RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part CSR-T Common Structural Rules for Double Hull Oil Tankers

Rules for the Survey and Construction of Steel Ships
Part CSR-T 2010 AMENDMENT NO.2

Rule No.52 20th May 2010
Resolved by Technical Committee on 10th May 2010
Approved by Board of Directors on 20th May 2010

ClassNK
NIPPON KAIJI KYOKAI

Rule No.52 20th May 2010
AMENDMENT TO THE RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

"Rules for the survey and construction of steel ships" has been partly amended as follows:

Part CSR-T Common Structural Rules for Double Hull Oil Tankers

Section 2 RULE PRINCIPLES

3. Design Basis

3.1 General

3.1.7 External environment

Paragraph 3.1.7.4 has been amended as follows.

3.1.7.1 To cover worldwide trading operations and also to deal with the uncertainty in the future trading pattern of the ship and the corresponding wave conditions that will be encountered, a severe wave environment is used for the design assessment. The rule requirements are based on a ship trading in the North Atlantic wave environment for its entire design life.
3.1.7.2 The effects of wind and current on the structure are considered to be negligible and hence are not explicitly included.
3.1.7.3 The Rules do not include the effects of ice.
3.1.7.4 The Rules assume that the structural assessment of hull strength members is valid for the following design temperatures:

(a) lowest daily mean temperature in air is ~~-15 °C~~ -10 °C
(b) lowest daily mean temperature in sea water is 0 °C

Ships operating for long periods in areas with lower daily mean air temperature may be subject to additional requirements as specified by the individual Classification Society.

Section 4 BASIC INFORMATION

3. Structure Design Details

3.2 Termination of Local Support Members

Paragraph 3.2.3.4 bis has been added as follows.

3.2.3 Bracketed connections

3.2.3.1 At bracketed end connections, continuity of strength is to be maintained at the stiffener connection to the bracket and at the connection of the bracket to the supporting member. The brackets are to have scantlings sufficient to compensate for the non-continuous stiffener flange or non-continuous stiffener.

3.2.3.2 The arrangement of the connection between the stiffener and the bracket is to be such that at no point in the connection, the section modulus is less than that required for the stiffener.

3.2.3.3 Minimum net bracket thickness, $t_{bkt\text{-}net}$, is to be taken as:

$$t_{bkt-net} = \left(2 + f_{bkt}\sqrt{Z_{rl-net}}\right)\left(\sqrt{\frac{\sigma_{yd-stf}}{\sigma_{yd-bkt}}}\right) \quad (mm)$$

, but is not to be less than 6*mm* and need not be greater than 13.5*mm*

Where:

f_{bkt} 0.2 for brackets with flange or edge stiffener
0.3 for brackets without flange or edge stiffener

$Z_{rl\text{-}net}$: net rule section modulus, for the stiffener, in cm^3. In the case of two stiffeners connected, it need not be taken as greater than that of the smallest connected stiffener

$\sigma_{yd\text{-}stf}$: specified minimum yield stress of the material of the stiffener, in N/mm^2

$\Sigma_{yd\text{-}bkt}$: specified minimum yield stress of the material of the bracket, in N/mm^2

3.2.3.4 Brackets to provide fixity of end rotation are to be fitted at the ends of discontinuous local support members, except as otherwise permitted by **3.2.4**. The end brackets are to have arm lengths, $l_{bkt,}$ not less than:

$$l_{bkt} = c_{bkt}\sqrt{\frac{Z_{rl-net}}{t_{bkt-net}}} \qquad mm\text{, but is not to be less than:}$$

1.8 times the depth of the stiffener web for connections where the end of the stiffener web is supported and the bracket is welded in line with the stiffener web or with offset necessary to enable welding, see **Fig. 4.3.1(c)**

2.0 times for other cases, see **Fig. 4.3.1(a), (b)** and **(d)**

Where:

c_{bkt} 65 for brackets with flange or edge stiffener
70 for brackets without flange or edge stiffener

$Z_{rl\text{-}net}$: net rule section modulus, for the stiffener, in cm^3. In the case of two stiffeners connected, it need not be taken as greater than that of the smallest connected stiffener

$t_{bkt\text{-}net}$: minimum net bracket thickness, as defined in **3.2.3.3**

3.2.3.4 bis In case of different arm lengths the lengths of the arms, measured from the plating to the toe of the bracket, are to be such that the sum of them is greater than $2l_{bkt}$ and each arm not to be less than $0.8l_{bkt}$, where l_{bkt} is as defined in **3.2.3.4**.

3.2.3.5 The proportions and edge stiffening of brackets are to be in accordance with the requirements of **Section 10/2.4**. Where an edge stiffener is required, the depth of stiffener web, d_w, is not to be less than:

$$d_w = 45\left(1 + \frac{Z_{rl-net}}{2000}\right) \quad mm\text{, but is not to be less than } 50mm$$

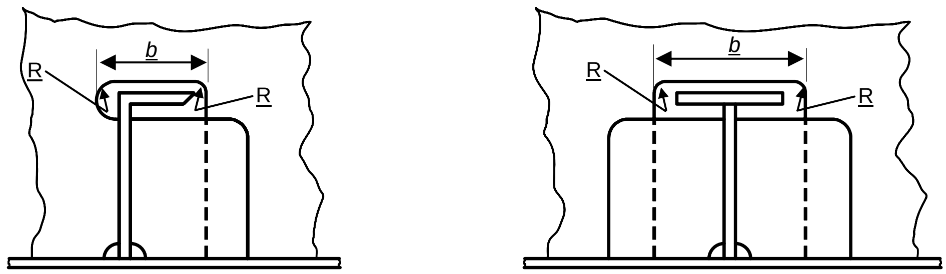
Where:

Z_{rl-net} : net rule section modulus, for the stiffener, in cm^3. In the case of two stiffeners connected, it need not be taken as greater than that of the smallest connected stiffener

3.4 Intersections of Continuous Local Support Members and Primary Support Members

Fig.4.3.4 has been amended as follows.

Fig. 4.3.4 Collars for Cut-outs in Areas of High Stress



R=0,2*b*
(min. 25mm)

3.4.2 Details of cut-outs

Paragraph 3.4.2.1 has been amended as follows.

3.4.2.1 ~~Cut-outs~~ In general, cut-outs are to have rounded corners and the corner radii, *R*, are to be as large as practicable, with a minimum of 20 *percent* of the breadth, *b*, of the cut-out or 25*mm*, whichever is greater, but need not be greater than 50 *mm*, see **Fig. 4.3.4**. Consideration will be given to other shapes on the basis of maintaining equivalent strength and minimizing stress concentration.

