07-391

RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part CSR-B Common Structural Rules for Bulk Carriers

Rules for the Survey and Construction of Steel Ships
Part CSR-B 2007 AMENDMENT NO.2

Rule No.48 27th September 2007
Resolved by Technical Committee on 2nd July 2007
Approved by Board of Directors on 24th July 2007

ClassNK
NIPPON KAIJI KYOKAI

Rule No.48 27th September 2007
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-B Common Structural Rules for Bulk Carriers

Chapter 3 STRUCTURAL DESIGN PRINCIPLES

Section 6 STRUCTURAL ARRANGEMENT PRINCIPLES

7. Double Side structure

7.1 Application

Paragraph 7.1.1 has been amended as follow.

7.1.1

The requirement of this article applies to longitudinally or transversely framed side structure.
The transversely framed side structures are built with transverse frames possibly supported by horizontal side girders.
The longitudinally framed side structures are built with longitudinal ordinary stiffeners supported by vertical primary supporting members.
The side within the hopper and topside tanks is, in general, to be longitudinally framed. It may be transversely framed when this is accepted for the double bottom and the deck according to ~~**6.1.1**~~**6.1.2** and **9.1.1**, respectively.

10. Bulkhead structure

10.4 Corrugated bulkheads

Paragraph 10.4.1 and 10.4.8 have been amended as follow.

10.4.1 General

For ships of 190m of length L and above, the transverse vertically corrugated watertight bulkheads are to be fitted with a lower stool and generally with an upper stool below ~~the~~ deck. ~~In ships less than 150 *m* in length,~~ For ships less than 190m in length L, corrugations may extend from ~~the~~ inner bottom to ~~the~~ deck provided the global strength of hull structures are satisfactorily proved for ships having ship length L of 150m and above by DSA as required by **Ch 7**.

10.4.8 Upper stool

The upper stool, when fitted, is to have a height in general between two and three times the depth of corrugations. Rectangular stools are to have a height in general equal to twice the depth of corrugations, measured from the deck level and at the hatch side girder.

The upper stool of transverse bulkhead is to be properly supported by deck girders or deep brackets between the adjacent hatch end beams.

The width of the upper stool bottom plate is generally to be the same as that of the lower stool top plate. The stool ~~bottom~~ top of non-rectangular stools is to have a width not less than twice the depth of corrugations.

The thickness and material of the stool bottom plate are to be the same as those of the bulkhead plating below. The thickness of the lower portion of stool side plating is to be not less than 80% of that required for the upper part of the bulkhead plating where the same material is used.

The ends of stool side ordinary stiffeners when fitted in a vertical plane, are to be attached to brackets at the upper and lower end of the stool.

The stool is to be fitted with diaphragms in line with and effectively attached to longitudinal deck girders extending to the hatch end coaming girders or transverse deck primary supporting members as the case may be, for effective support of the corrugated bulkhead.

Scallops in the brackets and diaphragms in way of the connection to the stool bottom plate are to be avoided.

Chapter 4   DESIGN LOADS

Section 3   HULL GIRDER LOADS

1.   General

1.1   Sign conventions of bending moments and shear forces

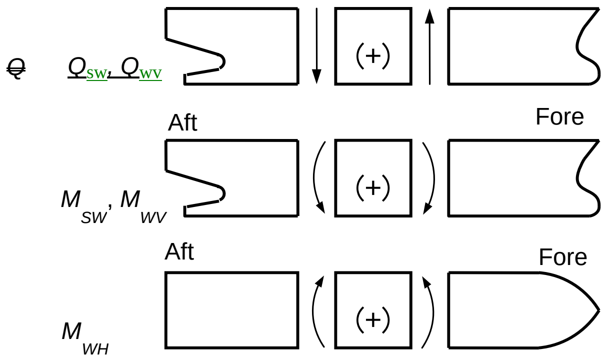
Paragraph 1.1.1 has been amended as follow.

1.1.1

Absolute values are to be taken for bending moments and shear forces introduced in this Section. The sign of bending moments and shear forces is to be considered according to **Sec 4**, **Table 3**. The sign conventions of vertical bending moments, horizontal bending moments and shear forces at any ship transverse section are as shown in **Fig. 1**, namely:

- the vertical bending moments M_{SW} and M_{WV} are positive when they induce tensile stresses in the strength deck (hogging bending moment) and are negative in the opposite case (sagging bending moment)
- the horizontal bending moment M_{WH} is positive when it induces tensile stresses in the starboard and is negative in the opposite case.
- the vertical shear force ~~Q~~ Q_{sw}, Q_{wv} ~~is~~ are positive in the case of downward resulting forces preceding and upward resulting forces following the ship transverse section under consideration, and is negative in the opposite case.

