum service speed of the ship is higher, that speed shall be used.

The local scantlings of rudders shall be determined assuming that the whole rudder belongs to the ice belt. Further, the rudder plating and frames shall be designed using the ice pressure p for the plating and frames in the midbody region.

For ice classes **IA** and **IA Super** the rudder (rudder stock and the upper part of the rudder) shall be protected from direct contact with intact ice by an ice knife that extends below the LIWL, if practicable (or equivalent means). Special consideration of the Register shall be given to the design of the rudder and the ice knife for ships with flap-type rudders.

For ice classes **IA** and **IA Super** due regard shall be paid to the large loads that arise when the rudder is forced out of the midship position while going astern in ice or into ice ridges. Suitable arrangement such as rudder stoppers shall be installed to absorb these loads.

Relief valves for hydraulic pressure in rudder turning mechanism(s) shall be installed. The components of the steering gear (e.g. rudder stock, rudder coupling, rudder horn etc.) shall be dimensioned to withstand loads causing yield stresses in the rudder stock.

10.7 PROPULSION MACHINERY

10.7.1 Scope.

These regulations apply to propulsion machinery covering open- and ducted-type propellers with controllable pitch or fixed pitch design for the ice classes **IA Super**, **IA**, **IB** and **1C**.

The given loads are the expected ice loads for the whole ship's service life under normal operational conditions, including loads resulting from the changing rotational direction of FP propellers. However, these loads do not cover off-design operational conditions, for example when a stopped propeller is dragged through ice.

The regulations also apply to azimuthing and fixed thrusters for main propulsion, considering loads resulting from propeller/ice interaction. However, the load models of the regulations do not include propeller/ice interaction loads when ice enters the propeller of a turned azimuthing thruster from the side (radially) or load cases when ice block hits on the propeller hub of a pulling propeller.

Ice loads resulting from ice impacts on the body of thrusters have to be estimated, but ice load formulae are not available.

10.7.2 Definitions.

D — propeller diameter, in m.

R — propeller radius, in m.

c — chord length of blade section, in m.

$c_{0,7}$ — chord length of blade section at propeller radius $r = 0{,}7R$, in m.

d — external diameter of propeller hub (at propeller plane), in m.

D_{limit} — limit value for propeller diameter, in m.

F_b — maximum backward blade force for the ship's service life, in kN.

F_{ex} — ultimate blade load resulting from blade loss through plastic bending, in kN.

F_f — maximum forward blade force for the ship's service life, in kN.

F_{ice} — ice load, in kN.

$(F_{ice})_{\max}$ — maximum ice load for the ship's service life, in kN.

h_0 — depth of the propeller centreline from LIWL, in m.

H_{ice} — thickness of maximum design ice block entering to propeller, in m.

I — equivalent mass moment of inertia of all parts on engine side of component under consideration, in kgm^2.

I_t — equivalent mass moment of inertia of the whole propulsion system, in kgm^2.

k — shape parameter for Weibull distribution.

m — slope for SN curve in log/log scale.

M_{BL} — blade bending moment, in kNm.

n — propeller rotational speed, in rev/s.

n_n — nominal propeller rotational speed at MCR in free running condition, in rev/s.

N_{class} — reference number of impacts per propeller rotational speed per ice class.

N_{ice} — total number of ice loads on propeller blade for the ship's service life.

N_R — reference number of load for equivalent fatigue stress (108 cycles).

N_Q — number of propeller revolutions during a milling sequence.

$P_{0,7}$ — propeller pitch at radius $r = 0{,}7R$, in m.

$P_{0,7n}$ — propeller pitch at radius $r = 0{,}7R$ at MCR in free running condition, in m.

$P_{0,7b}$ — propeller pitch at radius $r = 0{,}7R$ at MCR in bollard condition, in m.

Q — torque, in kNm.

$Q_{e\max}$ — maximum engine torque, in kNm.

$Q_{\max}$ — maximum torque on the propeller resulting from propeller/ice interaction, in kNm.

Q_{motor} — electric motor peak torque, in kNm.

Q_n — nominal torque at MCR in free running condition, in kNm.

Q_r — maximum response torque along the propeller shaft line, in kNm.

$Q_{s\max}$ — maximum spindle torque of the blade for the ship's service life, in kNm.

r — propeller radius, in m.

T — propeller thrust, in kN.

T_b — maximum backward propeller ice thrust for the ship's service life, in kN.

T_f — maximum forward propeller ice thrust for the ship's service life, in kN.

T_n — propeller thrust at MCR in free running condition, in kN.

T_r — maximum response thrust along the shaft line, in kN.

t — maximum blade section thickness, in m.

Z — number of propeller blades.

a_t — duration of propeller blade/ice interaction expressed in rotation angle, in deg.

γ_e — reduction factor for fatigue; scatter and test specimen size effect.

γ_v — reduction factor for fatigue; variable amplitude loading effect.

γ_m — reduction factor for fatigue; mean stress effect.

p — reduction factor for fatigue correlating the maximum stress amplitude to the equivalent fatigue stress for 10^8 stress cycles.

$\sigma_{0,2}$ — proof yield strength (at 0,2 per cent offset) of blade material, in MPa.

σ_{exp} — mean fatigue strength of blade material at 108 cycles to failure in sea water, in MPa.

σ_{fat} — equivalent fatigue ice load stress amplitude for 108 stress cycles, in MPa.

σ_{fl} — characteristic fatigue strength for blade material, in MPa.

σ_u — ultimate tensile strength of blade material, in MPa.

σ_{ref} — $\sigma_{ref} = 0{,}6\sigma_{0,2} + 0{,}4\sigma_u$, in MPa.

σ_{ref2} — $\sigma_{ref2} = 0{,}7\sigma_u$ or

σ_{ref2} — $\sigma_{ref2} = 0{,}6\sigma_{0,2} + 0{,}4\sigma_u$, whichever is less, in MPa.

σ_{st} — maximum stress resulting from F_b or F_f, in MPa.

$(\sigma_{ice})_{b_{max}}$ — principal stress caused by the maximum backward propeller ice load, in MPa.

$(\sigma_{ice})_{f_{max}}$ — principal stress caused by the maximum forward propeller ice load, in MPa.

$(\sigma_{ice})_{max}$ — maximum ice load stress amplitude, in MPa.

10.7.3 **Design ice conditions.**

In estimating the ice loads of the propeller for ice classes, different types of operation as given in Table 10.7.3-1 were taken into account. The maximum design ice block entering the propeller is a rectangular ice block with the dimensions $H_{ice} \cdot 2H_{ice} \cdot 3H_{ice}$. The thickness of the ice block H_{ice} is given in Table 10.7.3-2.

Table 10.7.2

Definition of loads

	Definition	Use of the load in design process
F_b	The maximum lifetime backward force on a propeller blade resulting from propeller/ice interaction, including hydrodynamic loads on that blade. The direction of the force is perpendicular to 0,7R chord line (refer to Fig. 10.7.2)	Design force for strength calculation of the propeller blade.
F_f	The maximum lifetime forward force on a propeller blade resulting from propeller/ice interaction, including hydrodynamic loads on that blade. The direction of the force is perpendicular to 0,7*R* chord line.	Design force for calculation of strength of the propeller blade.
Q_{smax}	The maximum lifetime spindle torque on a propeller blade resulting from propeller/ice interaction, including hydrodynamic loads on that blade.	In designing the propeller strength, the spindle torque is automatically taken into account because the propeller load is acting on the blade as distributed pressure on the leading edge or tip area.
T_b	The maximum lifetime thrust on propeller (all blades) resulting from propeller/ice interaction. The direction of the thrust is the propeller shaft direction and the force is opposite to the hydrodynamic thrust.	Is used for estimation of the response thrust T_r. T_b can be used as an estimate of excitation for axial vibration calculations.
T_f	The maximum lifetime thrust on propeller (all blades) resulting from propeller/ice interaction. The direction of the thrust is the propeller shaft direction acting in the direction of hydrodynamic thrust.	Is used for estimation of the response thrust T_r. T_f can be used as an estimate of excitation for axial vibration calculations.
Q_{max}	The maximum ice-induced torque resulting from propeller/ice interaction on one propeller blade, including hydrodynamic loads on that blade.	Is used for estimation of the response torque along the propulsion shaft line and as excitation for torsional vibration calculations.
F_{ex}	Ultimate blade load resulting from blade loss through plastic bending. The force is acting on 0,8*R*. Spindle arm shall be taken as 2/3 of the distance between the axis of blade rotation and leading/trailing edge (whichever is the greater) at the 0,8*R* radius.	Blade failure load is used to dimension the blade bolts, pitch control mechanism, propeller shaft, propeller shaft bearing and trust bearing. The objective is to guarantee that total propeller blade failure should not cause damage to other components.
Q_r	Maximum response torque along the propeller shaft line, taking into account the dynamic behavior of the shaft line for ice excitation (torsional vibration) and hydrodynamic mean torque on propeller.	Design torque for propeller shaft line components.
T_r	Maximum response thrust along shaft line, taking into account the dynamic behavior of the shaft line for ice excitation (axial vibration) and hydrodynamic mean thrust on propeller.	Design thrust for propeller shaft line components.

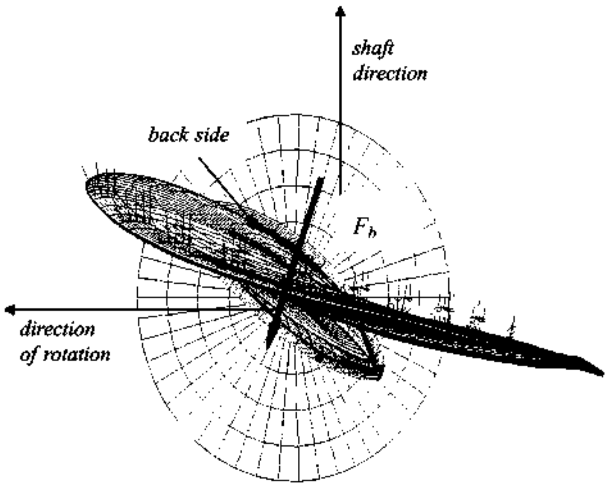


Fig.10.7.2 Direction of force F_b.
Ice contact pressure at leading edge is shown with small arrows

Table 10.7.3-1

Operation characteristics

Ice class	Operation of the ship
IA Super	Operation in ice channels and in level ice The ship may proceed by ramming
IA, IB, IC	Operation in ice channels

Table 10.7.3-2

Thickness of the design maximum ice block entering the propeller

Ice class	IA Super	IA	IB	IC
H_{ice}	1,75 m	1,5 m	1,2 m	1,0 m

10.7.4 Materials.

10.7.4.1 Materials exposed to sea water.

Materials of components exposed to sea water, such as propeller blades, propeller hubs, and thruster body, shall have an elongation of not less than 15 per cent on a test specimen, the gauge length of which is five times the diameter.

A Charpy V-notch impact test shall be carried out for materials other than bronze and austenitic steel. An average impact energy value of 20 J taken from three tests shall be obtained at -10 °C.

10.7.4.2 Materials exposed to sea water temperature.

Materials exposed to sea water temperature shall be of steel or other ductile material. An average impact energy value of 20 J taken from three tests shall be obtained at -10 °C.

This requirement applies to blade bolts, CP mechanisms, shaft bolts, strut-pod connecting bolts etc. This does not apply to surface hardened components, such as bearings and gear teeth.

10.7.5 Design loads.

The loads specified in the Section are intended for component strength calculations only and are total loads including ice-induced loads and hydrodynamic loads during propeller/ice interaction.

The values of the parameters in the formulae in this section shall be given in the units shown in 10.7.2.

If the propeller is not fully submerged when the ship is in ballast condition, the propulsion system shall be designed according to ice class **IA** for ice classes **IB** and **IC**.

10.7.5.1 Design loads on propeller blades.

F_b is the maximum force experienced during the lifetime of the ship that bends a propeller blade backwards when the propeller mills an ice block while rotating ahead.