Section 6 MATERIALS AND WELDING

1. Steel Grades

1.2 Application of Steel Materials

1.2.3 Operation in areas with low air temperature

Paragraph 1.2.3.1 has been amended as follows.

1.2.3.1 For ships intended to operate for long periods in areas with a lowest daily mean air temperature below ~~–15 *degrees* C~~ –10 *degrees* C (i.e. regular service during winter to Arctic or Antarctic waters) the materials in exposed structures will be specially considered.

Table 6.1.3 has been amended as follows.

Table 6.1.3 Material Class or Grade of Structural Members

Structural member category	Material Class or Grade	
	Within $0.4L_{CSR-T}$ Amidships	Outside $0.4L_{CSR-T}$
Secondary Longitudinal bulkhead strakes, other than those belonging to primary category Deck plating exposed to weather other than that belonging to primary or special category Side plating	Class I	Grade A(8)/AH
Primary Bottom plating including keel plate Strength deck plating, excluding that belonging to the special category (10)(11) Continuous longitudinal members above strength deck, excluding longitudinal hatch coamings Uppermost strake in longitudinal bulkheads (10)(11) Vertical strake (hatch side girder) and upper sloped strake in top wing tank	Class II	Grade A(8) /AH
Special Sheer strake at strength deck (1)(2)(3)(10)(11) Stringer plate in strength deck (1)(2)(3)(10)(11) Deck strake at longitudinal bulkhead (2)(4)(10)(11) Strength deck plating at outboard corners of cargo hatch openings(11) Bilge strake (2)~~(5)~~(6) Continuous longitudinal hatch coamings(11)	Class III	Class II (Class I outside $0.6L_{CSR-T}$ amidships)
Other Categories Plating for stern frames, rudder horns~~, rudders~~ and shaft brackets ~~(7)~~ Longitudinal strength members of strength deck plating for ships with single strength deck (11) Strength members not referred to in above categories (9)	– Grade B /AH Grade A(8) /AH	Class II – Grade A(8) /AH

Notes

1. Not to be less than E/EH within $0.4L_{CSR-T}$ amidships in vessels with length, L_{CSR-T}, exceeding 250m.
2. Single strakes required to be of material class III or E/EH are, within $0.4L_{CSR-T}$ amidships, to have breadths not less than $800 + 5L_{CSR-T}$ mm, but need not be greater than 1800mm.
3. A radius gunwale plate may be considered to meet the requirements for both the stringer plate and the sheer strake, provided it extends generally 600mm inboard and vertically.
4. For tankers having a breadth, B, exceeding 70m, the centreline strake and the strakes in way of the longitudinal bulkheads port and starboard, are to be class III.
5. ~~May be class II in vessels with a double bottom over the full breadth, B, and with a length, L_{CSR-T}, less than 150m.~~(Void)
6. To be not lower than D/DH within $0.6L_{CSR-T}$ amidships of vessels with length, L_{CSR-T}, exceeding 250m.
7. ~~For rudder and rudder body plates subjected to stress concentrations (e.g. in way of lower support of semi-spade rudders or at upper part of spade rudders) class III is to be applied.~~ (Void)
8. Grade B/AH to be used for plate thickness more than 40mm. However, engine foundation heavy plates outside $0.6L_{CSR-T}$ amidships may be of Grade A/AH.
9. The material class used for reinforcement and the quality of material (i.e. whether normal or higher strength steel) used for welded attachments, such as spill protection bars and bilge keel, is to be similar to that of the hull envelope plating in way. Where attachments are made to round gunwale plates, special consideration will be given to the required grade of steel, taking account of the intended structural arrangements and attachment details.
10. The material class for deck plating, sheer strake and upper strake of longitudinal bulkhead within $0.4L_{CSR-T}$ amidships is also to be applied at structural breaks of the superstructure, irrespective of position.
11. To be not lower than B/AH within $0.4L_{CSR-T}$ amidships for ships with single strength deck.

Section 8 SCANTLING REQUIREMENTS

1. Longitudinal Strength

1.4 Hull Girder Buckling Strength

1.4.2 Buckling assessment

Paragraph 1.4.2.5 has been amended as follows.

1.4.2.5 The design hull girder shear stress for the buckling assessment, $\tau_{hg\text{-}net50}$, is to be calculated based on net hull girder sectional properties and is to be taken as:

$$\tau_{hg-net50} = \left| \left(Q_{sw-perm-sea} + Q_{wv} \right) \left(\frac{1000 q_v}{t_{ij-net50}} \right) \right| \qquad (N/mm^2)$$

Where:

$Q_{sw\text{-}perm\text{-}sea}$: positive and negative still water permissible shear force for seagoing operation, in *kN*, as defined in **Section 7/2.1.3**

Q_{wv} : positive or negative vertical wave shear, in *kN*, as defined in **Section 7/3.4.3**.
Q_{wv} is to be taken as:
$Q_{wv\text{-}pos}$ for assessment with the positive permissible still water shear force
$Q_{wv\text{-}neg}$ for assessment with the negative permissible still water shear force

$t_{ij\text{-}net50}$: net thickness for the plate *ij*, in *mm*
$= t_{ij\text{-}grs} - 0.5 t_{corr}$

$t_{ij\text{-}grs}$: gross plate thickness of plate *ij*, in *mm*. The gross plate thickness for corrugated bulkheads is to be taken as the minimum of $t_{w\text{-}grs}$ and $t_{f\text{-}grs}$, in *mm*

$t_{w\text{-}grs}$: gross thickness of the corrugation web, in *mm*

$t_{f\text{-}grs}$: gross thickness of the corrugation flange, in *mm*

t_{corr} : corrosion addition, in *mm*, as defined in **Section 6/3.2**

q_v : unit shear per *mm* for the plate being considered as defined in **1.3.2.2**

Notes

1. Maximum of the positive shear (still water + wave) and negative shear (still water + wave) is to be used as the basis for calculation of design shear stress
2. All plate elements ij that contribute to the hull girder shear capacity are to be assessed. See also **Table 8.1.4** and **Fig. 8.1.2**
3. The gross rule required thicknesses is to be calculated considering shear force correction.
4. For longitudinal bulkheads between cargo tanks, $t_{ij\text{-}net50}$ is to be taken as $t_{sfc\text{-}net50}$ and $t_{str\text{-}k}$ as appropriate.

2. Cargo Tank Region

2.5 Bulkheads

2.5.7 Vertically corrugated bulkheads

Paragraph 2.5.7.6 has been amended as follows.

