RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part CSR-B&T Common Structural Rules for Bulk Carriers and Oil Tankers

Rules for the Survey and Construction of Steel Ships
Part CSR-B&T 2020 AMENDMENT NO.1

Rule No.2 10 March 2020
Resolved by Technical Committee on 22 January 2020

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NIPPON KAIJI KYOKAI

Rule No.2 10 March 2020
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&T COMMON STRUCTURAL RULES FOR BULK CARRIERS AND OIL TANKERS

Part 1 GENERAL HULL REQUIREMENTS

Chapter 1 RULE GENERAL PRINCIPLES

Section 2 RULE PRINCIPLES

2. General Assumptions

2.2 Application and Implementation of the Rules

Paragraph 2.2.2 has been amended as follows.

2.2.2
(Omitted)

(b) Design aspects:

- The owner specifies the intended use of the ship, and the ship is designed according to operational requirements as well as the structural requirements given in the Rules.
- The builder identifies and documents the operational limits for the ship so that the ship can be safely and efficiently operated within these limits.
- Verification of the design is performed by the builder to check compliance with provisions contained in the Rules in addition to national and international regulations.
- The design is performed by appropriately qualified, competent and experienced personnel.
- The Society performs a technical appraisal of the design plans and related documents for a ship to verify compliance with the appropriate classification Rules.
- For spaces where lighting and ventilation are to be fitted, the builder is to give consideration to the influence on the structural design and arrangement from the relevant requirements of International Conventions such as *SOLAS* and *MLC2006 Regulation 3.1* - Accommodation and recreational facilities, and Society's rules if any. ~~For general guidance, human element factors may be considered based on *IACS Recommendation No. 132* and/or an ergonomic standard accepted by the Society.~~ Human element considerations, including enhanced safety and productivity, may be considered using *Recommendation No. 132* or other ergonomic standards accepted by the Society.
- For continually manned spaces ~~normally occupied or manned by shipboard~~

~~personnel~~ where noise is to be minimised, the builder is to give consideration to the influence on the structural design and arrangement from the relevant requirements of *SOLAS Ch II-1, Reg.3-12* and "*The Code on Noise Levels Onboard Ships*" adopted at *MSC.337(91)*.

- For continually manned spaces ~~normally occupied or manned by shipboard personnel~~ where vibration is to be minimised, the builder is to give consideration to the influence on the structural design and arrangement from the relevant requirements of relevant statutory requirements such as *MLC 2006 Regulation 3.1* - Accommodation and recreational facilities. ~~For general guidance, human element factors may be considered based on *IACS Recommendation No. 132* or on an ergonomic standard accepted by the Society.~~ Human element considerations, including enhanced safety and productivity, may be considered using *Recommendation No. 132* or other ergonomic standards accepted by the Society.

(Omitted)

Section 3 VERIFICATION OF COMPLIANCE

1. General

1.1 Newbuilding

Paragraph 1.1.5 has been amended as follows.

1.1.5

Through all stages of ship construction, it is the builder's responsibility to promptly inform ~~promptly~~ the Society of ~~the~~ modifications or departures from approved ~~arrangements and to deal with as necessary~~ plans. The builder is to ensure that any deviations from the requirements of the Rules or approved plans~~, other than those of a minor nature not affecting the structural strength of the vessel,~~ are, in any case, accepted by the Society~~'s approval office~~.

Section 4 SYMBOLS AND DEFINITIONS

3. Definitions

3.8 Glossary

3.8.1 Definitions of Terms

Table 7 has been amended as follows.

Table 7 Definition of Terms

Terms	Definition
(Omitted)	
Compartment	An internal space bounded by bulkheads or plating.
~~Confined space~~	~~A space identified by one of the following characteristics: limited openings for entry and exit, unfavourable natural ventilation or not designed for continuous worker occupancy.~~
Continually manned space	A space in which the continuous or prolonged presence of seafarers is necessary for normal operational periods. This includes spaces routinely occupied for a period of 20 minutes or more during normal operational periods.
Corrugated bulkhead	A bulkhead including corrugations and usually fitted with lower and upper stools.
(Omitted)	
Normally unmanned space	A space not normally manned (without the continuous or prolonged presence of seafarers) during normal operational periods. This includes spaces routinely occupied for a period of less than 20 minutes during normal operational periods.
Notch	A discontinuity in a structural member caused by welding.
Oil fuel tank	A tank used for the storage of fuel oil.

Chapter 2 GENERAL ARRANGEMENT DESIGN

Section 1 GENERAL

1. General

1.1 General

1.1.1

This chapter covers the general structural arrangement requirements for the ship.

Paragraphs 1.1.2 and 1.1.3 have been added as follows.

1.1.2

Arrangements for continually manned spaces are to include consideration of ventilation, lighting, noise and whole-body vibration in accordance with industry standards accepted by the Society. See also **Sec 4, 1.1.1** to **1.1.3**.

1.1.3

Arrangements for normally unmanned spaces are to include consideration of lighting and ventilation for periodic inspections, survey and maintenance in accordance with industry standards accepted by the Society. See also **Sec 4, 1.1.1** to **1.1.5**.

Title of Section 4 has been amended as follows.

