# Polski Rejestr Statków

# RULES

**AMENDMENTS NO. 2/2012**

to

PUBLICATION NO. 85/P

**REQUIREMENTS CONCERNING THE CONSTRUCTION AND STRENGTH OF THE HULL AND HULL EQUIPMENT OF SEA-GOING, DOUBLE HULL OIL TANKERS OF 150 M IN LENGTH AND ABOVE**

2010

GDAŃSK

*Amendments No. 2/2012 to Publication No. 85/P – Requirements Concerning the Construction and Strength of the Hull and Hull Equipment of Sea-going Oil Tankers of 150 m in Length and above – 2010*, were approved by PRS Board on 25 July 2012 and enter into force on 1 August 2012.



PRS/AW, 07/2012

***The following amendments to Publication No. 85/P – Requirements Concerning the Construction and Strength of the Hull and Hull Equipment of Sea-going Oil Tankers of 150 m in Length and above – 2010, have been introduced:***

1. *In paragraph* **1.1.1.4***, the last sentence has been amended to read:*

   PRS will also decide how to apply these Rules to ships whose main particulars are outside normal ranges (see 2.3.1.2.4).

2. *Paragraph* **4.2.6.3.6** *has been amended to read:* **4.2.6.3.6** When several openings are located in or adjacent to the same cross-section, the total equivalent breadth of the combined openings $\Sigma b_{ded}$ shall be deducted, see 4.2.6.3.7 to 4.2.6.3.8 and Figure 4.2.6.3.6.

3. *In paragraph* **4.3.2.5.1**, *in the definition of "P", item d) has been added at the end:*

   d) Paragraphs 8.6.2.4.1 and 8.6.2.5.3 as applicable for the particular structure under consideration;

4. *In paragraph* **4.3.2.5.1**, *the definition of "$c_1$" has been amended to read:*

   $c_1$ – coefficient for the design load set being considered, to be taken as:
   = 1.2 for acceptance criteria set AC1 and sloshing design load,
   = 1.1 for acceptance criteria set AC2.

5. *Paragraph* **4.3.2.6.1** *has been amended to read:*

   **4.3.2.6.1** Air and drain holes and scallops shall be kept at least 200mm clear of the toes of end brackets, end connections and other areas of high stress concentration measured along the length of the stiffener toward the mid-span and 50 mm measured along the length in the opposite direction. See Figure 4.3.2.6.1 b). Openings that have been fitted with closing plates, such as scallops, may be permitted in way of block fabrication butts. In areas where the shear stress is less than 60 percent of the allowable limit, alternative arrangements may be accepted. Openings shall be well-rounded. Figure 4.3.2.6.1 a) shows some examples of air and drain holes and scallops. In general, the ratio of $a/b$, as defined in Figure 4.3.2.6.1a), shall be between 0.5 and 1.0. In fatigue sensitive areas further consideration may be required with respect to the details and arrangements of openings and scallops.

6. *In paragraph* **4.3.4.1.4**, *the penultimate sentence has been amended to read:*

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

7. *Sub-chapters/paragraphs* **6.1.2.5**, **6.1.2.5.1** and **6.1.2.6** *(at the beginning of Sub-chapter 6.1.2) have been renumbered to* **6.1.2.1**, **6.1.2.1.1** *and* **6.1.2.2** *respectively.*

8. *Paragraph* **6.1.2.3.1** *has been amended to read:*

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

9. ***Table 6.1.2.3.1-2*** *has been amended to read:*

**Table 6.1.2.3.1-2**
**Material Class or Grade of Structural Members**

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

Note

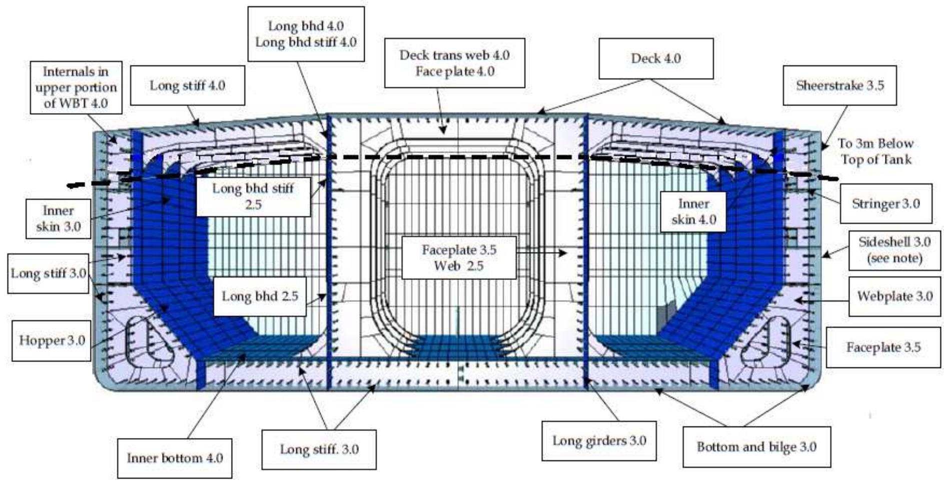
1. Not to be less than E/EH within 0.4$L$ amidships in vessels with length, $L$, exceeding 250m.
2. Single strakes required to be of material class III or E/EH are, within 0.4$L$ amidships, to have breadths not less than 800 + 5$L$ mm, but need not be greater than 1800mm.
3. A radius gunwale plate may 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, $L$, less than 150m.
6. To be not lower than D/DH within 0.6$L$ amidships of vessels with length, $L$, 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.
8. Grade B/AH to be used for plate thickness more than 40mm. For engine foundation heavy plates, Grade B/AH to be used for plate thickness more than 30 mm. However, engine foundation heavy plates outside 0.6$L$ 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 0.4$L$ amidships shall also be applied at structural breaks of the superstructure, irrespective of position.
11. To be not lower than B/AH within 0.4$L$ amidships for ships with single strength deck.