F_f is the maximum force experienced during the lifetime of the ship that bends a propeller blade forwards when the propeller mills an ice block while rotating ahead.

F_b and F_f originate from different propeller/ice interaction phenomena, not acting simultaneously. Hence they shall be applied to one blade separately.

10.7.5.1.1 Force F_b for open propellers.

$$F_b = 27[nD]^{0,7}\left[\frac{EAR}{Z}\right]^{0,3}D^2, \text{ in kN, when } D \leqslant D_{limit}; \quad (10.7.5.1.1\text{-}1)$$

$$F_b = 27[nD]^{0,7}\left[\frac{EAR}{Z}\right]^{0,3}DH_{ice}^{1,4}, \text{ in kN, when } D \leqslant D_{limit} \quad (10.7.5.1.1\text{-}2)$$

where $D_{limit} = 0,85H_{ice}^{1,4}$, in m;
$n = n_n$ for a CP propeller;
$n = 0,85n_n$ for a FP propeller.

10.7.5.1.2 Force F_f for open propellers.

$$F_f = 250\left[\frac{EAR}{Z}\right]D^2, \text{ in kN, when } D \leqslant D_{limit}; \quad (10.7.5.1.2\text{-}1)$$

$$F_f = 500\left[\frac{EAR}{Z}\right]D\frac{1}{\left(1-\frac{d}{D}\right)}H_{ice}, \text{ in kN, when } D \leqslant D_{limit} \quad (10.7.5.1.2\text{-}2)$$

where $D_{limit} = \frac{2}{\left(1-\frac{d}{D}\right)}H_{ice}$, in m.

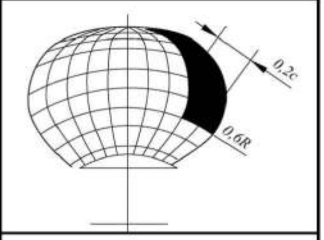
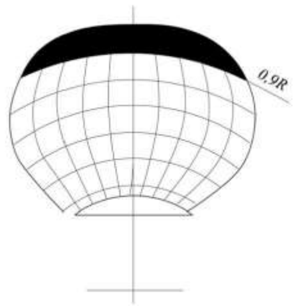
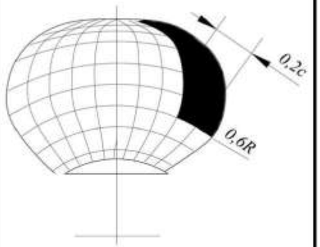
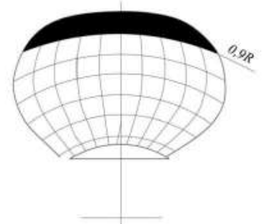
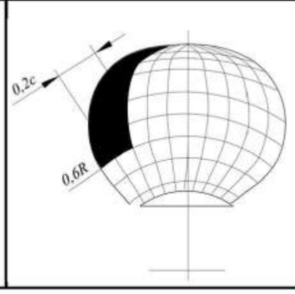
10.7.5.1.3 Loaded area on the blade for open propellers.

Load cases 1 — 4 have to be covered, as given in Table 10.7.5.1.3, for CP and FP propellers.

In order to obtain blade ice loads for a reversing propeller, load case 5 also has to be covered for FP propellers.

Table 10.7.5.1.3

Load cases for open propellers

	Force	Loaded area	Right-handed propeller blade seen from behind
Load case 1	F_b	Uniform pressure applied on the back of the blade (suction side) to an area from 0,6*R* to the tip and from the leading edge to 0,2 times the chord length	
Load case 2	50 per cent of F_b	Uniform pressure applied on the back of the blade (suction side) on the propeller tip area outside 0,9*R* radius	
Load case 3	F_f	Uniform pressure applied on the blade face (pressure side) to an area from 0,6*R* to the tip and from the leading edge to 0,2 times the chord length.	
Load case 4	50 per cent of F_f	Uniform pressure applied on propeller face (pressure side) on the propeller tip area outside 0,9*R* radius.	
Load case 5	60 per cent of F_f or F_b, whichever is greater	Uniform pressure applied on propeller face (pressure side) to an area from 0,6*R* to the tip and from the trailing edge to 0,2 times the chord length	

10.7.5.1.4 Maximum backward blade ice force F_b for ducted propellers.

$$F_b = 9{,}5[nD]^{0,7}\left[\frac{EAR}{Z}\right]^{0,3} D^2, \text{ in kN, when } D \leqslant D_{limit}; \qquad (10.7.5.1.4\text{-}1)$$

$$F_b = 66[nD]^{0,7}\left[\frac{EAR}{Z}\right]^{0,3} D^{0,6} H_{ice}^{1,4}, \text{ in kN, when } D \leqslant D_{limit}, \qquad (10.7.5.1.4\text{-}2)$$

where $D_{limit} = 4H_{ice}$, in m;
$n = n_n$ for a CP propeller;
$n = 0{,}85n_n$ for a FP propeller.

10.7.5.1.5 Maximum forward blade ice force F_f for ducted propellers.

$$F_f = 250\left[\frac{EAR}{Z}\right]D^2, \text{ in kN, when } D \leqslant D_{limit}; \quad (10.7.5.1.5\text{-}1)$$

$$F_f = 500\left[\frac{EAR}{Z}\right]D\frac{1}{\left(1-\frac{d}{D}\right)}H_{ice}, \text{ in kN, when } D \leqslant D_{limit} \quad (10.7.5.1.5\text{-}2)$$

where $D_{limit} = \frac{2}{\left(1-\frac{d}{D}\right)}H_{ice}$, in m.

10.7.5.1.6 Loaded area on the blade for ducted propellers.

Load cases 1 and 3 shall be covered as given in Table 10.7.5.1.6 for CP and FP propellers. Load case 5 shall be covered for FP propeller, to cover ice loads when the propeller is reversed.

10.7.5.1.7 Torque Q_{smax}.

The spindle torque Q_{smax} around the axis of the blade fitting shall be determined both for the maximum backward blade force F_b and forward blade force F_f, which are applied as in Tables 10.7.5.1.3 and 10.7.5.1.6.

If the above method gives a value, which is less than the default value given by Formula (10.7.5.1.7), the default value shall be used:

$$Q_{smax} = 0{,}25Fc_{0,7}, \text{ in kNm}, \quad (10.7.5.1.7)$$

where F — F_b or F_f, whichever is greater.

10.7.5.1.8 Load distributions for blade loads.

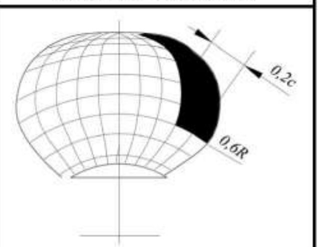
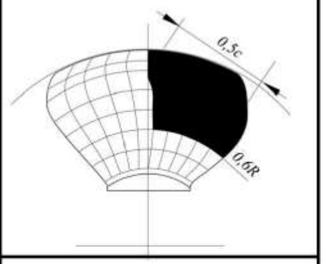
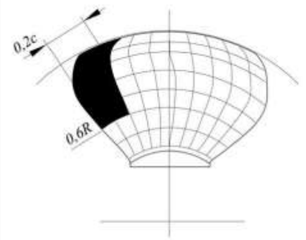
The Weibull-type distribution (probability that F_{ice} exceeds $(F_{ice})_{max}$) is used for the fatigue design of the blade.

$$P\left(\frac{F_{ice}}{(F_{ice})_{max}} \geqslant \frac{F}{(F_{ice})_{max}}\right) = e^{\left(-\left(\frac{F}{(F_{ice})_{max}}\right)\mathrm{In}(N_{ice})\right)} \quad (10.7.5.1.8)$$

where k = 0,75 shall be used for the ice force distribution of an open propeller;
k = 1,0 for that of a ducted propeller blade;
F_{ice} = random variable for ice loads on the blade, $0 < F_{ice} < (F_{ice})_{max}$.

Table 10.7.5.1.6

Load cases for ducted propellers

	Force	Loaded area	Right handed propeller blade seen from behind
Load case 1	F_b	Uniform pressure applied on the back of the blade (suction side) to an area from 0,6R to the tip and from the leading edge to 0,2 times the chord length	
Load case 3	F_f	Uniform pressure applied on the blade face (pressure side) to an area from 0,6R to the tip and from the leading edge to 0,5 times the chord length	
Load case 5	60 per cent of F_f or F_b, whichever is greater	Uniform pressure applied on propeller face (pressure side) to an area from 0,6R to the tip and from the trailing edge to 0,2 times the chord length	

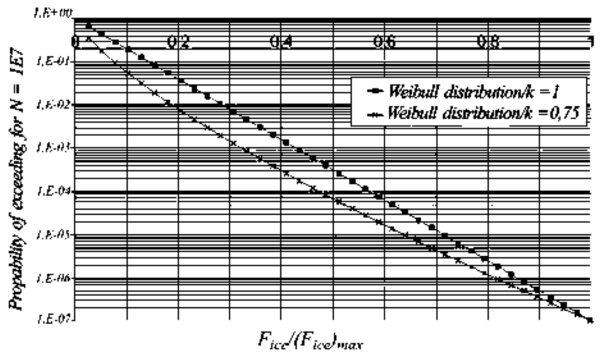


Fig. 10.7.5.1.8 The Weibull-type distribution

10.7.5.1.9 Number of ice loads.

The number of load cycles per propeller blade in the load spectrum shall be determined by the following formula:

$$N_{ice} = k_1 k_2 k_3 k_4 N_{class} n \qquad (10.7.5.1.9)$$

where

Ice class	IA Super	IA	IB	IC
Impacts in life n	$9 \cdot 10^6$	$6 \cdot 10^6$	$3{,}4 \cdot 10^6$	$2{,}1 \cdot 10^6$

Propeller location	Centre propeller	Wing propeller
Propeller location factor k_1	1	1,35

Propeller type	open	ducted
Propeller type factor k_2	1	1,1

Type	fixed	azimuthing
Propulsion type factor k_3	1	1,2

The submersion factor k_4 is determined from the following equation:

$k_4 = 0{,}8 - f$ when $f < 0$;
$k_4 = 0{,}8 - 0{,}4f$ when $0 \leqslant f \leqslant 1$;
$k_4 = 0{,}6 - 0{,}2f$ when $1 < f \leqslant 2{,}5$;
$k_4 = 0{,}1$ when $f > 2{,}5$

where the immersion function $f = \frac{h_0 - H_{ice}}{D/2} - 1$.

For components that are subject to loads resulting from propeller/ice interaction with all the propeller blades, the number of load cycles N_{ice} shall be multiplied by the number of propeller blades Z.

10.7.5.2 Axial design loads for open and ducted propellers.

10.7.5.2.1 Maximum thrusts T_f and T_b:

$$T_f = 1{,}1F_f, \text{ in кN;}$$

$$T_b = 1{,}1F_b, \text{ in кN.}$$

10.7.5.2.2 Design thrust along the propulsion shaft line.

The design thrust along the propeller shaft line T_r shall be calculated with the formulae below; the greater value of the forward and backward direction loads shall be taken as the design load for both directions. The factors 2,2 and 1,5 take into account the dynamic magnification resulting from axial vibration.

$$T_r = T + 2{,}2T_f, \text{ in кN;} \qquad (10.7.5.2.2\text{-}1)$$

$$T_r = 1{,}5T_b, \text{ in кN.} \qquad (10.7.5.2.2.\text{-}2)$$

If the hydrodynamic bollard thrust, T, is not known, T shall be taken as follows:

Propeller type	T
CP propellers (open)	$1{,}25T_n$
CP propellers (ducted)	$1{,}1T_n$
FP propellers driven by turbine or electric motor	T_n
FP propellers driven by diesel engine (open)	$0{,}85T_n$
FP propellers driven by diesel engine (ducted)	$0{,}75T_n$

Here T_n = nominal propeller thrust at MCR in the free running open water condition.