Section 4 ACCESS AND ESCAPE ARRANGEMENT

Title of Paragraph 1 has been amended as follows.

1. ~~C~~Enclosed Spaces

1.1 General

Paragraphs 1.1.1 and 1.1.2 have been renumbered to 1.1.2 and 1.1.3, and Paragraph 1.1.1 has been added as follows.

1.1.1 Special considerations

Human element considerations, including enhanced safety and productivity, may be considered using *Recommendation No. 132* or other ergonomic standards accepted by the Society.

Where spaces have special considerations or requirements for access; e.g. security restrictions for the CO2 room to prevent unintentional release, these are to be considered in conjunction with the requirements of this section, and any conflicts should be raised as soon as possible for consideration by the Society.

Paragraph 1.1.2 has been amended as follows.

1.1.~~1~~2 Enclosed spaces

All enclosed spaces are to be accessible with appropriate access arrangements for easy inspection, survey and maintenance i.e. access is to allow unobstructed passage to items for inspection for personnel wearing the appropriate clothing, including personal protective equipment, and using all necessary tools and test equipment. ~~Special measures for inspection and maintenance are to be put in place for small closed spaces for which the design causes impracticality for the access.~~

Provision is also to be made for appropriate arrangements to facilitate emergency egress of inspection personnel or ships' crew in accordance with industry standards accepted by the Society, notwithstanding the requirements set out in *SOLAS* or other relevant regulatory instruments.

Paragraph 1.1.3 has been amended as follows.

1.1.~~2~~3 Spaces not explicitly covered by *SOLAS*

For ~~areas~~ spaces which are not explicitly covered by *SOLAS, Ch II-1, Reg 3-6*, the builder is to provide ~~accesses~~ appropriate accesses arrangements for easy inspection, survey and maintenance in accordance with industry standards accepted by the Society. See also **1.1.5**. ~~For general guidance, human element factors may be considered based on *IACS Recommendation No. 132* or with an ergonomic standard accepted by the Society.~~

Provision is also to be made for appropriate arrangements to facilitate emergency egress of inspection personnel or ships' crew in accordance with industry standards accepted by the Society.

Special measures for inspection and maintenance are to be put in place for small closed spaces for which the design causes impracticality for the access.

Paragraph 1.1.4 has been added as follows.

1.1.4 Ventilation of normally unmanned spaces

Unless otherwise specifically detailed in these Rules, normally unmanned spaces are to be capable of being ventilated through natural or forced ventilation. Such ventilation could be achieved through the inclusion of mushroom ventilators, gooseneck ventilators, ventilators with weather proof covers etc. Exchange air may be provided through permanent or temporary mechanical ventilation and air trunk systems or a suitable air exchange path through tank openings and ventilators.

Paragraph 1.1.5 has been added as follows.

1.1.5 Permanent means of access to normally unmanned spaces

Unless otherwise specifically detailed in these Rules, permanent means of access to normally unmanned spaces is to be provided in accordance with *SOLAS, Ch II-1, Reg. 3-6*.

For enclosed spaces, which are not explicitly covered by *SOLAS, Ch II-1, Reg. 3-6*, the requirements of the Convention and associated Resolutions should be applied as far as practicable. The size of openings providing access to or emergency egress from spaces not entered during operation, entered for maintenance or entered for regular inspections shall, in general, not be less than 600 *mm* × 400 *mm* if oval or in accordance with industry standards accepted by the Society if circular.

Chapter 3 STRUCTURAL DESIGN PRINCIPLES

Section 6 STRUCTURAL DETAIL PRINCIPLES

5. Intersection of Stiffeners and Primary Supporting Members

5.1 Cut-outs

Paragraph 5.1.5 has been amended as follows.

5.1.5

At connection to shell envelope longitudinals below the scantling draught, T_{sc} and at connection to inner bottom longitudinals, a soft heel is to be provided in way of the heel of the primary supporting member web stiffeners when the calculated direct stress, σ_w, in the primary supporting member web stiffener according to **5.2** exceeds 80% of the permissible values. The soft heel is to have a keyhole, similar to that shown in item **(c)** in **Fig. 9**.

A soft heel is not required at the intersection with watertight bulkheads and primary supporting members, where a back bracket is fitted or where the primary supporting member web is welded to the stiffener face plate.

<u>When calculating the direct stress, σ_w, the bottom slamming or bow impact loads using the design pressures defined in **Ch 4, Sec 5, 3.2** and **3.3** need not be applied.</u>

5.2 Connection of Stiffeners to PSM

Paragraph 5.2.1 has been amended as follows.

5.2.1 General

For connection of stiffeners to PSM in case of lateral pressure ~~other than bottom slamming and bow impact loads~~, **5.2.2** and **5.2.3** are to be applied. ~~In case of bottom slamming or bow impact loads, **5.2.4** is to be applied.~~

The cross sectional areas of the connections are to be determined from the proportion of load transmitted through each component in association with its appropriate permissible stress.

Paragraph 5.2.2 has been amended as follows.

5.2.2

The load, W_1, in kN, transmitted through the shear connection is to be taken as follows.