10. *Paragraph* **6.2.1.1.2** *has been amended to read:*

**6.2.1.1.2** For ships contracted for construction on or after 8 December 2006, the date of IMO adoption of the amended *SOLAS* Regulation II-1/3-2, by which an IMO “Performance standard for protective coatings for ballast tanks and void spaces” will be made mandatory, the coatings of internal spaces subject to the amended *SOLAS* Regulation are to satisfy the requirements of the IMO performance standard.

For ships contracted for construction on or after 1 July 2012, the IMO performance standard is to be applied as interpreted by IACS UI SC 223 and UI SC 227. In applying IACS UI SC 223, “Administration” is to be read to be the Polish Register of Shipping.

*11. Figure* **6.3.2.1.2** *has been changed as follows:*




Note

1. Corrosion additions are given for a standard configuration and without heated cargo
2. 0.5mm to be added for side plating in the quay contact region defined in Figure 8.2.2.4.3.
3. The distance 3 m below top of tank is to be measured parallel to the deck.

*12. Sub-paragraph* **6.4.1.2.3 h)** *has been amended to read:*

h) special assembly

– the distance between upper and lower gudgeons, distance between aft edge of propeller boss and aft peak bulkhead, twist of stern frame assembly, deviation of rudder from shaft centreline, twist of rudder plate, and flatness, breadth and length of top plate of main engine bed. Where boring out of the propeller boss and stern frame, skeg or solepiece is carried out at a late stage of construction, it is to be carried out after completing the major part of the welding of the aft part of the ship. Where block boring is used, the shaft alignment is to be carried out using a method and sequence submitted to and recognized by PRS. The fit-up and alignment of the rudder, pintles and axles, are to be carried out after completing the major part of the welding of the aft part of the ship. The contacts between the conical surfaces of pintles, rudder stocks and rudder axles are to be checked before the final mounting

13. *In **Table 7.6.2.1.1**, the upper part has been amended to read:*

**Table 7.6.2.1.1**
**Design Load Combination**

| Load components \ Design Load Combination | | S | S + D | A |
|---|---|---|---|---|
| $M_{v\text{-}total}$ | | $M_{sw\text{-}harb}$ | $M_{sw\text{-}sea} + M_{wv}$ | - |
| $M_{h\text{-}total}$ | | - | $M_h$ | - |
| $Q$ | | $Q_{sw\text{-}harb}$ | $Q_{sw\text{-}sea} + Q_{wv}$ | - |
| $P_{ex}$ | Weather Deck | - | $P_{wdk\text{-}dyn}$ | - |
| | Hull envelope | $P_{hys}$ | $P_{hys} + P_{wv\text{-}dyn}$ | - |
| $P_{in}$ | Ballast tanks (BWE with sequential filling method) | the greater of<br>a) $P_{in\text{-}test}$<br>b) $P_{in\text{-}air} + P_{drop}$ | $P_{in\text{-}tk} + P_{in\text{-}dyn}$ | $P_{in\text{-}flood}$ |
| | Ballast tanks (BWE with flow-through method) | the greater of<br>a) $P_{in\text{-}test}$<br>b) $P_{in\text{-}air} + P_{drop}$ | $P_{in\text{-}air} + P_{drop} + P_{in\text{-}dyn}$ | $P_{in\text{-}flood}$ |
| | Cargo tanks including cargo tanks designed for filling with water ballast | the greater of<br>a) $P_{in\text{-}test}$<br>b) $P_{in\text{-}tk} + P_{valve}$ | $P_{in\text{-}tk} + P_{valve} - 25 + P_{in\text{-}dyn}$ | - |
| | Other tanks with liquid filling | the greater of<br>a) $P_{in\text{-}test}$<br>b) $P_{in\text{-}air}$ | $P_{in\text{-}tk} + P_{in\text{-}dyn}$ | $P_{in\text{-}flood}$ |
| | Watertight boundaries | - | - | $P_{in\text{-}flood}$ |
| $P_{dk}$ | Internal decks for dry spaces | $P_{stat}$ | $P_{stat} + P_{dk\text{-}dyn}$ | - |
| | Decks for heavy units | $F_{stat}$ | $F_{stat} + F_{dk\text{-}dyn}$ | - |

14. *Sub-paragraph* **8.1.1.2.2 a) i)** *has been amended to read:*

    i) homogenous loading conditions including a condition at the scantling draft (homogenous loading conditions shall not include filling of dry and clean ballast tanks at departure condition),

15. *In paragraph* **8.1.2.2.2**, *the definition of " $C_b$" has been amended to read:*

    $C_b$ – block coefficient, as defined in 4.1.1.9.1, but is not to be taken as less than 0.70

16. *In paragraph* **8.1.3.2.2**, *the definition of "$q_{1\text{-}net50}$" has been amended to read:*

    $q_{1\text{-}net50}$ – first moment of area about the horizontal neutral axis of the effective longitudinal members between the vertical level at which the shear stress is being determined and the vertical extremity, taken at the section being considered, [cm$^3$]. The first moment of area is to be based on the net thickness $t_{net50}$;

*17. In paragraph* **8.1.3.4.1**, *the definition of* $Q_{str\text{-}k}$ *has been amended to read:*

$Q_{str\text{-}k}$ – shear force on the longitudinal bulkhead from the stringer in loaded condition with tanks abreast full:

$$= 0.8F_{str-k}\left(1-\frac{z_{str}-h_{db}}{h_{blk}}\right), \text{ [kN];}$$

*18. Paragraph* **8.1.6.3.1** *has been amended to read:*

**8.1.6.3.1** The vertical extent of higher strength steel $z_{hts}$ used in the deck or bottom and measured from the moulded deck line at side or keel is not to be taken less than the following, see also Figure 8.1.6.3.1.

$$z_{hts} = z_1\left(1-\frac{\sigma_{perm}}{\sigma_1}\right), \text{ [m]} \qquad (8.1.6.3.1)$$

where:

$z_1$ – distance from horizontal neutral axis to moulded deck line or keel respectively, [m];

$\sigma_1$ – to be taken as $\sigma_{dk}$ or $\sigma_{kl}$ for the hull girder deck and keel respect ively, [N/mm$^2$];

$\sigma_{dk}$ – hull girder bending stress at moulded deck line given by:

$$= \frac{\left|M_{sw-perm-sea} + M_{wv-v}\right|}{I_{v-net50}}\left(z_{dk-side} - z_{NA-net50}\right)10^{-3}, \text{ [N/mm}^2\text{]}$$

$\sigma_{kl}$ – hull girder bending stress at keel given by:

$$= \frac{\left|M_{sw-perm-sea} + M_{wv-v}\right|}{I_{v-net50}}\left(z_{NA-net50} - z_{kl}\right)10^{-3}, \text{ [N/mm}^2\text{];}$$

$\sigma_{perm}$ – permissible hull girder bending stress as given in Table 8.1.2.3.3 for design load combination S+D, [N/mm$^2$];

$M_{sw\text{-}perm\text{-}sea}$ – permissible hull girder still water bending moment for seagoing operation, as defined in Sub-chapter 7.2.1.1, [kNm];

$M_{wv\text{-}v}$ – hogging and sagging vertical wave bending moments, as defined in Sub-chapter 7.3.4.1, [kNm]. $M_{wv\text{-}v}$ is to be taken as:

$M_{wv\text{-}hog}$ – for assessment with respect to hogging vertical wave bending moment,

$M_{wv\text{-}sag}$ – for assessment with respect to sagging vertical wave bending moment;

$I_{v\text{-}net50}$ – net vertical hull girder moment of inertia, as defined in 4.2.6.1.1, [m$^4$];

$z_{NA\text{-}net50}$ – net vertical hull girder moment of inertia, [m$^4$], as defined in 4.2.6.1.1;

$z_{dk\text{-}side}$ – distance from baseline to moulded deck line at side, [m];

$z_{kl}$ – vertical distance from the baseline to the keel, [m];

$z_{NA\text{-}net50}$ – distance from baseline to horizontal neutral axis, [m];

$k_i$ – higher strength steel factor for the area *i* defined in Figure 8.1.6.3.1. The factor *k* is defined in Sub-chapter 6.1.1.4.

19. *Sub-paragraph* **8.2.5.7.9 b*)*** *has been amended to read:*

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, and 'Z' grade steels as given in 6.1.1.5 are to be used unless plate through thickness properties are documented for approval.

20. ***Table 8.2.5.7.6*** *has been amended to read:*

**Table 8.2.5.7.6**
**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 | $C_1$ | $C_{m1}$ | $0.65C_{m1}$ |
| Longitudinal Bulkhead | $C_3$ | $C_{m3}$ | $0.65C_{m3}$ |

Where:

$C_1$ $= a_1 + b_1\sqrt{\frac{A_{dt}}{b_{dk}}}$ but shall 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

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

$= 1.0$ 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 shall 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 0.55

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

$= 0.85$ 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 shall 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; |
| $a_3$ | $= 0.86 - \frac{0.35}{R_{bl}}$ | |
| | $= 1.0$ | 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 shall 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; |
| $a_{m3}$ | $= 0.32 + \frac{0.24}{R_{bl}}$; | |
| | $= 0.85$ | 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, [m²]<br>= 0 if no upper stool is fitted; |
| $A_{dl}$ | – | cross sectional area enclosed by the moulded lines of the longitudinal bulkhead upper stool, [m²];<br>= 0 if no upper stool is fitted; |
| $A_{bt}$ | – | cross sectional area enclosed by the moulded lines of the transverse bulkhead lower stool, [m²]; |
| $A_{bl}$ | – | cross sectional area enclosed by the moulded lines of the longitudinal bulkhead lower stool, [m²]; |
| $b_{av-t}$ | – | average width of transverse bulkhead lower stool. See Figure 8.2.5.6.2, [m]; |
| $b_{av-l}$ | – | average width of longitudinal bulkhead lower stool. See Figure 8.2.5.6.2, [m]; |
| $h_{st}$ | – | height of transverse bulkhead lower stool. See Figure 8.2.5.6.2, [m]; |
| $h_{sl}$ | – | height of longitudinal bulkhead lower stool. See Figure 8.2.5.6.2, [m]; |
| $b_{ib}$ | – | breadth of cargo tank at the inner bottom level between hopper tanks, or between the hopper tank and centreline lower stool. See Figure 8.2.5.6.2, [m]; |

$b_{dk}$ – 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. See Figure 8.2.5.6.2, [m];

$l_{ib}$ – length of cargo tank at the inner bottom level between transverse lower stools. See Figure 8.2.5.6.2, [m];

$l_{dk}$ – length of cargo tank at the deck level between transverse upper stools or between the corrugation flanges if no upper stool is fitted. See Figure 8.2.5.6.2, [m].

21. *Formula* **8.6.3.7.5** *has been amended to read*:

$$t_{w-net} = \frac{s_w}{70}\sqrt{\frac{\sigma_{yd}}{235}}, \text{ [mm]} \qquad (8.6.3.7.5)$$

22. *Paragraph* **8.6.4.5.1** *has been amended to read:*

**8.6.4.5.1** The effective net plastic section modulus $Z_{pl-net}$ of each stiffener, in association with the effective plating to which it is attached, is not to be less than:

$$Z_{pl-net} = \frac{P_{im} s l_{bdg}^2}{f_{bdg} C_s \sigma_{yd}}, \text{ [cm}^3\text{]} \qquad (8.6.4.5.1)$$

where:

$P_{im}$ – bow impact pressure as given in Sub-chapter 7.4.4 and calculated at the load calculation point defined in Sub-chapter 3.5.2.2, [kN/m$^2$];

$s$ – stiffener spacing, as defined in Sub-chapter 4.2.2, [mm];

$l_{bdg}$ – effective bending span, as defined in Sub-chapter 4.2.1.1, [m];

$f_{bdg}$ – bending moment factor:

$$= 8\left(1 + \frac{n_s}{2}\right)$$

$n_s$ – = 2.0 for continuous stiffeners or where stiffeners are bracketed at both ends, see 8.6.4.3.2 for alternative arrangements;

$C_s$ – permissible bending stress coefficient = 0.9 for acceptance criteria set AC3;

$\sigma_{yd}$ – specified minimum yield stress of the material, [N/mm$^2$].