Fig. 1   Sign conventions for shear forces ~~Q~~ Q_{SW}, Q_{WV} and bending moments M_{SW}, M_{WV}, M_{WH}



Chapter 5 HULL GIRDER STRENGTH

Section 1 YIELDING CHECK

4. Section modulus and moment of inertia

4.4 Midship section moment of inertia

Paragraph 4.4.1 has been amended as follow.

4.4.1

The net midship section moment of inertia about its horizontal neutral axis is to be not less than the value obtained, in m^4, from the following formula:

$$I_{YR} = 3Z'_{R,MIN} L \cdot 10^{-2}$$

where $Z'_{R,MIN}$ is the required net midship section modulus $Z_{R,MIN}$, in m^3, calculated as specified in **4.2.1** ~~or 4.2.2~~, but assuming k = 1.

Appendix 1 HULL GIRDER ULTIMATE STRENGTH

2. Criteria for the calculation of the curve *M-χ*

2.2 Load-end shortening curves *σ–ε*

Paragraph 2.2.4, 2.2.5 and 2.2.7 have been amended as follow.

2.2.4 Beam column buckling

The equation describing the load-end shortening curve σ_{CR1}-ε for the beam column buckling of ordinary stiffeners composing the hull girder transverse section is to be obtained from the following formula (see **Fig. 3**):

$$\sigma_{CR1} = \Phi \sigma_{C1} \frac{A_{Stif} + 10 b_E t_p}{A_{Stif} + 10 s t_p}$$

where:

Φ: Edge function defined in **2.2.3**

A_{Stif} : Net sectional area of the stiffener, in cm^2, without attached plating

σ_{C1} : Critical stress, in N/mm^2, equal to:

(No further amendments)

2.2.5 Torsional buckling

The equation describing the load-end shortening curve σ_{CR2}-ε for the flexural-torsional buckling of ordinary stiffeners composing the hull girder transverse section is to be obtained according to the following formula (see **Fig. 4**).

$$\sigma_{CR2} = \Phi \frac{A_{Stif} \sigma_{C2} + 10 s t_p \sigma_{CP}}{A_{Stif} + 10 s t_p}$$

where:

Φ: Edge function defined in **2.2.3**

A_{Stif} : Net sectional area of the stiffener, in cm^2, without attached plating

σ_{C2} : Critical stress, in N/mm^2, equal to:

(No further amendments)

2.2.7 Web local buckling of ordinary stiffeners made of flat bars

The equation describing the load-end shortening curve σ_{CR4}–ε for the web local buckling of flat bar ordinary stiffeners composing the hull girder transverse section is to be obtained from the following formula (see **Fig. 5**):

$$\sigma_{CR4} = \Phi \frac{10 s t_P \sigma_{CP} + A_{Stif} \sigma_{C4}}{A_{Stif} + 10 s t_P}$$

where:

Φ: Edge function defined in **2.2.3**

A_{Stif} : Net sectional area of the stiffener, in cm^2, without attached plating
σ_{CP}: Buckling stress of the attached plating, in N/mm^2, defined in **2.2.5**
σ_{C4}: Critical stress, in N/mm^2, equal to:

(No further amendments)

Chapter 6 HULL SCANTLINGS

Section 1 PLATING

2. General requirements

2.5 Sheerstrake

Paragraph 2.5.1 has been amended as follow.

2.5.1 Welded sheerstrake

The net thickness of a welded sheerstrake is to be not less than the actual net thicknesses of the adjacent 2 *m* width side plating, taking into account higher strength steel corrections if needed.

Section 2 ORDINARY STIFFENERS

3. Yielding check

3.3 Strength criteria for side frames of single side bulk carriers

Paragraph 3.3.2 has been amended as follow.

3.3.2 Supplementary strength requirements

In addition to **3.3.1**, the net moment of inertia, in cm^4, of the 3 side frames located immediately abaft the collision bulkhead is to be not less than the value obtained from the following formula:

$$I = 0.18 \frac{(p_S + p_W)\ell^4}{n}$$

where:

ℓ : Side frame span, in *m*

n : Number of frames from the bulkhead to the frame in question, taken equal to 1, 2 or 3

s : Frame spacing, in *m*.