- If the web stiffener is connected to the intersecting stiffener:

$$W_1 = W\left(\alpha_a + \frac{A_1}{4f_c A_w + A_1}\right)$$

- If the web stiffener is not connected to the intersecting stiffener:

$$W_1 = W$$

where:

W: Total load, in kN, transmitted through the stiffener connection to the PSM taken equal to:

$$\cancel{W = \frac{P_1 s_1\left(S_1 - \frac{s_1}{2000}\right) + P_2 s_2\left(S_2 - \frac{s_2}{2000}\right)}{2} 10^{-3}}$$

$$W = \frac{P_1 s_1\left(S_1 - \frac{s_1}{2000}\right) + P_2 s_2\left(S_2 - \frac{s_2}{2000}\right)}{2 sin\varphi_{w1} sin\varphi_{w2}} 10^{-3}$$

P_1, P_2: Design pressure applied on the stiffener for the design load set being considered, in kN/m^2, on each side of the considered connection. For bottom slamming or bow impact loads, P_1 and P_2 are the design pressure as defined in **Ch 4, Sec 5, 3.2** and **3.3** respectively.

S_1, S_2: Spacing between the considered and the adjacent PSM on each side of the considered connection, in *m*.

s_1, s_2: Spacing of the stiffener, in *mm*, on each side of the considered connection.

φ_{w1}: Angle between primary supporting member and attached plating, in deg, as defined in **Ch 3, Sec 7, Symbols** and **Ch 10, Sec 1, Fig. 5**.

φ_{w2}: Angle between stiffener and attached plating, in deg, as defined in **Ch 3, Sec 7, Symbols** and **Ch 3, Sec 7, Fig. 14**.

(Omitted)

Paragraph 5.2.3 has been amended as follows.

5.2.3

The load, W_2, in *kN*, transmitted through the PSM web stiffener is to be taken as:

(Omitted)

σ_{perm}: Permissible direct stress given in **Table 1** for AC-S ~~and~~, AC-SD and AC-I, in N/mm^2.

τ_{perm}: Permissible shear stress given in **Table 1** for AC-S ~~and~~, AC-SD and AC-I, in N/mm^2.

Paragraph 5.2.4 has been deleted.

~~5.2.4 Bottom slamming and bow impact loads~~

~~For bottom slamming or bow impact loads, the load *W*, in *kN*, transmitted through the PSM web stiffener is to comply with the following criteria instead of those defined in **5.2.2** and **5.2.3**:~~

$$\cancel{0.9W \le \frac{\left(A_1 \tau_{perm} + A_w \sigma_{perm}\right)}{10}}$$

~~where:~~

~~W : Load, in *kN*, as defined in **5.2.2**.~~

~~A_1 : Effective net shear area, in cm^2, as defined in **5.2.2**.~~

~~A_w : Effective net cross sectional area, in cm^2, as defined in **5.2.2**.~~

~~σ_{perm}: Permissible direct stress given in **Table 1** for AC-I, in N/mm^2.~~

~~τ_{perm}: Permissible shear stress given in **Table 1** for AC-I, in N/mm^2.~~

5.2.9

The size of the fillet welds is to be calculated according to **Ch 12, Sec 3, 2.5** based on the weld factors given in **Table 2**. For the welding in way of the shear connection the size is not to be less than that required for the PSM web plate for the location under consideration.

Table 2 has been amended as follows.

Table 2 Weld factors for Connection between Stiffeners and PSMs

Item	Acceptance criteria	Weld factor
PSM stiffener to intersecting stiffener	AC-S AC-SD <u>AC-I</u>	$0.6\sigma_{wc}/\sigma_{perm}$ not to be less than 0.38
Shear connection inclusive of lug or collar plate	AC-S AC-SD <u>AC-I</u>	0.38
Shear connection inclusive of lug or collar plate, where the web stiffener of the PSM is not connected to the intersection stiffener	AC-S AC-SD <u>AC-I</u>	$0.6\tau_{wc}/\tau_{perm}$ not to be less than 0.44
~~PSM stiffener to intersecting stiffener~~ ~~Shear connection inclusive of lug or collar plate~~	~~AC-I~~	$\cancel{0.6\frac{9W}{A_1\tau_{perm}+A_W\sigma_{perm}}}$
Note 1: τ_w: Shear stress, in *N/mm*^{2}, as defined in **5.2.3**. σ_{wc}: Stress, in *N/mm*^{2}, as defined in **5.2.3**. τ_{perm}: Permissible shear stress, in *N/mm*^{2}, see **Table 1**. σ_{perm}: Permissible direct stress, in *N/mm*^{2}, see **Table 1**. W: Load, in *kN*, as defined in **5.2.2**. A_1: Effective net shear area, in *cm*^{2}, as defined in **5.2.2**. A_w: Effective net cross sectional area, in *cm*^{2}, as defined in **5.2.2**.		

Section 7 STRUCTURAL IDEALISATION

Symbols

Symbols has been amended as follows.

For symbols not defined in this section, refer to **Ch 1, Sec 4**.

φ_w : Angle, in *deg*, between the stiffener or primary supporting member web and the attached plating, see **Fig. 14** <u>for stiffener and **Ch 10, Sec 1, Fig. 5** for primary supporting member</u>. φ_w is to be taken equal to 90 *deg* if the angle is greater than or equal to 75 *deg*.