23. *In paragraph* **8.6.4.7.5**, *the definition of "$P_{im}$"* has been amended to read:

$P_{im}$ – bow impact pressure as given in Sub-chapter 7.4.4 and calculated at the load calculation point defined in Sub-chapter 3.5.3.1, [kN/m$^2$];

24. *Paragraph* **9.1.1.1.2** *has been amended to read:*

**9.1.1.1.2** The scantling requirement in this Sub-chapter are to be applied to any cross section along the entire vessel's length and are in addition to all other requirements within the rules.

25. *Sub-paragraph* **9.2.3.1.1 e)** *has been amended to read:*

e) end brackets and attached web stiffeners of typical longitudinal stiffeners of double bottom and deck, and adjoining vertical stiffener of transverse bulkhead. If longitudinal stiffeners are fitted above the deck, then the connection in way of the transverse bulkhead are to be assessed.

26. *Paragraph* **9.2.4.5.5** *has been added:*

**9.2.4.5.5** The plate thickness required for strengthening against hull girder shear loads of the side shell, longitudinal bulkheads and inner hull longitudinal bulkheads in way of a transverse bulkhead is to be taken as the greater from the corresponding vertical location of the forward and aft transverse bulkhead of the middle tanks of the cargo tank finite element model as required by 14.1.1.1.5. All relevant requirements in other sections of the Rules are also to be complied with.

27. *Sub-paragraph* **10.1.1.1.4 g)** *has been amended to read:*

g) for plates with openings, the buckling strength of the areas surrounding the opening or cut out and any edge reinforcements are adequate, see 10.3.4.1 and 10.2.4.3.

28. ***Table*** **11.1.4.10.1-1** *has been amended to read:*

**11.1.4.10.1-1**
**Values of '$C_4$'**

| **Bulkhead location** | **Value of '$C_4$'** |
|---|---|
| Unprotected front, lowest tier | $2.0+L_2/120$ |
| Unprotected front, 2nd tier | $1.0+L_2/120$ |
| Unprotected front, 3rd tier and above | $0.5+L_2/150$ |
| Protected front, all tiers | $0.5+L_2/150$ |
| Sides, all tiers | $0.5+L_2/150$ |
| Aft ends, aft of amidships, all tiers | $0.7+(L_2/1000)-0.8x/L$ |
| Aft ends, forward of amidships, all tiers | $0.5+(L_2/1000)-0.4x/L$ |

*29. Figure 11.1.5.3.4 has been amended as follows:*

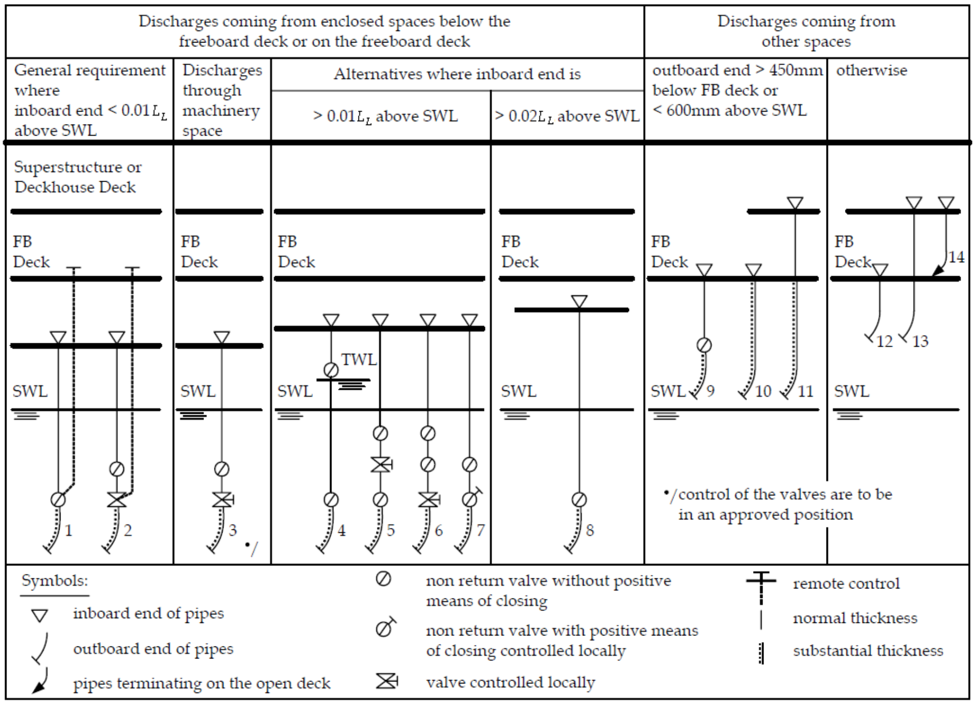



Figure 11.1.5.3.4 Diagrammatic Arrangement of discharge and Scupper Systems

*30. In paragraph* **11.4.1.1.1**, *at the end, two notes have been added:*

Notes

a) screens or bulwarks 1.5 m or more in height are to be regarded as parts of houses when determining *h* and *A*,

b) if a house having a breadth greater than *B*/4 is above a house with a breadth of *B*/4 or less then the wide house is to be included but the narrow house ignored.

*31. Paragraph* **11.5.1.5.1** *has been amended to read:*

**11.5.1.5.1** All boundary welds, erection joints, and penetrations including pipe connections, except welds made by automatic processes are to be examined in accordance with the approved procedure and under a pressure of at least 0.15 bar with a leak indicating solution (e.g. soapy water solution). Pressures greater than 0.20 bar are not recommended.