2.5.7.6 The net section modulus at the lower and upper ends and at the mid length of the corrugation ($l_{cg}/2$) of a unit corrugation, Z_{cg-net}, are to be taken as the greatest value calculated for all applicable design load sets, as given in **Table 8.2.7**, and given by the following. ~~This requirement is not applicable to corrugated bulkheads without a lower stool, see **2.5.7.9**.~~

$$Z_{cg-net} = \frac{1000 M_{cg}}{C_{s-cg}\,\sigma_{yd}} \qquad (cm^3)$$

Where:

M_{cg} $= \dfrac{C_i |P| s_{cg} l_o^2}{12000}$ (kNm)

P $= \dfrac{P_u + P_l}{2}$ (kN/m^2)

P_l, P_u : design pressure for the design load set being considered, calculated at the lower and upper ends of the corrugation, respectively, in kN/m^2

(a) for transverse corrugated bulkheads, the pressures are to be calculated at a section located at $b_{tk}/2$ from the longitudinal bulkheads of each tank

(b) for longitudinal corrugated bulkheads, the pressures are to be calculated at the ends of the tank, i.e., the intersection of the forward and aft transverse bulkheads and the longitudinal bulkhead

b_{tk} : maximum breadth of tank under consideration measured at the bulkhead, in *m*

s_{cg} : spacing of corrugation, in *mm*. See **Fig. 8.2.3**

l_o : effective bending span of the corrugation, measured from the mid depth of the lower stool to the mid depth of the upper stool, or upper end where no upper stool is fitted, in *m*, see **Fig. 8.2.3**

l_{cg} : length of corrugation, which is defined as the distance between the lower stool and the upper stool or the upper end where no upper stool is fitted, in *m*, see **Fig. 8.2.3**

C_i : the relevant bending moment coefficients as given in **Table 8.2.3**

C_{s-cg} : permissible bending stress coefficient at the mid length of the corrugation length, l_{cg}

= c_e, but not to be taken as greater than 0.75 for acceptance criteria set AC1

= c_e, but not to be taken as greater than 0.90 for acceptance criteria set AC2 at the lower and upper ends of corrugation length, l_{cg}

= 0.75 for acceptance criteria set AC1

= 0.90 for acceptance criteria set AC2

c_e $= \dfrac{2.25}{\beta} - \dfrac{1.25}{\beta^2}$ for $\beta \geq 1.25$

$= 1.0$ for $\beta < 1.25$

β $= \dfrac{b_f}{t_{f-net}} \sqrt{\dfrac{\sigma_{yd}}{E}}$

b_f : breadth of flange plating, in *mm*, see **Fig. 8.2.3**

$t_{f\text{-}net}$: net thickness of the corrugation flange, in *mm*

E : modulus of elasticity, in N/mm^2

σ_{yd} : specified minimum yield stress of the material, in N/mm^2

Table 8.2.3 has been amended as follows.

Table 8.2.3 Values of C_i

Bulkhead	At lower end of l_{cg}	At mid length of l_{cg}	At upper end of l_{cg}
Transverse Bulkhead	C_1	C_{m1}	$0.80C_{m1}$
Longitudinal Bulkhead	C_3	C_{m3}	$0.65C_{m3}$

Where:

C_1 $= a_1 + b_1\sqrt{\frac{A_{dt}}{b_{dk}}}$ but is not to be taken as less than 0.60

$= a_1 - b_1\sqrt{\frac{A_{dt}}{b_{dk}}}$ for transverse bulkhead with no lower stool, but is not to be taken as less than 0.55

a_1 $= 0.95 - \frac{0.41}{R_{bt}}$

$= 0.6$ for transverse bulkhead with no lower stool

b_1 $= -0.20 + \frac{0.078}{R_{bt}}$

$= 0.13$ for transverse bulkhead with no lower stool

C_{m1} $= a_{m1} + b_{m1}\sqrt{\frac{A_{dt}}{b_{dk}}}$ but is not to be taken as less than 0.55

$= a_{m1} - b_{m1}\sqrt{\frac{A_{dt}}{b_{dk}}}$ for transverse bulkhead with no lower stool, but is not to be taken as less than 0.60

a_{m1} $= 0.63 + \frac{0.25}{R_{bt}}$

$= 0.96$ for transverse bulkhead with no lower stool

b_{m1} $= -0.25 - \frac{0.11}{R_{bt}}$

$= 0.34$ for transverse bulkhead with no lower stool

C_3 $= a_3 + b_3\sqrt{\frac{A_{dl}}{l_{dk}}}$ but is not to be taken as less than 0.60

$= a_3 - b_3\sqrt{\frac{A_{dl}}{l_{dk}}}$ for longitudinal bulkhead with no lower stool, but is not to be taken as less than 0.55

a_3 $= 0.86 - \frac{0.35}{R_{bl}}$

$= 0.6$ for longitudinal bulkhead with no lower stool

b_3 $= -0.17 + \frac{0.10}{R_{bl}}$

$= 0.13$ for longitudinal bulkhead with no lower stool

C_{m3} $= a_{m3} + b_{m3}\sqrt{\frac{A_{dl}}{l_{dk}}}$ but is not to be taken as less than 0.55

$= a_{m3} - b_{m3}\sqrt{\frac{A_{dl}}{l_{dk}}}$ for longitudinal bulkhead with no lower stool, but is not to be taken as less than 0.60

a_{m3} $= 0.32 + \frac{0.24}{R_{bl}}$

$= 0.9$ for longitudinal bulkhead with no lower stool

b_{m3} $= -0.12 - \frac{0.10}{R_{bl}}$

$= 0.19$ for longitudinal bulkhead with no lower stool

R_{bt} $= \frac{A_{bt}}{b_{ib}}\left(1+\frac{l_{ib}}{b_{ib}}\right)\left(1+\frac{b_{av-t}}{h_{st}}\right)$ for transverse bulkheads

R_{bl} $= \frac{A_{bl}}{l_{ib}}\left(1+\frac{l_{ib}}{b_{ib}}\right)\left(1+\frac{b_{av-l}}{h_{sl}}\right)$ for longitudinal bulkheads

A_{dt}	: cross sectional area enclosed by the moulded lines of the transverse bulkhead upper stool, in m^2
	= 0 if no upper stool is fitted
A_{dl}	: cross sectional area enclosed by the moulded lines of the longitudinal bulkhead upper stool, in m^2
	= 0 if no upper stool is fitted
A_{bt}	: cross sectional area enclosed by the moulded lines of the transverse bulkhead lower stool, in m^2
A_{bl}	: cross sectional area enclosed by the moulded lines of the longitudinal bulkhead lower stool, in m^2
b_{av-t}	: average width of transverse bulkhead lower stool, in *m*. See **Fig. 8.2.3**
b_{av-l}	: average width of longitudinal bulkhead lower stool, in *m*. See **Fig. 8.2.3**
h_{st}	: height of transverse bulkhead lower stool, in *m*. See **Fig. 8.2.3**
h_{sl}	: height of longitudinal bulkhead lower stool, in *m*. See **Fig. 8.2.3**
b_{ib}	: breadth of cargo tank at the inner bottom level between hopper tanks, or between the hopper tank and centreline lower stool, in *m*. See **Fig. 8.2.3**
b_{dk}	: breadth of cargo tank at the deck level between upper wing tanks, or between the upper wing tank and centreline deck box or between the corrugation flanges if no upper stool is fitted, in *m*. See **Fig. 8.2.3**
l_{ib}	: length of cargo tank at the inner bottom level between transverse lower stools, in *m*. See **Fig. 8.2.3**
l_{dk}	: length of cargo tank at the deck level between transverse upper stools or between the corrugation flanges if no upper stool is fitted, in *m*. See **Fig. 8.2.3**

Paragraph 2.5.7.9 has been amended as follows.