10.7.5.3 Torsional design loads.

10.7.5.3.1 Maximum torque on a propeller Q_{max} for open propellers.

$$Q_{max} = 10{,}9\left[1 - \frac{d}{D}\right]\left[\frac{P_{0,7}}{D}\right]^{0,16} (nD)^{0,17} D^3, \text{ in кNm,}$$

when $D \leqslant D_{limit}$;

$$Q_{max} = 20{,}7\left[1 - \frac{d}{D}\right]\left[\frac{P_{0,7}}{D}\right]^{0,16} (nD)^{0,17} D^{1,9} H_{ice}^{1,1}, \text{ in кNm,}$$

when $D > D_{limit}$

where $D_{limit} = 1{,}8H_{ice}$, in m;

n = rotational propeller speed in bollard condition. If not known, n shall be taken as follows:

Тип движителя	n
CP propellers	n_n
FP propellers driven by turbine or electric motor	n_n
FP propellers driven by diesel engine	$0{,}85n_n$

For CP propellers, the propeller pitch, $P_{0,7}$ shall correspond to MCR in bollard condition. If not known, $P_{0,7}$ shall be taken as $0{,}7P_{0,7n}$, where $P_{0,7n}$ — propeller pitch at MCR in free running condition.

10.7.5.3.2 Maximum torque on a propeller Q_{max} for ducted propellers.

$$Q_{max} = 7{,}7\left[1 - \frac{d}{D}\right]\left[\frac{P_{0,7}}{D}\right]^{0,16} (nD)^{0,17} D^3, \text{ in кNm,}$$

when $D \leqslant D_{limit}$;

$$Q_{max} = 14,6\left[1-\frac{d}{D}\right]\left[\frac{P_{0,7}}{D}\right]^{0,16}(nD)^{0,17}D^{1,9}H_{ice}^{1,1}, \text{ in kNm,}$$

when $D > D_{limit}$

where $D_{limit} = 1,8H_{ice}$, in m;

for n and $P_{0,7}$ — refer to 10.7.5.3.1.

10.7.5.3.3 Ice torque excitation for open and ducted propellers.

The propeller ice torque excitation for shaft line transient torsional vibration analysis shall be described by a sequence of blade impacts which are of a half sine shape (refer to Fig. 10.7.5.3.3). The torque resulting from a single blade ice impact as a function of the propeller rotation angle is then

$$Q(\varphi) = C_4 Q_{max}\sin(\varphi(180/\alpha_i)) \text{ when } \varphi = 0...\alpha_i;$$

$$Q(\varphi) = 0 \text{ when } \varphi = \alpha_i...360°$$

where C_q and α_i parameters are given in Table 10.7.5.3.3.

Table 10.7.5.3.3

Torque excitation	Propeller/ice interaction	C_q	α_i
Case 1	Single ice block	0,75	90
Case 2	Single ice block	1,0	135
Case 3	Two ice blocks (phase shift 360/2/Z, in deg.)	0,5	45

The total ice torque is obtained by summing the torque of single blades, taking into account the phase shift 360°/Z. In addition, at the beginning and at the end of the milling sequence a linear ramp functions for 270° of rotation angle shall be used.

The number of propeller revolutions during a milling sequence shall be obtained from the formula

$$N_Q = 2H_{ice}.$$

The number of impacts is $Z \cdot N_Q$ for blade order excitation.

10.7.5.3.4 Design torque along propeller shaft line.

If there is not any relevant first blade order torsional resonance within the designed operating rotational speed range extended 20 per cent above the maximum and 20 per cent below the minimum operating speeds, the following estimation of the maximum torque Q_r can be used.

$$Q_r = Q_{emax}\frac{I}{I_t}, \text{ in kNm.}$$

All the torques and the inertia moments shall be reduced to the rotation speed of the component being examined.

If the maximum torque Q_{emax} is not known, it shall be taken as follows:

Propeller type	Q_{emax}
Propellers driven by electric motor	Q_{motor}
CP propellers not driven by electric motor	Q_n
FP propellers driven by turbine	Q_n
FP propellers driven by diesel engine	$0,75Q_n$

If there is a first blade order torsional resonance within the designed operating rotational speed range extended 20 per cent above the maximum and 20 per cent below the minimum operating speeds, the design torque Q_r of the shaft component shall be determined by means of torsional vibration analysis of the propulsion line.

10.7.5.4 Blade failure load

$$F_{ex} = \frac{300ct^2\sigma_{ref}}{0,8D-2r}, \text{ in kN,}$$

where c, t, and r are determined for the weakest blade section outside the root filet.

10.7.6 Design.

10.7.6.1 Design principle.

The strength of the propulsion line shall be designed according to the pyramid strength principle. This means that the loss of the propeller blade shall not cause any significant damage to other propeller shaft line components.

10.7.6.2 Propeller blade.

10.7.6.2.1 Calculation of blade stresses.

The blade stresses shall be calculated for the design loads given in 10.7.5.1.

Finite element analysis shall be used for stress analysis for final approval for all propellers. The following simplified formulae can be used in estimating the blade

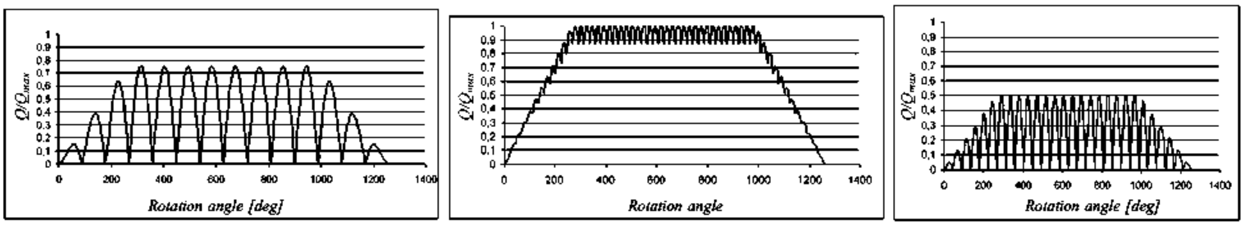


Fig. 10.7.5.3.3 The shape of the propeller ice torque excitation for 90° and 135° single-blade impact sequences and 45° double blade impact sequence. Figures apply for propellers with 4 blades

stresses for all propellers at the root area (r/R < 0,5). The root area dimensions based on Formula (10.7.6.2.1) can be accepted even if the FEM analysis would show greater stresses at the root area.

$$\sigma_{st} = C_1 \frac{M_{BL}}{100ct^2}, \text{ in MPa,} \qquad (10.7.6.2.1)$$

where $C_1 = \frac{\text{actual stress}}{\text{stress obtained with beam equation}}$. If the actual value is not available, C_1 shall be taken as 1,6.

$M_{BL} = (0,75 - r/R)\cdot R\cdot F$

where $F = F_b$ or F_f, whichever is greater.

10.7.6.2.2 Acceptability criterion.

The following criterion for calculated blade stresses has to be fulfilled:

$$\frac{\sigma_{ref2}}{\sigma_{st}} \geqslant 1,5.$$

If FEM analysis is used in estimating the stresses, von Mises stresses shall be used.

10.7.6.2.3 Fatigue design of propeller blade.

The fatigue design of the propeller blade is based on an estimated load distribution for the service life of the ship and the S-N curve for the blade material. An equivalent stress that produces the same fatigue damage as the expected load distribution shall be calculated and the acceptability criterion for fatigue shall be fulfilled. The equivalent stress is normalised for 10^8 cycles.

If the following criterion is fulfilled, fatigue calculations according to this chapter are not required.

$$\sigma_{exp} \geqslant B_1 \sigma_{ref2}^{B_2} \log(N_{ice})^{B_3}$$

where B_1, B_2 and B_3 = coefficients for open and ducted propellers are given in Table 10.7.6.2.3-1.

Table 10.7.6.2.3-1

	Open propeller	Ducted propeller
B_1	0,00270	0,00184
B_2	1,007	1,007
B_3	2,101	2,470

For calculation of equivalent stress two types of SN-curves are available:

two slope SN-curve (slopes 4,5 and 10), refer to Fig. 10.7.6.2.3-1;

one slope SN-curve(the slope can be chosen), refer to Fig. 10.7.6.2.3-2.

The type of the SN-curve shall be selected to correspond to the material properties of the blade. If the SN-curve is not known, the two slope SN-curve shall be used.

10.7.6.2.3.1 Equivalent fatigue stress.

The equivalent fatigue stress for 10^8 stress cycles which produces the same fatigue damage as the load distribution is:

$$\sigma_{fat} = \rho(\sigma_{ice})_{max} \qquad (10.7.6.2.3.1)$$

where $(\sigma_{ice})_{max} = 0,5((\sigma_{ice})_{f\,max} - (\sigma_{ice})_{b\,max})$.

In calculation of $(\sigma_{ice})_{max}$, case 1 and case 3 (or case 2 and case 4) are considered as a pair for $(\sigma_{ice})_{f\,max}$ and $(\sigma_{ice})_{b\,max}$ calculations. Case 5 is excluded from the fatigue analysis.

10.7.6.2.3.2 Calculation of parameter ρ for two-slope SN-curve.

The parameter ρ relates the maximum ice load to the distribution of ice loads according to the regression formula

$$\rho = C_1(\sigma_{ice})_{max}C_2\sigma_{fl}C_3\log(N_{ice})C_4 \qquad (10.7.6.2.3.2)$$

where $\sigma_{fl} = \gamma_\varepsilon\gamma_v\gamma_m\sigma_{exp}$.

The following values shall be used for the reduction factors if actual values are not available: γ_ε = 0,67, γ_v = 0,75 и γ_m = 0,75.

The coefficients C_1, C_2, C_3 and C_4 are given in Table 10.7.6.2.3.2.

Table 10.7.6.2.3.2

	Open propeller	Ducted propeller
C_1	0,000711	0,000509
C_2	0,0645	0,0533
C_3	– 0,0565	– 0,0459
C_4	2,22	2,584

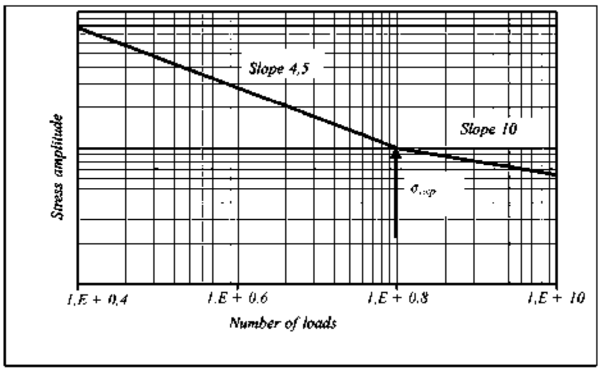


Fig. 10.7.6.2.3-1 Two-slope SN-curve

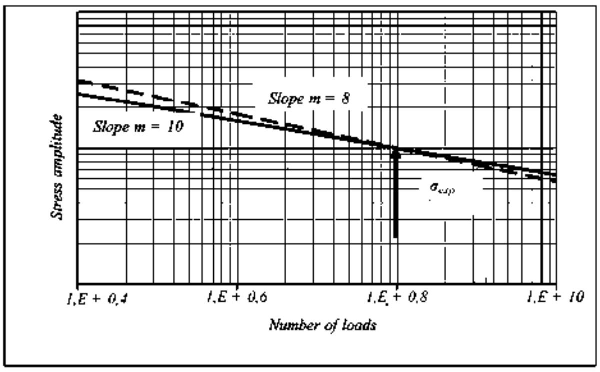


Fig. 10.7.6.2.3-2 Constant-slope SN-curve

10.7.6.2.3.3 Calculation of parameter p for constant-slope SN-curve.

For materials with a constant-slope SN-curve, the factor p shall be calculated from the formula

$$p = \left(G \frac{N_{ice}}{N_R}\right)^{1/m} (\ln(N_{ice}))^{-1/k} \qquad (10.7.6.2.3.3)$$

where k = 1,0 for ducted propellers;
k = 0,75 for open propellers.

Values for the parameter G are given in Table 10.7.6.2.3.3. Linear interpolation may be used to calculate the value for other m/k ratios than given in Table 10.7.6.2.3.3.

10.7.6.2.4 Acceptability criterion for fatigue.

The equivalent fatigue stress at all locations on the blade has to fulfil the following acceptability criterion

$$\frac{\sigma_{fl}}{\sigma_{fat}} \geqslant 1,5$$

where $\sigma_{fl} = \gamma_\varepsilon \gamma_v \gamma_m \sigma_{exp}$.

The following values shall be used for the reduction factors if actual values are not available: γ_ε = 0,67, γ_v = 0,75 и γ_m = 0,75.

10.7.6.3 Propeller bossing and CP mechanism.

The blade bolts, the CP mechanism, the propeller boss, and the fitting of the propeller to the propeller shaft shall be designed to withstand the maximum and fatigue design loads, as defined in 10.7.5. The safety factor against yielding shall be greater than 1,3 and that against fatigue greater than 1,5. In addition, the safety factor for loads resulting from loss of the propeller blade through plastic bending as defined in 10.7.5.4 shall be greater than 1,0 against yielding.

10.7.6.4 Propulsion shaft line.

The shafts and shafting components, such as the thrust and sterntube bearings, couplings, flanges and sealings, shall be designed to withstand the propeller/ice interaction loads as given in 10.7.5. The safety factor is to be at least 1,3.

10.7.6.4.1 Shafts and shafting components.

The ultimate load resulting from total blade failure as defined in 10.7.5.4 shall not cause yielding in shafts and shaft components. The loading shall consist of the combined axial, bending, and torsion loads, wherever this is significant. The minimum safety factor against yielding shall be not less than 1,0 for bending and torsional stresses.

10.7.6.5 Azimuthing main propulsors.

In addition, special consideration shall be given to those loading cases which are extraordinary for propulsion units when compared with conventional propellers. The estimation of loading cases has to reflect the way of operation of the ship and the thrusters. In this respect, for example, the loads caused by the impacts of ice blocks on the propeller hub of a pulling propeller have to be considered. Furthermore, loads resulting from the thrusters operating at an oblique angle to the flow have to be considered.

The steering mechanism, the fitting of the unit, and the body of the thruster shall be designed to withstand the loss of a blade without damage. The loss of a blade shall be considered for the propeller blade orientation which causes the maximum load on the component being studied. Typically, top-down blade orientation places the maximum bending loads on the thruster body.

Azimuth thrusters shall also be designed for estimated loads caused by thruster body/ice interaction. The thruster body has to stand the loads obtained when the maximum ice blocks, which are given in 10.7.3, strike the thruster body when the ship is at a typical ice operating speed. In addition, the design situation in which an ice sheet glides along the ship's hull and presses against the thruster body should be considered. The thickness of the sheet shall be taken as the thickness of the maximum ice block entering the propeller, as defined in section 10.7.3.

10.7.6.6 Calculation of shaft line vibrations.

The propulsion system shall be designed in such a way that the complete dynamic system is free from hamrful torsional, axial, and bending resonances at a 1-order blade frequency within the designed running speed range, extended by 20 per cent above and below the maximum and minimum operating rotational speeds. If this condition cannot be fulfilled, a detailed vibration analysis has to be carried out in order to determine that the acceptable strength of the components can be achieved.

10.7.7 Alternative design procedure.

10.7.7.1 Scope.

As an alternative to 10.7.5 and 10.7.6, a comprehensive design study may be carried out upon agreement with the Register. The study may be based on ice conditions given for different ice classes in 10.7.3, include fatigue and maximum load design calculations and fulfil the pyramid strength principle, as given in 10.7.6.1.

Table 10.7.6.2.3.3

Value for the parameter *G* for different *m/k* ratios

m/k	3	3,5	4	4,5	5	5,5	6	6,5	7	7,5	8	8,5	9	9,5	10
G	6	11,6	24	52,3	120	287,9	720	1871	5040	14034	40320	119292	362880	$1,133 \cdot 10^6$	$3,623 \cdot 10^6$

10.7.7.2 Loading.

Loads on the propeller blade and propulsion system shall be based on an acceptable estimation of hydrodynamic and ice loads.

10.7.7.3 Design levels.

The analysis shall indicate that all components transmitting random (occasional) forces, excluding propeller blade, are not subjected to stress levels in excess of the yield stress of the component material, with a reasonable safety margin. Cumulative fatigue damage calculations shall indicate a reasonable safety factor. Due account shall be taken of material properties, stress raisers, and fatigue enhancements.

Vibration analysis shall be carried out and shall indicate that the complete dynamic system is free from harmful torsional resonances resulting from propeller/ice interaction.

10.8 MISCELLANEOUS MACHINERY REQUIREMENTS

10.8.1 **Starting arrangements.**

The capacity of the air receivers shall be sufficient to provide without reloading not less than 12 consecutive starts of the propulsion engine, if this has to be reversed for going astem, or 6 consecutive starts if the propulsion engine does not have to be reversed for going astern.

If the air receivers serve any other purposes than starting the propulsion engine, they shall have additional capacity sufficient for these purposes.

The capacity of the air compressors shall be sufficient for charging the air receivers from atmospheric to full pressure in 1 h, except for a ship with the ice class **IA Super**, if its propulsion engine shall be reversed for going astem, in which case the compressor shall be able to charge the receivers in 30 min.

10.8.2 **Cooling water system.**

The cooling water system shall be designed to ensure supply of cooling water when navigating in ice.

For this purpose at least one cooling water inlet chest shall be arranged as follows:

.1 the sea inlet shall be situated near the centreline of the ship and well aft if possible;

.2 as guidance for design the volume of the chest shall be about 1 m^3 for every 750 kW engine output of the ship including the output of auxiliary engines necessary for the ship's service;

.3 the chest shall be sufficiently high to allow ice to accumulate above the inlet pipe;

.4 a pipe for discharge cooling water, allowing full capacity discharge, shall be connected to the chest;

.5 the open area of the strainer plates shall not be less than four times the inlet pipe sectional area.

If there are difficulties to meet the requirements of 10.8.2.2 and 10.8.2.3, two smaller chests may be arranged for alternating intake and discharge of cooling water, at that the requirements in 10.8.2.1, 10.8.2.4 and 10.8.2.5 shall be met.

Heating coils may be installed in the upper part of the sea chest.

Arrangements for using ballast water for cooling purposes may be useful as a reserve in ballast condition but cannot be accepted as a substitute for sea a inlet chest as described above.

APPENDIX

ICE CLASS DRAUGHT MARKING

Subject to 10.3.2, the ship's sides shall be provided with a warning triangle and with a draught mark at the maximum permissible ice class draught amidships (refer to Fig.). The purpose of the warning triangle is to provide information on the draught limitation of the vessel when it is sailing in ice for masters of icebreakers and for inspection personnel in ports.

Notes: 1. The upper edge of the warning triangle shall be located vertically above the "ICE" mark, 1000 mm higher than the summer load line in fresh water but in no case higher than the deck line. The sides of the triangle shall be 300 mm in length.

2. The ice class draught mark shall be located 540 mm abaft the centre of the load line ring or 540 mm abaft the vertical line of the timber load line mark, if applicable.

3. The marks and figures shall be cut out of 5 — 8 mm plate and then welded to the ship's side. The marks and figures shall be painted in a red or yellow reflecting colour in order to make the marks and figures plainly visible even in ice conditions.

4. The dimensions of all letters shall be the same as those used in the summer load line mark.

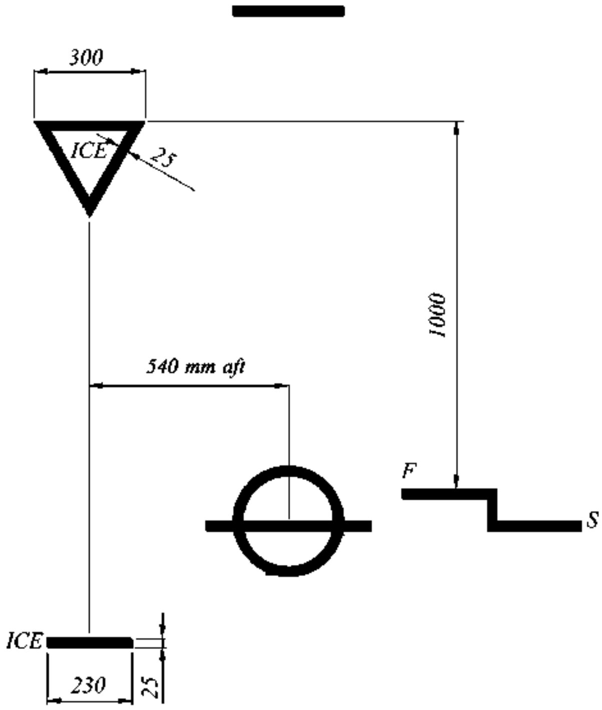


Fig. Ice class draught marking

See circular 926c

See circular 931c

See circular 954c

LIST OF CIRCULAR LETTERS AMENDING/SUPPLEMENTING NORMATIVE DOCUMENT

ND 2-020101-087-E

Rules for the Classification and Construction of Sea-Going Ships (2016)

Part XVII

(Normative document No. and title)

Item No.	Circular letter No., date of approval	List of amended and supplemented paras
1.	314-08-872c dated 16.03.2016	7.4.6, 7.4.6.1, 7.4.6.2, 7.9.1.4, 7.9.2.1.14.
2.	312-11-926c dated 08.08.2016	New section 11
3.	312-11-931c dated 05.09.2016	New section 12
4.	312-11-954c dated 15.11.2016	New section 13

RUSSIAN MARITIME REGISTER OF SHIPPING

HEAD OFFICE

CIRCULAR LETTER	No. 314-08-872c	dated	16.03.2016

Re:

Implementation of the requirements of IMO resolutions MEPC.264(68) and MSC.385(94) "International Code for Ships Operating in Polar Waters (Polar Code)" to Section 7, 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, 2016, ND No2-020101-087-E.

Item of supervision:

Ship operated in Polar waters

Implementation	upon receipt
Valid: till	
Validity period extended till	
Cancels / amends / adds circular letter №	dated
Number of pages:	1+1
Appendices:	Amendments to Section 7, 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, 2016, ND No2-020101-087-E.

Technical Director - Head of Classification Directorate Vladimir I. Evenko

Amends Rules for the Classification and Construction of Sea-Going Ships

We hereby inform that in connection with application of the requirements of IMO resolutions MEPC.264(68) and MSC.385(94) , the amendments mentioned in the Appendix to this Circular letter shall be introduced to Section 7, 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, 2016, ND No2-020101-087-E.

Above mentioned amendments shall come in force on 1t January, 2017.

It is necessary to do the following:

1) Apply the provisions of the Circular Letter during review of technical documentation since1 January, 2017.
2) Bring the content of the circular letter to the notice of the surveyors of the RS Branch Offices and interested organizations in the area of the RS Branch Offices' activity.

Person in charge: Vitaliy S. Odegov Department 314 +7 (812)312-85-72

DMS THESIS № 16-40599

Appendix to the Circular letter
No. 314-08-872c from 16.03.2016

Rules for the Classification and Construction of Sea-Going Ships, 2016, ND No2-020101-087-E
Part XVII "Distinguishing Marks and Descriptive Notations in the Class Notation Specifying Structural and Operational Particulars of Ships"

Chapter 7.4 shall be supplemented with paras 7.4.6, 7.4.6.1 and 7.4.6.2 reading as follows:

"**7.4.6 Signal means.**
7.4.6.1 Manually operated flashing red light visible from astern to indicate when the ship is stopped shall be provided onboard. This shall be capable of use from any location from which the ship can be maneuvered. The flashing light shall have a range of visibility of at least 2 nautical miles. Construction and characteristics of the light shall meet the applicable requirements of 3.1.6 and 3.2.1, Part III "Signal Means" of the Rules for the Equipment of Sea-Going Ships. Arc of visibility in horizontal and vertical plane shall be the same as for stern lights in compliance with 3.1.2, Part III "Signal Means" of the Rules for the Equipment of Sea Going Ships.
7.4.6.2 The light specified in 7.11.6.1 shall be effective at design ambient temperature or at the temperature stated in 3.1.3.3, Part III "Signal Means" of the Rules for the Equipment of Sea-Going Ships (whichever is lower)».

Chapter 7.9 shall be supplemented with paras 7.9.1.4 and 7.9.2.1.14 reading as follows:

"**7.9.1.4** Sufficient emergency rations for the maximum expected time of rescue shall be provided onboard",

"**7.9.2.1.14** Immersion suits shall be of the insulated type."

RUSSIAN MARITIME REGISTER OF SHIPPING

CIRCULAR LETTER	**No.** 312-11-926c	dated 08.08.2016

Re:

Introducing the requirements for bunkering ships of liquefied natural gas (LNG) to the Rules for the Classification and Construction of Sea-Going Ships, 2016, ND No. 2-020101-087-E

Item of supervision:

LNG bunkering ships

Implementation	from the date of publication	
Valid: till	-	
Validity period extended till	-	
~~Cancels / amends / adds circular letter №~~	-	dated -
Number of pages:	11	
Appendices:	Text of the RS requirements for LNG bunkering ships	
Director General		Konstantin Palnikov

Amends Rules for the Classification and Construction of Sea-Going Ships, 2016, ND No. 2-020101-087-E

We hereby inform that new RS requirements for gas carriers engaged in transportation of liquefied natural gas (LNG) and intended to ensure the transfer of LNG to ships using LNG as fuel shall be introduced to the Rules for the Classification and Construction of Sea-Going Ships, 2016, ND No. 2-020101-087-E

Text of the requirements is specified in the Appendix.

It is necessary to do the following:

1. Familiarize surveyors of the RS Branch Offices and interested organizations in the area of the RS Branch Offices' activity with the content of the Circular Letter.
2. Apply the above RS requirements in practical activity.

Person in charge: V.F. Piskorsky Department 312 +7 (812) 312-24-28

DMS THESIS № 16-187508

Appendix to the Circular Letter
No. 312-11-926c of 08.08.2016

RULES OF THE CLASSIFICATION AND CONSTRUCTION OF SEA-GOING SHIPS, 2016, ND NO. 2-020101-087

PART I. CLASSIFICATION

2.2 CLASS NOTATION OF A SHIP

Para 2.2.29 shall be amended to read:

"In compliance with the requirements of Section 11, Part XVII "Distinguishing Marks and Descriptive Notations in the Class Notation Specifying Structural and Operational Particulars of Ships", for Gas carriers engaged in transportation of liquefied natural gas (LNG) and intended to ensure the transfer of LNG to ships using LNG as fuel may be assigned an additional descriptive notation **LNG bunkering ship** after the descriptive notation **Gas carrier** to be added to the class notation.

When additional functions related to servicing of ships using LNG as a fuel are available on board the ship and when the ship meets the requirements stated in 11.13 of the abovementioned Part of the Rules, the distinguishing marks: **RE**, **IG-Supply**, **BOG** shall be added to the class notation of the ship.".

PART XVII. DISTINGUISHING MARKS AND DESCRIPTIVE NOTATIONS IN THE CLASS NOTATION SPECIFYING STRUCTURAL AND OPERATIONAL PARTICULARS OF SHIPS

New Section 11 shall be introduced as follows:

«11 REQUIREMENTS TO LNG BUNKERING SHIPS

11.1 GENERAL PROVISIONS AND SCOPE OF APPLICATION

11.1.1 These requirements apply to the gas carriers engaged in transportation of liquefied natural gas (LNG) and intended to ensure the transfer of LNG on board the ships using LNG as a fuel (hereinafter – LNG bunkering ships).

An additional descriptive notation and marks stated in 2.2.29, Part I "Classification" may be added to LNG bunkering ships complying with these requirements.

11.1.2 Descriptive notation and marks in class of notation of LNG bunkering ships.

For gas carrier complying the requirements of this Section, except Chapter 11.13, after the descriptive notation **Gas carrier** the descriptive notation **LNG bunkering ship** may be added to the class notation.
When additional functions related to servicing of ships using LNG as a fuel are available on board the ship and when the ship meets the requirements stated in 11.13, the following distinguishing marks may be added to the descriptive notation:

RE – where the ship is designed to receive LNG from a gas fuelled ship for which the LNG fuel tanks shall be emptied;
IG-Supply – where the ship is designed to supply inert gas and dry air, to ensure gas freeing and aeration in compliance with 6.10.4 of the International Code of Safety for Ships Using Gases or Other Low Flashpoint Fuels (IGF Code)
BOG – where the ship is designed to recover and manage the boil-off gas generated during the bunkering operation.

11.1.3 Definitions.

LNG bunkering station means room or space fitted with the following equipment:
hoses and piping connections used for liquid and vapour return lines, including the isolating valves and the emergency shut-down valves;
automation and alarms systems;
the drip tray with its draining arrangement and other arrangements intended for the ship structure protection;
the gas and LNG leak detection systems;
the associated firefighting installations.

LNG bunkering control room means a safe location with regards to bunkering operations and may be from the cargo control room. At this location, overfilling alarm, automatic and manual shutdown shall be indicated.

Emergency shutdown system (ESD) means a system that safely and effectively stops the transfer of LNG (and vapour as applicable) between the receiving ship and the bunkering ship in the event of an emergency during the bunkering operation, and puts the system in a safe condition.

Bunkering connections mean liquid and vapour connections between ships used for liquid product transfer to receiving ship and product vapour return to the bunker ship (i.e. manifold for a system with flexible hose and before the swivel for a system with transfer arm).

Emergency release coupling (ERC) means a coupling located on the receiving ship bunkering manifold or on the LNG transfer system, which separates at a predetermined section, when required, each separated section containing a self-closing shut-off valve, which seals automatically.

An emergency release coupling can be activated:
by maximal allowable forces applied to the predetermined section
by manual or automatic control, in case of emergency.

Quick connect/disconnect coupler (QCDC) means a manual or hydraulic mechanical device used to connect the LNG transfer system to the receiving ship manifold.

Sloshing means liquid oscillations effect at significant free surface in cargo and fuel tanks.

11.2 TECHNICAL DOCUMENTATION

11.2.1 In addition to technical documentation specified in 3.2, Part I “Classification” of these Rules and 6.1, Part I “Classification” of the Rules for the Classification and Construction of Ships Carrying Liquefied Gases in Bulk, the following technical documentation shall be submitted:

.1 general arrangement of the ship showing the location of LNG bunkering station and bunkering control station and escape routes;

.2 diagram and description of the cargo system/ Drawings of hose lines, swivels and transfer arms (where applicable);

.3 diagram and description of LNG vapour return transfer system. Documentation for the reliquefaction system (where applicable). Calculation of maximum bunkering flow and maximum pressure;

.4 technical documentation for ESD bunkering system;

.5 single line diagrams for all intrinsically safe circuits;

.6 electrical equipment in hazardous areas for electrical circuits related to bunker operations;

.7 technical documentation for fire and gas detection and alarm systems of the bunkering installation, including location of gas detectors, lines, valves and sampling points on board;

.8 technical documentation for measuring, alarm and pressure monitoring in the cargo spaces and piping;

.9 technical documentation for control and warning alarm system of cargo pumps.

11.2.2 The following operating documentation shall be submitted:

.1 risk analysis of LNG bunkering operations, including inerting and gas freeing as per IACS Recommendation No. 142 given in the Supplement to rules and guidelines of Russian Maritime Register of Shipping "IACS Procedural Requirements, Unified Interpretations and Recommendations" (published in electronic format as a separate edition). The analysis shall cover risks of hull members damage and failure of equipment due to the accident related to gas fuel freeing. The results of risk analysis shall be included in the ship's Operating manual;

.2 operating instructions containing the procedures of bunkering, interting, vapour return control as per IACS Recommendation No. 142.

11.3 ARRANGEMENT OF LNG BUNKERING SHIP

11.3.1 LNG bunkering ship shall comply with the requirements of the Rules for the Classification and Construction of Ships Carrying Liquefied Gases in Bulk and the International Code of Safety for Ships Using Gases or Other Low Flashpoint Fuels (IGF Code).

11.3.2 The LNG bunkering station shall be located on the open deck in the area with sufficient natural ventilation. Closed or semi-enclosed bunkering stations will be subject to special consideration. The LNG bunkering station shall be physically separated or structurally shielded from accommodation and control stations.

11.3.3 Bunker manifold area and escape routes shall have safe access for crew engaged in operation. It shall have unrestricted natural ventilation and be sufficiently illuminated.

11.3.4 The bunker connections shall be clearly visible from the navigation bridge and bunker operation control position where continuous watch is kept during the transfer. CCTV can be accepted as substitute for the direct view when it provides unobstructed view of the bunker connections.

11.3.5 Arrangement of work platforms in areas where liquid spill may occur shall exclude liquid spill accumulation at the platform surface. Gratings used in this location shall be suitable for low temperatures and correspond to boiling point of gas bunker. Area under the gratings shall be equipped with spill collecting trays with drainage arrangements suitable for draining the accumulated spill overboard. The drain shall be fitted with a valve.

11.3.6 Drip trays shall be fitted below the liquid bunkering connections and where leakage may occur which can cause damage to the ship structure. Thermal sensors shall be positioned in way of bunkering connections in the drip tray. The drip trays shall be made of stainless steel, and capable of being remotely drained over the ship's side without risk of damage to the ship structure and to the receiving ship.

11.3.7 When bunker boiling point is lower than design temperature of the hull steel, the hull in the manifold area shall be effectively protected from low temperature in case of a major bunker spill. Where water curtain is used for hull protection, the pumps shall be arranged with redundancy.

11.4 HULL AND STABILITY

11.4.1 The hull structure and stability of the LNG bunkering ship shall meet the requirements of Parts II "Gas Carrier Design" and III "Stability, Subdivision. Freeboard" of the Rules for the Classification and Construction of Ships Carrying Liquefied Gases in Bulk and the following additional requirements:

.1 Bunkering ship shall be able to abort bunkering operation at any stage in case of emergency. Cargo tanks on bunker ship therefore shall not have restrictions on intermediate filling;
.2 However, internal transfer between cargo tanks within short period of time to leave dangerous sloshing zone may be accepted upon special considerations.

11.5 FIRE PROTECTION

11.5.1 Structural fire protection of LNG bunkering ship shall meet the requirements of Part V "Fire Protection" of the Rules for the Classification and Construction of Ships Carrying Liquefied Gases in Bulk and the following additional requirements:

When applicable, the bunkering station shall be separated by class A-60 insulation towards other spaces, except
for spaces such as tanks, voids, auxiliary machinery spaces of no fire risk, sanitary and similar spaces where insulation standard may be reduced to class A-0.

11.5.2 Fire extinguishing systems of LNG bunkering ship shall meet the requirements of Part V "Fire Protection" of the Rules for the Classification and Construction of Ships Carrying Liquefied Gases and the following additional requirements:

.1 The water spray system shall be fitted to protect the bunkering manifold, associated piping installations and the transfer area. The system capacity shall not be less than those stated in 3.3.2 of Part V "Fire Protection" of the Rules for the Classification and Construction of Ships Carrying Liquefied Gases in Bulk;

.2 In the bunkering station area a permanently installed dry chemical powder extinguishing system shall cover all possible leak points. The capacity shall be at least 3,5 kg/s for a maximum of 45 s discharges. The system shall be arranged for easy manual release from a safe location outside of the protected area;

.3 one portable dry powder extinguisher of at least 5 kg capacity shall be located near the bunkering station.

11.5.3 Exhaust gas system shall meet the requirements of Part VI "Systems and Piping" of these Rules, therewith, the outlets of the exhaust gas system of the internal combustion engines and boilers shall be provided with spark arresters.

11.5.4 Use of equipment for cargo vapor thermal oxidation not complying with the requirements of 4.3, Part VI "Systems and Piping" shall be prohibited during the bunkering operations.

11.6 CARGO SYSTEM

11.6.1 The following components shall be obligatory included in the cargo system:

bunkering hoses and/or loading arms;
quick release connection;

emergency release coupling;
electrical insulating joint.

11.6.2 Cargo system and the bunkering fuel transfer procedure shall be so designed .to avoid the release of gas or liquid to the atmosphere both from bunkering and receiving ships during bunkering.

11.6.3 Bunker transfer piping system for products with boiling point below -55°C shall be thermally insulated to minimise heat leaks to transferred gas bunker and protect personnel from direct contact with cold surfaces.

11.6.4 Bunkering hoses.

11.6.4.1 Bunkering hoses shall meet the requirements of 5.11.7 of the IGC Code, applicable requirements of 6.2, Part VI "Systems and Piping" and shall have Type Approval Certificate (CTO). In addition to the above requirements, the requirements given in 11.6.4.2 – 11.6.4.10 shall be complied with during the type testing.
11.6.4.2 All the applicable materials shall be compatible with each other and transported medium (LNG and LNG vapors). The end fittings shall be made of stainless steel and comply with the IGC Code requirements.

11.6.4.3 The following characteristics shall be defined by the designer and submitted to the Society:
• Extreme service temperature
• Maximum working load
• Maximum design pressure
• Minimum bend radius (MBR)
• Maximum allowable applied twist (MAAT).

11.6.4.4 Each hose type shall be subjected to a pressure cycle test at ambient temperature to demonstrate that the hose is capable of withstanding 2 000 pressure cycle test from zero to at least twice the specified maximum working pressure. The hose assembly is also to be subjected to a cryogenic temperature and pressure cycle test with a minimum of 200 combined test cycles. After the cycling test, the crushing test shall be carried out at the pressure at least 5 times exceeding the maximum working pressure at the minimum working pressure.

11.6.4.5 The hose assembly shall be subjected to a bending cycle fatigue test, at ambient and cryogenic temperature, with 400 000 cycles without failure. The fatigue bend radius shall be in accordance with manufacturer's recommendation.

11.6.4.6 The hose assembly shall be subjected to a crushing test at ambient temperature and cryogenic temperature without damage. The hose assembly shall be held between two rigid plates (an area equivalent to the diameter of the hose) and a force of 1000N shall be applied ten times at the same location in the middle of each flexible hose.

11.6.4.7 The hose assembly shall be subjected to a tensile test at ambient and cryogenic temperature to ensure that the hose is capable of withstanding the maximum working load.

11.6.4.8 Each hose type shall be subjected to a bending test at ambient and cryogenic temperature to ensure that the hose is capable of withstanding the maximum working pressure at minimum working bend radius (MBR). Hose should be gradually bent to the MBR and then pressurized to the maximum working pressure. Hose shall be examined for leaks whilst being held for 15 min at MBR and no damage should be evident on return pre-test conditions.

11.6.4.9 Each hose type shall be subjected to a tensile test at ambient and cryogenic temperature to ensure that the hose is capable of withstanding the maximum working load. The hose assembly shall be subjected to a ambient and cryogenic twist test to ensure that the hose is capable of withstanding its maximum working load whilst at MAAT. The hose assembly shall

be gradually twisted to the MAAT and then pressurized to the maximum working pressure. The hose shall be examined for leaks whilst being held for 15 min at MAAT and no damage should be evident on return pre-test conditions.
11.6.4.10 The hose assembly shall be subjected to an electrical test. The hose assembly shall be drained and supported above ground by non-conductive means and the resistance measured
between the two end fittings (connection face). Electrically continuous hoses shall have a resistance of less than 10 Ohm. Electrically discontinuous hoses shall have a resistance of not less than 25 kilohm.

11.6.5 Quick connect disconnect coupler (QCDC).

11.6.5.1 QCDC shall be type approved by the Society. The QCDC shall be subjected to a hydraulic pressure test, at ambient temperature, to a pressure not less than 1,5 times the design pressure, to demonstrate that the QCDC is capable of withstanding its pressure without leaking.

11.6.5.2 Controls of quick connect disconnect couplers (QCDC) shall be fitted with mechanical interlocking device to prevent unintended operation. In case of supply failure the quick connect disconnect couplers (QCDC) shall not change the position (shall remain in as-is position).

11.6.6 Emergency release coupling (ERC).

11.6.6.1 Emergency release coupling (ERC) or break-away coupling shall be provided in the bunkering line. Adequacy shall be observed regarding the compatibility with hoses and the maximum axial and shear forces likely to be exerted on the break-away or the ERC during the bunkering operations. Alternatively the manifold area may be suitably reinforced. Details of the manifold loads shall be submitted to the society for information. Emergency release coupling (ERC) or break-away coupling shall have Type Approval Certificate.

11.6.6.2 Emergency release couplings (ERC) used in bunker connection shall be of “dry-break” type and be capable to self-disconnect upon application of force at any direction of ship’s relative motion which exceeds design loads and at pressure surge exceeding the coupling design pressure. ERC fitted in lines for transfer of gas fuel shall be capable to break-away through the ice accumulated on the coupling during the transfer.

11.6.7 Emergency release system.

Each emergency release system shall be air tested. In this case the resistance shall be at least 10 kiloOhm. Resistance of each insulating flange shall be at least 1000 Ohm, but shall not exceed 1000 kiloOhm.

11.6.8 Cargo swivel.

11.6.8 Cargo swivel having Type Approval Certificate shall be provided in the bunkering line. Swivels shall be subject to static hydraulic pressure tests at the maximum working pressure. During the dynamic tests, at least two complete rotations in each direction shall be performed at normal conditions and minimum working temperature.

11.6.9 The bunkering line shall be suitably supported in such a way that to prevent the hose abrasion and to observe that the allowable bending radius is satisfied.

11.6.10 The QCDC shall be subjected in assembly to a hydraulic pressure test, at ambient temperature, to a pressure not less than 1,5 times the design pressure, to demonstrate that the QCDC is capable of withstanding its pressure without leaking.

11.6.11 All welds of cargo system and hose line items shall be made by full penetration welding with 100% inspection of welds by non-destructive examination.

11.6.12 The LNG velocity in the piping system shall not exceed 10m/s in order to avoid the generation of static electricity and to limit the heat transfer due to friction inside the pipes.

The maximum LNG transfer rate shall be justified, taking into consideration:

• The management of the BOG generated during bunkering operation;
• The temperature of the LNG supplied to the ship;
• Characteristics of the receiving tank;
• The maximum flow permitted by the ERC;
• The maximum flow permitted by the hose;
• The maximum flow permitted by the QCDC.

11.7 INERT GAS SYSTEM

11.7.1 Prior to the bunkering operations, the possibility shall be provided for tightness test of connections between the bunkering and receiving ships. The procedure thereof shall be specified in the ship's operating manual.

11.7.2 The relevant measures and procedures shall be provided for inerting the hose lines prior to filling them with bunkering fuel or LNG vapors, as well as inert-gas pressurization of bunkering fuel or LNG vapors upon completion of cargo operations prior to disconnection. The cargo residuals shall be leading back to the cargo tanks.

11.8 GAS DETECTION SYSTEM

11.8.1 Installed onboard gas detection system shall be capable to measure gas concentration in the manifold connections area in addition to arrangements described in Section 6, Part VIII "Instrumentation and Automation System" of the Rules for the Classification and Construction of Ships Carrying Liquefied Gases in Bulk and have arrangement to provide a remote gas detection point for receiving ship.

11.8.2 Gas detecting equipment at the manifold connection shall provide continuous monitoring and activate alarm when concentration of hydrocarbons reaches 30% of lower flammable limit (LFL).
11.8.3 Audible and visible alarm from the permanently installed gas detection equipment shall be located on the navigation bridge, in the bunkering operation control position and at the gas detector readout location.

11.9 ELECTRICAL EQUIPMENT

The requirements of this Chapter cover the electrical equipment of LNG bunkering ships and supplement the requirements of Part XI "Electrical Equipment" of these Rules and Part VII "Electrical Equipment" of the Rules for the Classification and Construction of Ships Carrying Liquefied Gases in Bulk.

11.9.1 The following systems of generation and distribution of electric energy are acceptable:

.1 direct current:
.1.1 two-wire insulated;
.2 alternating current переменного тока:
.2.1 single-phase, two-wire insulated;
.2.2 three-phase, three-wire insulated;
.2.3 three-phase, four-wire insulated.
11.9.1.3 In insulated distribution systems, no current carrying part is to be earthed, other than:
.1 through an insulation level monitoring device
.2 through components used for the suppression of interference.

11.9.2 Earthed systems with hull return.

11.9.2.1 Earthed systems with hull return are not permitted, with the following exceptions to the satisfaction of the Society:

.1 impressed current cathodic protective systems;
.2 limited and locally earthed systems, such as starting and ignition systems of internal combustion engines, provided that any possible resulting current does not flow directly through any hazardous area;
.3 insulation level monitoring devices, provided that the circulation current of the device does not exceed 30 mA under the most unfavourable conditions.
.4 earthed intrinsically safe circuits;

.5 power supplies, control circuits and instrumentation circuits in non-hazardous areas where technical or safety reasons preclude the use of a system with no connection to earth, provided the current in the hull is limited to not more than 5 A in both normal and fault conditions;

.6 limited and locally earthed systems, such as power distribution systems in galleys and laundries to be fed through isolating transformers with the secondary windings earthed, provided that any possible resulting hull current does not flow directly through any hazardous area.

11.9.3 Контроль сопротивления изоляции цепей во взрывоопасных зонах.

11.9.3.1 The devices intended to continuously monitor the insulation level of all distribution systems are also to monitor all circuits, other than intrinsically safe circuits, connected to apparatus in hazardous areas or passing through such areas.

11.9.3.2 An audible and visual alarm shall be given, at a manned position, in the event of an abnormally low level of insulation.

11.10 EMERGENCY SHUT-DOWN SYSTEM (ESD)

11.10.1 The requirements of Part VIII “Instrumentation and Automation System” of the Rules for the Classification and Construction of Ships Carrying Liquefied Gases in Bulk are applicable to emergency shut-down systems (ESD). Any activation of the ESD systems shall be implemented simultaneously on both bunkering facility and receiving ship.

11.10.2 Pendant with means of control for local manual activation position for the ESD system shall be provided on board the receiving ship. When a bunkering ship may connect on board ESD system to those of the receiving ship, no remote panel is required.

11.10.3 The ESD function shall be initiated in following circumstances:
.1 automatically, if the distance of connection on receiving ship from the connection on bunker ship exceeds safe operational envelope for transfer arrangement
.2 by activating manual ESD button on ESD pendant
.3 automatically at ERS activation.

11.10.4 Opening of main transfer valves shall not be possible unless ERS is re-assembled.

11.11 TRANSFER CONTROL SYSTEM

11.11.1 The transfer control system shall have provisions of automatic control of flow rate and limiting pressure in the transfer system. Parameters of the control system critical for the safe transfer shall have adjustable settings.

11.11.2 Deviations from set values mentioned in 11.11.1 shall activate audible and visual alarms at the bunker operations control position and on the navigation bridge.

11.11.3 The transfer control system for liquid shall automatically reduce the liquid transfer rate when set values for pressure in the vapour return/vapour recovery system is exceeded.

11.11.4 If the transfer rate exceeds a maximum value, alarm and automatic stop of transfer shall be activated and manifold valves closed.

11.11.5 The receiving ship shall have possibility to control transfer flow rate by means of a ship-to-ship link, e.g. flexible cable and pendant with means of control.

11.11.6 Alarms and safety actions required for the transfer system are given in Table 11.11.6.

Table 11.11.6

Alarms and safety actions required for the LNG transfer system

Parameters	Alarm	Activation of the ESD systems	Automatic activation of the emergency release coupling
Low pressure in the supply tank	X	X	
Sudden pressure drop at the transfer pump discharge	X	X	
High level in the receiving tank	X	X	
High pressure in the receiving tank	X	X	
LNG leak detection or vapour detection (anywhere)	X	X	
Gas detection around the bunkering lines	X	X	
Manual activation of the emergency release coupling	X		
Safe working envelope of the loading arm exceeded	X	X	X
Disconnection of the ERC	X	X	

11.12 COMMUNICATION SYSTEMS

11.12.1 A communication system with back-up shall be provided between the bunkering ship and the receiving ship.

11.12.2 Communications shall be maintained between the bunkering ship and the receiving ship at all times during the bunkering operation. In the event that communications cannot be maintained, bunkering shall be stopped and not resumed until communications are restored.

11.12.3 The components of the communication system located in hazardous and safety zones shall be of a suitable safe type.

11.13 ADDITIONAL SERVICE FEATURES RELATED TO SHIPS USING LNG AS FUEL

11.13.1 When the additional features related to ships servicing are provided on board the LNG bunkering ship using LNG as fuel and indicated by an additional descriptive notation **RE** in the class notation, the BOG handling system of the LNG bunkering ship shall be sized to handle the extra vapours generated during this operation taking into account the fact that the level in the receiving cargo tanks is increasing.

To confirm the ship compliance with the requirements applicable to ships with the additional descriptive notation **RE** the Bunkering procedure for LNG receiving from a gas fueled ship with the required calculations shall be submitted.

11.13.2 When the additional features related to ships servicing are provided on board the LNG bunkering ship using LNG as fuel and indicated by an additional descriptive notation **IG-Supply** in the class notation, the LNG bunkering ship shall be fitted with supply of inert gas and/or dry air to ensure gas freeing and aeration of fuel tanks in compliance with 6.10.4 of the IGF Code. The lines used for the inert gas shall be independent from the liquid and vapour lines used for normal operation. To confirm the ship compliance with the requirements applicable to ships with the additional descriptive notation **IG-Supply**, a Diagram of the gas freeing system and Procedure for gas freeing shall be submitted.

11.13.3 When the additional features related to ships servicing are provided on board the LNG bunkering ship using LNG as fuel and indicated by an additional descriptive notation **BOG** in the class notation, the boil-off-gas system (BOG) generated during bunkering shall be provided . The LNG bunkering ship shall be capable of handling all or part of the boil-off gas from receiving ship, in addition to its own boil-off, generated during the LNG bunkering operation without release to the atmosphere. The boil-off gas handling capacity of the bunkering ship shall be indicated and justified by calculations.

Different ways to dispose of the BOG or their combination may be considered:
• liquefaction
• using gas a fuel in the ships dual-fuel engine or boilers
• combustion using gas flaring unit in compliance with 4.3, Part VI “Systems and Piping” of the of the Rules for the Classification and Construction of Ships Carrying Liquefied Gases in Bulk.
To confirm the ship compliance with the requirements applicable to ships with the additional descriptive notation **BOG**, the following documents shall be submitted:
Bunkering procedure for boil-off gas management indicating the operations.
Calculation of the maximum LNG vapour flow rate possible to be generated during the bunkering to be less than the capacity of boil-off gas unit specified in the Bunkering procedure.

RUSSIAN MARITIME REGISTER OF SHIPPING

CIRCULAR LETTER	**No.** 312-11-931c	dated 05.09.2016

Re:
Introduction of new distinguishing marks and descriptive notations in class notation of a ship

Item of supervision:
Ships under construction and in service

Implementation	from the date of publication
Valid: till	until re-publication of the Rules for the Classification and Construction of Sea-Going Ships, 2017
Validity period extended till	-
~~Cancels / amends / adds circular letter №~~	- dated
Number of pages:	4
Appendices:	Text of additions to the RS Rules
Director General	Konstantin Palnikov

Amends Rules for the Classification and Construction of Sea-Going Ships, 2016, ND No. 2-020101-087-E

We hereby inform that new distinguishing marks and descriptive notations shall be introduced to the Rules for the Classification and Construction of Sea-Going Ships, 2016, ND No. 2-020101-087-E.
Text of the requirements is given in the Appendix to the Circular Letter.

It is necessary to do the following:

1. Familiarize surveyors of the RS Branch Offices and interested organizations in the area of the RS Branch Offices' activity with the content of the Circular Letter.
2. Apply the above requirements in the RS practical activity.

Person in charge: D.A. Grubov Department 312 +7 (812) 312-24-28

"Thesis" System No.: 222648

RULES FOR THE CLASSIFICATION AND CONSTRUCTION OF SEA-GOING SHIPS, 2016, ND No. 2-020101-087-E

Part I. CLASSIFICATION

2.2 CLASS NOTATION OF A SHIP

The Chapter shall be supplemented by **new paras 2.2.29 – 2.2.35** reading as follows:

"**2.2.29 Distinguishing mark for ships fitted with a machinery technical condition monitoring system.**

If a ship is fitted with a machinery technical condition monitoring system for machinery installations to comply with Section 11 of Part VII "Machinery Installations", and on board the Planned Maintenance Scheme for Machinery (PMS) has been implemented/applied according to 2.7, Part II "Survey Schedule and Scope" of the Rules for the Classification Surveys of Ships in Service, the distinguishing mark **PMS** (Planned Maintenance Scheme for Machinery) is added to the character of classification.

2.2.30 Distinguishing mark for ships fitted for possible carriage of the international standard containers.

If a ship without a descriptive notation **Container Ship** in the class notation is fitted for carriage of cargo in international standard containers on deck and/or in appropriate holds, the distinguishing mark **CONT** is added to the character of classification and the container transportation area is specified in parenthesis **(deck) (cargo hold(s) No.)**.

2.2.31 Distinguishing mark for ships fit for the carriage of dangerous goods.

If a ship complies with Section 7 of Part VI "Fire Protection" and was duly surveyed according to 2.1.5, Part III "Survey of Ships in Compliance with International Conventions, Codes and Resolutions" of the Guidelines on Technical Supervision of Ships in Service and is recognized fit for carriage of dangerous goods, the distinguishing mark **DG** is added to the character of classification with the following specified in parenthesis depending on the type of the dangerous goods: **(bulk)** – in bulk, **(pack)** – packaged.

2.2.32 Distinguishing mark for implementation of modified survey of a propeller shaft.

The distinguishing mark for implementation of modified survey of a propeller shaft in compliance with 2.10.2.7, Part II "Survey Schedule and Scope" of the Rules for the Classification Surveys of Ships in Service, the distinguishing mark **TMS** is added to the character of classification.

2.2.33 Distinguishing mark for ships prepared for in-water survey.

For a ship built according to Section 12 of Part XVII "Distinguishing Marks and Descriptive Notations in the Class Notation Specifying Structural and Operational Particulars of Ships" the distinguishing mark **IWS** is added to the character of classification.

2.2.34 Distinguishing mark for alternative method of reducing SO_x emissions.

If on board a ship, as an alternative, the exhaust gas (SO_x) cleaning system of the fuel oil combustion unit approved by RS is fitted, considering IMO resolution MEPC.184(59), the distinguishing mark **SO_x Cleaning** is added to the character of classification.

2.2.35 Distinguishing mark for marine diesel engines fitted with NO_x-reducing devices.

If the marine diesel engines are fitted with NO_x-reducing devices and tested in compliance with IMO resolution MEPC.198(62), as amended by IMO resolution MEPC.260(68), the distinguishing mark **DE+SCR** is added to the character of classification.

Para 2.2.29 shall be renumbered 2.2.36. The list of descriptive notations given in this para shall be supplemented with the following:

Standby vessel
Supply vessel (OS)
Pipe laying vessel
Cable laying vessel
Pipe laying barge
Cable laying barge.

"Other than supply vessel (OS)" shall be added to the existing definition of a descriptive notation **Supply vessel**.

Para 2.2.30 shall be renumbered 2.2.36.

2.3 ADDITIONAL DESCRIPTIVE NOTATIONS

Para 2.3.1. The words "the ship is fit for the carriage of dangerous goods as it is indicated in the Certificate …; the ship is equipped for the carriage of cargo in international standard containers on deck and/or in appropriate holds;" shall be replaced by the following text: "the ship is equipped for episodic roll-on/roll-off;".

PART XVII. DISTINGUISHING MARKS AND DESCRIPTIVE NOTATIONS IN THE CLASS NOTATION SPECIFYING STRUCTURAL AND OPERATIONAL PARTICULARS OF SHIPS

New **Section 12** shall be introduced reading as follows:

"12. REQUIREMENTS TO SHIPS FOR COMPLIANCE WITH DISTINGUISHING MARK IWS IN THE CLASS NOTATION

12.1 General provisions and scope of application.

12.1.1 For the ships built in compliance with this Chapter, the distinguishing mark **IWS (in-water survey)** is added to the character of classification denoting the ship is fit for in-water survey.

12.1.3 The conditions for in-water survey are specified in 2.5 of Part II "Survey Schedule and Scope" of the Rules for the Classification Surveys of Ships in Service.

12.2 Technical documentation.

Drawing of the marking on the side and bottom plating to identify the tanks shall be submitted in the scope of plan approval documentation for a ship under construction.

12.3 Technical requirements.

The distinguishing mark **IWS** may be assigned to the ships complying with the following additional requirements.

12.3.1 A ship shall have the distinguishing mark **TMS** in the class notation or propeller and shafting arrangement shall comply with 2.10.2, Part II "Survey Schedule and Scope" of the Rules for the Classification Surveys of Ships in Service for the minimum interval between surveys of 5 years.

12.3.2 Interval between the complete survey of main AMSS (if installed on board) shall not be less than 5 years in accordance with 2.10.8, Part II "Survey Schedule and Scope" of the Rules for the Classification Surveys of Ships in Service.

12.3.3 Underwater hull is fitted with an effective corrosion protective system consisting of combination of coating systems and cathodic protection.

12.3.4 Possible underwater washing of sea chests shall be provided, where necessary. To achieve this, closures of intake gratings shall have such a structure for their safe opening and closure by a diver.

12.3.4 For the water-lubricated rudder bearings, measures shall be provided to enable the in-water measurement of clearance in the rudder stock and pintles.

12.3.5 Underwater hull shall be marked.

Transverse and longitudinal reference lines of 300 m in length and 25 mm in width shall be indicated as marking. The marks shall be permanent and made by welding or similar way, of contrasting colour to the hull.

As a rule, the marks shall be placed as follows:

at the flat bottom in the regions of tank bulkhead intersection or integrity of floors of the bottom longitudinal girders;

on board in the areas of transverse framing (marking shall not be higher than 1 m above the hopper plating);

at the double bottom intersection with watertight floor in the area of the ship sides

at all suction and exhaust side valves.

Letter and numeric codes shall be placed on the plating for identification of tanks, suction and exhaust sea inlets.".

RUSSIAN MARITIME REGISTER OF SHIPPING
HEAD OFFICE

CIRCULAR LETTER	**No.** 312-11-954c	dated 15.11.2016

Re:
requirements to vessels intended for offshore support services

Item of supervision:
ships under construction and in service

Implementation	from the date of signing	
Valid: till	-	
Validity period extended till	---	
~~Cancels / Amends / Supplements Circular~~ Letter	-	dated -
Number of pages:	1 + 5	
Appendices:	Text of amendments to the Rules for the Classification and Construction of Sea-Going Ships, 2016, ND No. 2-020101-087-E and Rules for the Classification and Construction of Sea-Going Ships, 2017, ND No. 2-020101-095-E	
Director General	Konstantin G. Palnikov	

Amends: Rules for the Classification and Construction of Sea-Going Ships, 2016, ND No. 2-020101-087-E and Rules for the Classification and Construction of Sea-Going Ships, 2017, ND No. 2-020101-095-E

We hereby inform that a new section shall be introduced to Part XVII "Distinguishing Marks and Descriptive Notations in the Class Notation Specifying Structural and Operational Particulars of Ships" of the Rules regarding requirements to offshore service vessels, and amendments to Part II "Hull" of the Rules shall be introduced regarding requirements to hull structures of such vessels.

It is necessary to do the following:

1. Familiarize the RS surveyors and interested organizations in the area of the RS Branch Offices' activity with the content of the Circular Letter.
2. Apply the above requirements in the RS practical activity.

Person in charge: D.A. Grubov 313 (812) 312 24 28

"Thesis" System № 275518

Appendix to Circular Letter
№ 312-11-954c dated 15.11.2016

RULES FOR THE CLASSIFICATION AND CONSTRUCTION OF SEA-GOING SHIPS, 2016, ND No. 2-020101-087-E AND RULES FOR THE CLASSIFICATION AND CONSTRUCTION OF SEA-GOING SHIPS, 2017, ND No. 2-020101-095-E

PART II. HULL

3.8 SUPPLY VESSELS

The text of the Chapter 3.8 shall be amended to read:

"3.8 OFFSHORE SERVICE VESSELS

3.8.1 The requirements of this Chapter apply to supply and standby vessels. Structural elements not covered by this Chapter shall comply with the requirements of Sections 1 and 2.

3.8.2 Construction.

3.8.2.1 Provision shall be made for longitudinal fenders at the weather deck and the deck below level.

3.8.2.2 The fenders shall extend not less than 0,02*L* forward of the section where the weather deck has its full breadth.

3.8.2.3 The weather deck shall be efficiently stiffened in way of deck equipment or cargo which load exceeds the design deck load value.

3.8.2.4 Shell plating in way of stern rollers and fenders areas shall be efficiently stiffened.

3.8.2.5 In the forward region 0,2*L* from the forward perpendicular (FP) the ends of framing members of hull, forecastle and the first tier of deckhouse shall be connected by brackets.

3.8.3 Design loads.

3.8.3.1 Design loads on hull structures shall be taken in compliance with Sections 1 and 2.

3.8.3.2 For determining the scantlings of deck stiffeners according to 3.8.2.3 as well as scantlings of the supporting pillars, the load shall be calculated with due regard to the inertia force components in horizontal and vertical direction due to the vessel's rolling and pitching.

3.8.4 Scantlings of structural members.

3.8.4.1 The thickness of the side shell plating shall be 1 mm greater than required by 2.2.4. In any case the thickness of the side shell plating shall not be taken less than 9,0 mm.

3.8.4.2 In fenders area the thickness of the side shell plating shall not be taken as less than

$$smin = (6 + 0{,}05\,L)\cdot\frac{a}{a_0}$$

where a = main framing spacing;

a_0 = normal spacing according to 1.1.3;

a/a_0 shall not be taken less than 1,0.

3.8.4.3 If fenders are suspended in the length, the thickness of unprotected side areas shall be 50 per cent greater than required by 3.8.4.2. The reinforced region shall be extended 600 mm transversely below deck or tween-deck, as far as applicable.

3.8.4.4 Scallop and one-sided welds shall not be used in connections between side frames and shell plating.

3.8.4.5 Section modulus of hold, tween-deck or forecastle frames shall not be less than specified in 3.7.4.4 with p determined by Formula (3.7.3.3-1), α_1 = 1,16, α_2 = 1,0. However, for supply vessels no needs to take the section modulus of side longitudinals, hold or tween-deck frames more than 1,25 times as required in 2.5.4.

3.8.4.6 The thickness of weather deck plating shall be determined from 2.6.4, but it shall not be less than 8,0 mm. If the weather deck is intended to carry deck cargoes, the thickness shall be increased by 1,0 mm as required by 2.6.4. If the weather deck is intended to carry anchors and anchor chain cables, the thickness shall be increased by 2,5 mm as required by 2.6.4.

3.6.4.7 The thickness of the weather deck stringer in the region of rescue zone shall be not less than

$$smin = (7 + 0{,}02\,L) \cdot \frac{a}{a_0}$$

where a/a_0 shall not be less than 1,0.

3.8.4.8 The scantlings of weather deck framing members shall be determined as required by 2.6.4 with a design load corresponding to the specified value but not less than 35 kPa.

3.8.4.9 While obtaining reinforcements for stern rollers and mooring winches, 4.3.5 of Part III "Equipment, Arrangements and Outfit" shall be guided by.

3.8.4.10 The section modulus of vertical frames of fronts, sides and after ends of deckhouses located on the forecastle deck shall be not less than required by 2.12.4.5.2. The assumed head p, in kPa, shall not be taken less than given in Table 3.8.4.10.

Table 3.8.4.10

Deckhouse tier	Assumed head p, in kPa			s_{min}, mm
	Front bulkhead	Side bulkhead	Aft end bulkhead	
First	90	60	25	10,8a
Second and above	75	50	25	10a
Note. a – spacing between bulkhead vertical frames.				

3.8.4.11 The plate thickness of the side and end bulkheads of deckhouses shall be not less than indicated in 3.8.4.10.

3.8.4.12 Thickness of bulwark plating shall be at least 7 mm, and the width of the stanchion lower edge measured along the weld shall be not less than 360 mm. The distance between stanchions shall not exceed two spacings or 1,3 m, whichever is the lesser.".

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

Shall be supplemented by new Section 13 reading as follows:

"13 REQUIREMENTS FOR OFFSHORE SERVICE VESSELS

13.1 MODU/FOP SUPPLY VESSELS

13.1.1 General.

For vessels intended to supply MODU/FOP and complying with the requirements of the present Chapter, a descriptive notation **Supply vessel (OS)** may be added to the character of classification.

13.1.2 Hull.

The hull structure shall comply with 3.8 of Part II "Hull".

13.1.3 Equipment, arrangements and outfit.

13.1.3.1 Access means to the spaces located under the open cargo deck shall comply with 7.1.6 of Part III "Equipment, Arrangements and Outfit".

13.1.3.2 Access means to machinery and boiler spaces shall comply with 7.6.6 of Part III "Equipment, Arrangements and Outfit".

13.1.3.3 Location of ventilators shall comply with 7.8.4 of Part III "Equipment, Arrangements and Outfit".

13.1.4 Stability.

The vessel's stability shall comply with 3.11 of Part IV "Stability".

13.1.5 Subdivision.

As regards the subdivision, the vessel shall comply with 3.4.9 of Part V "Subdivision".

13.1.6 Systems and piping.

Uptakes of boilers, exhaust pipes of main and auxiliary engines and incinerators shall comply with 11.1.3 of Part VIII "Systems and Piping".

13.2 STANDBY VESSELS

13.2.1 General.

For vessels intended to carry out rescue and standby services in offshore areas of hydrocarbon production and complying with the requirements of this Chapter, a descriptive notation **Standby vessel** may be added to the character of classification.

13.2.2 Hull.

The hull structure shall comply with the applicable requirements of 3.8, Part II "Hull".

13.2.3 Equipment, arrangements and outfit.

13.2.3.1 Access means to the spaces located under the open cargo deck shall comply with 7.1.6 of Part III ""Equipment, Arrangements and Outfit".

13.2.3.2 Access means to machinery and boiler spaces shall comply with 7.6.6 of Part III "Equipment, Arrangements and Outfit".

13.2.3.3 Location of ventilators shall comply with 7.8.4 of Part III "Equipment, Arrangements and Outfit".

13.2.3.4 The vessel shall be arranged on each side with a clearly marked rescue zone with a length of not less than 5 m. Rescue zones shall be located well clear of the propellers as well as any discharges extended at least 2 m below the load waterline.

13.2.3.5 In the rescue zones area the vessel's sides shall be free of appendages (fenders, etc.).

13.2.3.6 The access routes from rescue zones to survivors' accommodation as well as to helicopter winching area, where provided, shall have non-slip surface or wooden sheathings.

13.2.3.7 Deck in way of the rescue zone shall be free of any obstruction when this becomes practical (air pipes, valves, small hatches, etc.). If any, proper arrangement shall be provided as protection against personnel injury.

13.2.3.8 Bulwark or railings in way of the rescue zone shall be of a type easy to open or remove.

13.2.3.9 Each rescue zone shall be provided with a scrambling net made of corrosion resistant in the marine environment and non-slip material of at least 5 m wide and length enough to extend at least 1 m from the deploying area in the rescue zone till the minimal service waterline.

13.2.3.10 The vessel shall be provided with power assisted means capable of ensuring careful recovery of disabled persons from the sea.

13.2.3.11 The vessel shall be equipped with gears for towing of liferafts and rescue boats.

13.2.3.12 Bridge front and side windows shall be equipped with efficient storm shutters installed at any side of bulkhead. Strength of these shutters shall be equivalent to strength of the bulkhead. Storm shutters shall provide visibility from the bridge; they may be portable and stowed in an accessible position, so as to be readily mounted.

13.2.4 Life-saving appliances.

13.2.4.1 The vessel shall be equipped with at least one fast rescue boat of type complying with LSA Code, permanently ready for use. The emergency source of power of the launching arrangement of a fast rescue boat shall provide operation of the launching arrangement for at least 4 h.

13.2.4.2 Type approved lifejackets shall be provided for 25 per cent of the number of survivors for which the vessel is intended to carry.

13.2.5 Survivors' spaces.

13.2.5.1 The vessel shall have a treatment room for casualties, a recovery room with berths, and enclosed space to accommodate survivors. These spaces shall be provided with lighting and means to control temperature and humidity suitable for the area of operation.

13.2.5.2 The designed capacity of survivors shall be determined considering 0,75 m^2 per person. This includes free floor space and floor space with loose furniture, fixed seating and/or fixed beds. Other fixed furniture, toilets and bathrooms shall be excluded.

13.2.5.3 At least one installation comprising a toilet, a wash basin and shower shall be provided for each group of 50 survivors.

13.2.6 Stability.

The vessel's stability shall comply with 3.11 of Part IV "Stability".

13.2.7 Subdivision.

As regards the subdivision, the vessel shall comply with 3.4.3 of Part V "Subdivision".

13.2.8 Systems and piping.

13.2.8.1 Uptakes of boilers, exhaust pipes of main and auxiliary engines and incinerators shall comply with 11.1.3 of Part VIII "Systems and piping".

13.2.8.2 A decontamination area equipped with a shower system shall be arranged before entering to deckhouse accommodations from rescue zones.

13.2.9 Machinery installations.

The vessel shall be fitted with at least two propulsion systems capable of moving the vessel in the forward and aft direction.

13.2.10 Electrical equipment.

13.2.10.1 A searchlight shall be available on each side and adjustable from inside the navigation bridge. Each searchlight shall be able to provide an illumination level of 50 lux in clear air, within an area not less than 10 m diameter, to a distance of at least 250 m.

13.2.10.2 In addition to 6.7.1 of Part XI "Electrical equipment", illumination of the following spaces shall be at least:
.1 overboard spaces, at a distance of within 5 m from the ship side in the rescue zone and reception areas for survivors – 150 lux of total illumination level;
.2 satisfactory lighting shall be available along the rescue zone and survivors reception area capable of providing minimum 50 lux at 20 m from the vessel.

13.2.10.3 In addition to 6.1.1 of Part XI "Electrical equipment" lighting with power from the main and emergency source shall be provided for the following spaces:
.1 storage spaces for rescue boats and their launching arrangements, reception areas for survivors and rescue zones;
.2 overboard spaces in the rescue zone, survivors' reception areas, in areas of rescue boats launching;
.3 helicopter winching area and routes to this area from survivors' reception areas.
Time of lighting source from emergency source shall be at least 30 min.".

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