*32. In **Table 11.5.1.9.2**, item 3 has been amended to read:*

| | | | | |
|---|---|---|---|---|
| 3 | Cargo Tanks | Structural[1)] | The greatest of<br>- to the top of overflow,<br>- to 2.4m above top of tank [2)],<br>or<br>- to the top of tank [2)] plus setting of any pressure relief valve | Tank boundaries tested from at least one side |
| | Fuel Oil Bunkers | Structural[1)] | | |

*33. Paragraph* **13.2.2.2.4** *has been amended to read:*

**13.2.2.2.4** The size and modelling of hard corner elements shall be as follows:

a) it shall be assumed that the hard corner extends up to $s/2$ from the plate intersection for longitudinally stiffened plate[1], where $s$ is the stiffener spacing,

b) it is to be assumed that the hard corner extends up to $20t_{grs}$ from the plate intersection for transversely stiffened plates[2], where $t_{grs}$ is the gross plate thickness.

*34. Paragraphs* **13.2.2.2.5** to **13.2.2.2.7** *have been added:*

**13.2.2.2.5** Where the plate members are stiffened by non-continuous longitudinal stiffeners, the non-continuous stiffeners are considered only as dividing a plate into various elementary plate panels.

**13.2.2.2.6** Openings are to be considered in accordance with 4.2.6.3.

**13.2.2.2.7** Where attached plating is made of steels having different thicknesses and/or yield stresses, an average thickness and/or average yield stress obtained by the following formula are to be used for the calculation:

$$t = \frac{t_1 s_1 + t_2 s_2}{s} \qquad (13.2.2.2.7\text{-}1)$$

$$\sigma_{ydp} = \frac{\sigma_{ydp1} t_1 s_1 + \sigma_{ydp2} t_2 s_2}{ts} \qquad (13.2.2.2.7\text{-}2)$$

where:

$t_1$, $s_1$, $t_2$, $s_2$, $\sigma_{ydp1}$, $\sigma_{ydp2}$, $s$, see Figure 13.2.2.2.7.

---

1 For longitudinally stiffened plate, the effective breadth of attached plate is equal to the mean sparing of the ordinary stiffener when the panels on both sides of the stiffener are longitudinally stiffened, or equal to the breadth of the longitudinally stiffened panel when the panel on one side of the stiffener is longitudinally stiffened and the other panel is of the transversely stiffened.

2 For transversely stiffened plate, the effective breadth of plate for the load shortening portion of the stress-strain curve is to be taken as the full plate breadth, i.e. to the intersection of other plates – not from the end of the hard corner if any.

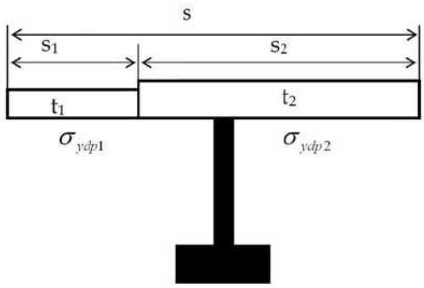



Figure 13.2.2.2.7 Definitions

*35. Paragraphs* **13.2.3.1.2** and **13.2.3.1.3** *have been added:*

**13.2.3.1.2** Where the plate members are stiffened by non-continuous longitudinal stiffeners, the stress of the element is to be obtained in accordance with 13.2.3.3 to 13.2.3.7, taking into account the non-continuous longitudinal stiffener. In calculating the total forces for checking the hull girder ultimate strength, the area of non-continuous longitudinal stiffener is to be assumed as zero.

**13.2.3.1.3** Where openings are provided in the plate panel, the considered area of the element is to be obtained by deducting the opening area from the plating in calculating the total force for checking the hull girder ultimate strength. Openings are to be considered in accordance with 4.2.6.3.

*36. Paragraph* **13.2.3.3.1** (with Figure 13.2.3.3.1) *has been amended to read:*

**13.2.3.3.1** The equation describing the stress-strain[1] curve $\sigma - \varepsilon$ or the elasto-plastic failure of structural elements shall be obtained from the following formula, valid for both positive (compression or shortening) of hard corners and negative (tension or lengthening) strains of all elements (see Figure 13.2.3.3.1):

$$\sigma = \Phi\, \sigma_{ydA} \qquad (13.2.3.3.1)$$

where:

$\Phi$ – edge function:

$\Phi = -1$ for $\varepsilon < -1$

$\Phi = \varepsilon$ for $-1 < \varepsilon < 1$

$\Phi = 1$ for $\varepsilon > 1$;

$\varepsilon$ – relative strain:

$$\varepsilon = \frac{\varepsilon_E}{\varepsilon_{yd}}$$

$\varepsilon_E$ – element strain;

[1] The signs of the stresses and strains in this Chapter are opposite to those in the rest of these *Rules*.

$\varepsilon_{yd}$ – strain corresponding to yield stress in the element:

$$\varepsilon = \frac{\sigma_{ydA}}{E}$$

$\sigma_{ydA}$ – equivalent minimum yield stress of the considered element, [N/mm$^2$]:

$$\sigma_{ydA} = \frac{\sigma_{ydp} A_{p-net50} + \sigma_{yds} A_{s-net50}}{A_{p-net50} + A_{s-net50}}$$

$\sigma_{ydp}$ – specified minimum yield stress of the material of the plate, [N/mm$^2$];

$\sigma_{yds}$ – specified minimum yield stress of the material of the stiffener, [N/mm$^2$];

$A_{p\text{-}net50}$ – net sectional area of attached plating, [cm$^2$];

$A_{s\text{-}net50}$ – net sectional area of the stiffener without attached plating, [cm$^2$];