2.5.7.9 For ships with a moulded depth, see **Section 4/1.1.4**, less than 16*m*, the lower stool may be eliminated provided the following requirements, in addition to the requirements of **2.5.7.6**, are complied with:

(a) general:

- double bottom floors or girders are to be fitted in line with the corrugation flanges for transverse or longitudinal bulkheads, respectively
- brackets/carlings are to be fitted below the inner bottom and hopper tank in line with corrugation webs.
  Where this is not practicable gusset plates with shedder plates are to be fitted, see item (c) below and Fig. 8.2.3
- the corrugated bulkhead and its supporting structure is to be assessed by Finite Element (FE) analysis in accordance with Section 9/2. In addition the local scantlings requirements of 2.5.6.4 and 2.5.6.5 and the minimum corrugation depth requirement of 2.5.7.4 are to be applied.

(b) inner bottom and hopper tank plating:

- the inner bottom and hopper tank in way of the corrugation is to be of at least the same material yield strength as the attached corrugation

(c) supporting structure:

- within the region of the corrugation depth below the inner bottom the net thickness of the supporting double bottom floors or girders is not to be less than the net thickness of the corrugated bulkhead flange at the lower end and is to be of at least the same material yield strength
- the upper ends of vertical stiffeners on supporting double bottom floors or girders are to be bracketed to adjacent structure
- brackets/carlings arranged in line with the corrugation web are to have a depth of not less than 0.5 *times* the corrugation depth and a net thickness not less than 80% of the net thickness of the corrugation webs and are to be of at least the same material yield strength
- cut outs for stiffeners in way of supporting double bottom floors and girders in line with corrugation flanges are to be fitted with full collar plates
- where support is provided by gussets with shedder plates, the height of the gusset plate, see h_g in **Fig. 8.2.3**, is to be at least equal to the corrugation depth, and gussets with shedder plates are to be arranged in every corrugation. The gusset plates are to be fitted in line with and between the corrugation flanges.
  The net thickness of the gusset and shedder plates are not to be less than 100% and 80%, respectively, of the net thickness of the corrugation flanges and are to be of at least the same material yield strength. Also see **2.5.7.11**.
- scallops in brackets, gusset plates and shedder plates in way of the connections to the inner bottom or corrugation flange and web are not permitted.

2.6 Primary Support Members

Paragraph 2.6.1 has been amended as follows.

2.6.1 General

2.6.1.1 The ~~following requirements relate to the determination of~~ scantlings of the primary support members in the cargo tank region for the extents shown in **Fig. 8.2.4** are to be in accordance with the requirements of **2.6.1.2** to **2.6.1.7**.

2.6.1.2 The section modulus and shear area criteria for primary support members contained in **2.6** apply to structural configurations shown in **Fig. 2.3.1** and are applicable to the following structural elements:

(a) floors and girders within the double bottom;
(b) deck transverses fitted below the upper deck;
(c) side transverses within double side structure;
(d) vertical web frames on longitudinal bulkheads with or without cross ties;
(e) horizontal stringers on transverse bulkheads, except those fitted with buttresses or other intermediate supports; and
(f) cross ties in wing cargo and centre cargo tanks.

~~The section modulus and shear area criteria for primary support members of structural configurations other than those listed above are to be obtained by calculation methods as described in **Section 8/7**.~~

2.6.1.3 The scantlings of primary support members are to be verified by the Finite Element (FE) cargo tank structural analysis defined in **Section 9/2**.

2.6.1.4 The section modulus and/or shear area of a primary support member and/or the cross sectional area of a primary support member cross tie may be reduced to 85% of the prescriptive requirements provided that the reduced scantlings comply with the FE cargo tank structural analysis and with **2.1.6**.

2.6.1.5 In general, primary support members are to be arranged in one plane to form continuous transverse rings. Brackets forming connections between primary support members of the ring are to be designed in accordance with **Section 4/3.3.3**.

2.6.1.6 Webs of the primary support members are to be stiffened in accordance with **Section 10/2.3**.

2.6.1.7 Webs of the primary support members are to have a depth of not less than given by the requirements of **2.6.4.1**, **2.6.6.1** and **2.6.7.1**, as applicable. Lesser depths may be accepted where equivalent stiffness is demonstrated. See **3/5.3.3.4**. Primary support members that have open slots for stiffeners are to have a depth not less than 2.5 *times* the depth of the slots.

2.6.1.8 The scantlings of the first primary support members from the transverse bulkhead are to be in accordance with **Section 8/7**, **2.6.1.3**, **2.6.1.4**, **2.6.1.5**, **2.6.1.6**, **2.6.4.3** and **2.6.4.4**. In the application of **2.6.4.3** and **2.6.4.4** only the design green sea pressure is to be considered.

5. Aft End

5.3 Shell Structure

5.3.1 Shell plating

Paragraph 5.3.1.1 has been amended as follows.

5.3.1.1 The net thickness of the side shell and transom plating, t_{net}, is to comply with the requirements in **3.9.2.1** and is not to be less than:

$$t_{net} = 0.035(L_2 - 42) + 0.009s \quad (mm)$$

Where:

L_2 : rule length, L_{CSR-T}, as defined in **Section 4/1.1.1.1**, but need not be taken greater than 300*m*

s : stiffener spacing, in *mm*, as defined in **Section 4/2.2**

6. Evaluation of Structure for Sloshing and Impact Loads

Table 8.6.2 has been amended as follows.