(Omitted)

1. Structural Idealisation of Stiffeners and Primary Supporting Members

1.3 Effective Breadth

Paragraph 1.3.3 has been amended as follows.

1.3.3 Effective area of curved face plate and attached plating of primary supporting members

The effective net area given in **(a)** and **(b)** is only applicable to curved face plates and curved attached plating of primary supporting members. This is not applicable for the area of web stiffeners parallel to the face plate.

The effective net area is applicable to primary supporting members for the following calculations:

- Actual net section modulus used for comparison with the scantling requirements in **Ch 6**.
- Actual effective net area of curved face plates, modelled by beam elements, used in **Ch 7**.

(a) The effective net area, $A_{eff\text{-}n50}$, in mm^2, is to be taken as:

$A_{eff\text{-}n50} = C_f \, t_{f\text{-}n50} \, b_f$

where:

C_f : Flange efficiency coefficient ~~taken equal to~~ is to be obtained from the following formula but not to be greater than 1.0:

$$\cancel{C_f = C_{f1}\frac{\sqrt{r_f t_{f-n50}}}{b_1}}$$ ~~but not to be taken greater than 1.0.~~

$$C_f = C_{f1}\frac{1.285}{\beta k_1}$$ for symmetrical face plate.

$$C_f = 0.18 + \frac{0.08}{\beta^2}$$ for unsymmetrical face plate.

$$C_f = C_{f1}\frac{1.285}{\beta}$$ for attached plating of box girders.

C_{f1} : Coefficient taken equal to:

- For symmetrical ~~and unsymmetrical~~ face plates,

$$\cancel{C_{f1} = \frac{0.643(\sinh\beta\cosh\beta + \sin\beta\cos\beta)}{(\sinh\beta)^2 + \sin^2\beta}}$$

$$C_{f1} = \frac{(\sinh k_1\beta \cosh k_1\beta + \sin k_1\beta \cos k_1\beta)}{(\cosh k_1\beta)^2 + (\cos k_1\beta)^2}$$

- For attached plating of box girders with two webs,

$$C_{f1} = \frac{0.78(\sinh\beta + \sin\beta)(\cosh\beta - \cos\beta)}{(\sinh\beta)^2 + \sin^2\beta}$$

- For attached plating of box girders with multiple webs,

$$C_{f1} = \frac{1.56(\cosh\beta - \cos\beta)}{\sinh\beta + \sin\beta}$$

k_1 : Coefficient calculated as:

$k_1 = 1.4 + 1.25(1.4 - \beta)^3$ for $\beta < 1.4$

$k_1 = 1.4$ for $\beta \geq 1.4$

(Omitted)

Chapter 4 LOADS

Section 4 HULL GIRDER LOADS

2. Vertical Still Water Hull Girder Loads

2.3 Vertical Still Water Shear Force

Paragraph 2.3.4 has been amended as follows.

2.3.4 Permissible still water shear force in harbour/sheltered water and tank testing condition

The permissible vertical still water shear forces, Q_{sw-p} for oil tankers and bulk carriers, in the harbour/sheltered water and tank testing condition at any longitudinal position are to envelop:

- The most severe still water shear forces, positive or negative, for the harbour/sheltered water loading conditions defined in **Ch 4, Sec 8** after shear force correction in case of bulk carrier.
- The most severe still water shear forces for the harbour/sheltered water loading conditions defined in the loading manual after shear force correction in case of bulk carrier.
- The permissible vertical still water shear force defined in **2.3.3**.
- For oil tankers, the minimum still water shear forced for harbour/sheltered water conditions defined in **2.3.2**.

The following value may be used as guidance at preliminary design stage:

$$Q_{sw-p} = Q_{sw} + 0.6Q_{wv}$$

where:

Q_{sw} : Permissible still water shear force Q_{sw}, as defined in **2.3.3**.

Q_{wv} : Vertical wave shear force for strength assessment Q_{wv-pos} and Q_{sw-neg}, as defined in **3.2.1** using f_p equal to 1.0.

Section 8 LOADING CONDITIONS

3. Oil Tankers

3.2 Design load Combinations for Direct Strength Analysis

Paragraph 3.2.6 has been amended as follows.

3.2.6 Tankers with two oil-tight longitudinal bulkheads except with a cross tie arrangement in the wing cargo tanks

For tankers with two oil-tight longitudinal bulkheads except with a cross tie arrangement in the wing cargo tanks, loading patterns A7 ~~and A12~~ in **Table 2**, **Table 4**, **Table 6** and **Table 8** ~~are~~ is to be examined for the possibility that unequal filling levels in transversely paired wing cargo tanks would result in a more onerous stress response. Loading pattern A7 is required to be analysed only if such a non-symmetric seagoing loading condition is included in the ship loading manual. The actual loading pattern, draught, GM and k_r from the loading manual are to be used in the FE analysis. Where the GM and kr are not given in the ship's loading manual, GM and k_r are to be determined in accordance with **Ch 4**, **Sec 3**.

If loading pattern~~s~~ A7 ~~and A12 are~~ is not considered, an operational restriction describing that the difference in filling level between corresponding port and starboard wing cargo tanks is not to exceed 25% of the filling height in the wing cargo tank, is to be added in the loading manual.