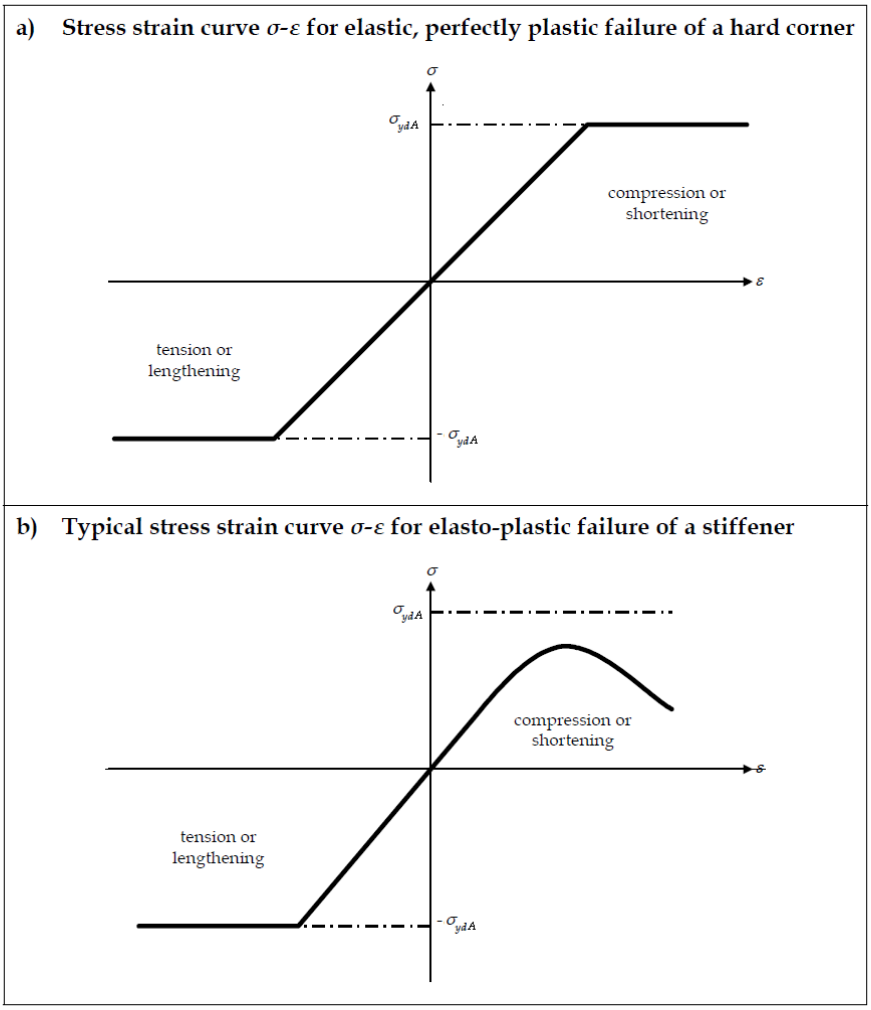



Figure 13.2.3.3.1 Example of Stress Strain Curves $\sigma$- $\varepsilon$

*37. Paragraph* **13.2.3.4.1** *has been amended to read:*

**13.2.3.4.1** The equation describing the shortening portion of the stress strain curve $\sigma_{CR1}$-$\varepsilon$ for the beam column buckling of stiffeners is to be obtained from the following formula:

$$\sigma_{CR1} = \Phi\sigma_{C1}\left(\frac{A_{s-net50} + 10^{-2} b_{eff-p} t_{net50}}{A_{s-net50} + 10^{-2} s t_{net50}}\right), \text{[N/mm}^2\text{]} \qquad (13.2.3.4.1)$$

where:

$\Phi$ – edge function defined in 13.2.3.3.1;

$A_{s\text{-}net50}$ – net area of the stiffener, without attached plating, [cm$^2$];

$\sigma_{C1}$ – critical stress, [N/mm$^2$]:

$$\sigma_{C1} = \frac{\sigma_{E1}}{\varepsilon} \qquad \text{for } \sigma_{E1} \le \frac{\sigma_{ydB}}{2}\varepsilon$$

$$\sigma_{C1} = \sigma_{ydB}\left(1 - \frac{\sigma_{ydB}\varepsilon}{4\sigma_{E1}}\right) \qquad \text{for } \sigma_{E1} \rangle \frac{\sigma_{ydB}}{2}\varepsilon;$$

ε – relative strain defined in 13.2.3.3.1;

$\sigma_{E1}$ – Euler column buckling stress, [N/mm$^2$]:

$$\sigma_{E1} = \pi^2 E \frac{I_{E-net50}}{A_{E-net50} l_{stf}^2} 10^{-4}$$

$E$ – modulus of elasticity, $2.06 \times 10^5$ [N/mm$^2$];

$I_{E\text{-}net50}$ – net moment of inertia of stiffeners, with attached plating of width $b_{eff\text{-}s}$, [cm$^4$];

$b_{eff\text{-}s}$ – effective width of the attached plating for the stiffener, [mm]:

$$b_{eff-s} = \frac{s}{\beta_p} \qquad \text{for } \beta_p > 1.0$$

$$b_{eff-s} = s \qquad \text{for } \beta_p \le 1.0;$$

$$\beta_p = \frac{s}{t_{net50}}\sqrt{\frac{\varepsilon\sigma_{yd}}{E}};$$

$s$ – plate breadth taken as the spacing between the stiffeners, as defined in Sub-chapter 4.2.2.1, [mm];

$t_{net50}$ – net thickness of attached plating, [mm];

$A_{E\text{-}net50}$ – net area of stiffeners with attached plating of width $b_{eff\text{-}p}$, [cm$^2$];

$l_{stf}$ – span of stiffener equal to spacing between primary support members, [m];