Table 8.6.2 Allowable Bending Stress Coefficient, C_s, for Assessment of Sloshing on Stiffeners

The permissible bending stress coefficient for the design load set being considered is to be taken as:

$$C_s = \beta_s - \alpha_s \frac{|\sigma_{hg}|}{\sigma_{yd}}$$ but not to be taken greater than C_{s-max}

Where:

α_s, β_s, C_{s-max} : permissible bending stress factors and are to be taken as follows

Acceptance Criteria Set	Structural Member		β_s	α_s	C_{s-max}
AC1	Longitudinal strength members in the cargo tank region including but not limited to: deck stiffeners stiffeners on longitudinal bulkheads stiffeners on longitudinal girders and stringers within the cargo tank region	Longitudinal stiffeners	0.85	1.0	0.75
		Transverse or vertical stiffeners	0.7	0	0.7
	Other strength members including: stiffeners on transverse bulkheads stiffeners on transverse stringers and web frames stiffeners on tank boundaries and primary support members outside the cargo tank region		0.75	0	0.75

σ_{hg} : hull girder bending stress for the design load set being considered at the reference point defined in **Section 3/5.2.2.5**

$$= \left(\frac{(z - z_{NA-net50}) M_{sw-perm-sea}}{I_{v-net50}} \right) 10^{-3} \qquad (N/mm^2)$$

z : vertical coordinate of the reference point defined in **Section 3/5.2.2.5**, in *m*

$z_{NA-net50}$: distance from the baseline to the horizontal neutral axis, as defined in **Section 4/2.6.1**, in *m*

$M_{sw-perm-sea}$: permissible hull girder hogging and sagging still water bending moment for seagoing operation at the location being considered, in *kNm*. ~~The greatest of the sagging and hogging bending moment is to be used, see **Section 7/2.1**~~.

Stiffener Location	$M_{sw-perm-sea}$	
	Pressure acting on Plate Side	Pressure acting on Stiffener Side
Above Neutral Axis	Sagging SWBM	Hogging SWBM
Below Neutral Axis	Hogging SWBM	Sagging SWBM

$I_{v-net50}$: net vertical hull girder moment of inertia, at the longitudinal position being considered, as defined in **Section 4/2.6.1**, in m^4

σ_{yd} : specified minimum yield stress of the material, in N/mm^2

Chapter 9 OTHER STRUCTURES

Section 2 AFT PART

Notes of Table 9.2.1 has been amended as follows.

Table 9.2.1 Maximum Permissible Stresses

Structural component	Yield utilisation factor
Internal structure in tanks	
Plating of all non-tight structural members including transverse web frame structure, wash bulkheads, internal web, horizontal stringers, floors and girders. Face plate of primary support members modelled using plate or rod elements	$\lambda_y \le 1.0$ (load combination $S + D$) $\lambda_y \le 0.8$ (load combination S)
Structure on tank boundaries	
Plating of deck, sides, inner sides, hopper plate, bilge plate, plane and corrugated cargo tank longitudinal bulkheads. Tight floors, girders and webs	$\lambda_y \le 0.9$ (load combination $S + D$) $\lambda_y \le 0.72$ (load combination S)
Plating of inner bottom, bottom, plane transverse bulkheads and corrugated bulkheads.	$\lambda_y \le 0.8$ (load combination $S + D$) $\lambda_y \le 0.64$ (load combination S)

Where:	
λ_y	yield utilisation factor $= \dfrac{\sigma_{vm}}{\sigma_{yd}}$ for plate elements in general $= \dfrac{\sigma_{rod}}{\sigma_{yd}}$ for rod elements in general
σ_{vm}	von Mises stress calculated based on membrane stresses at element's centroid, in N/mm^2
σ_{rod}	axial stress in rod element, in N/mm^2
σ_{yd}	specified minimum yield stress of the material, in N/mm^2, but not to be taken as greater than 315 N/mm^2 for load combination $S + D$ in areas of stress concentration (2)

Notes:

1. Structural items given in the table are for guidance only. Stresses for all parts of the FE model specified in **2.2.5.2** are to be verified against the permissible stress criteria. See also **Appendix B/2.7.1**
2. Areas of stress concentration are corners of openings, knuckle joints, toes and heels of primary supporting structural members and stiffeners
3. Where a lower stool is not fitted to a transverse or longitudinal corrugated bulkhead, the maximum permissible stresses are to be reduced by 10% in accordance with **2.2.5.5**.
4. The yield utilisation factor for plane and corrugated longitudinal bulkheads between cargo tanks may be taken as for non-tight structural members for FE load cases where either both sides of the bulkhead are empty or both sides are loaded. The water-tight bottom girder under the longitudinal bulkhead is to be treated as a tight structural member.

Section 11 GENERAL REQUIREMENTS

3. Support Structure and Structural Appendages

3.1 Support Structure for Deck Equipment

3.1.2 Supporting structures for anchoring windlass and chain stopper

Paragraph 3.1.2.15 has been amended as follows.

3.1.2.15 The stresses resulting from anchoring design loads induced in the supporting structure are not to be greater than the permissible values given below, based on the gross thickness of the structure:

~~Direct~~ Normal stress 1.00 σ_{yd}

Shear stress 0.58 σ_{yd}

Where:

σ_{yd} : specified minimum yield stress of the material, in N/mm^2

Normal stress is the sum of bending stress and axial stress with the corresponding shearing stress acting perpendicular to the normal stress.

Paragraph 3.1.2.18 has been amended as follows.

3.1.2.18 The stresses resulting from green sea design loads induced in the supporting structure are not to be greater than the permissible values given below, based on the gross thickness of the structure:

~~Direct~~ Normal stress 1.00 σ_{yd}

Shear stress 0.58 σ_{yd}

Where:

σ_{yd} : specified minimum yield stress of the material, in N/mm^2

Normal stress is the sum of bending stress and axial stress with the corresponding shearing stress acting perpendicular to the normal stress.

3.1.4 Supporting structure for cranes, derricks and lifting masts

Paragraph 3.1.4.21 has been amended as follows.

3.1.4.21 The stresses induced in the supporting structure are not to exceed the permissible values given below, based on the gross thickness of the structure:

~~Direct~~ Normal stress 0.67 σ_{yd}

Shear stress 0.39 σ_{yd}

Where:

σ_{yd} : specified minimum yield stress of the material, in N/mm^2

Normal stress is the sum of bending stress and axial stress with the corresponding shearing stress acting perpendicular to the normal stress.

3.1.5 Supporting structures for components used in emergency towing arrangements on tankers

Paragraph 3.1.5.12 has been amended as follows.

3.1.5.12 For the design load specified in **3.1.5.10** and **3.1.5.11** the stresses induced in the supporting structure and welds, in way of strong-points and fairleads, are not to exceed the permissible values given below based on the gross thickness of the structure:

~~Direct~~ Normal stress 1.00 σ_{yd}

Shear stress 0.58 σ_{yd}

Where:

σ_{yd} : specified minimum yield stress of the material, in N/mm^2

Normal stress is the sum of bending stress and axial stress with the corresponding shearing stress acting perpendicular to the normal stress.