As an alternative, supporting structures, such as horizontal stringers, are to be fitted between the collision bulkhead and a side frame which is in line with transverse webs fitted in both the topside tank and hopper tank, maintaining the continuity of forepeak stringers within the foremost hold.

3.4 Upper and lower connections of side frames of single side bulk carriers

Paragraph 3.4.2 has been amended as follow.

3.4.2

The net connection area, A_i, in cm^2, of the bracket to the *i*-th longitudinal stiffener supporting the bracket is to be obtained from the following formula:

$$A_i = 0.4 \frac{w_i s}{\ell_1^2} \frac{k_{bkt}}{k_{lg,i}}$$

where:

w_i: Net section modulus, in cm^3, of the *i*-th longitudinal stiffener of the side or sloped bulkheads that support the lower or the upper end connecting bracket of the side frame, as applicable

ℓ_1: As defined in **3.4.1**

k_{bkt} : Material factor for the bracket

$k_{lg,i}$: Material factor for the *i*-th longitudinal stiffener.

s : Frame spacing, in *m*.

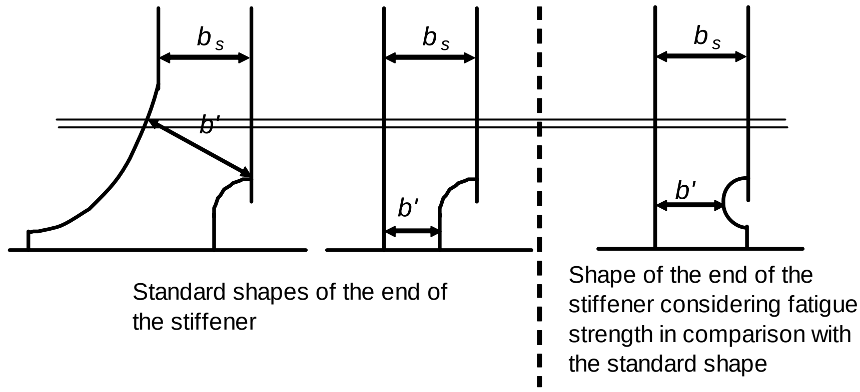
4. Web stiffeners of primary supporting members

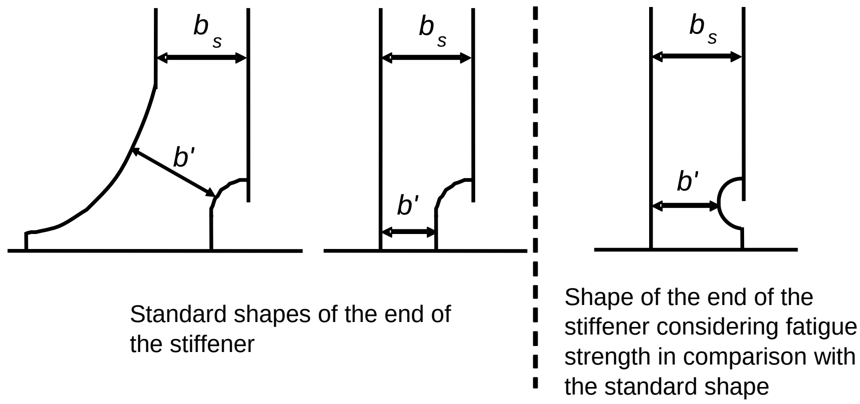
4.1 Net scantlings

4.1.3 Connection ends of web stiffeners

Figure 9 has been amended as follow.

Fig. 9 Shape of the end of the web stiffener





Section 3 BUCKLING & ULTIMATE STRENGTH OF ORDINARY STIFFENERS AND STIFFENED PANELS

1. General

1.1

Paragraph 1.1.2 has been amended as follow.

1.1.2

The buckling checks have to be performed for the following elements:

(a) according to requirements of **2**, **3** and **4** and for all load cases as defined in **Ch 4**, **Sec 4** in intact condition:
  - elementary plate panels and ordinary stiffeners in a hull transverse section analysis,
  - elementary plate panels modeled in *FEM* as requested in **Ch 7**.

(b) according to requirements of **6** and only in flooded condition:
  - transverse vertically corrugated watertight bulkheads~~ for *BC-A* and *BC-B* ships~~.

4. Buckling criteria of partial and total panels

4.2 Ultimate strength in lateral buckling mode

4.2.2 Evaluation of the bending stress σ_b

Definition of symbol, *p* has been amended as follow.

p : Lateral load in kN/m^2, as defined in **Ch 4**, **Sec5** and **Ch 4**, **Sec 6** calculated at the load point as defined in **Ch 6**, **Sec 2**, ~~**1.4.2**~~**1.4**

Paragraph 4.2.3 has been amended as follow.

4.2.3 Equivalent criteria for longitudinal and transverse ordinary stiffeners not subjected to lateral pressure

Longitudinal and transverse ordinary stiffeners not subjected to lateral pressure are considered as complying with the requirement of **4.2.1** if their net moments of inertia I_x and I_y, in cm^4, are not less than the value obtained by the following formula:

- For longitudinal stiffener : ~~$I_x = \frac{p_{zx} a^2}{\pi^2 10^4} \left(\frac{w_{0x} h_w}{\frac{R_{eH}}{S} - \sigma_x} + \frac{a^2}{\pi^2 E} \right)$~~

$$I_x = \frac{p_{zx} a^2}{\pi^2 10^4}\left(\frac{w_0 h_w}{\frac{R_{eH}}{S}-\sigma_x}+\frac{a^2}{\pi^2 E}\right)$$

- For transverse stiffener : ~~$I_y = \frac{p_{zy} (nb)^2}{\pi^2 10^4}\left(\frac{w_{0y} h_w}{\frac{R_{eH}}{S}-\sigma_y}+\frac{(nb)^2}{\pi^2 E}\right)$~~

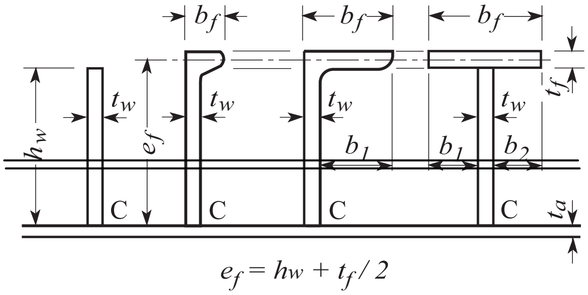
$$I_y = \frac{p_{zy} (nb)^2}{\pi^2 10^4}\left(\frac{w_0 h_w}{\frac{R_{eH}}{S}-\sigma_y}+\frac{(nb)^2}{\pi^2 E}\right)$$

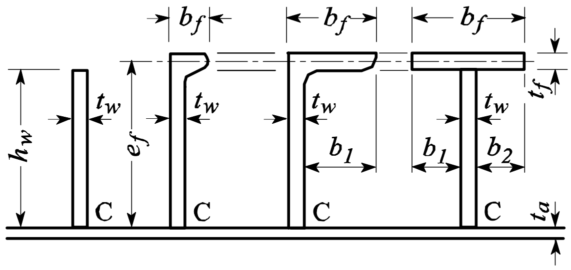
4.3 Torsional buckling

4.3.1 Longitudinal stiffeners

Figure 2 has been amended as follow.

Fig. 2 Dimensions of stiffeners





Title of 6. has been amended as follow.

6. Transverse vertically corrugated watertight bulkhead in flooded conditions~~for *BC-A* and *BC-B* ships~~

Section 4 PRIMARY SUPPORTING MEMBERS

3. Additional requirements for primary supporting members of *BC-A* and *BC-B* ships

3.1 Evaluation of double bottom capacity and allowable hold loading in flooded conditions

3.1.4 Allowable hold loading

Definition of symbol z_F has been amended as follow.

z_F : Flooding level, in *m*, defined in **Ch 4**, **Sec 6**, ~~**3.3.3**~~ <u>**3.4.3**</u>

Chapter 7 DIRECT STRENGTH ANALYSIS

Section 2 GLOBAL STRENGTH FE ANALYSIS OF CARGO HOLD STRUCTURES

2. Analysis model

2.5 Consideration of hull girder loads

2.5.4 Influence of local loads

Definition of symbols, Q_{V_FEM}, Q_{V_FEM}, Q_{V_FEM} and Q_{V_FEM} has been amended as follow.

Q_{V_FEM}, Q_{H_FEM}, M_{V_FEM} and M_{H_FEM} :Vertical and horizontal shear forces and bending moments created by the local loads applied on the *FE* model. Sign of Q_{V_FEM}, M_{V_FEM} and M_{H_FEM} is in accordance with the sign convention defined in **Ch 4, Sec 3**. The sign convention for reaction forces is that a positive creates a positive shear force.

2.5.6 Direct method

Definition of some symbols has been amended as follow.

Q_{V_T}, Q_{H_T}, M_{V_T}, M_{H_T} : Target vertical and horizontal shear forces and bending moments, defined in **Table 3** or **Table 4**, at the location x_{eq}. Sign of Q_{V_T}, M_{V_T} and M_{H_T} is in accordance with sign convention defined in **Ch 4, Sec 3**.

$M_{Y\_aft\_SF}$, $M_{Y\_fore\_SF}$, $M_{Y\_aft\_BM}$, $M_{Y\_fore\_BM}$: Enforced moments to apply at the aft and fore ends for vertical shear force and bending moment control, positive for clockwise around *y*-axis. The sign convention for $M_{Y\_aft\_SF}$, $M_{Y\_fore\_SF}$, $M_{Y\_aft\_BM}$ and $M_{Y\_fore\_BM}$ is that of the FE model axis. The sign convention for other bending moment, shear forces and reaction forces is in accordance with the sign convention defined in **Ch 4, Sec 3**.

$M_{Z\_aft\_SF}$, $M_{Z\_fore\_SF}$, $M_{Z\_aft\_BM}$, $M_{Z\_fore\_BM}$: Enforced moments to apply at the aft and fore ends for horizontal shear force and bending moment control, positive for clockwise around *z*-axis. The sign convention for $M_{Z\_aft\_SF}$, $M_{Z\_fore\_SF}$, $M_{Z\_aft\_BM}$ and $M_{Z\_fore\_BM}$ is that of the FE model axis. The sign convention for other bending moment, shear forces and reaction forces is in accordance with the sign convention defined in **Ch 4, Sec 3**.

Chapter 8 FATIGUE CHECK OF STRUCTURAL DETAILS

Section 2 FATIGUE STRENGTH ASSESSMENT

3. Calculation of fatigue damage

3.2 Long-term distribution of stress range

Paragraph 3.2.1 has been amended as follow.

3.2.1

The cumulative probability density function of the long-term distribution of combined notch stress ranges is to be taken as a two-parameter Weibull distribution:

~~$F(x) = 1 - \exp\left[-\left(\frac{x}{\Delta\sigma_{W,j}} \right)^{\xi} (\ln N_R)^{1/\xi} \right]$~~

$$F(x) = 1 - \exp\left[-\left(\frac{x}{\Delta\sigma_{E,j}} \right)^{\xi} \left(\ln N_R\right) \right]$$

where:

ξ : Weibull shape parameter, taken equal to 1.0

N_R : Number of cycles, taken equal to 10^4.

Section 4 STRESS ASSESSMENT OF STIFFENERS

3. Hot spot mean stress

3.3 Mean stress according to the simplified procedure

Paragraph 3.3.2 has been amended as follow.

3.3.2 Stress due to still water hull girder moment

The hot spot stress due to still water bending moment, in *N/mm*^{2}, in loading condition "(*k*)" is to be obtained with the following formula:

$$\sigma_{GS,(k)} = K_{gh} \frac{M_{S,(k)} \left(z - N\right)}{I_Y} 10^{-3}$$

where:

$M_{S,(k)}$: Still water vertical bending moment, in *kN-m*, defined in **Sec 3**, ~~**3.2.1**~~ **<u>3.2.2</u>**.

Appendix 1 CROSS SECTIONAL PROPERTIES FOR TORSION

1. Calculation Formulae

1.4 Computation of cross sectional properties for the entire cross section

Formula of I_z for symmetric cross section in Table has been amended as follow.

~~$$I_z = 2\left(\sum I_z - \sum A y\right)_s^2$$~~

$$I_z = 2\left(\sum I_z - \sum A y_s^2\right)$$

Chapter 9 OTHER STRUCTURES

Section 1 FORE PART

3. Load model

3.2 Pressure in bow area

Paragraph 3.2.2 has been amended as follow.

3.2.2 Lateral pressure in testing conditions

The lateral pressure p_T in testing conditions is ~~defined in **Ch 4, Sec 6, 4**~~ taken equal to:

- $p_T = p_{ST} - p_S$ for bottom shell plating and side shell plating
- $p_T = p_{ST}$ otherwise,

where:

p_{ST} : Testing pressure defined in **Ch 4, Sec 6, 4**

p_S: Pressure taken equal to:

- if the testing is carried out afloat: hydrostatic pressure defined in **Ch 4, Sec 5, 1** for the draught T_1, defined by the Designer, at which the testing is carried out. If T_1 is not defined, the testing is considered as being not carried out afloat
- if the testing is not carried out afloat: $p_S = 0$

Section 2 AFT PART

2. Load model

2.2 Lateral pressures

Paragraph 2.2.2 has been amended as follow.

2.2.2 Lateral pressure in testing conditions

The lateral pressure p_T in testing conditions is ~~defined in **Ch 4, Sec 6, 4.**~~ taken equal to:

- $p_T = p_{ST} - p_S$ for bottom shell plating and side shell plating
- $p_T = p_{ST}$ otherwise,

where:

p_{ST} : Testing pressure defined in **Ch 4, Sec 6, 4**

p_S: Pressure taken equal to:

- if the testing is carried out afloat: hydrostatic pressure defined in **Ch 4, Sec 5, 1** for the draught T_1, defined by the Designer, at which the testing is carried out. If T_1 is not defined, the testing is considered as being not carried out afloat
- if the testing is not carried out afloat: $p_S = 0$

Section 3 MACHINERY SPACE

7. Main machinery seating

7.2 Minimum scantlings

7.2.1

Table 2 has been amended as follow.

Table 2 Minimum scantlings of the structural elements in way of machinery seatings

Scantling minimum value	Scantling minimum value
Net cross-sectional area, in cm^2, of each bedplate of the seatings	$40 + 70\frac{P}{n_r L_E}$
Bedplate net thickness, in ~~*m*~~ *mm*	Bedplates supported by two or more girders: $\sqrt{240 + 175\frac{P}{n_r L_E}}$ Bedplates supported by one girder: $5 + \sqrt{240 + 175\frac{P}{n_r L_E}}$
Total web net thickness, in *mm*, of girders fitted in way of machinery seatings	Bedplates supported by two or more girders: $\sqrt{320 + 215\frac{P}{n_r L_E}}$ Bedplates supported by one girder: $\sqrt{95 + 65\frac{P}{n_r L_E}}$
Web net thickness, in *mm*, of floors fitted in way of machinery seatings	$\sqrt{55 + 40\frac{P}{n_r L_E}}$

Section 5 HATCH COVERS

4. Load model

4.1 Lateral pressures and forces

Paragraph 4.1.2 has been amended as follow.

4.1.2 Sea pressures

The still water and wave lateral pressures are to be considered and are to be taken equal to:

- still water pressure: $p_S = 0$
- wave pressure p_W, as defined in **Ch 4**, **Sec 5**, ~~**2.2**~~ **5.2**.

5. Strength check

5.2 Plating

Paragraph 5.2.2 has been amended as follow.

5.2.2 Minimum net thickness

Ref. ILLC, as amended (Resolution MSC.143(77) Reg. 16 (5, c))

In addition to **5.2.1**, the net thickness, in *mm,* of the plating forming the top of the hatch cover is to be not less than the greater of the following values:

t = ~~0.01s~~ 10s

$t = 6$

Chapter 10 HULL OUTFITTING

Section 1 RUDDER AND MANOEUVRING ARRANGEMENT

4. Rudder couplings

4.5 Cone couplings with special arrangements for mounting and dismounting the couplings

Paragraph 4.5.1 has been amended as follow.

4.5.1

Where the stock diameter exceeds 200 *mm*, the press fit is recommended to be effected by a hydraulic pressure connection. In such cases the cone is to be more slender, ~~$c \approx 1:2$~~ $c \approx 1:12$ to $\approx 1:20$.

EFFECTIVE DATE AND APPLICATION

1. The effective date of the amendments is 1 April 2006.

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 IACS Procedural Requirement(PR) No.29 (Rev.4).

IACS PR No.29 (Rev.4)

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.

Notes:
1. This Procedural Requirement applies to all IACS Members and Associates.
2. This Procedural Requirement is effective for ships "contracted for construction" on or after 1 January 2005.
3. Revision 2 of this Procedural Requirement is effective for ships "contracted for construction" on or after 1 April 2006.
4. Revision 3 of this Procedural Requirement was approved on 5 January 2007 with immediate effect.
5. Revision 4 of this Procedural Requirement was adopted on 21 June 2007 with immediate effect.