$b_{eff\text{-}p}$ – effective width of the plating, [mm]:

$$b_{eff-p} = \left(\frac{2.25}{\beta_p} - \frac{1.25}{\beta_p^2}\right)s \qquad \text{for } \beta_p > 1.25$$

$$b_{eff-p} = s \qquad \text{for } \beta_p \le 1.25$$

$\sigma_{ydB}$ – equivalent minimum yield stress of the considered element, [N/mm²]:

$$\sigma_{ydB} = \frac{\sigma_{ydp} A_{p-net50} l_{pE} + \sigma_{yds} A_{s-net50} l_{sE}}{A_{pE-net50} l_{pE} + A_{s-net50} l_{sE}};$$

$A_{pE-net50}$ – effective area, [cm²]:

$$A_{pE-net50} = 10^{-2} b_{eff-s} t_{net50};$$

$\sigma_{ydp}$ – specified minimum yield stress of the material of the plate, [N/mm²];

$\sigma_{yds}$ – specified minimum yield stress of the material of the stiffener, [N/mm²];

$l_{Pe}$ – distance measured from the neutral axis of the stiffener with attached plate of width $b_{eff\text{-}s}$ to the bottom of the attached plate, [mm];

$l_{Se}$ – distance measured from the neutral axis of the stiffener with attached plate of width $b_{eff\text{-}s}$ to the top of the stiffener, [mm].

38. *Paragraph* **13.2.3.5.1** *has been amended to read:*

**13.2.3.5.1** The equation describing the shortening portion of the stress-strain curve $\sigma_{CR2\text{-}\varepsilon}$ for the lateral-flexural buckling of stiffeners shall be obtained according to the following formula:

$$\sigma_{CR2} = \Phi \frac{A_{s-net50}\sigma_{C2} + 10^{-2} s t_{net50} \sigma_{CP}}{A_{s-net50} + 10^{-2} s t_{net50}}, \text{ [N/mm}^2\text{]} \qquad (13.2.3.5.1)$$

where:

$\Phi$ – edge function defined in 13.2.3.3.1;

$A_{s-net50}$ – net area of the stiffener, without attached plating, [cm²];

$\sigma_{C2}$ – critical stress, [N/mm²]:

$$\sigma_{C2} = \frac{\sigma_{E2}}{\varepsilon} \qquad \text{for } \sigma_{E2} \le \frac{\sigma_{yds}}{2}\varepsilon$$

$$\sigma_{C2} = \sigma_{yds}\left(1 - \frac{\sigma_{yds}\varepsilon}{4\sigma_{E2}}\right) \qquad \text{for } \sigma_{E2} \rangle \frac{\sigma_{yds}}{2}\varepsilon$$

$\sigma_{E2}$ – Euler torsional buckling stress, [N/mm²]:

$\sigma_{E2} = \sigma_{ET}$

$\sigma_{ET}$ – reference stress for torsional buckling, defined in Sub-chapter 10.3.3.3.1, calculated based on gross thickness minus the corrosion addition $0.5t_{corr}$, [N/mm²];

$\varepsilon$ – relative strain defined in 13.2.3.3.1;

$s$ – plate breadth, taken as the spacing between the stiffeners, as defined in Sub-chapter 4.2.2.1, [mm];

$t_{net50}$ – net thickness of attached plating, [mm];

$\sigma_{CP}$ – ultimate strength of the attached plating for the stiffener, [N/mm²]:

$$\sigma_{CP} = \left(\frac{2.25}{\beta_p} - \frac{1.25}{\beta_p^2}\right)\sigma_{ydp} \quad \text{for } \beta_p > 1.25$$

$$\sigma_{CP} = \sigma_{ydp} \quad \text{for } \beta_p \le 1.25;$$

$\beta_p$ – coefficient defined in 13.2.3.4.
$\sigma_{ydp}$ – specified minimum yield stress of the material of the plate, [N/mm$^2$];
$\sigma_{yds}$ – specified minimum yield stress of the material of the stiffener, [N/mm$^2$].

39. *Paragraph* **13.2.3.6.1** *has been amended to read:*

**13.2.3.6.1** The equation describing the shortening portion of the stress strain curve $\sigma_{CR3\text{-}\varepsilon}$ for the web local buckling of flanged stiffeners shall be obtained from the following formula:

$$\sigma_{CR3} = \Phi \frac{b_{eff-p} t_{net50} \sigma_{ydp} + \left(d_{w-eff} t_{w-net50} + b_f t_{f-net50}\right)\sigma_{yds}}{s t_{net50} + d_w t_{w-net50} + b_f t_{f-net50}}, \text{ [N/mm}^2\text{]} \quad (13.2.3.6.1)$$

where:
$\Phi$ – edge function defined in 13.2.3.3.1;
$b_{eff\text{-}p}$ – effective width of the plating, defined in 13.2.3.4, [mm];
$t_{net50}$ – net thickness of plate, [mm];
$d_w$ – depth of the web, [mm];
$t_{w\text{-}net50}$ – net thickness of web, [mm];
$b_f$ – breadth of the flange, [mm];
$t_{f\text{-}net50}$ – net thickness of flange, [mm];
$s$ – plate breadth taken as the spacing between the stiffeners, as defined in Sub-chapter 4.2.2.1, [mm];
$d_{w\text{-}eff}$ – effective depth of the web, [mm]:

$$d_{w-eff} = \left(\frac{2.25}{\beta_w} - \frac{1.25}{\beta_w^2}\right) d_w \quad \text{for } \beta_w > 1.25$$

$$d_{w-eff} = d_w \quad \text{for } \beta_w \le 1.25$$

$$\beta_w = \frac{d_w}{t_{w-net50}} \sqrt{\frac{\varepsilon \sigma_{yds}}{E}};$$

$\varepsilon$ – relative strain defined in 13.2.3.3.1;
$E$ – modulus of elasticity, 2.06 x 10$^5$ N/mm$^2$;
$\sigma_{ydp}$ – specified minimum yield stress of the material of the plate, [N/mm$^2$];
$\sigma_{yds}$ – specified minimum yield stress of the material of the stiffener, [N/mm$^2$].