Loading pattern~~s~~ A7 ~~and A12~~ needs not be examined for tankers with a cross tie arrangement in the wing cargo tanks.

Chapter 7 DIRECT STRENGTH ANALYSIS

Section 2 CARGO HOLD STRUCTURAL STRENGTH ANALYSIS

4. Load Application

4.4 Procedure to Adjust Hull Girder Shear Forces and Bending Moments

Paragraph 4.4.5 has been amended as follows.

4.4.5 Hull girder shear force adjustment procedure

The hull girder shear force adjustment procedure defined in this requirement applies to all FE load combinations given in **Ch 4, Sec 8**. The FE load combinations not directly covered by the load combination tables of **Ch 4, Sec 8** are to be considered on a case by case basis.

The two following methods are to be used for the shear force adjustment:

- Method 1 (M1): for shear force adjustment at one bulkhead of the mid-hold as given in **4.4.6**,
- Method 2 (M2): for shear force adjustment at both bulkheads of the mid-hold as given in **4.4.7**.

For the considered FE load combination, the method to be applied is to be selected as follows:

- For maximum shear force load combination (Max SFLC), the method 1 applies at the bulkhead mentioned in **Table 4** if the shear force after the adjustment with method 1 at the other bulkhead does not exceed the target value. Otherwise, the method 2 applies.
- For other shear force load combination:
  - The shear force adjustment is not requested when the shear forces at both bulkheads are lower or equal to the target values. This applies to cargo hold analysis in whole cargo area except for aft most and foremost cargo hold.
    For aft most and foremost cargo hold analyses, the shear force adjustment is to be applied with method 1. The target hull girder vertical shear force at the aft and forward transverse bulkheads, $Q_{targ-aft}$ and $Q_{targ-fwd}$, are to be set to values of vertical shear force due to local loads Q_{aft} and Q_{fwd} accordingly:
    $Q_{targ-fwd} = Q_{fwd}$
    $Q_{targ-aft} = Q_{aft}$
  - The method 1 applies when the shear force exceeds the target at one bulkhead and the shear force at the other bulkhead after the adjustment with method 1 does not exceed the target value. Otherwise the method 2 applies,
  - The method 2 applies when the shear forces at both bulkheads exceed the target values,

The "maximum shear force load combinations" are marked as "Max SFLC" in the load combination tables of **Ch 4, Sec 8**. The "other shear force load combinations" are those which are not the maximum shear force load combinations. They are not marked in the load combination tables of **Ch 4, Sec 8**.

Paragraph 4.4.6 has been amended as follows.

4.4.6 Method 1 for vertical shear force adjustment at one bulkhead

The required adjustments in shear force at aft or forward transverse bulkhead of the mid-hold are to be made by applying vertical bending moments, M_{Y_aft}, M_{Y_fore} at model ends. For aft most cargo and foremost cargo hold models, the following additional vertical loads are to be applied at the transverse frame positions as shown in **Table 7**:

- $\delta w'_1$ - for aft most cargo hold model
- $\delta w'_3$ - for foremost cargo hold model

The required adjustments in shear force at following transverse bulkheads of the mid-hold are given by:

- Aft bulkhead:

$$\cancel{M_{Y\_aft} = M_{Y\_fore} = \frac{(x_{fore} - x_{aft})}{2}(Q_{\text{targ}-aft} - Q_{aft})}$$

$$M_{Y\_aft} = M_{Y\_fore} = \frac{(x_{fore} - x_{aft})}{2}(Q_{\text{targ}-aft} - Q_{aft}) - M'_{1-aft}$$

$$\Delta Q_{aft} = \Delta Q_{fwd} = 0$$

$$\delta w'_1 = \frac{Q_{targ-aft} - Q_{aft} + R_{v\_aft}}{(n_1 - 1)}$$ for aftmost cargo hold model only

$$\delta w'_3 = \frac{Q_{targ-aft} - Q_{aft} + R_{v\_aft}}{(n_3 - 1)}$$ for foremost cargo hold model only

- Forward bulkhead

$$\cancel{M_{Y\_aft} = M_{Y\_fore} = \frac{(x_{fore} - x_{aft})}{2}(Q_{\text{targ}-fwd} - Q_{fwd})}$$

$$M_{Y\_aft} = M_{Y\_fore} = \frac{(x_{fore} - x_{aft})}{2}(Q_{\text{targ}-fwd} - Q_{fwd}) - M'_{1-fwd}$$

$$\Delta Q_{aft} = \Delta Q_{fwd} = 0$$

$$\delta w'_1 = \frac{Q_{targ-fwd} - Q_{fwd} + R_{v\_aft}}{(n_1 - 1)}$$ for aftmost cargo hold model only

$$\delta w'_3 = \frac{Q_{targ-fwd} - Q_{fwd} + R_{v\_fore}}{(n_3 - 1)}$$ for foremost cargo hold model only

where:

M_{Y_aft}, M_{Y_fore} : Vertical bending moment, in *kNm*, to be applied at the aft and fore ends in accordance with **4.4.10**, to enforce the hull girder vertical shear force adjustment as shown in **Table 5**. The sign convention is that of the FE model axis.

Q_{aft} : Vertical shear force, in *kN*, due to local loads at aft bulkhead location of mid-hold, x_{b_aft}, resulting from the local loads calculated according to **4.4.3**. Since the vertical shear force is discontinued at the transverse bulkhead location, Q_{aft} is the maximum absolute shear force between the stations located right after and right forward of the aft bulkhead of mid-hold.

Q_{fwd} : Vertical shear force, in *kN*, due to local loads at the forward bulkhead location of mid-hold, x_{b_fwd}, resulting from the local loads calculated according to **4.4.3**. Since the vertical shear force is discontinued at the transverse bulkhead location, Q_{fwd} is the maximum absolute shear force between the stations located right after and right forward of the forward bulkhead of mid-hold.

M'_{1-aft}, M'_{1-fwd}: Additional vertical bending moment, in *kNm*, applicable for aftmost and foremost cargo hold analysis only, taken as:

· Aft most cargo hold model

$$M'_{1-aft} = \frac{\ell_1}{4}\left(Q_{targ-aft} - Q_{aft} + R_{v\_aft}\right)$$

$$M'_{1-fwd} = \frac{\ell_1}{4}\left(Q_{targ-fwd} - Q_{fwd} + R_{v\_aft}\right)$$

· Foremost cargo hold mode

$$M'_{1-aft} = \frac{\ell_3}{4}\left(Q_{targ-aft} - Q_{aft} + R_{v\_fore}\right)$$

$$M'_{1-fwd} = \frac{\ell_3}{4}\left(Q_{targ-fwd} - Q_{fwd} + R_{v\_fore}\right)$$

$\delta w'_1$: Distributed load, in *kN*, at frame in the modelled engine room of aftmost cargo hold model, see also **Table 8**.

$\delta w'_3$: Distributed load, in *kN*, at frame in the modelled forepeak of foremost cargo hold model, see also **Table 8**.

$\Delta Q_{aft}, \Delta Q_{fwd}$: Shear force adjustments, as given in **Table 8**.

R_{v_aft}, R_{v_fore}: Reaction forces at the aft and fore ends, in *kN*, as defined in **4.4.3**.

ℓ_1: Length of the modelled engine room in aftmost cargo hold model, in *m*. See also **Table 8**.

ℓ_3: Length of the modelled forepeak in foremost cargo hold model, in *m*. See also **Table 8**.

n_1, n_3: Number of frame spaces, see **Table 8**.

Paragraph 4.4.7 has been amended as follows.

4.4.7 Method 2 for vertical shear force adjustment at both bulkheads

The required adjustments in shear force at both transverse bulkheads of the mid-hold are to be made by applying:

- Vertical bending moments, M_{Y_aft}, M_{Y_fore} at model ends and,
- Vertical loads at the transverse frame positions as shown in **Table 7** in order to generate vertical shear forces, ΔQ_{aft} and ΔQ_{fwd}, at the transverse bulkhead positions.
- For aft most cargo and foremost cargo hold models, the following additional vertical loads are to be applied at the transverse frame positions as shown in **Table 7**:
  - $\delta w'_1$: for aft most cargo hold model
  - $\delta w'_3$: for foremost cargo hold model

Table 6 shows examples of the shear adjustment application due to the vertical bending moments and to vertical loads.

$$\cancel{M_{Y\_aft} = \frac{x_{fore} - x_{aft}}{2} \cdot \frac{Q_{targ-fwd} - Q_{fwd} + Q_{targ-aft} - Q_{aft}}{2}}$$

$$M_{Y\_fore} = M_{Y\_aft} = \frac{x_{fore} - x_{aft}}{2} \cdot \frac{Q_{targ-fwd} - Q_{fwd} + Q_{targ-aft} - Q_{aft}}{2} - M'_2$$

$$\Delta Q_{fwd} = \frac{Q_{targ-fwd} - Q_{fwd} - \left(Q_{targ-aft} - Q_{aft}\right)}{2}$$

$$\Delta Q_{aft} = -\Delta Q_{fwd}$$

· Aft most cargo hold model

$$\delta w'_1 = \left(\frac{\left(Q_{targ-aft} - Q_{aft}\right)(\ell - \ell_2 - \ell_1) + \left(Q_{targ-fwd} - Q_{fwd}\right)(\ell - \ell_2 - \ell_3)}{2\ell - \ell_1 - 2\ell_2 - \ell_3} + R_{v\_aft}\right)\frac{1}{(n_1 - 1)}$$

• Foremost cargo hold model

$$\delta w'_3 = \left(\frac{(Q_{targ-fwd} - Q_{fwd})(\ell - \ell_2 - \ell_3) + (Q_{targ-aft} - Q_{aft})(\ell - \ell_2 - \ell_1)}{2\ell - \ell_1 - 2\ell_2 - \ell_3} + R_{v\_fore} \right) \frac{1}{(n_3 - 1)}$$

where:

M_{Y_aft}, M_{Y_fore} : Vertical bending moment, in kNm, to be applied at the aft and fore ends in accordance with **4.4.10**, to enforce the hull girder vertical shear force adjustment. The sign convention is that of the FE model axis.

ΔQ_{aft}: Adjustment of shear force, in *kN*, at aft bulkhead of mid-hold.

ΔQ_{fwd}: Adjustment of shear force, in *kN*, at fore bulkhead of mid-hold.

M'_2: Additional vertical bending moment, in *kNm*, applicable for aftmost and foremost cargo hold analysis only, taken as:

- Aftmost cargo hold model $M'_2 = \frac{\ell_1 (n_1 - 1) \delta w'_1}{4}$
- Foremost cargo hold model $M'_2 = \frac{\ell_3 (n_3 - 1) \delta w'_3}{4}$

$\delta w'_1$: Distributed load, in *kN*, at frame in the modelled engine room of aftmost cargo hold model, see also **Table 8**.

$\delta w'_3$: Distributed load, in *kN*, at frame in the modelled forepeak of foremost cargo hold model, see also **Table 8**.

R_{v_aft}, R_{v_fore}: Reaction forces at the aft and fore ends, in *kN*, as defined in **4.4.3**.

ℓ_1: Length of the modelled engine room in aftmost cargo hold model, in *m*. See also **Table 8**.

ℓ_3: Length of the modelled forepeak in foremost cargo hold model, in *m*. See also **Table 8**.

n_1, n_3: Number of frame spaces, see **Table 8**.

The above adjustments in shear forces, ΔQ_{aft} and ΔQ_{fwd}, at the transverse bulkhead positions are to be generated by applying vertical loads at the transverse frame positions as shown in **Table 7**. For bulk carriers, the transverse frame positions correspond to the floors. Vertical correction loads are not to be applied to any transverse tight bulkheads, any frames forward of the forward cargo hold and any frames aft of the aft cargo hold of the FE model.

The vertical loads to be applied to each transverse frame to generate the increase/decrease in shear force at the bulkheads may be calculated as shown in **Table 7**. In case of uniform frame spacing, the amount of vertical force to be distributed at each transverse frame may be calculated in accordance with **Table 8**.

Table 8 Formulae for Calculation of Vertical Loads for Adjusting Vertical Shear Forces

$$\delta w_1 = \frac{\Delta Q_{aft}(2\ell - \ell_2 - \ell_3) + \Delta Q_{fwd}(\ell_2 + \ell_3)}{(n_1 - 1)(2\ell - \ell_1 - 2\ell_2 - \ell_3)} + \delta w'_1$$

$$\cancel{F = 0.5\left(\frac{W1(\ell_2 + \ell_1) - W3(\ell_2 + \ell_3)}{\ell}\right)}$$

$$\delta w_2 = \frac{(W1 + W3)}{(n_2 - 1)} = \frac{(\Delta Q_{aft} - \Delta Q_{fwd})}{(n_2 - 1)}$$

$$\delta w_3 = \frac{-\Delta Q_{fwd}(2\ell - \ell_1 - \ell_2) - \Delta Q_{aft}(\ell_1 + \ell_2)}{(n_3 - 1)(2\ell - \ell_1 - 2\ell_2 - \ell_3)} - \delta w'_3$$

In general

$$F = F_{aft} = F_{fwd} = 0.5\left(\frac{W1(\ell_2 + \ell_1) - W3(\ell_2 + \ell_3)}{\ell}\right)$$

For aftmost and foremost cargo hold FE model

$$F = F_{aft} = \left(\frac{W1(\Delta\ell_{fore} + \ell_3 + \ell_2 + 0.5l_1) + W2(\Delta\ell_{fore} + \ell_3 + 0.5\ell_2) + W3(\Delta\ell_{fore} + 0.5\ell_3)}{\ell}\right)$$

where:

ℓ_1 :	Length of aft cargo hold of model, in *m*.
ℓ_2 :	Length of mid-hold of model, in *m*.
ℓ_3 :	Length of forward cargo hold of model, in *m*.
ΔQ_{aft} :	Required adjustment in shear force, in *kN*, at aft bulkhead of middle hold, see **4.4.7**.
ΔQ_{fwd} :	Required adjustment in shear force, in *kN*, at fore bulkhead of middle hold, see **4.4.7**.
F :	End reactions, in *kN*, due to application of vertical loads to frames.
~~W_1~~ $W1$:	Total evenly distributed vertical load, in *kN*, applied to aft hold of FE model, $(n_1 - 1)\delta w_1$
~~W_2~~ $W2$:	Total evenly distributed vertical load, in *kN*, applied to mid-hold of FE model, $(n_2 - 1)\delta w_2$
~~W_3~~ $W3$:	Total evenly distributed vertical load, in *kN*, applied to forward hold of FE model, $(n_3 - 1)\delta w_3$
n_1 :	Number of frame spaces in aft cargo hold of FE model.
n_2 :	Number of frame spaces in mid-hold of FE model.
n_3 :	Number of frame spaces in forward cargo hold of FE model.
δw_1 :	Distributed load, in *kN*, at frame in aft cargo hold of FE model.
δw_2 :	Distributed load, in *kN*, at frame in mid-hold of FE model.
δw_3 :	Distributed load, in *kN*, at frame in forward cargo hold of FE model.
$\delta w'_1$:	Additional distributed load, in *kN*, at frame in the modelled engine room of aftmost cargo hold model. Formulae of $\delta w'_1$ are given in **4.4.6** and **4.4.7** for shear force adjustment method 1 and method 2 accordingly.
$\delta w'_3$:	Additional distributed load, in *kN*, at frame in the modelled forepeak of foremost cargo hold model. Formulae of $\delta w'_3$ are given in **4.4.6** and **4.4.7** for shear force adjustment method 1 and method 2 accordingly.
$\Delta\ell_{end}$:	Distance, in *m*, between end bulkhead of aft cargo hold to aft end of FE model. $\Delta\ell_{end} = 0$ in the aftmost cargo hold model
$\Delta\ell_{fore}$:	Distance, in *m*, between fore bulkhead of forward cargo hold to forward end of FE model. $\Delta\ell_{fore} = 0$ in the foremost cargo hold model
ℓ :	Total length, in *m*, of FE model including portions beyond end bulkheads: $= \ell_1 + \ell_2 + \ell_3 + \Delta\ell_{end} + \Delta\ell_{fore}$

Note 1 : Positive direction of loads, shear forces and adjusting vertical forces in the formulae is in accordance with **Table 6** and **Table 7**.

Note 2 : ~~$W_1 + W_3 = W_2$~~ $W1 + W3 = W2$ (not applicable for aftmost and foremost cargo FE model).

Note 3 : The above formulae are only applicable if uniform frame spacing is used within each hold. The length and frame spacing of individual cargo holds may be different.

6. Analysis Criteria

6.2 Acceptance Criteria

Paragraph 6.2.1 has been amended as follows.

6.2.1

Verification of stress results against the acceptance criteria is to be carried out in accordance with **6.1**.

The structural assessment is to demonstrate that the stress complies with the following criteria:

$\lambda_f \leq \lambda_{fperm}$

where:

λ_f: Fine mesh yield utilisation factor.

$\lambda_f = \frac{\sigma_{vm}}{R_Y}$ or shell elements in general

$\lambda_f = \frac{|\sigma_{axial}|}{R_Y}$ for rod or beam elements in general

σ_{vm}: Von Mises stress in N/mm^2.

σ_{axial}: Axial stress in rod element, in N/mm^2.

λ_{fperm}: Permissible fine mesh utilisation factor, taken as:

- Element not adjacent to weld:
  - $\lambda_{fperm} = 1.70 f_f$ for S+D
  - $\lambda_{fperm} = 1.36 f_f$ for S
- Element adjacent to weld:
  - $\lambda_{fperm} = 1.50 f_f$ for S+D
  - $\lambda_{fperm} = 1.20 f_f$ for S

f_f: Fatigue factor, taken as:

- $f_f = 1.0$ in general, including the free edge of base material
- $f_f = 1.2$ for details assessed by very fine mesh analysis complying with the fatigue assessment criteria given in **Ch 9, Sec 2**.

Note 1: The maximum permissible stresses are based on the mesh size of 50 × 50mm. Where a smaller mesh size is used, an average von Mises stress calculated in accordance with **6.1** over an area equal to the specified mesh size may be used to compare with the permissible stresses.

Note 2: Average von Mises stress is to be calculated based on weighted average against element areas:

$$\sigma_{vm-av} = \frac{\sum_1^n A_i \sigma_{vm-i}}{\sum_1^n A_i}$$

where:

σ_{vm-av} is the average von Mises stress.

Note 3: Stress averaging is not to be carried across structural discontinuities and abutting structure.

Chapter 12 CONSTRUCTION

Section 3 DESIGN OF WELD JOINTS

2. Tee or Cross Joint

2.5 Weld Size Criteria

Paragraph 2.5.8 has been amended as follows.

2.5.8 ~~Shear area of primary supporting member end connections~~ Longitudinals

Welding of longitudinals to plating is to be doubled continuous at the ends of the longitudinals at the extent of 15 % of shear span as defined in **Ch 3**, **Sec 7**, **1.1.3**.

In way of primary supporting members, the length of the double continuous weld is to be equal to the depth of the longitudinal or the end bracket, whichever is greater.

Part 2 SHIP TYPES

Chapter 1 BULK CARRIERS

Section 1 GENERAL ARRANGEMENT DESIGN

Paragraph 2 has been added as follows.

<u>2. Access Arrangements</u>

<u>2.1 Special arrangements for bulk carriers</u>

<u>2.1.1</u>

<u>Where a duct keel or pipe tunnel is fitted, provision is to be made for at least two exits to the open deck arranged at a maximum distance from each other.</u>

<u>The aft access may lead from the engine room to the duct keel. Where an aft access is provided from the engine room to the duct keel, the access opening to the duct keel is to be provided with watertight hatch cover, cover plate or door.</u>

<u>Ventilation may be aided by the use of mechanical means as required.</u>

<u>2.1.2</u>

<u>Where a watertight door is fitted for access to the duct keel, the scantlings of the watertight door are to comply with the requirements of the individual Society.</u>

EFFECTIVE DATE AND APPLICATION

1. The effective date of the amendments is 1 July 2020.
2. Notwithstanding the amendments to the Rules, the current requirements apply to ships for which the date of contract for construction* is before the effective date.
3. Notwithstanding the provision of preceding **2.**, the amendments to the Rules may apply to ships for which the date of contract for construction* is before the effective date upon request.

   * "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.