3.1.6 Supporting structure for bollards and bitts, fairleads, stand rollers, chocks and capstans

Paragraph 3.1.6.13 has been amended as follows.

3.1.6.13 For the design load specified in **3.1.6.10**, **3.1.6.11** and **3.1.6.12** the stresses induced in the supporting structure and welds are not to exceed the permissible values given below based on the net thickness of the structure. The required gross thickness is obtained by adding the relevant full corrosion addition specified in **Section 6/3** to the required net thickness.

~~Direct~~ Normal stress 1.00 σ_{yd}

Shear stress 0.60 σ_{yd}

Where:

σ_{yd} : specified minimum yield stress of the material, in N/mm^2

Normal stress is the sum of bending stress and axial stress with the corresponding shearing stress acting perpendicular to the normal stress.

Appendix A HULL GIRDER ULTIMATE STRENGTH

2. Calculation of Hull Girder Ultimate Capacity

2.1 Single Step Ultimate Capacity Method

2.1.1 Procedure

Paragraph 2.1.1.1 has been amended as follows.

2.1.1.1 The single step procedure for calculation of the sagging hull girder ultimate bending capacity is a simplified method based on a reduced hull girder bending stiffness accounting for buckling of the deck, see **Fig. A.2.1.** The hull girder ultimate bending moment capacity, M_U, is to be taken as:

$$M_U = Z_{red}\sigma_{yd} \cdot 10^3 \qquad (kNm)$$

Where:

Z_{red} : reduced section modulus of deck (to the mean deck height)

$$= \frac{I_{red}}{z_{dk-mean} - z_{NA-red}} \qquad (m^3)$$

I_{red} : reduced hull girder moment of inertia, in m^4. The inertia is to be calculated in accordance with **Section 4/2.6.1.1,** using

- a hull girder net thickness of t_{net50} for all longitudinally effective members
- the effective net area after buckling of each stiffened panel of the deck, A_{eff}

A_{eff} : effective net area after buckling of the stiffened deck panel. The effective area is the proportion of stiffened deck panel that is effectively able to be stressed to yield

$$= \frac{\sigma_U}{\sigma_{yd}} A_{net50} \qquad (m^2)$$

Note :
The effective area of deck girders is to be taken as the net area of the girders using a thickness of tnet50.

A_{net50} : net area of the stiffened deck panel, in m^2

σ_U : buckling capacity of stiffened deck panel, in N/mm^2. To be calculated for each stiffened panel using

- the advanced buckling analysis method, see **Section 10/4** and **Appendix D**
- the net thickness t_{net50}

σ_{yd} : specified minimum yield stress of the material, in N/mm^2, that is used to determine the hull girder section modulus. In the case of the stiffener and plate having different specified minimum yield stress, σ_{yd}, is to be taken as the lesser of the two.

$z_{dk-mean}$: vertical distance to the mean deck height, taken as the mean of the deck at side and the deck at centre line, measured from the baseline, in *m*

$z_{NA\text{-}red}$: vertical distance to the neutral axis of the reduced section measured from the baseline, in *m*

Appendix B STRUCTURAL STRENGTH ASSESSMENT

2. Cargo Tank Structural Strength Analysis

2.3 Loading Conditions

2.3.1 Finite element load cases

Paragraph 2.3.1.7 has been amended as follows.

2.3.1.7 Where a ballast condition is specified in the ship loading manual with ballast water filled in one or more cargo tanks, loading patterns A8 and B7 in **Tables B.2.3** and **B.2.4** are to be examined. <u>If this loading is un-symmetrical then additional strength assessment is to be carried out according to the requirements of the individual Classification Society.</u>

Notes of Table B.2.4 has been amended as follows.

Table B.2.4 Load Cases for Tankers with One Centreline Oil-tight Longitudinal Bulkhead

Notes:

1.

(a) For the assessment of scantlings of longitudinal hull girder structural members, primary supporting structural members and transverse bulkheads within midship region, see **1.1.1.5.**

(b) For the assessment of strengthening of longitudinal hull girder shear structural members in way of transverse bulkheads for hull girder vertical shear loads, see **1.1.1.6, 1.1.1.7** and **1.1.1.8.**

2. The selection of permissible SWBM and SWSF for the assessment of different cargo regions of the ship is to be in accordance with **Table B.2.6**. The percentage of the permissible SWBM and SWSF to be applied are to be accordance with this table.

3. The actual shear force that results from the application of static and dynamic local loads to the FE model are to be used.

4. The actual shear force that results from the application of static and dynamic local loads are to be used. Where this shear force exceeds the target SWSF (design load combination S) or target combined SWSF and VWSF, calculated in accordance with **2.4.5.2**, (design load combination S+D) as specified in the table, correction vertical loads are to be applied to adjust the shear force down to the required value.

5. Correction vertical loads are to be applied to adjust the shear force to the required value specified.

6. Load cases B2, B5 and B10 are only required if the structure is not symmetrical about the ship's centreline.

7. Ballast loading pattern B7 with ballast filled in cargo tanks (i.e. gale ballast/emergency ballast conditions etc.) is only required to be analysed if the condition is specified in the ship's loading manual. The actual loading pattern and draught from the loading manual for the condition is to be used in the analysis, see **Table B.2.5.** <u>If the actual loading pattern is different from load case B7 then:</u>

<u>(a) An operational restriction corresponding to the analysed condition is to be added in the Loading Manual.</u>

<u>(b) 100% of the permissible SWBM is to be applied when analyzing loading pattern with ballast in cargo tanks.</u>

8. No dynamic loads are to be applied to Design Load Combination S (harbour and tank testing load cases).

4. Evaluation of Hot Spot Stress for Fatigue Analysis

4.3 Loading Conditions

4.3.1 General

Paragraph 4.3.1.2 has been amended as follows.

4.3.1.2 The cargo density to be used for the fatigue assessment is to be ~~taken as the greater of the cargo density specified for the homogeneous scantling draught condition and 0.9t/m^3.~~ :

(a) longitudinal end connections - the greater of the cargo density specified for the homogeneous scantling draught condition and 0.9t/m^3

(b) connection between inner bottom and hopper plate - 0.9t/m^3.

Appendix C FATIGUE STRENGTH ASSESSMENT

1. Nominal Stress Approach

1.4 Fatigue Damage Calculation

1.4.4 Definition of stress components

Paragraph 1.4.4.6 has been amended as follows.

1.4.4.6 For the calculation of stress components, the vertical wave hull girder stress, σ_v, is given by:

$$\sigma_v = \frac{M_{wv-v-amp}}{Z_{v-net75}} 10^{-3} \qquad (N/mm^2)$$

Where:

$M_{wv\text{-}v\text{-}amp}$: pseudo amplitude (half range), in kNm, as defined in **1.3.4**

$Z_{v\text{-}net75}$ $= \dfrac{I_{v-net75}}{|z - z_{NA-net75}|}$ (m^3) see **Section 4/2.6.1**

$I_{v\text{-}net75}$: net vertical hull girder moment of inertia, of hull cross-section about transverse neutral axis ~~(openings deducted)~~, in m^4
$I_{v\text{-}net75}$ is to be calculated based on gross thickness, minus the corrosion addition $0.25t_{corr}$ of all effective structural elements, see **Section ~~4/2.6.1.3~~ 4/2.6.1**

z : distance from baseline to the critical location of the considered member, i.e. top of flange of longitudinal stiffener, in m

$z_{NA\text{-}net75}$: distance from baseline to horizontal neutral axis consistent with $I_{v\text{-}net75}$, in m

Paragraph 1.4.4.8 has been amended as follows.

1.4.4.8 The horizontal wave hull girder stress, σ_h, is to be taken as:

$$\sigma_h = \frac{M_{wv-h-amp}}{Z_{h-net75}} 10^{-3} \qquad (N/mm^2)$$

Where:

$M_{wv\text{-}h\text{-}amp}$: in kNm, as defined in **1.3.5**

$Z_{h\text{-}net75}$: $\dfrac{I_{h-net75}}{|y|}$ (m^3) see **Section 4/2.6.2**

y : distance from vertical neutral axis of hull cross section to the critical location of the considered member, in m. i.e. top of face plate of longitudinal stiffener

$I_{h\text{-}net75}$: net horizontal hull girder moment of inertia, of the hull cross-section about the vertical neutral axis ~~(openings deducted)~~, in m^4.

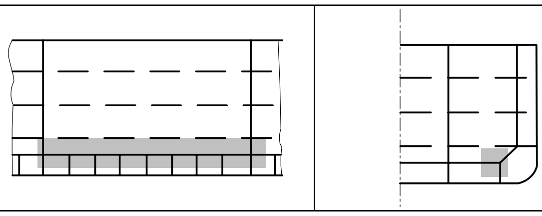
: $I_{h-net75}$ is to be calculated based on gross thickness, minus the corrosion addition $0.25t_{corr}$ for all effective structural elements, see **Section 4/2.6.2**

Fig. C.2.2 has been amended as follows.

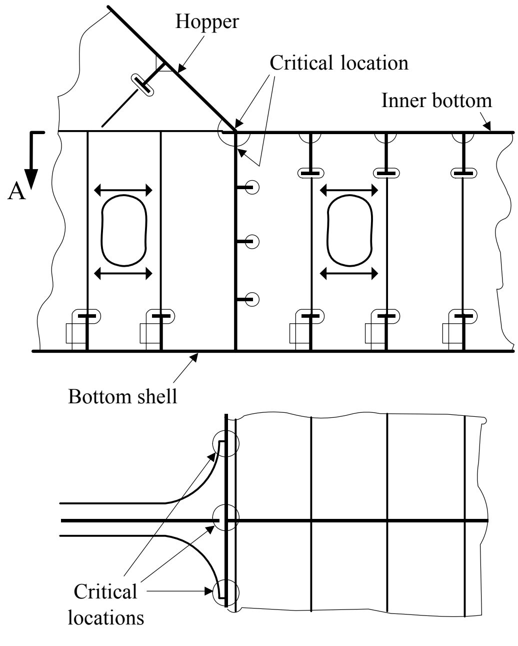
Fig. C.2.2 Hopper Knuckle Connection Detail, Without Bracket

Connections of floors in double bottom tanks to hopper tanks
Hopper corner connections employing welded inner bottom and hopper sloping plating

CRITICAL AREAS

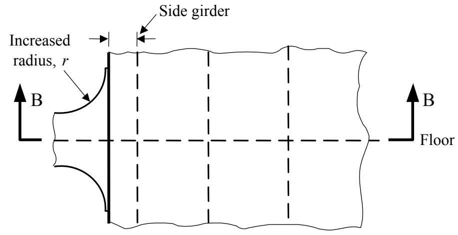


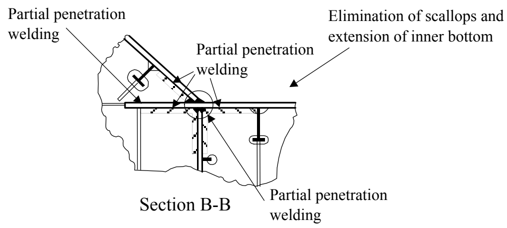
CRITICAL LOCATIONS



Section A-A

DETAIL DESIGN STANDARD A





Weld between hopper plating and inner bottom plating to be ~~dressed~~ extended and ground smooth. Visible undercuts are to be removed.
Weld extension and grinding to be applied 200 *mm* either side of the floor.
~~Extent of dressing both sides of floor.~~

~~VLCC~~	~~250 mm~~
~~Suezmax~~	~~200 mm~~
~~Aframax~~	~~150 mm~~
~~Product~~	~~100 mm~~

Notes:
1. A root face with a maximum of 1/3 of the abutting plate thickness is acceptable for the partial penetration welding, see **Section 6/5.3.4**.
2. Grinding need not be applied in the No.1 tank in which floor spans are reduced due to shape.
3. Grinding need not be applied for the knuckle joints at transverse bulkhead positions, or at the floor adjacent to the transverse bulkhead.

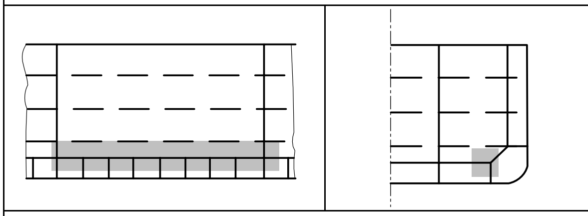
Minimum Requirement	As a minimum, detail design standard A or B is to be fitted. Further consideration will be given where the hopper angle exceeds 50 *degrees*. The ground surface is to be protected by a stripe coat, of suitable paint composition, where the lower hopper knuckle region of cargo tanks is not coated.
Critical Location	Hopper sloping plating connections to inner bottom plating in way of floors. Floor connections to inner bottom plating and side girders in way of hopper corners.
Detail Design Standard	Elimination of scallops in way of hopper corners, extension of inner bottom plating to reduce level of resultant stresses arising from cyclic external hydrodynamic pressure, cargo inertia pressure and hull girder loads. Scarfing bracket thickness is to be close to that of the inner bottom in way of knuckle.
Building Tolerances	Median line of hopper sloping plate is to be in line with the median line of the girder with an allowable tolerance of *t*/3 or 5*mm*, whichever is less, ~~towards centreline in way of the floor,~~ where *t* is the inner bottom thickness. The allowable tolerance is to be measured parallel to the inner bottom.
Welding Requirements	Partial penetration welding (hopper sloping plating to inner bottom plating). Partial penetration weld (connection of floors to inner bottom plating and to side girders, connection of hopper transverse webs to sloping plating, to inner bottom plating, and to side girders in way of hopper corners).

Fig. C.2.3 has been amended as follows.

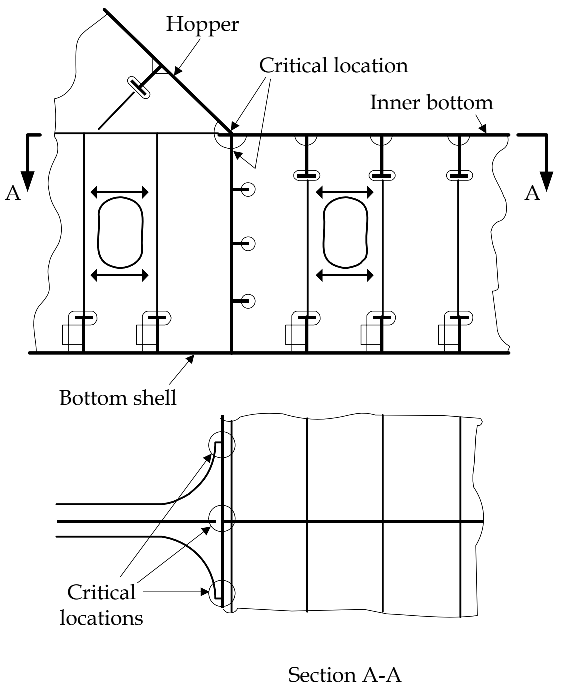
Fig. C.2.3 Option: Hopper Knuckle Connection Detail, With Bracket

Connections of floors in double bottom tanks to hopper tanks
Hopper corner connections employing welded inner bottom and hopper sloping plating

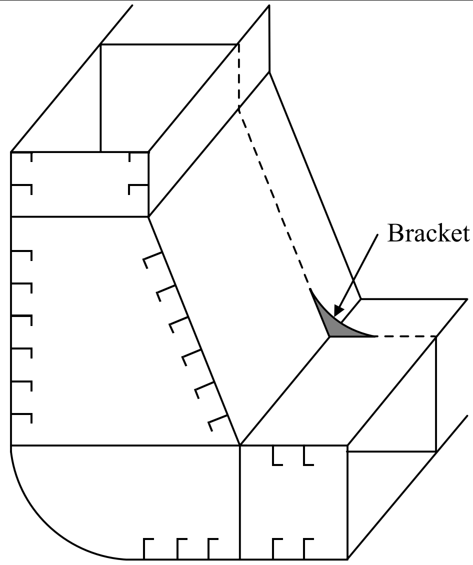
CRITICAL AREAS



CRITICAL LOCATIONS



DETAIL DESIGN STANDARD B



Notes:
1. Bracket to be fitted inside cargo tank
2. Bracket to extend approximately to the first longitudinal
3. The bracket toes are to have a soft nose design
4. Full penetration welding at bracket toes
5. Bracket material to be same as that of inner bottom
6. Buckling of bracket to be checked:

$$\frac{d}{t_{bkt}} < 21\sqrt{235/\sigma_{yd}}$$

where:
d =bracket max depth, as defined in **Table 10.2.3**
t_{bkt} =bracket thickness
σ_{yd} =specified minimum yield stress of material

Minimum Requirement	As a minimum, detail design standard A or B is to be fitted. Further consideration will be given where hopper angle exceeds 50*degrees*. ~~The ground surface is to be protected by a stripe coat, of suitable paint composition, where the lower hopper knuckle region of cargo tanks is not coated.~~
Critical Location	Hopper sloping plating connections to inner bottom plating in way of floors. Floor connections to inner bottom plating and side girders in way of hopper corners.
Detail Design Standard	Elimination of scallops in way of hopper corners, extension of inner bottom plating to reduce level of resultant stresses arising from cyclic external hydrodynamic pressure, cargo inertia pressure and hull girder loads. Scarfing bracket thickness to be close to that of the inner bottom in way of knuckle.
Building Tolerances	Median line of hopper sloping plate is to be in line with the median line of the girder with an allowable tolerance of $t/3$ or 5*mm*, whichever is less, ~~towards centreline in way of the floor,~~ where t is the inner bottom thickness.
Welding Requirements	Partial penetration welding (hopper sloping plating to inner bottom plating). Partial penetration weld (connection of floors to inner bottom plating and to side girders, connection of hopper transverse webs to sloping plating, to inner bottom plating, and to side girders in way of hopper corners).

EFFECTIVE DATE AND APPLICATION

1. The effective date of the amendments is 1 July 2010.

2. Notwithstanding the amendments to the Rules, the current requirements may apply to ships for which the date of contract for construction* is before the effective date.

* "contract for construction" is defined in the latest version of IACS Procedural Requirement (PR) No.29.

IACS PR No.29 (Rev.0, July 2009)

1. The date of "contract for construction" of a vessel is the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. This date and the construction numbers (i.e. hull numbers) of all the vessels included in the contract are to be declared to the classification society by the party applying for the assignment of class to a newbuilding.

2. The date of "contract for construction" of a series of vessels, including specified optional vessels for which the option is ultimately exercised, is the date on which the contract to build the series is signed between the prospective owner and the shipbuilder.
For the purpose of this Procedural Requirement, vessels built under a single contract for construction are considered a "series of vessels" if they are built to the same approved plans for classification purposes. However, vessels within a series may have design alterations from the original design provided:
(1) such alterations do not affect matters related to classification, or
(2) If the alterations are subject to classification requirements, these alterations are to comply with the classification requirements in effect on the date on which the alterations are contracted between the prospective owner and the shipbuilder or, in the absence of the alteration contract, comply with the classification requirements in effect on the date on which the alterations are submitted to the Society for approval.
The optional vessels will be considered part of the same series of vessels if the option is exercised not later than 1 year after the contract to build the series was signed.

3. If a contract for construction is later amended to include additional vessels or additional options, the date of "contract for construction" for such vessels is the date on which the amendment to the contract, is signed between the prospective owner and the shipbuilder. The amendment to the contract is to be considered as a "new contract" to which **1.** and **2.** above apply.

4. If a contract for construction is amended to change the ship type, the date of "contract for construction" of this modified vessel, or vessels, is the date on which revised contract or new contract is signed between the Owner, or Owners, and the shipbuilder.

Note:
This Procedural Requirement applies from 1 July 2009.