*40. Paragraph* **13.2.3.7.1** *has been amended to read:*

**13.2.3.7.1** The equation describing the shortening portion of the stress-strain curve $\sigma_{CR4-\varepsilon}$ for the web local buckling of flat bar stiffeners is to be obtained from the following formula:

$$\sigma_{CR4} = \Phi\left(\frac{st_{net50}\sigma_{CP} + 10^{-2}A_{s-net50}\sigma_{C4}}{st_{net50} + 10^{-2}A_{s-net50}}\right), \text{[N/mm}^2\text{]} \qquad (13.2.3.7.1)$$

where:

$\Phi$ – edge function defined in 13.2.3.3.1;

$\sigma_{CP}$ – ultimate strength of the attached plating, defined in 13.2.3.5, [N/mm$^2$];

$\sigma_{C4}$ – critical stress, [N/mm$^2$]:

$$\sigma_{C4} = \frac{\sigma_{E4}}{\varepsilon} \qquad \text{for } \sigma_{E4} \le \frac{\sigma_{yds}}{2}\varepsilon$$

$$\sigma_{C4} = \sigma_{yds}\left(1 - \frac{\sigma_{yds}\varepsilon}{4\sigma_{E4}}\right) \qquad \text{for } \sigma_{E4} \rangle \frac{\sigma_{yds}}{2}\varepsilon$$

$\sigma_{E4}$ – Euler buckling stress, [N/mm$^2$]:

$$\sigma_{E4} = 160000\left(\frac{t_{w-net50}}{d_w}\right)^2$$

$\varepsilon$ – relative strain defined in 13.2.3.3.1;

$A_{s-net50}$ – net area of stiffener, see 13.2.3.5.1, [cm$^2$];

$t_{w-net50}$ – net thickness of web, [mm];

$\underline{d_w}$ – depth of the web, [mm];

$s$ – plate breadth, taken as the spacing between the stiffeners, as defined in Subchapter 4.2.2.1, [mm];

$t_{net50}$ – net thickness of attached plating, [mm];

$\sigma_{yds}$ – specified minimum yield stress of the material of the stiffener, [N/mm$^2$].

*41 Paragraph* **14.2.3.8.1** *has been amended to read:*

**14.2.3.8.1** The equation describing the shortening portion of the stress-strain curve $\sigma_{CR5-\varepsilon}$ for the buckling of transversely stiffened panels is to be obtained from the following formula:

$$\sigma_{CR5} = \min\begin{cases} \Phi\sigma_{ydp}\left[\dfrac{s}{1000l_{stf}}\left(\dfrac{2.25}{\beta_p} - \dfrac{1.25}{\beta_p^2}\right) + 0.1\left(1 - \dfrac{s}{1000l_{stf}}\right)\left(1 + \dfrac{1}{\beta_p^2}\right)^2\right] \\ \sigma_{ydp}\Phi \end{cases}, \text{[N/mm}^2\text{]}$$

(13.2.3.8.1)

where:

$\beta_p$ – coefficient defined in 13.2.3.4.1;

$\Phi$ – edge function defined in 13.2.3.3.1;

$s$ – plate breadth taken as the spacing between the stiffeners, as defined in Subchapter 4.2.2.1, [mm];

$l_{stf}$ – stiffener span equal to spacing between primary support members, [m];

$\sigma_{ydp}$ – specified minimum yield stress of the material of the plate, [N/mm$^2$].

42. *Paragraph* **14.2.4.7.7** *has been amended to read:*

**14.2.4.7.7** The following are to be considered when calculating the static tank pressure in cargo tanks for harbour/tank testing load cases (design combination S) as required by Table 7.6.2.1.1:

– Maximum $h_{air}$, as defined in paragraph 7.2.2.3.2 and Figure 7.2.2.3.1, of all cargo tanks in the cargo region is to be considered in the calculation of $P_{in\text{-}test}$, see paragraph 7.2.2.3.5.

43. *Paragraph* **14.2.4.7.9** *has been added:*

**14.2.4.7.9** Maximum setting of pressure relief valve $P_{valve}$ as defined in 7.2.2.3.5 is to be considered in design combination S and S+D as required by Table 7.6.2.1.1.

44. *Paragraph* **14.2.5.1.2** *has been amended to read:*

**14.2.5.1.2** Vertical distributed loads are applied to each frame position, together with a vertical bending moment applied to the model ends to produce the required value of vertical shear force at both the forward and aft bulkhead of the middle tank of the FE model, and the required value of vertical bending moment at a section within the length of the middle tank of the FE model. The required values are specified in 14.2.4.5.

45. *Paragraph* **14.2.5.2.1** *has been amended to read:*

**14.2.5.2.1** The vertical shear forces generated by the local loads are to be calculated at the transverse bulkhead positions of the middle tank of the FE model. The maximum absolute shear force at the bulkhead position of the middle tank of the FE model is to be used to obtain the required adjustment in shear forces at the transverse bulkhead, see 14.2.5.3. The vertical bending moment distribution generated by the local loads is to be calculated along the length of the middle tank of the three cargo tank FE model. The FE model can be used to calculate the shear forces and bending moments. Alternatively, a simple beam model representing the length of the 3-tank FE model with simply supported ends may be used to determine the shear force and bending moment values.

46. *In paragraph* **14.2.5.3.2**, *the definitions of "$\Delta Q_{aft}$" and "$\Delta Q_{fwd}$" have been amended to read:*

$\Delta Q_{aft}$ – required adjustment in shear force at aft bulkhead of middle tank based on the maximum absolute shear force at the bulkhead;

$\Delta Q_{fwd}$ – required adjustment in shear force at fore bulkhead of middle tank based on the maximum absolute shear force at the bulkhead;

47. *In paragraph* **15.1.4.4.20**, *the beginning has been amended to read:*

**15.1.4.4.20** The stress range combination factors, $f_1$, $f_2$, $f_3$ and $f_4$, which are to be applied to the following zones*, are given in Tables 15.1.4.4.20-1 to 15.1.4.4.20-3: