Amendments of Rules / Guidance

(External Review)

Pt. 3 Hull Structures

2019. 8.

Hull Rule Development Team

Present	Amendment	Note
Pt 3 <Rule>	**Pt 3 <Rule>**	
CHAPTER 1 GENERAL	**CHAPTER 1 GENERAL**	
Section 1 Definitions	**Section 1 Definitions**	
101. <omit>	**101. <omit>**	
102. Length [See Guidance] The length ~~of ship~~ (L) is the distance in *metres* on the load line defined in **110.,** from the fore side of stem to the after side of rudder post in case of a ship with rudder post, or to the axis of rudder stock in case of a ship without rudder post or stern post. L is not to be less than 96 % and need not be greater than 97 % of the extreme length on the load line.	**102. Rule Length [See Guidance]** The rule length (L) is the distance in *metres* measured on the waterline at the scantling draught from the fore side of stem to the after side of rudder post in case of a ship with rudder post, or to the axis of rudder stock in case of a ship without rudder post or stern post. L is not to be less than 96 % and need not be greater than 97 % of the extreme length on the waterline at the scantling draught. In ships without rudder stock (e.g. ships fitted with azimuth thrusters), L is to be taken equal to 97% of the extreme length on the waterline at the scantling draught. In ships with unusual stern and bow arrangement the rule length, L will be specially considered.	- IACS UR S2 (R2)
103. <omit>	**103. <omit>**	
104. Breadth [See Guidance] The breadth of ship (B) is the horizontal distance in *metres* from the outside of frame to the outside of frame measured at the broadest part of the hull.	**104. Breadth [See Guidance]** The breadth of ship (B) is the horizontal distance in *metres* from the outside of frame to the outside of frame measured amidships at the scantling draught, d_s.	
113. Block coefficient The block coefficient (C_b) is the coefficient obtained by dividing the moulded volume corresponding to △ by $L \times B \times d$.	**113. Block coefficient** The block coefficient (C_b) is the moulded coefficient corresponding to waterline at the scantling draught, d_s, based on rule length, L and moulded bredth, B. $C_b = \frac{Moulded\ displacement[m^3]\ at\ scantling\ draught\ d_s}{L \times B \times d_s}$.	

Present	Amendment	Note
114. ~ 125 <omit>	**114. ~ 125 <same as current>**	
<newly added>	**126. Scantlig draught** Scantling draught, d_s at which the strength requirements for the scantlings of the ship are met and represents the full load condition. The scantling draught is to be not less than that corresponding to the assigned freeboard.	
Section 2 ~ Section 8 <omit> ⚓	**Section 2 ~ Section 8 <same as current>** ⚓	

Present	Amendment	Note
CHAPTER 3 LONGITUDINAL STRENGTH **Section 2 Bending Strength** **201. <omit>** **202. Bending strength at sections other than amidships [See Guidance]** **1.** ~ **3. <omit>** **4.** For ships with large deck openings ~~such as container ships~~, the bending strength of sections at or near to 0.25 L and 0.75 L are to be checked. For such ships with cargo holds aft of the superstructure, deckhouse or engine room, strength checks of sections in way of aft end of the aft-most holds, and aft end of the deckhouse or engine room are to be performed. **203. <omit>**	**CHAPTER 3 LONGITUDINAL STRENGTH** **Section 2 Bending Strength** **201. <same as current>** **202. Bending strength at sections other than amidships [See Guidance]** **1.** ~ **3.** <same as current> **4.** For ships with large deck openings, the bending strength of sections at or near to 0.25 L and 0.75 L are to be checked. For such ships with cargo holds aft of the superstructure, deckhouse or engine room, strength checks of sections in way of aft end of the aft-most holds, and aft end of the deckhouse or engine room are to be performed. **203. <same as current>**	-UR S11(R9)
Pt 3 <Guidance> **Annex 3-1 Guidance for Survey and Composition of Loading Manuals** **1., 2. <omit>** **3. Standard loading condition** (1) In general, the following design cargo and ballast loading conditions, based on amount of bunker, fresh water and stores at departure and arrival, are to be considered for the calculations of still water bending moment ~ <omit> (A) Cargo ships,~~ container ships,~~ roll on roll off ships, refrigerated cargo ships, bulk carriers, ore carriers, etc. (a) ~ (i) <omit> (B) ~ (I) <omit> **4., 5 <omit>**	**Pt 3 <Guidance>** **Annex 3-1 Guidance for Survey and Composition of Loading Manuals** **1., 2.** <same as current> **3. Standard loading condition** (1) In general, the following design cargo and ballast loading conditions, based on amount of bunker, fresh water and stores at departure and arrival, are to be considered for the calculations of still water bending moment ~ <same as current> (A) Cargo ships, roll on roll off ships, refrigerated cargo ships, bulk carriers, ore carriers, etc. (a) ~ (i) <same as current> (B) ~ (I) <same as current> **4., 5 <omit>**	-UR S11(R9)

Present	Amendment	Note
Part 3 <Guidances>	**Part 3 <Guidances>**	
CHAPTER 15 DEEP TANKS	**CHAPTER 15 DEEP TANKS**	
Section 2 Bulkheads of Deep Tank	**Section 2 Bulkheads of Deep Tank**	
202. Builkheads	**202. Builkheads**	
1. <omit>	**1.** <same as current>	
2. When the flow-through ballast water exchange operations is used in applying the requirements in **202** of the Rules, the following water heads are to be additionally considered. $h_4 = z_{\top} + h_{air} + h_{drop} - z$ z_{top} : height of highest point of tank (m) h_{air} : height of air or overflow pipe above tank top (m) h_{drop} : Overpressure due to sustained liquid flow through air pipe or overflow pipe in case of overfilling or filling during flow through ballast water exchange. It is to be defined by the designer, but not to be less than 2.5. z : height to the considered location (m) $h_5 = 0.85\,(h_4 + \Delta h)$ Δh : as specified in **105.** of the Rules	**2.** <delete>	
3. <omit>	**2.** <same as current>	
4. <omit>	**3.** <same as current>	

Present	Amendment	Note
203. Longitudinals	**203. Longitudinals**	
1. ~4. <omit>	**1. ~4.** <same as current>	
5. When the flow-through ballast water exchange operations is used in applying the requirements in **203. 1** of the Rules, the following water heads are to be additionally considered. h_4 and h_5 : as specified in **202.2**	**5. <delete>**	
6. <omit>	**5.** <same as current>	
7. <omit>	**6.** <same as current>	
204. ~ 209. <omit> ⚓	**204. ~ 209. <same as current>** ⚓	

Present	Amendment	Note
Part 3 <Guidance>	**Part 3 <Guidance>**	
CHAPTER 3 LONGITUDINAL STRENGTH	**CHAPTER 3 LONGITUDINAL STRENGTH**	
Section 1 General	**Section 1 General**	
101. Application	**101. Application**	
1. Transverse section modulus of ship which is completed corrosion control with an approved measure	**1.<delete>**	
For deck or longitudinal strength members which is consist with one of a cargo tanks, ballast tanks, if they are completed the approved measure of corrosion control in accordance with **Ch 1, 801.** of the Rules, transverse section modulus may be reduced 5% to the value of specified in **201.** of the Rules. However, transverse minimum second moment of inertia (I_{min}) is not to be less than the value specified in **Table 3.3.1** of the Rules.		
2. Transverse section modulus of ships with unusual proportion	**1. Transverse section modulus of ships with unusual proportion**	
For the ships with $L/B \le 5$ or $B/D_s \ge 2.5$, all strength excepting longitudinal strength is to be adequately considered.	For the ships with $L/B \le 5$ or $B/D_s \ge 2.5$, all strength excepting longitudinal strength is to be adequately considered.	
3., 4 <omit>	**2., 3 <same as current>**	
103., 104. <omit>	**103., 104. <same as current>**	
Section 2 ~ Section 4 <omit>	**Section 2 ~ Section 4 <same as current>**	

Present	Amendment	Note
CHAPTER 4 PLATE KEELS AND SHELL PLATINGS	**CHAPTER 4 PLATE KEELS AND SHELL PLATINGS**	
Section 4 Special Requirements for Shell Plating	**Section 4 Special Requirements for Shell Plating**	
401. Shell plating at a location where flare is specially large	**401. Shell plating at a location where flare is specially large**	
For ships with large flare like as pure car carriers, the thickness of shell plate above the load line for 0.1L forward is not to be less than that obtained from the following formula:	For ships with large flare, the thickness of shell plate above the load line for 0.1L forward is not to be less than that obtained from the following formula:	
<omit>	<omit>	
CHAPTER 8 FRAMES	**CHAPTER 8 FRAMES**	
Section 1 General	**Section 1 General**	
108. Frames at a location where flare is specially large	**108. Frames at a location where flare is specially large**	
1. For ships with large flare like as pure car carriers, the plastic section modulus Z_p of transverse frames and side longitudinals, which are fitted in the bow flare position considered to endure large wave impact pressure, above the load line for 0.1 L forward is not to be less than that obtained from the following formula.	**1.** For ships with large flare, the plastic section modulus Z_p of transverse frames and side longitudinals, which are fitted in the bow flare position considered to endure large wave impact pressure, above the load line for 0.1 L forward is not to be less than that obtained from the following formula.	
<omit>	<omit>	
2. For ships with large flare like as pure car carriers, the scantling of web frames supporting side longitudinals, which are fitted in the bow flare position considered to endure large wave impact pressure, above the load line for 0.1 L forward is to be in accordance with requirements of side stringers supporting transverse frames in **Ch 9, 104.**	**2.** For ships with large flare, the scantling of web frames supporting side longitudinals, which are fitted in the bow flare position considered to endure large wave impact pressure, above the load line for 0.1 L forward is to be in accordance with requirements of side stringers supporting transverse frames in **Ch 9, 104.**	

Present	Amendment	Note
CHAPTER 9 WEB FRAMES AND SIDE STRINGERS **Section 1 General** **104. Web frames and side stringers at a location where flare is specially large** **1.** For ships with large flare like as pure car carriers, the thickness t_{wG} of web plate and section modulus Z_G, of side stringers supporting transverse frames and web frames supporting these side stringers, which are fitted in the bow flare position considered to endure large wave impact pressure, above the load line for 0.1 L forward are not to be less than those obtained from the following formulae. <omit>	**CHAPTER 9 WEB FRAMES AND SIDE STRINGERS** **Section 1 General** **104. Web frames and side stringers at a location where flare is specially large** **1.** For ships with large flare, the thickness t_{wG} of web plate and section modulus Z_G, of side stringers supporting transverse frames and web frames supporting these side stringers, which are fitted in the bow flare position considered to endure large wave impact pressure, above the load line for 0.1 L forward are not to be less than those obtained from the following formulae. <omit>	

Present	Amendment	Note
Part 3 <Guidance>	**Part 3 <Guidance>**	
CHAPTER 14 WATERTIGHT BULKHEAD	**CHAPTER 14 WATERTIGHT BULKHEAD**	
Section 2 Arrangements of Watertight Bulkheads	**Section 2 Arrangements of Watertight Bulkheads**	
201. Collision bulkheads <omit>	**201. Collision bulkheads <same as current>**	
204. Hold bulkheads	**204. Hold bulkheads**	
	1. In case the spacing between bulkheads is not more than $0.7\sqrt{L}$ (m), these bulkheads are regarded as one bulkhead.	- re-arrangement
1. The expression "to the approval of the Society" in 204. 2 of the Rules means that the ships are complied with the International convention or relative Laws of flag state for damage stability and subdivision regulation, for other ships are to be complied with the following 2.	**2.** The expression "to the approval of the Society" in 204. 2 of the Rules means that the ships are complied with the International convention or relative Laws of flag state for damage stability and subdivision regulation, for other ships are to be complied with the following 2.	
2. Omission standard	**3. Omission standard**	
(1) The arrangement of watertight bulkheads may be different from that specified of the Rules, provided that, under the loading condition corresponding to the load line, the final waterline will not exceed the upper surface of bulkhead deck at side even after any one compartment, except the machinery space, has been flooded. In this case, the ratio of flooding used in the flooding calculations are to be as follows.	(1) The arrangement of watertight bulkheads may be different from that specified of the Rules, provided that, under the loading condition corresponding to the load line, the final waterline will not exceed the upper surface of bulkhead deck at side even after any one compartment, except the machinery space, has been flooded. In this case, the ratio of flooding used in the flooding calculations are to be as follows.	
(2) In case the spacing between bulkheads is not more than $0.7\sqrt{L}$ (m), these bulkheads are regarded as one bulkhead		
3. For the ships which is not less than 186 m in length, the number of hold bulkheads is not to be less than that determined by the above mentioned **2.**	**4.** For the ships which is not less than 186 m in length, the number of hold bulkheads is not to be less than that determined by the above mentioned **3.**	
207. Chain lockers <omit>	**207. Chain lockers <same as current>**	
Section 3 ~ Section 4 <omit> ⚓	**Section 3 ~ Section 4 <same as current>** ⚓	

Present	Amendment	Note
Part 3 <Rule>	**Part 3 <Rule>**	
CHAPTER 14 WATERTIGHT BULKHEADS	**CHAPTER 14 WATERTIGHT BULKHEADS**	
Section 1 ~ 3 <omit>	**Section 1 ~ 3 <same as current>**	
Section 4 Watertight Doors	**Section 4 Watertight Doors**	
401. General **[See Guidance]**	**401. General** **(2020)** **[See Guidance]**	
1. Any access openings, doors, manholes or ducts for ventilation, etc. are not to be cut in the collision bulkhead below freeboard deck. The number of openings in collision bulkheads above the freeboard deck is to be kept to a minimum as possible and all such openings are to be provided with weathertight means of closing.	**1.** Any access openings, doors, manholes or ducts for ventilation, etc. are not to be cut in the collision bulkhead below freeboard deck. The number of openings in collision bulkheads above the freeboard deck is to be kept to a minimum as possible and all such openings are to be provided with weathertight means of closing.	
2. Watertight doors(or access hatch cover) are to be provided for all access openings in the watertight bulkheads or openings to ensure the watertight integrity of the inner decks in accordance with the requirements in the following **402.** to **405.**	**2.** The design and testing requirements for watertight doors vary according to their location relative to the 1) equilibrium waterplane or intermediate waterplane at any stage of assumed flooding and or 2) bulkhead deck or freeboard deck.	- SC156 Application
	3. Definitions (1) Watertight: Capable of preventing the passage of water in any direction under a design head. The design head for any part of a structure shall be determined by reference to its location relative to the bulkhead deck or freeboard deck, as applicable, or to the most unfavourable equilibrium/intermediate waterplane, in accordance with the applicable subdivision and damage stability regulations, whichever is the greater. A watertight door is thus one that will maintain the watertight integrity of the subdivision bulkhead in which it is located. (2) Equilibrium Waterplane: The waterplane in still water when, taking account of flooding due to an assumed damage, the weight and buoyancy forces acting on a vessel are in balance. This relates to the final condition when no further flooding takes place or after cross flooding is completed.	- SC156 1.

Present	Amendment	Note
	(3) Intermediate Waterplane: The waterplane in still water, which represents the instantaneous floating position of a vessel at some intermediate stage between commencement and completion of flooding when, taking account of the assumed instantaneous state of flooding, the weight and buoyancy forces acting on a vessel are in balance. (4) Sliding Door or Rolling Door: A door having a horizontal or vertical motion generally parallel to the plane of the door. (5) Hinged Door: A door having a pivoting motion about one vertical or horizontal edge.	
402. Type of watertight doors **【See Guidance】**	**402. Type of watertight doors** **【See Guidance】**	
1. Watertight doors are to be of sliding type. Hinged or rolling type may, however, be accepted having regard to the position or the service condition of the door.	**1. <same as current>**	
2. Notwithstanding the provisions in **1** above, where watertight door is as small as crew can pass, the watertight door may be of hinged type or rolling type, except where the doors are required to be capable of being closed remotely in accordance with **404. 2.**	**2.** ~ in accordance with **404. 3.**	
3. Notwithstanding the provisions in **1** above, watertight doors in large cargo hold division may be of a type other than sliding type provided that such doors are permanently closed at sea.	**3. 4. <same as current>**	
4. Doors which are closed by dropping or by the action of a dropping weight are not permitted.		
	5. Doors should be fitted in accordance with all requirements regarding their operation mode, location and outfitting, i.e. provision of controls, means of indication, etc., as shown in **Table 3.14.5** below. *(2020)*	- SC156 3.
403. <omit>	**403. <same as current>**	- SC156 2.

Present	Amendment	Note
404. Control **[See Guidance]**	**404. Control** *<2020>* **[See Guidance]**	
	1. Watertight doors are categorized as the following (1) to (4) corresponding to its purpose and frequency of use. (1) Normally Closed at sea : Kept closed at sea but may be used if authorised. To be closed again after use. (2) Permanently Closed at sea : The time of opening such doors in port and of closing them before the ship leaves port shall be entered in the log-book. (3) Normally Open at sea : May be left open provided it is always ready to be immediately closed. (4) Used at sea : In regular use, may be left open provided it is ready to be immediately closed.	- SC156 3.1
1. All watertight doors, except those which are to be permanently closed at sea, are to be capable of being opened and closed by hand locally, from both sides of the doors, with the ship listed of 30 degrees to either side.	**2.** All watertight doors, except those which are to be permanently closed at sea, are to be capable of being opened and closed by hand (and by power, where applicable) locally, from both sides of the doors, with the ship listed of 30 degrees to either side.	- 1. ~ 3.→ 2. ~ 4. - SC156 3.3.1 1st
2. In addition to the requirements of **1** above, watertight doors which are used at sea or normally open at sea, are to be capable of being remotely closed by power from the navigation bridge.	**3.** Where indicated in **Table 3.14.5**, the doors are to be capable of being remotely closed by power from the bridge for all ships.	- SC156 3.3.2 1st
3. It is not to be possible to remotely open any watertight door. In addition, watertight doors which are applying to the provisions of **402. 3** are not to be remotely controlled.	**4.** It is not to be possible to remotely open any watertight door. In addition, watertight doors which are applying to the provisions of **402. 3** are not to be remotely controlled.	

Present	Amendment	Note
405. Indication **[See Guidance]**	**405. Indication** *<2020>* **[See Guidance]**	
1. Watertight doors, except those permanently closed at sea, are to be provided with position indicators showing whether the doors are open or closed at all operating positions.	**1.** Where shown in **Table 3.14.5,** position indicators are to be provided at all remote operating positions (5), for all ships and provided locally on both sides of the internal doors (6) for cargo ships, to show whether the doors are open or closed and, if applicable, with all dogs/cleats fully and properly engaged.	- SC156 3.4.1
2. In addition to the requirements of **1** above for watertight doors which are to be capable of being remotely closed, an indication is to be placed locally showing that the door is in remote control mode.	**2.** <same as current>	
	3. The door position indicating system is to be of self-monitoring type and the means for testing of the indicating system are to be provided at the position where the indicators are fitted.	- SC156 3.4.2
	4. Signboard/instructions should be placed in way of the door advising how to act when the door is in "doors closed" mode.	- SC156 3.4.4
406. Alarms **[See Guidance]** Watertight doors which are capable of being remotely closed are to be provided with an audible alarm which will sound at the door position whenever such a door is remotely closed.	**406. <same as current>**	- SC156 3.5.2
407. Source of power	**407. Source of power**	
1. The remote controls, indications and alarms required in **404.** to **406.** are to be operable in the event of main power failure.	**1.** The remote controls, indications and alarms required in **404.** to **406.** are to be operable in the event of main power failure. Failure of the normal power supply of the required alarms shall be indicated by an audible and visual alarm. *(2020)*	- SC156 3.5.1
2. Where Electrical installations specified in **1** are situated below the freeboard deck, they are to be provided with a degree of protection appropriate for flooding. **[See Guidance]**	**2.~ 3.** <same as current>	
3. Cables for devices specified in 1. are to comply with the requirements of **Pt 6, Ch 1, Sec 5** of the Rules.		

Present	Amendment	Note
408. Notices **1.** Watertight doors which are to be normally closed at sea are to have notices fixed to both sides of the doors stating "**To be kept closed at sea**". **2.** Watertight doors which are to be permanently closed at sea are to have notices fixed to both sides stating "**Not to be opened at sea**". Such doors which are accessible during the voyage are to be fitted with a device which prevents opening. **[See Guidance]**	**408. Notices** **1.** Watertight doors which are to be normally closed at sea but not provided with means of remote closure, are to have notices fixed to both sides of the doors stating "**To be kept closed at sea**". **2.** <same as current>	- SC156 3.6
409. Sliding doors **[See Guidance]** **1.** Sliding watertight doors are to be capable of being operated from an accessible position above the bulkhead deck and are to have an index at the operating positon showing whether the door is open or closed. This remote control of the door may, however, be omitted where the Society is satisfied with such an arrangement having regard to the service condition of the door. **2.** Where the above control means is operated by rods, the lead of operating rods is to be as direct as possible and the screw is to work in a nut of gun-metal or other approved material. **3.** Sliding doors controlled from remote positions are also to be capable of being operated at the position of the door. **4.** The frames of vertically sliding watertight doors are to have no groove at the bottom in which dirt might lodge and prevent the door from closing.	**409. <same current>**	
410. Hinged and rolling doors **1.** For hinged and rolling watertight doors, the hinge pins and the wheel axle of these doors are to be of gun-metal or other approved materials. **2.** Hinged and rolling watertight doors except those are to be permanently closed at sea, are to be of quick acting or single acting type which is capable of being closed and secured from both sides of the doors.	**410. <same current>**	

Present	Amendment	Note
411. Others For fitting of valves or cocks to a watertight bulkhead, see **Pt 5, Ch 6, 107. 11.** For pipes passing through bulkheads, see **Pt 5, Ch 6, 107. 8** and **10.** For electric cables passing through bulkhead, see **Pt 6, Ch 1, 508. 1** to **3.** ⫝	**411. <same current>**	
	412. Test *(2020)* **【See Guidance】**	
	1. Doors which become immersed by an equilibrium or intermediate waterplane, are to be subjected to a hydrostatic pressure test.	- SC156 5.1
	2. For large doors intended for use in the watertight subdivision boundaries of cargo spaces, structural analysis may be accepted in lieu of pressure testing. Where such doors utilise gasket seals, a prototype pressure test to confirm that the compression of the gasket material is capable of accommodating any deflection, revealed by the structural analysis, is to be carried out. ⫝	- SC156 5.1.1

Table 3.14.5 : Doors in Internal Watertight Bulkheads and External Watertight Boundaries in Cargo Ships *(2020)*

A. Door in Internal Watertight Bulkheads

Position relative to bulkhead or freeboard deck	**1. Frequency of Use while at sea**	**2. Type**	**3. Remote Closure**	**4. Remote Indication**	**5. Audible or Visual Alarm**	**6. Notice**	**7. Regulation**	**8. Comments**
(1) Below	Used	POS	Yes	Yes	Yes (local)	No	SOLAS II-1/13-1.2 and 22.3 MARPOL I/28.3 ICLL66+A.320 1988 Protocol to ICLL66 IBC, and IGC	
	Norm. Closed	S, H	No	Yes	No	Yes	SOLAS II-1/13-1.3, 22.3 and 24.4	See Note 1
	Perm. Closed	S, H	No	No	No	Yes	24.3, and 24.4 Perm. SOLAS II-1/ 13-1.4, Closed S, H No No No Yes See Notes 3 + 4 13-1.5, 22.2, 24.3 and 24.4	See Notes 3 + 4
(2) At or above	Used	POS	Yes	Yes	Yes (local)	No	SOLAS II-1/13-1.2 and 22.3 MARPOL I/28.3 ICLL66+A.320 1988 Protocol to ICLL66 IBC, and IGC	See Notes 2 + 5
	Norm. Closed	S, H	No	Yes	No	Yes	SOLAS II-1/13-1.3, 22.3 and 24.4	See Note 1
	Perm. Closed	S, H	No	No	No	Yes	SOLAS II-1/13-1.4, 13-1.5, 24.3 and 24.4	See Notes 3 + 4

Notes:

Type

- Power operated, sliding or rolling	POS
- Power operated, hinged	POH
- Sliding or Rolling	S
- Hinged	H

1. If hinged, this door shall be of quick acting or single action type.
2. Under ICLL66, doors separating a main machinery space from a steering gear compartment may be hinged quick acting type provided the lower sill of such doors is above the Summer Load Line and the doors remain closed at sea whilst not in use.
3. The time of opening such doors in port and closing them before the ship leaves port shall be entered in the logbook, in case of doors in watertight bulkheads subdividing cargo spaces.
4. Doors shall be fitted with a device which prevents unauthorized opening.
5. Under MARPOL, hinged watertight doors may be acceptable in watertight bulkhead in the superstructure.
6. Passenger ships which have to comply with SOLAS II-1/14.2 require an indicator on the navigation bridge to show automatically when each door is closed and all door fastenings are secured.
7. Refer to the Explanatory Note to Regulation 17.1 of Res.MSC.429(98) regarding sliding watertight doors with a reduced pressure head and sliding semi-watertight doors.

B. Door in External Watertight Boundaries below equilibrium or intermediate waterplane

Position relative to bulkhead or freeboard deck	**1. Frequency of Use while at sea**	**2. Type**	**3. Remote Closure**	**4. Remote Indication**	**5. Audible or Visual Alarm**	**6. Notice**	**7. Regulation**	**8. Comments**
(1) Below	Perm. Closed	S, H	No	Yes	No	Yes	SOLAS II-1/15.9, 15-1.2, 15-1.3, 15- 1.4, 22.6, 22.12 and 24.1	See Notes 2 + 3
(2) At or above	Norm. Closed	S, H	No	Yes	No	Yes	SOLAS II-1/15-1.2	See Note 1
	Perm. Closed	S, H	No	Yes	No	Yes	SOLAS II-1/15-1.2 and 15-1.4	See Notes 2 +3

Notes:

Type

- Power operated, sliding or rolling	POS
- Power operated, hinged	POH
- Sliding or Rolling	S
- Hinged	H

1. If hinged, this door shall be of quick acting or single action type.
2. The time of opening such doors in port and closing them before the ship leaves port shall be entered in the logbook.
3. Doors shall be fitted with a device which prevents unauthorized opening.

Present	Amendment	Note
Part 3 <Guidance>	**Part 3 <Guidance>**	
CHAPTER 14 WATERTIGHT BULKHEADS	**CHAPTER 14 WATERTIGHT BULKHEADS**	
Section 1 ~ 3 <omit>	**Section 1 ~ 3 <same as current>**	
Section 4 Watertight Doors	**Section 4 Watertight Doors**	
401. General [See Rule] **1.** Watertight doors are categorized as the following (1) to (4) corresponding to its purpose and frequency of use. (1) Watertight doors which are to be Permanently Closed at Sea: Such doors are open in port and closed before the ship leaves port. The time of opening/closing such doors is to be entered in the log-book. (e.g. Bulkhead doors for loading /unloading) (2) Watertight doors which are to be Normally Closed at Sea: Such doors are kept closed at sea but may be used if authorized by the officer of the watch and to be closed again after use. (3) Watertight doors which are Normally Open at Sea: Such doors may be left open provided those are always ready to be immediately closed. (4) Watertight doors which are Used at Sea: Such doors are normally used and may be left open provided those are ready to be immediately closed.	<move to Rule>	
402. Type of watertight doors [See Rule] Watertight doors provided in watertight bulkheads are to be sliding type as far as practicable. If hinged doors are used, they are to be accessible at any time and, further, to be protected against damages due to cargoes, etc. by suitable means.	**402. Type of watertight doors [See Rule]** **1.** Watertight doors provided in watertight bulkheads are to be sliding type as far as practicable. If hinged doors are used, they are to be accessible at any time and, further, to be protected against damages due to cargoes, etc. by suitable means. **2.** For passenger ships the watertight doors and their controls are to be located in compliance with **SOLAS II-1/13.5.3** and **II-1/13.7.1.2.2.** *(2020)*	- SC156 3.
403. <omit>	**403. <same as current>**	

Present	Amendment	Note
404. Control **[See Rule]**	**404. Control** ***(2020)*** **[See Rule]**	
1. Where it is necessary to operate the power unit for remote operation of the watertight door required by **404.** of the Rules, means to operate the power unit are also to be provided at remote control stations.	**1.** Where it is necessary to operate the power unit for remote operation of the watertight door required by **404.** of the Rules, means to operate the power unit are also to be provided at remote control stations. The operation of such remote control is to be in accordance with **SOLAS II-1/13.8.1** to **13.8.3.** For tankers, where there is a permanent access from a pipe tunnel to the main pump room, the watertight door shall be capable of being manually closed from outside the main pump room entrance in addition to the requirements above.	- SC156 3.3.2 2nd - SC156 3.3.2 3rd - SC156 3.3.2 4th
	2. With respect to the provisions of **404. 2** of the Rules, for passenger ships, the angle of list at which operation by hand is to be possible is 15 degrees or the maximum angle of heel during intermediate stages of flooding, whichever is the greater.	- SC156 3.3.1 2nd - SC156 3.3.1 3rd
	3. Where indicated in **Table 3.14.3**, the doors are to be capable of being remotely closed by power from the bridge and by hand also from a position above the bulkhead deck for passenger ships as required by **SOLAS II-1/13 7.1.4.**	- SC156 3.3.2 1st
2. Remote controls required by **404.** of the Rules, are to be in accordance with the followings. (1) <omit> (2) The operating console at the navigation bridge is to be provided with a diagram showing the location of each door, with visual indicators to show whether each door is opened or closed. A red light is to indicate a door is fully opened and a green light is to indicate a door is fully closed. When the door is being closed remotely, the red light is to indicate the intermediate position by flashing. The indicating circuit is to be independent of the control circuit for each door.	**4.** Remote controls required by **404.** of the Rules, are to be in accordance with the followings. (1) <same as current> (2) The operating console at the navigation bridge is to be provided with a diagram showing the location of each door, with visual indicators to show whether each door is opened or closed. A red light is to indicate a door is fully opened and a green light is to indicate a door is fully closed. When the door is being closed remotely, the red light is to indicate the intermediate position by flashing. The indicating circuit is to be independent of the control circuit for each door. This applies to cargo ships and passenger ships.	- 2. → 4.
3. <omit>	**5.** <same as current>	- 3. → 5.. - SC156 4. 2nd

Present	Amendment	Note
4. With respect to the provisions of **404.** of the Rules, where a watertight door is located adjacent to a fire door, both doors are to be capable of independent operation, remotely if required and from both sides of the each door.	**6.** With respect to the provisions of **404.** of the Rules, where a watertight door is located adjacent to a fire door, both doors are to be capable of independent operation, remotely if required and from both sides of the each door. Watertight doors may also serve as fire doors but need not be fire-tested notwithstanding the fire resistance of the division in which the watertight doors are fitted. However, such doors fitted above the bulkhead deck on passenger ships shall be tested to the FTP Code in accordance with the division they are fitted. If it is not practicable to ensure self-closing, means of indication on the bridge showing whether these doors are open or closed and a notice stating 'To be kept closed at sea' can be alternative of the self-closing.	- 4. → 6. - SC156 4. 1st
5. The wording "navigation bridge" stated in **404.** of the Rules means the place always served by a watch officer and it normally represents the navigation bridge deckhouse.	**7.** <same as current>	- 5. → 7.
6. With respect to the provisions of **404. 1** of the Rules, an operation capability of the ship listed of 30 degrees to either side is to be verified by prototype tests, etc.	**8.** <same as current>	- 6. → 8.
7. With respect to the provisions of **404. 1** of the Rules, power operated doors are also to be capable of being opened and closed by power, as well as to by manual.	**9.** <same as current>	- 7. → 9.
405. <omit>	**405. <same as current>**	

Present	Amendment	Note
406. Alarm **[See Rule]** An audible alarm required by **406.** of the Rules is to sound from the door begins to move and continue to sound until the door is completely closed.	**406. Alarm** ***(2020)*** **[See Rule]** **1.** An audible alarm required by **406.** of the Rules is to sound from the door begins to move and continue to sound until the door is completely closed. Other audible alarms shall be provided that are distinct from those in the area. For passenger ships the alarm shall sound for at least 5 s but not more than 10 s before the door begins to move and shall continue sounding until the door is completely closed.	- SC156 3.5.2 1st - SC156 3.5.2 2nd
	2. In the case of remote closure by hand operation, an alarm is required to sound only while the door is actually moving. In passenger areas and areas of high ambient noise, the audible alarms are to be supplemented by visual signals at both sides of the doors.	- SC156 3.5.2 3rd
	3. All watertight doors, including sliding doors, operated by hydraulic door actuators, either a central hydraulic unit or independent for each door is to be provided with a low fluid level alarm or low gas pressure alarm, as applicable or some other means of monitoring loss of stored energy in the hydraulic accumulators. This alarm is to be both audible and visible and shall be located on the central operating console at the navigation bridge.	- SC156 3.5.3
407.~ 408. <omit>	**407.~ 408. <same as current>**	
409. Sliding doors **[See Rule]**	**409. Sliding doors** **[See Rule]**	
1. <omit>	**1.** <same as current>	
2. ~~In application to **409. 1** of the Rules, the term "where the Society is satisfied" means the cases as specified in **401. 1** (1) and (2) of the Guidance.~~	**2.** <delete>	
	412. Test ***(2020)***	
	1. Doors which are not immersed by an equilibrium or intermediate waterplane but become intermittently immersed at angles of heel in the required range of positive stability beyond the equilibrium position are to be hose tested.	- SC156 5.2

Present	Amendment	Note
	2. Pressure Testing	
	(1) The head of water used for the pressure test shall correspond at least to the head measured from the lower edge of the door opening, at the location in which the door is to be fitted in the vessel, to the bulkhead deck or freeboard deck, as applicable, or to the most unfavourable damage waterplane, if that be greater. Testing may be carried out at the factory or other shore based testing facility prior to installation in the ship.	- SC156 5.3.1
	(2) The following acceptable leakage criteria should apply to - Doors with gaskets No leakage - Doors with metallic sealing Max leakage 1 liter/min.	- SC156 5.3.2 1
	(3) Limited leakage may be accepted for pressure tests on large doors located in cargo spaces employing gasket seals or guillotine doors located in conveyor tunnels, in accordance with the following Leakage rate(liter/min.) = $\frac{(P+4.572)\times h^3}{6,568}$ where P = perimeter of door opening (m) h = test head of water (m)	- SC156 5.3.2.2
	(4) However, in the case of doors where the water head taken for the determination of the scantling does not exceed 6.10 m, the leakage rate may be taken equal to 0.375 liter/min if this value is greater than that calculated by the above-mentioned formula.	- SC156 5.3.2.3
	(5) For doors on passenger ships which are normally open and used at sea or which become submerged by the equilibrium or intermediate waterplane, a prototype test shall be conducted, on each side of the door, to check the satisfactory closing of the door against a force equivalent to a water height of at least 1 m above the sill on the centre line of the door.	- SC156 5.3.3
⚓	**3.** All watertight doors shall be subject to a hose test in accordance with **Annex 1-16 of Guidance Pt 1.** after installation in a ship. Hose testing is to be carried out from each side of a door unless, for a specific application, exposure to floodwater is anticipated only from one side. Where a hose test is not practicable because of possible damage to machinery, electrical equipment insulation or outfitting items, it may be replaced by means such as an ultrasonic leak test or an equivalent test. ⚓	- SC156 5.4

Table 3.14.3 : Doors in Internal Watertight Bulkheads and External Watertight Boundaries in Passenger Ships *(2020)*

A. Door in Internal Watertight Bulkheads

Position relative to bulkhead or freeboard deck	**1. Frequency of Use while at sea**	**2. Type**	**3. Remote Closure**	**4. Remote Indication**	**5. Audible or Visual Alarm**	**6. Notice**	**7. Regulation**	**8. Comments**
(1) Below	Norm. Closed	POS	Yes	Yes	Yes (local)	No	SOLAS II-1/13.4, 13.5.1, 13.5.2,13.6, 13.7.1,13.8.1, 13.8.2, 22.1, 22.3 and 22.4	Certain doors may be left open, see SOLAS II-1/22.3 and IMO MSC. 1/Circ.1564
	Perm. Closed	S, H	No	No	No	Yes	SOLAS II-1/13.9.1, 13.9.2, 14.2, 22.2 and 22.5	See Notes 3 + 4 + 6
(2) At or above	Norm. Closed	POS, POH	Yes	Yes	Yes (local)	No	SOLAS II-1/17.1 and 22.3	See Note 7
		S, H	No	Yes	Yes (remote)	Yes	SOLAS II-1/17-1.1, 17-1.2, 17-1.3, 23.6 and 23.8	See Note 1
		S, H	No	Yes	Yes (remote)	Yes	SOLAS II-1/17-1.1, 17-1.2, 17-1.3, 22.7 and 23.3 to 23.5	Doors giving access to below Ro-Ro Deck
	Perm. Closed	S, H	No	Yes	Yes (remote)	Yes		See Notes 1 + 3 + 4

Notes:

Type

- Power operated, sliding or rolling	POS
- Power operated, hinged	POH
- Sliding or Rolling	S
- Hinged	H

1. If hinged, this door shall be of quick acting or single action type.
2. Under ICLL66, doors separating a main machinery space from a steering gear compartment may be hinged quick acting type provided the lower sill of such doors is above the Summer Load Line and the doors remain closed at sea whilst not in use.
3. The time of opening such doors in port and closing them before the ship leaves port shall be entered in the logbook, in case of doors in watertight bulkheads subdividing cargo spaces.
4. Doors shall be fitted with a device which prevents unauthorized opening.
5. Under MARPOL, hinged watertight doors may be acceptable in watertight bulkhead in the superstructure.
6. Passenger ships which have to comply with SOLAS II-1/14.2 require an indicator on the navigation bridge to show automatically when each door is closed and all door fastenings are secured.
7. Refer to the Explanatory Note to Regulation 17.1 of Res.MSC.429(98) regarding sliding watertight doors with a reduced pressure head and sliding semi-watertight doors.

B. Door in External Watertight Boundaries below equilibrium or intermediate wate6rplane

Position relative to bulkhead or freeboard deck	**1. Frequency of Use while at sea**	**2. Type**	**3. Remote Closure**	**4. Remote Indication**	**5. Audible or Visual Alarm**	**6. Notice**	**7. Regulation**	**8. Comments**
(1) Below	Perm. Closed	S, H	No	No	No	Yes	SOLAS II-1/15.9, 22.6 and 22.12	See Notes 2 + 3
(2) At or above	Norm. Closed	S, H	No	Yes	No	Yes	SOLAS II-1/17.1 and 22.3 MSC.Circ.541	See Note 1
		S, H	No	Yes	Yes (Remote)	Yes	SOLAS II-1/17-1.1, 17-1.2, 17-1.3, 23.6 and 23.8	Doors giving access to below Ro-Ro Deck
	Perm. Closed	S, H	No	Yes	Yes (Remote)	Yes	SOLAS II-1/17-1.1, 17-1.2, 17-1.3, 23.3 and 23.5	See Notes 2 + 3

Notes:

Type

- Power operated, sliding or rolling	POS
- Power operated, hinged	POH
- Sliding or Rolling	S
- Hinged	H

1. If hinged, this door shall be of quick acting or single action type.
2. The time of opening such doors in port and closing them before the ship leaves port shall be entered in the logbook.
3. Doors shall be fitted with a device which prevents unauthorized opening.

Present	Amendment	Note
Pt. 3 <Rule> **CHAPTER 1 GENERAL** **Section 2 General** **205. Equivalency** Alternative hull construction, equipment, arrangement and scantlings will be accepted by the Society, provided that the Society is satisfied that such construction, equipment, arrangement and scantlings are equivalent to those required in the Rules.	**Pt. 3 <Rule>** **CHAPTER 1 GENERAL** **Section 2 General** **205. Equivalency** The equivalence of alternative and novel features which deviate from or are not directly applicable to the Rules is to be in accordance with **Pt 1, Ch 1** of Rules for the Classification of Steel Ships. (2020)	
Pt. 10 <Rule> **CHAPTER 1 GENERAL** **Section 2 General** **204. Equivalency** Alternative hull construction, equipment, arrangement and scantlings will be accepted by the Society, provided that the Society is satisfied that such construction, equipment, arrangement and scantlings are equivalent to those required in the Rules.	**Pt. 10 <Rule>** **CHAPTER 1 GENERAL** **Section 2 General** **204. Equivalency** The equivalence of alternative and novel features which deviate from or are not directly applicable to the Rules is to be in accordance with **Pt 1, Ch 1** of Rules for the Classification of Steel Ships. (2020)	

Errata

(External Review)

Hull - Pt.3, Pt.7, Pt.10

2019. 8.

Hull Rule Development Team

Present	Amendment	Note
Pt. 3 <Rule>	**Pt. 3 <Rule>**	
CHAPTER 9 WEB FRAMES AND SIDE STRINGER	**CHAPTER 9 WEB FRAMES AND SIDE STRINGER**	
Section 2 Web Frames	**Section 2 Web Frames**	
201. Scantlings	**201. Scantlings**	
1. <omit>	**1.** <omit>	
Thickness of web : t_1 or t_2, whichever is the greater.	Thickness of web : t_1 or t_2, whichever is the greater.	
$t_1 = \frac{C_2 KShl}{d_0} + 1.5$ (mm), $\underline{t_1 = 0.086 \sqrt[3]{\frac{d_0^2(t_1 - 1.5)}{kK}} + 1.5}$ (mm)	$t_1 = \frac{C_2 KShl}{d_0} + 1.5$ (mm), $\underline{t_2 = 0.086 \sqrt[3]{\frac{d_0^2(t_1 - 1.5)}{kK}} + 1.5}$ (mm)	- t_1 → t_2

Present

Pt. 3 <Guidance>

CHAPTER 7 DOUBLE BOTTOMS

Section 8 Construction of Strengthened Bottom Forward

801. Application

2. In ships of which L and C_b are not more than 150 m and 0.7 respectively and $V/\sqrt{L}$ is 1.4 and over, the construction of bottom forward is to be as required in the followings.

CHAPTER 8 FRAMES

Table 3.8.1 Coefficient K_p

β_0	K_p
$\beta_0 < 3^0$	255.85
$3^0 \leq \beta < 4^0$	$758.60\ e^{-0.3623\beta_0}$
$4^0 \leq \beta < 6^0$	$453.91\ e^{-0.2339\beta_0}$
$6^0 \leq \beta < 10^0$	$335.41\ e^{-0.1835\beta_0}$
$10^0 \leq \beta < 15^0$	$173.61\ e^{-0.1176\beta_0}$
$15^0 \leq \beta < 18^0$	$80.523\ e^{-0.0664\beta_0}$
$18^0 \leq \beta_0$	$\underline{1+\frac{\pi}{4}cot^2\beta_0}$

Amendment

Pt. 3 <Guidance>

CHAPTER 7 DOUBLE BOTTOMS

Section 8 Construction of Strengthened Bottom Forward

801. Application

2. In ships of which L and C_b are not more than 150 m and 0.7 respectively and $V/\sqrt{L}$ is 1.4 and over, the construction of bottom forward is to be as required in the followings. However, ships that carry a certain amount of cargo regularly such as Container Ships may comply with the requirements in **802.** to **804.** of the Rules instead.

CHAPTER 8 FRAMES

Table 3.8.1 Coefficient K_p

β_0	K_p
$\beta_0 < 3^0$	255.85
$3^0 \leq \beta < 4^0$	$758.60\ e^{-0.3623\beta_0}$
$4^0 \leq \beta < 6^0$	$453.91\ e^{-0.2339\beta_0}$
$6^0 \leq \beta < 10^0$	$335.41\ e^{-0.1835\beta_0}$
$10^0 \leq \beta < 15^0$	$173.61\ e^{-0.1176\beta_0}$
$15^0 \leq \beta < 18^0$	$80.523\ e^{-0.0664\beta_0}$
$18^0 \leq \beta_0$	$\underline{1+\frac{\pi^2}{4}cot^2\beta_0}$

Note

- missing in English version

Present	Amendment	Note
Annex 3-1 Guidance for Survey and Composition of Loading Manuals **3. Standard loading condition** (1) (G) Partially filled ballast tanks in ballast loading conditions Ballast loading conditions involving partially filled peak and/or other ballast tank at departure, arrival or during intermediate conditions are not permitted to be used as design conditions unless: (a) design stress limits are satisfied for all filling levels between empty and full, and (b) for bulk carriers, Rule **Pt 7, Ch 3, Sec 10**, as applicable, is complied with for all filling levels between empty and full. To demonstrate compliance with all filling levels between empty and full, it will be acceptable if, in each condition at departure, arrival and any intermediate condition, the tanks intended to be partially filled are assumed to be: (a) empty (b) full (c) partially filled at intended level Where multiple tanks are intended to be partially filled, all combinations of empty, full or partially filled at intended level for those tanks are to be investigated. However, for conventional ore carriers with large wing water ballast tanks in cargo area, where empty or full ballast water filling levels of one or maximum two pairs of those tanks lead to the ship's trim exceeding one of the following conditions, it is sufficient to demonstrate compliance with maximum, minimum and intended partial filling levels of those one or maximum two pairs of ballast tanks such that the ship's condition does not exceed any of these trim limits. Filling levels of all other wing ballast tanks are to be considered between empty and full.	**Annex 3-1 Guidance for Survey and Composition of Loading Manuals** **3. Standard loading condition** (1) (G) Partially filled ballast tanks in ballast loading conditions (a) Ballast loading conditions involving partially filled peak and/or other ballast tank at departure, arrival or during intermediate conditions are not permitted to be used as design conditions unless: (i) design stress limits are satisfied for all filling levels between empty and full, and (ii) for bulk carriers, Rule **Pt 7, Ch 3, Sec 10**, as applicable, is complied with for all filling levels between empty and full. (b) To demonstrate compliance with all filling levels between empty and full, it will be acceptable if, in each condition at departure, arrival and any intermediate condition, the tanks intended to be partially filled are assumed to be: (i) empty (ii) full (iii) partially filled at intended level (c) Where multiple tanks are intended to be partially filled, all combinations of empty, full or partially filled at intended level for those tanks are to be investigated. (d) However, for conventional ore carriers with large wing water ballast tanks in cargo area, where empty or full ballast water filling levels of one or maximum two pairs of those tanks lead to the ship's trim exceeding one of the following conditions, it is sufficient to demonstrate compliance with maximum, minimum and intended partial filling levels of those one or maximum two pairs of ballast tanks such that the ship's condition does not exceed any of these trim limits. Filling levels of all other wing ballast tanks are to be considered between empty and full.	- renumber

Present	Amendment	Note
However, for conventional ore carriers with large wing water ballast tanks in cargo area, where empty or full ballast water filling levels of one or maximum two pairs of those tanks lead to the ship's trim exceeding one of the following conditions, it is sufficient to demonstrate compliance with maximum, minimum and intended partial filling levels of those one or maximum two pairs of ballast tanks such that the ship's condition does not exceed any of these trim limits. Filling levels of all other wing ballast tanks are to be considered between empty and full. The trim conditions mentioned above are: (a) trim by stern of 3% of the ship's length, or (b) trim by bow of 1.5% of the ship's length, or (c) any trim that cannot maintain propeller immersion(I/D) not less than 25 %, where; I : the distance from propeller centerline to the waterline D : propeller diameter (see **Fig 1**) The maximum and minimum filling levels of the above mentioned pairs of side ballast tanks are to be indicated in the loading manual.	(d) However, for conventional ore carriers with large wing water ballast tanks in cargo area, where empty or full ballast water filling levels of one or maximum two pairs of those tanks lead to the ship's trim exceeding one of the following conditions, it is sufficient to demonstrate compliance with maximum, minimum and intended partial filling levels of those one or maximum two pairs of ballast tanks such that the ship's condition does not exceed any of these trim limits. Filling levels of all other wing ballast tanks are to be considered between empty and full. The trim conditions mentioned above are: (i) trim by stern of 3% of the ship's length, or (ii) trim by bow of 1.5% of the ship's length, or (iii) any trim that cannot maintain propeller immersion(I/D) not less than 25 %, where; I : the distance from propeller centerline to the waterline D : propeller diameter (see **Fig 1**) The maximum and minimum filling levels of the above mentioned pairs of side ballast tanks are to be indicated in the loading manual.	

Amendments of Guidance

(External review)

Pt. 3 Hull Structures

2019. 11.

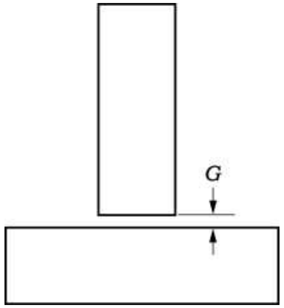
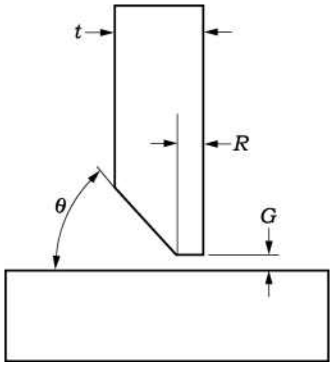
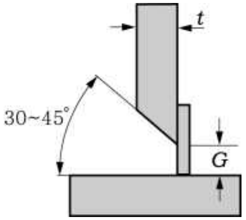
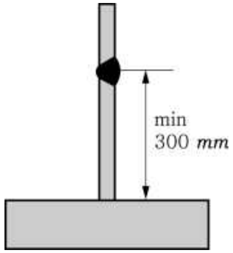
Hull Rule Development Team

Present	Amendment	Note

Annex 3-4 Guidance for the Hull Construction Monitoring Procedure

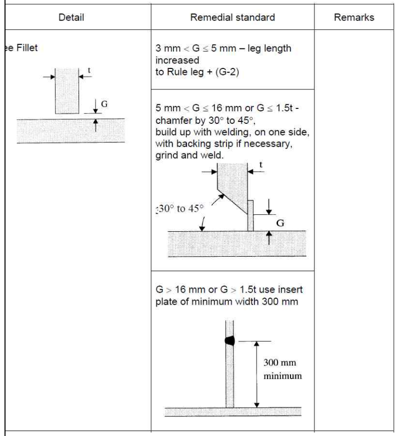
1. ~ 6. <omit>

Table 5 Fillet weld fit-up repair

Detail	Repair Standard	Note
 	<u>2 mm</u> $<$ G $\leq$ 5 mm : length of weld to Rule leg by $+(G-2)$	~~For cruciform joints :~~ ~~1) 3 mm $<$ G $\leq$ 6 mm~~ ~~The weld should be full penetration and subject to additional ultrasonic NDE using both 45° and 70° probes, to the satisfaction of the surveyor.~~ ~~2) G $>$ 6 mm~~ ~~The joint is to be adjusted until compliance is reached or an insert plate is to be fitted to the satisfaction of the surveyor.~~
	5 mm $<$ G $\leq$ 16 mm : champer to 30°- 45°, build up with welding on one side, with or without backing bar, remove backing strip if used, back gouge and seal with weld. 	
	G $\leq$ 16 mm or G $>$ $1.5t$ Insert plate of min width 300 mm to be used 	

- IACS Rec. 47 참조

TABLE 9.6 - Typical Fillet Weld Plate Edge Preparation Remedial



Detail	Remedial standard	Remarks
e Fillet	3 mm < G ≤ 5 mm – leg length increased to Rule leg + (G-2)	
	5 mm < G ≤ 16 mm or G ≤ 1.5t - chamfer by 30° to 45°, build up with welding, on one side, with backing strip if necessary, grind and weld.	
	G > 16 mm or G > 1.5t use insert plate of minimum width 300 mm	

<table>
<tr><th>Present</th><th>Amendment</th><th>Note</th></tr>
<tr><td></td><td>

Annex 3-4 Guidance for the Hull Construction Monitoring Procedure

1. ~ 6. <same as current>

Table 5 Fillet weld fit-up repair

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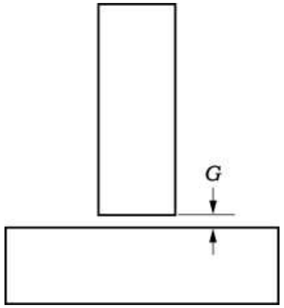
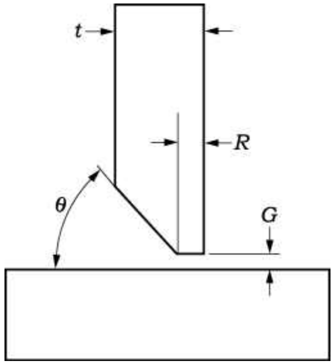
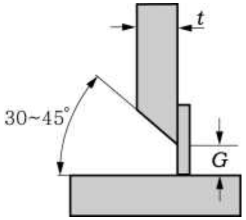
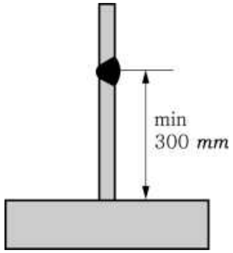
<tr><td rowspan="3">


</td><td>$3\text{ mm} < G \leq 5\text{ mm}$:
length of weld to Rule leg by + $(G-2)$</td><td rowspan="3">-</td></tr>
<tr><td>$5\text{ mm} < G \leq 16\text{ mm}$:
champer to 30°- 45°, build up with welding on one side, with or without backing bar, remove backing strip if used, back gouge and seal with weld.

</td></tr>
<tr><td>$G \leq 16\text{ mm}$ or
$G > 1.5t$
Insert plate of min width 300 mm to be used

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</td><td>- refer IACS Rec. 47</td></tr>
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Amendments of the Guidance

Pt. 3 Hull Structures

(External review)

2019. 11.

Hull Rule Development Team

Present	Amendment	Note
CHAPTER 15 DEEP TANKS <Guidance>	**CHAPTER 15 DEEP TANKS <Guidance>**	
Section 1 <omit>	**Section 1 <same as current>**	
Section 2 Bulkheads of Deep Tank	**Section 2 Bulkheads of Deep Tank**	
202. Bulkhead plates 【See Rule】	**202. Bulkhead plates 【See Rule】**	
1. ~ **3.** <omit>	**1.** ~ **3.** <same as current>	
4. For the thickness of deep tank bulkhead plating in Type A independent tanks, the following value of C_2 and h is to be used for the formula specified in **202.** in the Rules	**4.** For the thickness of deep tank bulkhead plating in Type A independent tanks, the following value of C_2 and h is to be used for the formula specified in **202.** in the Rules	
C_2 = 3.6	C_2 = 3.6	
h = water head, equal to internal pressure in **Pt 7, Ch 5, 403. 2. is to be calculated by dividing 10.**	h = water head(m), equal to internal pressure in **Pt 7, Ch 5, 413. 2.** is to be calculated by multiplying 100.	
203. ~ 209. <omit>	**203. ~ 209. <same as current>**	

Amendments of the Guidance

(Internal review)

Pt. 3 Hull Structures

2020. 02.

Hull Rule Development Team

Present	Amendment	Note
Pt. 3 Hull Structure <Rule> **Ch.4 PLATE KEELS AND SHELL PLATINGS** **Section 1 General** **101. <omit>** **102. Special consideration for contact with the quay, etc.** In cases where the service condition of the ship is considered to be such that there is possibility of indent of shell plating due to contact with the quay, etc., special consideration is to be given to the thickness of shell plating. **103. ~ 105. <omit>** **Section 2 ~ Section 7 <omit>** ⚓	**102. Special consideration for contact with the quay, etc. 【See Guidance】** <same as current>	<reference>
Pt. 3 Hull Structure <Guidance> **Ch.4 PLATE KEELS AND SHELL PLATINGS** **Section 1 General** <newly added> **103. <omit>** **Section 3 ~ Section 7 <omit>** ⚓	**Pt. 3 Hull Structure <Guidance>** **Ch.4 PLATE KEELS AND SHELL PLATINGS** **Section 1 General** **102. Special consideration for contact with the fishing gear, etc. 【See Rule】** In cases where the service condition of the ship is considered to be such that there is possibility of indent of shell plating due to contact with the fishing gear etc., special consideration is to be given to the thickness of shell plating. However, the Rules and Guidance 102. may not apply where the shell is protected by suitable accessories such as fenders. **103. <same as current>** **Section 3 ~ Section 7 <same as current>** ⚓	

Amendments of the Guidance

(Internal review)

Pt. 3 Hull Structures

2020. 02.

Hull Rule Development Team

Present	Amendment	Note
CHAPTER 9 WEB FRAMES AND SIDE STRINGER <Rule>	**CHAPTER 9 WEB FRAMES AND SIDE STRINGER <Rule>**	
Section 1 ~ Section 3 <omit>	**Section 1 ~ Section 3 <same as current>**	
Section 4 Side Transverse	**Section 4 Side Transverse**	
401. ~ 404. <omit>	**401. ~ 404. <same as current>**	
404. Attachments	**404. Attachments 【See Guidance】**	<Refer>
1. A stiffener is to be provided on the web at every longitudinal except for the middle part of the span of where stiffeners may be provided at alternate longitudinals.	**1.** A stiffener is to be provided on the web at every longitudinal except for the middle part of the span of where stiffeners may be provided at alternate longitudinals.	
2. Webs of longitudinals and side transverses are to be connected each other.	**2.** Webs of longitudinals and side transverses are to be connected each other.	
Section 5 Cantilever Beams <omit>	**Section 5 Cantilever Beams <same as current>**	
⚓	⚓	

Present	Amendment	Note
CHAPTER 9 WEB FRAMES AND SIDE STRINGER <Guidance>	**CHAPTER 9 WEB FRAMES AND SIDE STRINGER <Guidance>**	
Section 1 <omit>	**Section 1 <same as current>**	
<newly added>	**Section 4 Side Transverse** **404. Attachments 【See Rules】** **1.** With respect to the requirements of **404. 1** of the Rules, in case where the side transverse and adjacent structures are sufficiently strengthened, the requirements of **404. 1** may be considered as appropriate.	
Section 5 Cantilever Beams <omit>	**Section 5 Cantilever Beams <same as current>**	
⚓	⚓	

Amendments of Guidance

(For external opinion inquiry)

Pt. 3 Hull Structures

2020. 2.

Hull Rule Development Team

Present	Amendment	Reason
Annex 3-2 Guidance for the Direct Strength Assessment	**Annex 3-2 Guidance for the Direct Strength Assessment**	
I. General ⟨omitted⟩	**I. General ⟨same as the current Rules⟩**	
II. Direct Global Structural Analysis	**II. Direct Global Structural Analysis**	
1. General	**1.General**	
(1) Application	(1) Application	
(A) ~ (B) ⟨omitted⟩	(A) ~ (B) ⟨same as the current Rules⟩	
(C) It is recommended to use design loads in North atlantic, which is equivalent to 10^{-8} probability level of exceedance. *(2019)*	⟨Moved to 5. (3)⟩	
(D) ~ (E)	(C) ~ (D)	
(2) Documentation	(2) Documentation	
The followings should be presented to the Society for approval of the direct global structural analysis in accordance with this Guidance.	The followings should be presented to the Society for approval of the direct global structural analysis in accordance with this Guidance.	
- basic input(drawings, loading manual, etc) - structural model - hydrodynamic model - mass model - assumptions and theory used in analysis - results of the seakeeping and hydrodynamic analysis - results of the structural analysis	(A) List of drawings used for the direct global structural analysis(including date and revision number). (B) Information about the software used in the hydrodynamics and structural analysis (name, version and reference of the software). (C) Description of the idealized part of the structural modeling compared to the drawings. (D) Structural modeling information, including steel grades, plate thicknesses, and stiffener dimensions (figure and table). (E) Details of boundary conditions applied to structural analysis (figure and table). (F) Result of motion analysis and load analysis (transfer function, design wave calculation result, etc.). (G) Structural analysis results at design wave condition (figure and table). (a) Deformation shape and magnitude of structural analysis model.	

Present	Amendment	Reason
	(b) Stress contour and allowable stress ratio of all members. (c) Buckling strength of plate member. (H) The design amendment and evaluation result when the allowable stress and buckling strength evaluation is not satisfied.	
(3) 〈omitted〉	(3) 〈same as the current Rules〉	
2. Hydrodynamic model 〈omitted〉	**2. Hydrodynamic model 〈same as the current Rules〉**	
3. Structural model	**3. Structural model**	
(1) Modeling of structure	(1) Modeling of structure	
(A) The model of structure to be analysed is to include its surrounding members which are considered to have a material influence on the behaviors of the members.	(A) The extent of the finite element model is all hull structures, including superstructures, for the full breadth and length of the ship. All main longitudinal and transverse structural elements are to be modelled. These include: (a) Inner and outer shell, (b) Deck, (c) Double bottom floors and girders, (d) Transverse and vertical web frames, (e) Hatch coamings, (f) Stringers, (g) Transverse and longitudinal bulkhead structures, (h) Other primary supporting members, (i) Other structural members which contribute to hull girder strength.	
(B) A proper selection of shell elements, beam elements and truss elements is to be made to represent the global stiffness of the hull precisely.	(B) Four or three node shell elements and two node beam element are to be used for the finite element model.	
	(C) All stiffeners are to be modelled with beam elements having axial, torsional, bi-directional shear and bending stiffness. Face plates of primary supporting members and brackets are to be modelled using rod or beam elements.	
	(D) The aspect ratio of the shell elements is in general not to exceed 3. The use of triangular shell elements is to be kept to a minimum. Where possible, the aspect ratio of shell elements in areas where there are likely to behigh stresses or a high stress gradient is to be kept close to 1 and the use of triangular elements is to be avoided.	

<table>
<tr><th>Present</th><th>Amendment</th><th>Reason</th></tr>
<tr><td>(C) The scantlings is to be modelled with corrosion addition.</td><td>(E) The scantlings is to be modelled with corrosion addition.</td><td></td></tr>
<tr><td>(D) In general, one shell element may be used to model the structures between girders or floors in the global structural analysis. However, if the structural analysis is carried out to get deformation response and nominal stresses of the structural members in the midship hold area, the modelling is to be done in accordance with III. Hold Analysis. For the critical areas where the element size is not small enough to get a proper structural response, finer mesh divisions should be used. The finer mesh models may be solved separately in the condition of same boundary conditions as the global structural model.</td><td>(F) In general, the shell element mesh is to follow the stiffening system as far as practicable, hence representing the actual plate panels between stiffeners.</td><td></td></tr>
<tr><td>(E) The proper size of meshes should be selected to consider the stress distribution predicted in the model and to avoid abnormally large aspect ratios of meshes.</td><td>〈deleted〉</td><td></td></tr>
<tr><td>(F) If a shell element is stiffened by several stiffeners, two equivalent stiffeners each of which has the half of the total stiffness, may be modelled along the both sides of the element.</td><td></td><td></td></tr>
<tr><td>(G) The effective cross-section area of a stiffener is to decided according to following Table 1 which depends on the end connection.</td><td>(G) At least 3 elements over the depth of double bottom girders, floors, transverse web frames, vertical web frames and horizontal stringers on transverse bulkheads.</td><td></td></tr>
<tr><td>Table 1 Line element effective cross-section area
<table>
<tr><th>End connection</th><th>Effective cross-section area</th></tr>
<tr><td>sniped both ends</td><td>30 % cross-section area of stiffener</td></tr>
<tr><td>sniped one end, connected other end</td><td>70 % cross-section area of stiffener</td></tr>
<tr><td>connected both ends</td><td>100 % cross-section area of stiffener</td></tr>
<tr><td>Primary member face bars</td><td>100 % cross-section area</td></tr>
</table></td><td>〈deleted〉</td><td></td></tr>
<tr><td>(H) Model check 〈omitted〉
(2) Boundary conditions 〈omitted〉</td><td>(H) Model check〈same as the current Rules〉
(2) Boundary conditions 〈same as the current Rules〉</td><td></td></tr>
<tr><td>4. Mass model 〈omitted〉</td><td>4. Mass model 〈same as the current Rules〉</td><td></td></tr>
</table>

Present	Amendment	Reason
5. Load analysis (1) Loading condition The loading conditions are to include both of the ballast condition and the full load condition which are most demanded and also include both of the maximum still water sagging and the hogging condition. (2) Hydrostatic loads 〈omitted〉 (3) Hydrodynamic loads (A) In general, zero forward speed is recommended for the purpose of hydrodynamic analysis. (B) Wave heading angles The hydrodynamic load analysis should consider all heading angles from 0˚ to 360˚, with the heading angle spacing less than 30˚. (C) ~ (D) 〈omitted〉 (E) Short-term analysis The short-term analysis is to be carried out based on the transfer functions obtained from the analysis described in (D) above and the wave spectrum which represents the total energy of irregular seaway. The Bretschneider or two parameter Pierson-Moskowitz spectrum is recommended for the North Atlantic, described by the following expression : $S(\omega) = \frac{H_s^2}{4\pi}\left(\frac{2\pi}{T_z}\right)^4 \omega^{-5} \exp\left(-\frac{1}{\pi}\left(\frac{2\pi}{T_z}\right)^4 \omega^{-4}\right)$ where, H_s : Significant wave height (m) ω : Angular wave frequency (rad/s) T_z : Average Zero up-crossing wave period (s)	**5. Load analysis** (1) Loading condition The loading conditions are to include both of the ballast condition and the full load condition which are most demanded and also include both of the maximum still water sagging and the hogging condition. In addition, when the Society considers that the distribution of cargo loads may affect the overall behavior of the ship, additional loading conditions are to be considered. (2) Hydrostatic loads 〈same as the current Rules〉 (3) Hydrodynamic loads (A) It is recommended to use 5 knots for strength analysis and 2/3 of design speed for fatigue analysis. (B) Wave heading angles In the strength analysis, the wave heading angle should be considered in all directions from 0 ° to 360 ° and applied at intervals of up to 30 °. If the structure and loading conditions of the hull are left and right symmetrical and approved by the Society, it may be considered from 0 ° to 180 °. In the fatigue analysis, the wave heading angle should be considered for all directions from 0 ° to 360 °. (C) ~ (D) 〈same as the current Rules〉 (E) Short-term analysis The short-term analysis is to be carried out based on the transfer functions obtained from the analysis described in (D) above and the wave spectrum which represents the total energy of irregular seaway. The Bretschneider or two parameter Pierson-Moskowitz spectrum is recommended for the North Atlantic, described by the following expression : $S_\eta(\omega \vert H_s, T_z) = \frac{H_s^2}{4\pi}\left(\frac{2\pi}{T_z}\right)^4 \omega^{-5} \exp\left[-\frac{1}{\pi}\left(\frac{2\pi}{T_z}\right)^4 \omega^{-4}\right]$ where, H_s : Significant wave height (m) ω : Angular wave frequency (rad/s) T_z : Average Zero up-crossing wave period (s)	

Present	Amendment	Reason
$T_z = 2\pi\left(\frac{m_0}{m_2}\right)^{\frac{1}{2}}$ The spectral moments of order n of the response process for a given heading may be described as $m_n = \int_\omega \sum_{\theta_0-90^\circ}^{\theta_0+90^\circ} f_s(\theta)\omega^n S(\omega\|H_s, T_z, \theta)d\omega$ using a spreading function usually defined as $f_s(\theta) = k\cos^2(\theta)$ where k is selected such that : $\sum_{\theta_0-90^\circ}^{\theta_0+90^\circ} f_s(\theta) = 1$ where, θ_0 : Main wave heading θ : Relative spreading around the main wave heading (F) Long-term analysis The long-term analysis is to be carried out based on the results of short-term analysis described in above (E) and the wave data of the North Atlantic. The scatter diagram shown in **Table 3**(IACS Rec. No. 34)**,** represents the wave data of the North Atlantic which covers the areas designated as 8, 9, 15 and 16 in **Fig 3.**	~~$T_z = 2\pi\left(\frac{m_0}{m_2}\right)^{\frac{1}{2}}$~~ The short-term response spectrum of a ship is calculated using the load transfer function as follows. $S(\omega\|H_s, T_z, \theta) = \|H(\omega\|\theta)\|^2 S_\eta(\omega\|H_s, T_z)$ The spectral moments of order n of the response process for a given heading may be described as $m_n = \int_\omega \sum_{\theta_0-90^\circ}^{\theta_0+90^\circ} f_s(\theta)\left\|\omega - \frac{\omega^2 V}{g}cos\theta\right\|^n S(\omega\|H_s, T_z, \theta)$ using a spreading function usually defined as $f_s(\theta) = k\cos^2(\theta)$ where k is selected such that : $\sum_{\theta_0-90^\circ}^{\theta_0+90^\circ} f_s(\theta) = 1$ where, θ_0 : Main wave heading θ : Relative spreading around the main wave heading (F) Long-term analysis (a) The long-term analysis can be performed using wave data and short-term analysis results obtained in above (E). The wave data used in the strength analysis are for the North Atlantic region corresponding to 8, 9, 15, and 16 in Fig. 3, and are shown in the Table 3 (IACS Rec. No. 34). The wave data used for fatigue analysis is to	

Present	Amendment	Reason
〈newly added〉	be taken as the wave data considering the route of the ship or as recognized by the Society. (b) The wave load for the global structural analysis can be used by multiplying the value of 10^{-8} probability level calculated by the North Atlantic wave data condition with the coefficient $(f_R = 0.85)$ related to the ship operation.	
6. Design waves 〈newly added〉	**6. Design waves** (1) The target load is calculated according to (F) of **5.** (3) and can be replaced by the load specified in the Rules. For the beam sea condition (90° or 270°), the heading correction factor $(f_\beta = 0.8)$ can be additionally applied.	
(1) The design wave is defined as the regular wave that gives the same response level as the long-term value. The heading angle and the wave length of the design wave are chosen as the values where the relevant transfer function has its maximum and the design wave amplitude is chosen as the long-term value divided by the maximum value of the transfer function. If the wave steepness is too high (wave height/wave length〉1/7) it is necessary to choose a slightly longer wave length.	(2) The design wave is defined as the regular wave that gives the same response level as the target load. The heading angle and the wave length of the design wave are chosen as the values where the relevant transfer function has its maximum and the design wave amplitude is chosen as the target load divided by the maximum value of the transfer function. If the wave steepness is too high (wave height/wave length〉1/7) it is necessary to choose a slightly longer wave length and to apply corresponding wave amplitude.	
(2) Dominant Load Parameter (DLP), the basis of design wave determination, should be chosen to assure that structural members, where extreme wave loads may act on or severe stresses may occur, are safe. Following DLPs should be considered necessarily.	(3) Dominant Load Parameter (DLP), the basis of design wave determination, should be chosen to assure that structural members, where extreme wave loads may act on or severe stresses may occur, are safe. Following DLPs should be considered necessarily. In case where deemed necessary by the Society, additional dominant load parameters are to be considered.	
- Vertical bending moment at midship - Horizontal bending moment at midship - Torsional moment at $L/4$, $L/2$ and $3L/4$ - Vertical acceleration at FP - Roll	- Vertical bending moment at midship (including head sea and following sea conditions) - Horizontal bending moment at midship - Torsional moment at $L/4$, $L/2$ and $3L/4$ - Vertical acceleration at FP - Roll - Dynamic pressure acting on ship draught at midship.	
It is necessary to chose other DLPs where the structural safety	It is necessary to chose other DLPs where the structural safety	

Present	Amendment	Reason
should be assured due to its weak structure like a large opening.	should be assured due to its weak structure like a large opening.	
7. Loads transfer 〈omitted〉	**7. Loads transfer 〈same as the current Rules〉**	
8. Structural analysis and acceptance criteria	**8. Structural analysis and acceptance criteria**	
(1) Structural analysis 〈omitted〉	(1) Structural analysis 〈same as the current Rules〉	
〈newly added〉	(2) Structural members to be assessed (A) Structural safety assurance targets hull structural members affected by global behavior due to wave loads. Superstructures and deckhouses which are not continuously arranged in the longitudinal direction of the ship shall not be considered. However, the parts connected with the hull and affected by global behavior are included in the evaluation. (B) Areas of boundary condition in the fore and aft structure where local stress concentration is caused by unbalanced force are excluded from evaluation.	
(2) Acceptance criteria The results of global structural analysis is to be assessed for the failure mode of yielding according to the allowable stress shown in **Table 4**.	(3) Acceptance criteria The results of global structural analysis is to be assessed for the failure mode of yielding according to the allowable stress shown in **Table 4**.	

Present	Amendment	Reason

Table 4 Allowable stress

Structural members	Allowable stress		
	σ_e (N/mm^2)	σ (N/mm^2)	τ (N/mm^2)
Side shell, Double bottom	$0.9\,\sigma_Y/K$	-	-
Double bottom girder	$0.9\,\sigma_Y/K$	$177/K$	$83/K$
Longitudinal bulkhead	$0.9\,\sigma_Y/K$	-	$83/K$
Floor	$0.9\,\sigma_Y/K$	-	$108/K$
Upper deck	$0.9\,\sigma_Y/K$	$177/K$	-
Transverse bulkhead, Web frame	$177/K$	-	$83/K$
Fine mesh structural analysis			
Mean stress	σ_Y/K	-	-
Stress concentrate region	$< 1.2\,\sigma_Y/K$	-	-

(Notes)

1. σ_Y : 235 (N/mm^2)
2. The equivalent stress σ_e is to be as follows.

$$\sigma_e = \sqrt{\sigma_x^2 + \sigma_y^2 - \sigma_x\,\sigma_y + 3\tau^2}$$

σ_x : Normal stress in x-direction of element coordinate system

σ_y : Normal stress in y-direction of element coordinate system

τ : Sheer stress on the face in x-y-direction of element coordinate system

3. σ : σ_x or σ_y

Present	Amendment	Reason

Table 4 Allowable stress

Element type	Allowable stress
Shell element	$\sigma_e (\mathrm{N/mm^2})$
	$0.9\beta\sigma_Y/K$ 3.

(Notes)

1. σ_Y : 235 $\mathrm{N/mm^2}$
2. The equivalent stress σ_e is to be as follows.

$$\sigma_e=\sqrt{\sigma_x^2+\sigma_y^2-\sigma_x\sigma_y+3\tau^2}$$

σ_x : Normal stress in x-direction of element coordinate system
σ_y : Normal stress in y-direction of element coordinate system
τ : Shear stress in $x-y$ plane of element coordinate system

3. β : Mesh density factor taken as;
1.0 for longitudinal spacing mesh size,
1.15 for less than or equal to 200 x 200 mm mesh size,
1.25 for less than or equal to 100 x 100 mm mesh size,
1.5 for less than or equal to 50 x 50 mm mesh size,
1.7 for less than or equal to 2t x 2t mesh size,
where t is thickness of element, in mm.

Present

Table A 3.2.5 Material factor

Steel grades	*K*
A, B, D and *E*	1.0
AH32, DH32 and *EH32*	0.78
AH36, DH36 and *EH36*	0.72
AH40, DH40 and *EH40*	0.68
(newly added)	(newly added)

〈newly added〉

Amendment

Table 5 Material factor

Steel grades	*K*
A, B, D and *E*	1.0
AH32, DH32 and *EH32*	0.78
AH36, DH36 and *EH36*	0.72
AH40, DH40 and *EH40*	0.68(1)
AH47, DH47 and *EH47*	0.62(2)

Note:

(1) 0.66 for material factor provided that a fatigue assessment of the structure is performed to verify compliance with the requirements of **Annex 3-3** "Guidance for the Fatigue Strength Assessment of Ship Structures"

(2) For the application of extremely thick steel for container ships in accordance with **Guidance Pt 7, Annex 7-8**.

9. Local structural strength analysis

(1) Application

In case of (A) to (C) below, local structural strength analysis may be required at the discretion of the Society.

- (A) When the stress calculated by the structural analysis exceeds 95% of the allowable stress (when the element size exceeds 200×200 mm).
- (B) Areas where stress concentration is expected but cannot be assessed through **III. Guidance for the Hold Analysis** due to difficulties in applying loads and boundary conditions.
- (C) When the mesh density is large and it is difficult to reflect the structure in the drawing.

(2) Modelling

- (A) The extent of the fine mesh zone is not to be less than 10 elements in all directions from the area under investigation.
- (B) All plating within the fine mesh zone is to be represented

Reason

Present	Amendment	Reason
	by shell elements. (C) The aspect ratio of elements within the fine mesh zone is to be kept as close to 1 as possible. In all cases, the elements within the fine mesh model are to have an aspect ratio not exceeding 3. (D) Distorted elements, with element corner angles of less than 45° or greater than 135°, are to be avoided. (3) Stress assessment The results of local structural strength analysis should satisfy the allowable stress criteria in Table 4.	
〈newly added〉	**10. Buckling strength** The buckling strength calculation for the structural analysis results is based on **Ⅳ. Buckling strength calculation**.	
III. Guidance for the Hold Analysis	**III. Guidance for the Hold Analysis**	
1. General	**1. General**	
(1) Application 〈omitted〉	(1) Application 〈same as the current Rules〉	
(2) Procedure of hold analysis 〈omitted〉	(2) Procedure of hold analysis 〈same as the current Rules〉	
(3) Modeling of structure	(3) Modeling of structure	
(A) ~ (D) 〈omitted〉	(A) ~ (D) 〈same as the current Rules〉	
(E) The structural models of bulk carriers, double hull tankers, container ships, Ro-Ro and car carrier, membrane tank LNG ships and LPG Carriers with Independent Tank Type A are to comply with the requirements in **3**, **4**, **5**, **6** and **7** respectively.	(E) The structural models of bulk carriers, double hull tankers, container ships, Ro-Ro and car carrier, membrane tank LNG ships and LPG Carriers with Independent Tank Type A are to comply with the requirements in **3**, **4**, **5**, **6**, **7** and **8** respectively.	
(F) ~ (L) 〈omitted〉	(F) ~ (L) 〈same as the current Rules〉	
(4) Model check 〈omitted〉	(4) Model check 〈same as the current Rules〉	
(5) Boundary conditions Reasonable boundary conditions are to be applied to describe the behaviour of actual structure. The boundary conditions of bulk carriers, double hull tankers, container ships, Ro-Ro and car carrier and membrane tank LNG ships are to comply with the requirements in **3**, **4**, **5**, **6** and **7** respectively.	(5) Boundary conditions Reasonable boundary conditions are to be applied to describe the behaviour of actual structure. The boundary conditions of bulk carriers, double hull tankers, container ships, Ro-Ro and car carrier, membrane tank LNG ships and LPG Carriers with Independent Tank Type A are to comply with the requirements in **3**, **4**, **5**, **6**, **7** and **8** respectively.	
(6) ~ (10) 〈omitted〉	(6) ~ (10) 〈same as the current Rules〉	

Present	Amendment	Reason
2. Buckling strength calculation	〈deleted〉	
3. Bulk Carrier (1) ~ (5) 〈omitted〉 (6) Buckling strength Buckling strength assessment to be carried out in accordance with **2.** (7) Fatigue strength 〈omitted〉	**3. Bulk Carrier** (1) ~ (5) 〈same as the current Rules〉 (6) Buckling strength Buckling strength is to be calculated according to **Ⅳ. Buckling strength calculation**. Buckling strength is to satisfy the criteria defined in **1** (5) of **Ⅳ. Buckling strength calculation** based on static load combination. (7) Fatigue strength 〈same as the current Rules〉	
4. Double Hull Oil Tanker (1) ~ (6) 〈omitted〉 (7) Buckling Strength Buckling strength assessment to be carried out in accordance with **Par 2.** (8) Fatigue strength 〈omitted〉	**4. Double Hull Oil Tanker** (1) ~ (6) 〈same as the current Rules〉 (7) Buckling Strength Buckling strength is to be calculated according to **Ⅳ. Buckling strength calculation**. Buckling strength is to satisfy the criteria defined in **1** (5) of **Ⅳ. Buckling strength calculation** based on static load combination. (8) Fatigue strength 〈same as the current Rules〉	
5. Container ship (1) ~ (5) 〈omitted〉 (6) Buckling strength calculation Buckling strength assessment to be carried out in accordance with **2.** However, For LCA-1, buckling safety factor to be applied 1.0.	**5. Container ship** (1) ~ (5) 〈same as the current Rules〉 (6) Buckling strength calculation Buckling strength is to be calculated according to **Ⅳ. Buckling strength calculation**. Buckling strength is to satisfy the criteria defined in **1** (5) of **Ⅳ. Buckling strength calculation** based on static load combination. However, For LCA-1, allowable buckling utilization factor is to be applied 1.0.	
6. Ro-Ro and car carrier (1) ~ (5) 〈omitted〉 (6) Buckling strength calculation Buckling strength assessment is to be carried out in accordance with **2.**	**6. Ro-Ro and car carrier** (1) ~ (5) 〈same as the current Rules〉 (6) Buckling strength calculation Buckling strength is to be calculated according to **Ⅳ. Buckling**	

Present	Amendment	Reason
	strength calculation. Buckling strength is to satisfy the criteria defined in **1** (5) of **Ⅳ. Buckling strength calculation** based on static load combination.	
7. Structural Analysis Procedure for Membrane Tank LNG Carriers (1) ~ (5) 〈omitted〉 (6) Buckling strength calculation (A) Buckling criteria for all load cases in **Table 40** is to be in accordance with **Table 42**. (B) ~ (C) 〈omitted〉	**7. Structural Analysis Procedure for Membrane Tank LNG Carriers** (1) ~ (5) 〈same as the current Rules〉 (6) Buckling strength calculation (A) Buckling strength is to be calculated according to **Ⅳ. Buckling strength calculation**. Buckling criteria for all load cases in **Table 40** is to be in accordance with **Table 42**. (B) ~ (C) 〈same as the current Rules〉	
8. LPG Carriers with Independent Tank Type A (1) ~ (7) 〈omitted〉 (8) Buckling Strength (A) Buckling strength assessment is to be performed for the panels with stresses derived from the FE analysis according to **Pt 11, Ch 6, Sec 3** of the Rule. Stresses obtained from the cargo hold analysis are used and plate thickness of the panel should be deducted as described in (2) (C). $\lambda_{act} < \lambda_{allow}$ λ : Buckling usage factor obtained from **Pt11 Ch6 Sec3 [3.2.4]** of the Rule λ_{allow} : 0.9 for intact load cases : 1.0 for accidental load cases ⚓	**8. LPG Carriers with Independent Tank Type A** (1) ~ (7) 〈same as the current Rules〉 (8) Buckling Strength Buckling strength is to be calculated according to **Ⅳ. Buckling strength calculation**. Buckling strength is to satisfy the criteria defined in **1** (5) of **Ⅳ. Buckling strength calculation** based on static+dynamic load combination except below load cases. Load cases based on static load combination in 1 (5) of **Ⅳ. Buckling strength calculation**: - Table 46 and 47: LC9, LC10 and LC11, - Table 48: LC9 and LC10, - Table 49: LC8, LC9 and LC10. However, for the cargo hold structural members under intact load cases, following enforced buckling criterion is to be applied. $\eta_{act} \le 0.9\,\eta_{all}$ where: η_{act}, η_{all} : refer to **1** (5) of **Ⅳ. Buckling strength calculation.**	

Present	Amendment	Reason
〈newly added〉	**IV. Buckling strength calculation** **1. General** (1) Assumption This Guidance includes buckling strength calculation and criteria for direct strength analysis results of all structural members. Unless otherwise specified, the scantling requirements of structural members are based on net scantling obtained by removing t_c from the gross offered thickness, where t_c is defined in **3** (2), compressive and shear stresses are to be taken as positive, tension stresses are to be taken as negative. (2) Application The buckling checks are to be performed according to: • 2. for the buckling requirements of the FE analysis for the plates, stiffened panels and other structures. • 3. for the buckling capacity of prescriptive and FE buckling requirements. (3) Definitions 'Buckling' is used as a generic term to describe the strength of structures, generally under in-plane compressions and/or shear and lateral load. The buckling strength or capacity can take into account the internal redistribution of loads depending on the load situation, slenderness and type of structure. Buckling capacity based on this principle gives a lower bound estimate of ultimate capacity, or the maximum load the panel can carry without suffering major permanent set. Buckling capacity assessment utilises the positive elastic post-buckling effect for plates and accounts for load redistribution between the structural components, such as between plating and stiffeners. For slender structures, the capacity calculated using this method is typically higher than the ideal elastic buckling stress (minimum Eigen value). Accepting elastic buckling of structural components in slender stiffened panels implies that large elastic deflections and reduced in-plane stiffness will occur at higher buckling utilisation levels. (4) Assessment methods The buckling assessment is carried out according to one of the two methods taking into account different boundary condition types: • Method A: All the edges of the elementary plate panel are forced to remain straight (but free to move in the in-plane directions) due to the surrounding structure/neighbouring plates. • Method B: The edges of the elementary plate panel are not forced to remain straight due to low in-plane stiffness at the edges and/or no surrounding structure/neighbouring plates. (5) Allowable buckling utilization factor A structural member is considered to have an acceptable buckling strength if it satisfies the following criterion: $\eta_{act} \leq \eta_{all}$	

Present | **Amendment** | **Reason**

〈newly added〉

η_{act} : Buckling utilisation factor based on the applied stress, defined in 3.

η_{all} : Allowable buckling utilisation factor as defined in Table 50.

Table 50. Allowable buckling utilization factor

Structural component	Allowable buckling utilisation factor η_{all}
Plates and stiffeners Stiffened and unstiffened panels Vertically stiffened side shell plating of single side skin bulk carrier Web plate in ways of openings	1.00 for load combination: S+D 0.80 for load combination: S
Struts, pillars and cross ties	0.75 for load combination: S+D 0.65 for load combination: S
Corrugation of vertically corrugated bulkheads with lower stool and horizontally corrugated bulkhead, under lateral pressure from liquid loads, for shell elements only. Supporting structure in way of lower end of corrugated bulkheads without lower stool.	0.90 for load combination: S+D 0.72 for load combination: S
Corrugation of vertically corrugated bulkheads without lower stool under lateral pressure from liquid loads, for shell elements only.	0.81 for load combination: S+D 0.65 for load combination: S
Note 1: Supporting structure for a transverse corrugated bulkhead refers to the structure in longitudinal direction within half a web frame space forward and aft of the bulkhead, and within a vertical extent equal to the corrugation depth. Note 2: Supporting structure for a longitudinal corrugated bulkhead refers to the structure in transverse direction within three longitudinal stiffener spacings from each side of the bulkhead, and within a vertical extent equal to the corrugation depth.	

2. Buckling requirements for direct strength analysis

(1) General

The requirements of this Section apply for the buckling assessment of direct strength analysis subjected to compressive stress, shear stress and lateral pressure. All structural elements in the FE analysis are to be assessed individually. The buckling checks have to be performed for the following structural elements:

- Stiffened and unstiffened panels, inclusive curved panels.

Present	Amendment	Reason
〈newly added〉	• Web plate in way of openings. • Corrugated bulkhead. • Vertically stiffened side shell of single side skin bulk carrier. • Struts, pillars and cross ties. (2) Panel modeling and assessment The plate panel of hull structure is to be modelled as stiffened panel, SP or unstiffened panel, UP. Method A and Method B as defined in **1** (4) are to be used according to **Table 51** to **54** and **Figure 61** to **65**. Where the plate thickness along a plate panel is not constant, the panel used for the buckling assessment is to be modelled according to **III. Guidance for the Hold Analysis** with a weighted average thickness taken as: $t_{avr} = \dfrac{\sum_1^n A_i t_i}{\sum_1^n A_i}$ A_i : Area of the *i*-th plate element t_i : Net thickness of the *i*-th plate element. n : Number of finite elements defining the buckling plate panel. The panel yield stress R_{eH_P} is taken as the minimum value of the specified yield stresses of the elements within the plate panel.	

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<tr><td>〈newly added〉</td><td>

Table 51 Assessment method for longitudinal structural elements

<table>
<tr><th>Structural elements</th><th>Assessment method</th><th>Normal panel definition</th></tr>
<tr><td>Longitudinally stiffened panels, shell envelope, deck, inner hull, hopper tank side and longitudinal bulkheads</td><td>SP-A</td><td>Length: between web frames
Width: between primary supporting members</td></tr>
<tr><td>Double bottom longitudinal girders in line with longitudinal bulkhead or connected to hopper tank side</td><td>SP-A</td><td rowspan="4">Length: between web frames
Width: full web depth</td></tr>
<tr><td>Web of double bottom longitudinal girders not in line with longitudinal bulkhead or not connected to hopper tank side</td><td>SP-B</td></tr>
<tr><td>Web of horizontal girders in double side space connected to hopper tank side</td><td>SP-A</td></tr>
<tr><td>Web of horizontal girders in double side space not connected to hopper tank side</td><td>SP-B</td></tr>
<tr><td>Web of single skin longitudinal girders or stringers (regular meshed area)</td><td>SP-B</td><td rowspan="2">Plate between local stiffeners/face plate/PSM</td></tr>
<tr><td>Web of single skin longitudinal girders or stringers (irregular meshed area)</td><td>UP-B</td></tr>
</table>

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Present

〈newly added〉

Amendment

Table 52 Assessment method for transverse structural elements

Structural elements	Assessment method	Normal panel definition
Web of transverse deck frames including brackets (regular meshed area)	SP-B	Plate between local stiffeners/face plate/PSM
Web of transverse deck frames including brackets (irregular meshed area)	UP-B	
Vertical web in double side space	SP-B	Length: full web depth Width: between primary supporting members
Irregularly stiffened panels, e.g. web panels in way of hopper tank and bilge	UP-B	Plate between local stiffeners/face plate/PSM
Double bottom floors	SP-A	Length: full web depth Width: between primary supporting members
Vertical web frame including brackets (regular meshed area)	SP-B	Plate between vertical web stiffeners/face plate/PSM
Vertical web frame including brackets (irregular meshed area)	UP-B	
Cross tie web plate (regular meshed area)	SP-B	
Cross tie web plate (irregular meshed area)	UP-B	

Table 53 Assessment method for transverse oil-tight and watertight bulkheads

Structural elements	Assessment method	Normal panel definition
Regularly stiffened bulkhead panels inclusive the secondary buckling stiffeners perpendicular to the regular stiffener (such as carlings)	SP-A	Length: between primary supporting members Width: between primary supporting members
Irregularly stiffened bulkhead panels, e.g. web panels in way of hopper tank and bilge	UP-A	Plate between local stiffeners/face plate
Web plate of bulkhead stringers including brackets (regular meshed area)	SP-B	Plate between web stiffeners /face plate
Web plate of bulkhead stringers including brackets (irregular meshed area)	UP-B	

Reason

<table>
<tr><th>Present</th><th>Amendment</th><th>Reason</th></tr>
<tr><td>〈newly added〉</td><td>

Table 54 Assessment method for Transverse corrugated bulkheads and cross deck

<table>
<tr><th>Structural elements</th><th>Assessment method</th><th>Normal panel definition</th></tr>
<tr><td>Upper/lower stool including stiffeners</td><td>SP-A</td><td>Length: between internal web diaphragms
Width: length of stool side</td></tr>
<tr><td>Stool internal web diaphragm (regular meshed area)</td><td>SP-B</td><td rowspan="2">Plate between local stiffeners /face plate / PSM</td></tr>
<tr><td>Stool internal web diaphragm (irregular meshed area)</td><td>UP-B</td></tr>
<tr><td>Cross deck</td><td>SP-A</td><td>Plate between local stiffeners/ PSM</td></tr>
</table>

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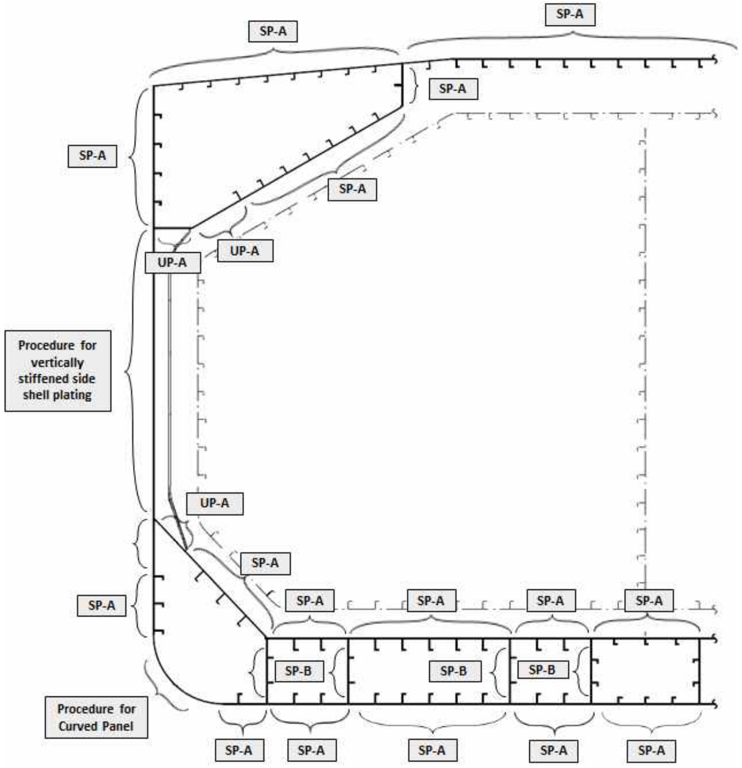
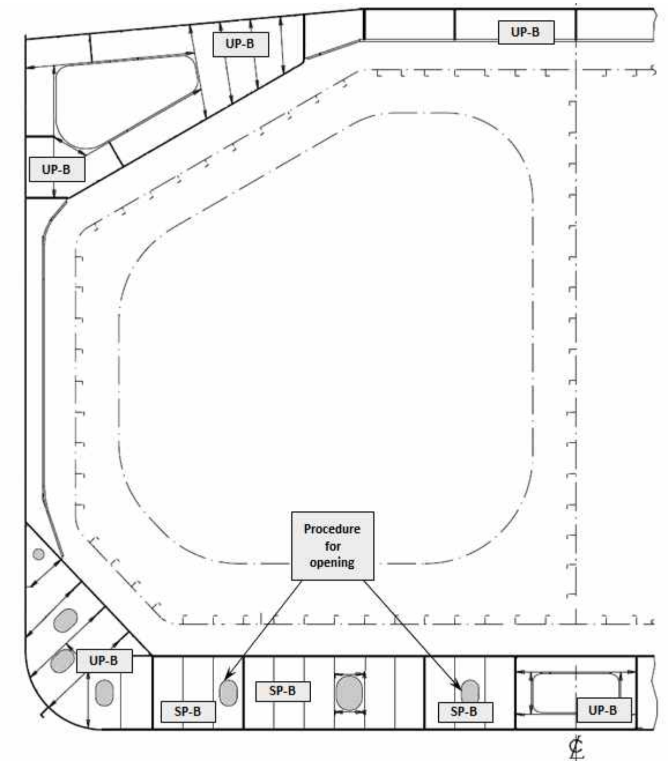
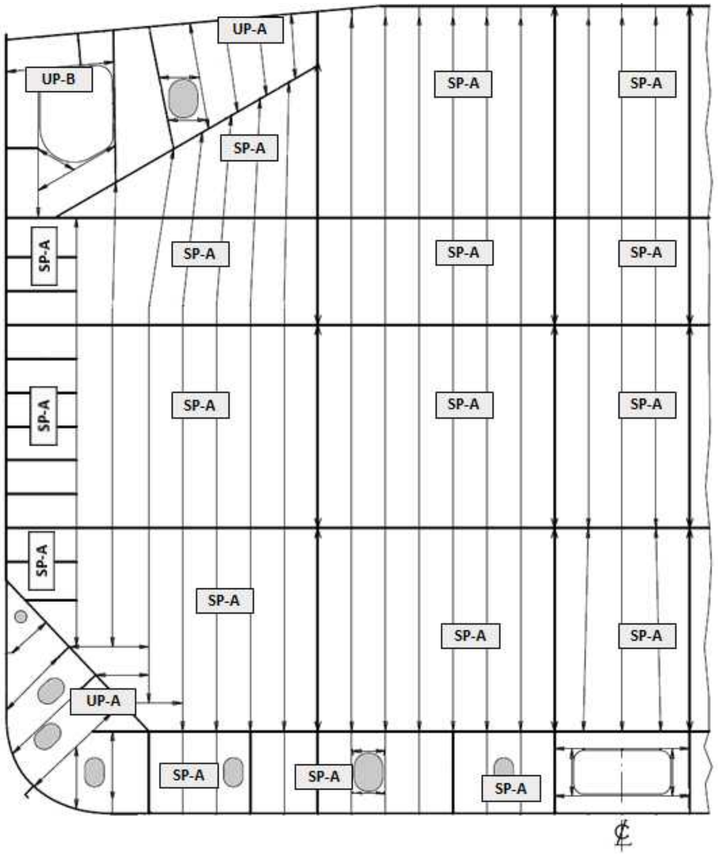
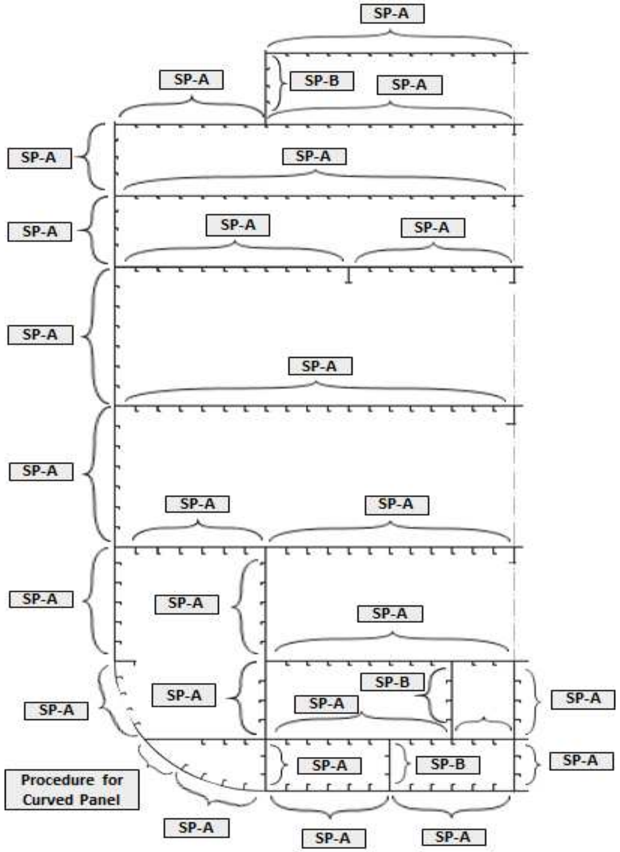
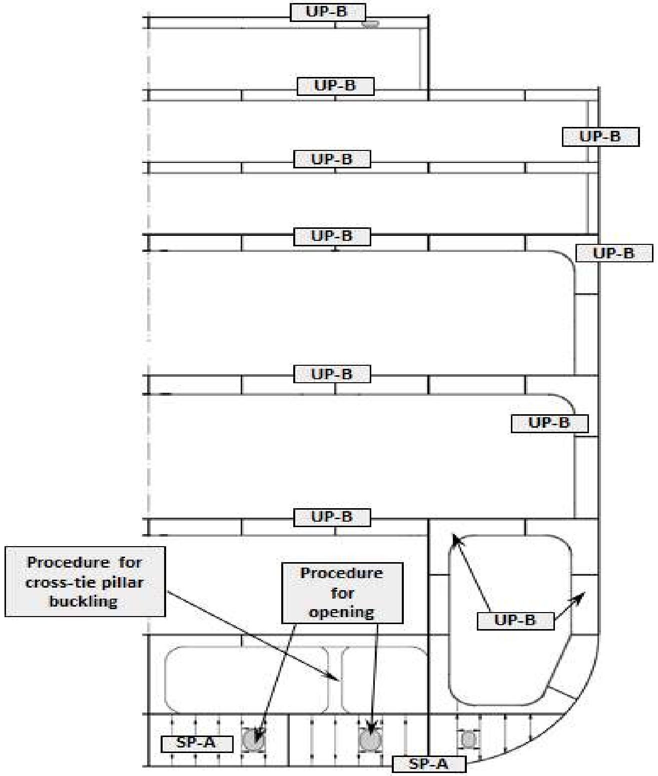
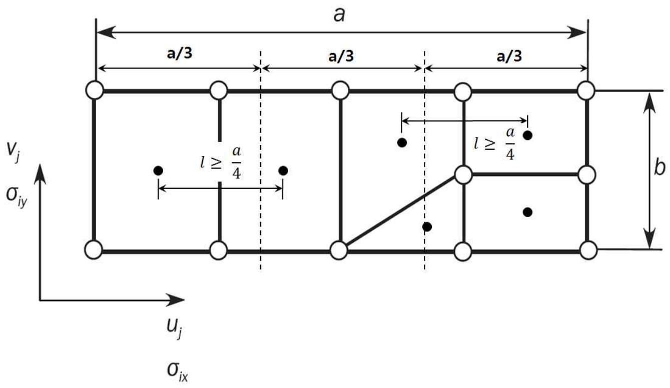
Present	Amendment	Reason
⟨newly added⟩	 Fig 61 Longitudinal plates in LPG carrier (Type A)	

Present	Amendment	Reason
〈newly added〉	 Fig 62 Transverse web frame in LPG carrier (Type A)	

Present	Amendment	Reason
〈newly added〉	 Fig 63 Transverse bulkhead in LPG carrier (Type A)	

Present	Amendment	Reason
〈newly added〉	 Fig 64 Longitudinal plate in car ferry	

Present	Amendment	Reason
〈newly added〉	 Fig 65 Transverse web frame in car ferry	

Present	Amendment	Reason
〈newly added〉	(3) Stiffened panels To represent the overall buckling behaviour, each stiffener with attached plate is to be modelled as a stiffened panel. If the stiffener properties or stiffener spacing varies within the stiffened panel, the calculations are to be performed separately for all configurations of the panels, i.e. for each stiffener and plate between the stiffeners. Plate thickness, stiffener properties and stiffener spacing at the considered location are to be assumed for the whole panel. (4) Unstiffened panels (A) Irregular plate panel In way of web frames, stringers and brackets, the geometry of the panel (i.e. plate bounded by web stiffeners/face plate) may not have a rectangular shape. In this case, an equivalent rectangular panel is to be defined according to (b) for irregular geometry and (c) for triangular geometry and to comply with buckling assessment. (B) Modelling of an unstiffened panel with irregular geometry is to be based on **Pt 13, Sub-pt 1, Ch 8, Sec 4, 2.3.2.** (C) Modelling of an unstiffened plate panel with triangular geometryis to be based on **Pt 13, Sub-pt 1, Ch 8, Sec 4, 2.3.3.** (5) Reference stress The stress distribution is to be taken from the direct strength analysis and applied to the buckling panel model. The reference stresses of buckling panel as shown in **Figure 12** are to be calculated using the Stress based reference stresses as defined in **Pt 13, Sub-pt 1, Ch 8, App 1.**  **Fig 66. Example of buckling panel**	

Present	Amendment	Reason
〈newly added〉	(6) Lateral pressure The lateral pressure applied to the direct strength analysis is also to be applied to the buckling assessment. Where the lateral pressure is not constant over a buckling panel defined by a number of finite plate elements, an average lateral pressure, $\mathrm{N/mm^2}$, is calculated using the following formula: $P_{avr} = \dfrac{\sum_{1}^{n} A_i P_i}{\sum_{1}^{n} A_i}$ where: A_i : Area of the i-th plate element, in $\mathrm{mm^2}$. P_i : Lateral pressure of the i-th plate element, in $\mathrm{N/mm^2}$ n : Number of finite elements in the buckling panel. (7) Buckling criteria of panel Buckling strength of panel is satisfy the criterion defined in **Pt 13, Sub-pt 1, Ch 8, Sec 4, 2.** (8) Buckling criteria of corrugated bulkhead Buckling strength of corrugated bulkhead is satisfy the criterion defined in **Pt 13, Sub-pt 1, Ch 8, Sec 4, 3.** (9) Buckling criteria of vertically stiffened side shell Buckling strength of vertically stiffened side shell is satisfy the criterion defined in **Pt 13, Sub-pt 1, Ch 8, Sec 4, 4.** (refer to **Figure 67**).	

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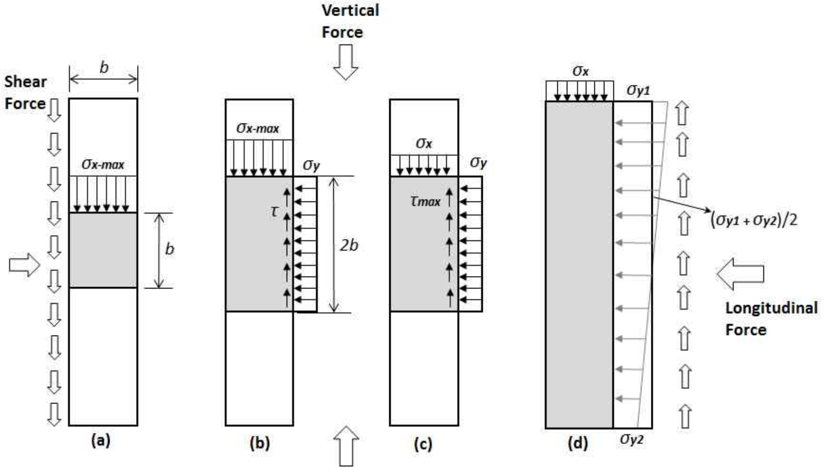

Figure 67 Vertically stiffened side shell

(10) Buckling criteria of strut, pillar and cross ties
Buckling strength of strut, pillar and cross ties is satisfy the criterion defined in **Pt 13, Sub-pt 1, Ch 8, Sec 4, 5.**

3. Buckling capacity

(1) Assessment
Assessment of bucking capacity for panel, stiffener, primary support members, strut, pillar, cross ties anf corrugated bulkhead is to perform according to **Pt 13, Sub-pt** 1, **Ch 9, Sec 5**. As determined by the Society. assessment of local plate panel can only be performed according to **Pt 11, Ch 6, Sec 3** or **Pt 13, Sub-pt 1, Ch 9, Sec 5.**

(2) Application of net thickness
Assessment of buckling capacity is to be based on net thickness extracted by corrosion addition, as shown in **Table 55**, from gross thickness. If the specific corrosion addition depending on a ship type based on measurement data is provided, this corrosion addition can be applied.

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<tr><th>Present</th><th>Amendment</th><th>Reason</th></tr>
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<td>
Table 55 Corrosion addition for each compartment
<table>
<tr><th>Compartment type</th><th>Corrosion addition</th></tr>
<tr><td>Ballast water tank, bilge tank, drain storage tank, chain locker(1)</td><td>1.0</td></tr>
<tr><td>Exposed to atmosphere</td><td>1.0</td></tr>
<tr><td>Exposed to sea water</td><td>1.0</td></tr>
<tr><td>Fuel oil and lube oil tank</td><td>0.5</td></tr>
<tr><td>Fresh water tank</td><td>0.5</td></tr>
<tr><td>Void spaces and dry spaces(2)(3)</td><td>0.0</td></tr>
<tr><td>Accommodation spaces</td><td>0.0</td></tr>
<tr><td>Compartments other than those mentioned above</td><td>0.5</td></tr>
<tr><td colspan="2">Note:
(1) 1.0 mm is to be added to the plate surface within 3 m above the upper surface of the chain locker bottom.
(2) For the determination of the corrosion addition of the outer shell plating, the pipe tunnel is considered as for a ballast water tank.
(3) For bottom plate of compartment, corrosion addition is to be taken equal to 0.5mm.</td></tr>
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Present	Amendment	Reason
Annex 3-3 Guidance for the Fatigue Strength Assessment of Ship Structures *(2017)*	**Annex 3-3 Guidance for the Fatigue Strength Assessment of Ship Structures**	
1. General	**1. General**	
(1) 〈omitted〉	(1) 〈same as the current Rules〉	
(2) The ships, which are contracted for construction on or after 1 July 2015 and are to be complied with Rule **Pt 13,** are to meet all the requirements of the corresponding parts. For other ships deemed necessary by the Society in consideration of the ship's kind, size and configuration, the requirements in this Annex are to be applied.	(2) The ships, which are to be complied with Rule **Pt 13** and **Pt 14,** are to meet all the requirements of the corresponding parts. For other ships deemed necessary by the Society in consideration of the ship's kind, size and configuration, the requirements in this Annex are to be applied.	
(3) For ships which were checked based on the above fatigue analysis method, following class notation are assigned.	(3) For ships which were checked based on the above fatigue analysis method, following class notation is assigned from (A) to (C), including information about evaluated sea area. NA - North Atlantic WW - Worldwide	
(A) The method of simplified fatigue analysis : **SeaTrust(FSA1)**	(A) The method of simplified fatigue analysis : **SeaTrust(FSA1[NA(or WW)])**	
(B) The method of fatigue analysis by hold analysis : **SeaTrust(FSA2)**	(B) The method of fatigue analysis by hold analysis : **SeaTrust(FSA2[NA(or WW)])**	
(C) The method of fatigue analysis by global analysis : **SeaTrust(FSA3)**	(C) The method of fatigue analysis by global analysis : **SeaTrust(FSA3[NA(or WW)])**	
However, in case that **SeaTrust(FSA2) or SeaTrust(FSA3)** is assigned to ships , **SeaTrust(DSA1)** is to be performed.	However, in case that **SeaTrust(FSA2)** or **SeaTrust(FSA3)** is assigned to ships , **SeaTrust(DSA1)** is to be performed.	
(4) 〈newly added〉	(4) Upon the request of the applicant, the design fatigue life which is exceeding 25 years for ships complied with to **Pt 13** and **Pt 14** or exceeding 20 years for other ships can be reviewed additionally. In this case, **[XX years]** is added to the class notation in (3) above (e.g. **SeaTrust(FSA1[WW, 30 years])**).	
(4) ~ (5) 〈omitted〉	(5) ~ (6) 〈same as the current Rules〉	
2. Definition of stress 〈omitted〉	**2. Definition of stress 〈same as the current Rules〉**	
3. Fatigue life assessment	**3. Fatigue life assessment**	
(1) Hot spot stress approach 〈omitted〉	(1) Hot spot stress approach 〈same as the current Rules〉	
(2) Design S-N curve (A) ~ (B) 〈omitted〉	(2) Design S-N curve (A) ~ (B) 〈same as the current Rules〉	

Present

(C) The design S-N curves are defined as the mean(the curves of (A) above) minus two standard deviations and thus correspond to survival probability of 97.6 %. The slopes of these curves are changed beyond $N = 10^7$ cycles considering Haibach effect. (see **Fig 2**)

$$\log N = \log c - mlog\sigma \qquad \text{for } N \leq 10^7$$
$$\log N = \log c' - m' \log\sigma \qquad \text{for } N > 10^7$$

where,

$\log c$ and $\log c'$ = the life intercepts of the S-N curve (See **Table 1**)

m and m' = the negative inverse slopes of the S-N curve (See **Table 1**)

Table 1 Value of $\log c, \log c'$ and m, m'

curves	$N \leq 10^7$		$N > 10^7$	
	$\log c$	m	$\log c'$	m'
B	15.006	4.0	17.006	5.0
C	13.626	3.5	16.466	5.0
D	12.182	3.0	15.625	5.0

Amendment

(C) The design S-N curves are defined as the mean(the curves of (A) above) minus two standard deviations and thus correspond to survival probability of 97.6 %. The slopes of these curves are changed beyond $N = 10^7$ cycles considering Haibach effect. (see **Fig 2**)

$$\log N = \log c - mlog\sigma \qquad \text{for } N \leq 10^7$$
$$\log N = \log c' - m' \log\sigma \qquad \text{for } N > 10^7$$

where,

$\log c$ and $\log c'$ = the life intercepts of the S-N curve (See **Table 1**)

m and m' = the negative inverse slopes of the S-N curve (See **Table 1**)

Table 1 Value of $\log c, \log c'$ and m, m'

curves	$N \leq 10^7$		$N > 10^7$	
	$\log c$	m	$\log c'$	m'
B	15.006	4.0	17.006	6.0
C	13.626	3.5	16.466	5.5
D	12.182	3.0	15.627	5.0

Reason

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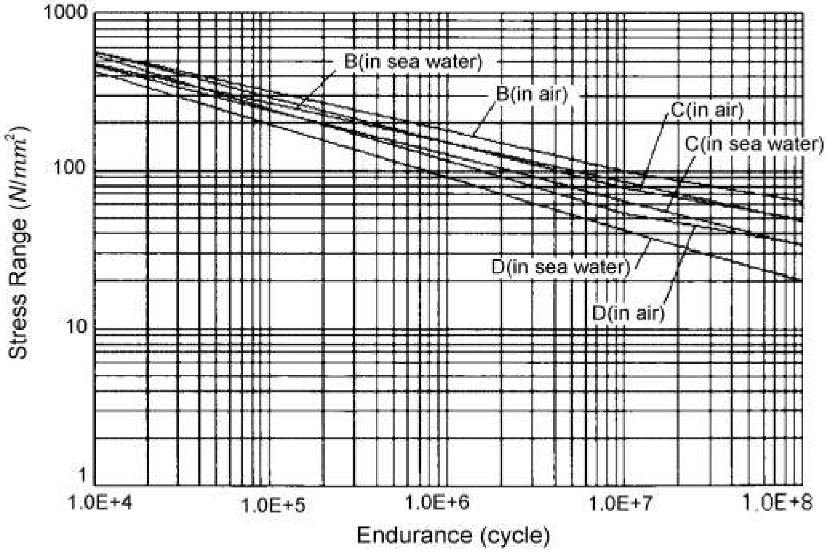

Fig 2 Design S-N curve[*1]

[*1] "Basic Design" S-N Curves for Non-nodal Joint“ given in "Offshore Installation; Guidance on Design, Construction and Certification, Sec. 21, 4th ed. London January, U.K

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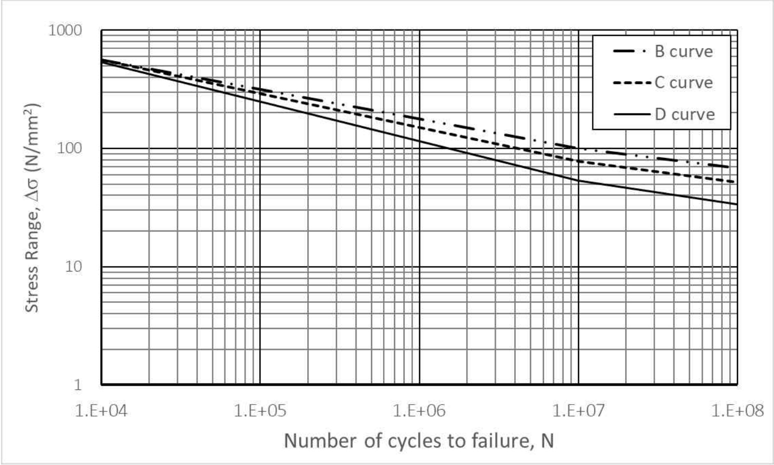
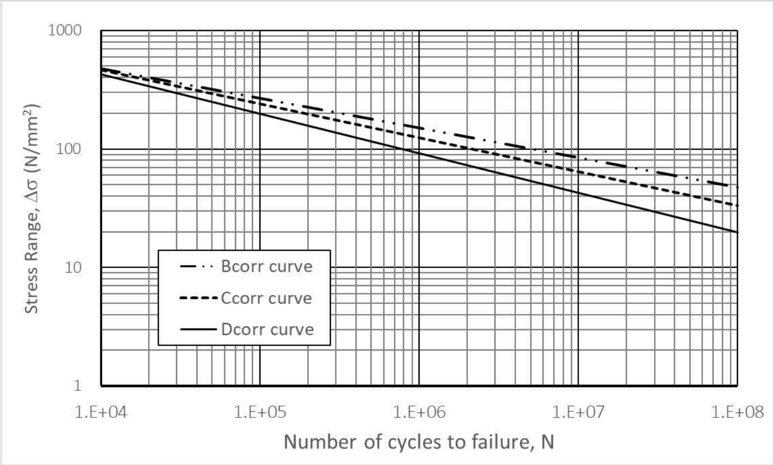


(a) In-air environment



(b) Corrosive environment

Fig 2 Design S-N curve

〈deleted〉

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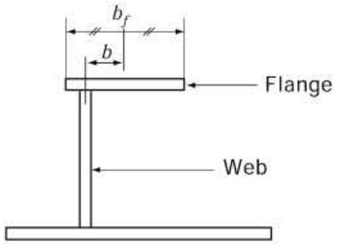
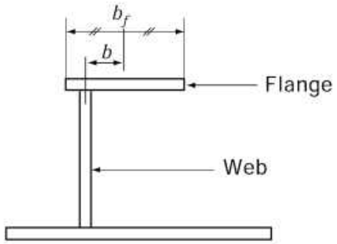
Present	Amendment	Reason
Department of Energy"		
(3) ~ (5) ⟨omitted⟩	(3) ~ (5) ⟨same as the current Rules⟩	
⟨newly added⟩	(6) Material effect For base material free edge, the fatigue stress range can be corrected to consider base material strength in accordance with **Pt 13, Ch 9, Sec 3, 3.1.3.**	
(6) Calculation of fatigue life ⟨omitted⟩	(7) Calculation of fatigue life ⟨same as the current Rules⟩	
4. Simplified fatigue analysis	**4. Simplified fatigue analysis**	
⟨omitted⟩	⟨same as the current Rules⟩	
(1) Fatigue design load ⟨omitted⟩	(1) Fatigue design load ⟨same as the current Rules⟩	
(2) Nominal stress calculation	(2) Nominal stress calculation	
(A) Nominal stress due to axial load	(A) Nominal stress due to axial load	
(a) The wave induced vertical hull girder bending stress range for the structural member is to be calculated as follows:	(a) The wave induced vertical hull girder bending stress range for the structural member is to be calculated as follows:	
(i) For the structural member above the neutral axis:	(i) For the structural member above the neutral axis:	
$\sigma_{nom,V} = \frac{M_w(+) - M_w(-)}{Z_D} \frac{z - z_{NA}}{D - z_{NA}} \times 10^3$ (N/mm^2)	$\Delta\sigma_{nom,V} = \frac{M_w(+) - M_w(-)}{Z_D} \frac{z - z_{NA}}{D - z_{NA}} \times 10^3$ (N/mm^2)	
(ii) For the structural member below the neutral axis:	(ii) For the structural member below the neutral axis:	
$\sigma_{nom,V} = \frac{M_w(+) - M_w(-)}{Z_B} \frac{z_{NA} - z}{z_{NA}} \times 10^3$ (N/mm^2)	$\Delta\sigma_{nom,V} = \frac{M_w(+) - M_w(-)}{Z_B} \frac{z_{NA} - z}{z_{NA}} \times 10^3$ (N/mm^2)	
where,	where,	
Z_D = the section moduli at the strength deck about the horizontal neutral axis (cm^3)	Z_D = the section moduli at the strength deck about the horizontal neutral axis (cm^3)	
Z_B = the section moduli at the bottom about the horizontal neutral axis (cm^3)	Z_B = the section moduli at the bottom about the horizontal neutral axis (cm^3)	

Present	Amendment	Reason
z = the vertical distances from the bottom to the structural member under consideration (m) z_{NA} = the vertical distances from the bottom to the horizontal neutral axis (m) (b) The wave induced horizontal hull girder bending stress range for the structural member is calculated as follows: $\underline{\sigma_{nom,H} = \frac{2\,M_H}{Z_H}\frac{y}{B/2}\times 10^3 \quad (\text{N/mm}^2)}$ where, Z_H = the section modulus at the ship's side about the ship's centerline (cm^3) y = the horizontal distance from the ship's centerline to the structural member under consideration (m) (c) Hull girder wave bending stress range The hull girder wave bending stress range is not to be less than that obtained from the following formula, whichever is the greater: $\underline{\sigma_{nom,g} = 0.5\,\sigma_{nom,V} + \sigma_{nom,H} \quad (\text{N/mm}^2)}$ $\underline{\sigma_{nom,g} = \sigma_{nom,V} \quad (\text{N/mm}^2)}$ (B) Nominal stress due to lateral load Nominal stress on the flange of a longitudinal, at the connection with a transverse web, can be analyzed by using a uniformly loaded beam with both ends fixed in consideration of the effective breadth of the shell plating. In addition, nominal stress is to account for the increased stress due to the asymmetrical section of the longitudinal. Then, the nominal stress on the flange of the longitudinal is defined as	z = the vertical distances from the bottom to the structural member under consideration (m) z_{NA} = the vertical distances from the bottom to the horizontal neutral axis (m) (b) The wave induced horizontal hull girder bending stress range for the structural member is calculated as follows: $\underline{\Delta\sigma_{nom,H} = \frac{2\,M_H}{Z_H}\frac{y}{B/2}\times 10^3 \quad (\text{N/mm}^2)}$ where, Z_H = the section modulus at the ship's side about the ship's centerline (cm^3) y = the horizontal distance from the ship's centerline to the structural member under consideration (m) (c) Hull girder wave bending stress range The hull girder wave bending stress range is not to be less than that obtained from the following formula, whichever is the greater: $\underline{\Delta\sigma_{nom,g} = 0.5\,\Delta\sigma_{nom,V} + \Delta\sigma_{nom,H} \quad (\text{N/mm}^2)}$ $\underline{\Delta\sigma_{nom,g} = \Delta\sigma_{nom,V} \quad (\text{N/mm}^2)}$ (B) Nominal stress due to lateral load Nominal stress on the flange of a longitudinal, at the connection with a transverse web, can be analyzed by using a uniformly loaded beam with both ends fixed in consideration of the effective breadth of the shell plating. In addition, nominal stress is to account for the increased stress due to the asymmetrical section of the longitudinal. Then, the nominal stress on the flange of the longitudinal is defined as	

Present	Amendment	Reason
$\underline{\sigma_{nom,l} = \sqrt{\sigma_e^2 + \sigma_i^2 + 2\rho_c\sigma_e\sigma_i}}$ ρ_c = the correlation factor between the wave load and internal load, being taken as $\rho_c = -0.6$ $\underline{\sigma_e}$ = nominal stress due to external sea pressure load is determined according to the following formula. $\underline{\sigma_e = (1+C_t)\frac{p_d S l^2}{12 Z_f} \times 10^3 \quad (\mathrm{N/mm^2})}$ $\underline{\sigma_i}$ = nominal stress due to liquid cargo or ballast water is determined according to the following formula. $\underline{\sigma_i = (1+C_t)\frac{p_i S l^2}{12 Z_f} \times 10^3 \quad (\mathrm{N/mm^2})}$ p_d = wave pressure (N/mm^2) as specified in (1) (B) (b). p_i = internal pressure load (kN/m^2) due to liquid cargo or ballast water as specified in (1) (C) (a). S = spacing of longitudinal (m) l = spacing of transverse web (m) Z_f = section modulus of longitudinal (cm^3) C_t = the stress increasing factor due to the asymmetrical section of a longitudinal is to be calculated as follows: $C_t = 1.68(0.38 + A_f/A_w)(e^2 + 0.28e)$	$\underline{\Delta\sigma_{nom,l} = \sqrt{\Delta\sigma_e^2 + \Delta\sigma_i^2 + 2\rho_c\Delta\sigma_e\Delta\sigma_i}}$ ρ_c = the correlation factor between the wave load and internal load, being taken as $\rho_c = -0.6$ $\underline{\Delta\sigma_e}$ = nominal stress due to external sea pressure load is determined according to the following formula. $\underline{\Delta\sigma_e = (1+C_t)\frac{p_d S l^2}{12 Z_f} \times 10^3 \quad (\mathrm{N/mm^2})}$ $\underline{\Delta\sigma_i}$ = nominal stress due to liquid cargo or ballast water is determined according to the following formula. $\underline{\Delta\sigma_i = (1+C_t)\frac{p_i S l^2}{12 Z_f} \times 10^3 \quad (\mathrm{N/mm^2})}$ p_d = wave pressure (N/mm^2) as specified in (1) (B) (b). p_i = internal pressure load (kN/m^2) due to liquid cargo or ballast water as specified in (1) (C) (a). S = spacing of longitudinal (m) l = spacing of transverse web (m) Z_f = section modulus of longitudinal (cm^3) C_t = the stress increasing factor due to the asymmetrical section of a longitudinal is to be calculated as follows: $C_t = 1.68(0.38 + A_f/A_w)(e^2 + 0.28e)$	

Present	Amendment	Reason
$e = \frac{b}{b_f}$ A_f = flange area (cm^2) A_w = web area (cm^2) b = distance from the flange center to the web center (cm) (See **Fig 4**) b_f = breadth of the flange (cm) (See **Fig 4**)  **Fig 4** b **and** b_f (C) Nominal stress due to relative deflection (a) At the connection of a longitudinal to a transverse bulkhead, the additional bending stress, due to the relative deflection between the transverse bulkhead and the adjacent transverse web, is to be considered and defined as $\sigma_{nom,r} = \frac{6EI\delta}{Z_f l^2} \times 10^{-5}$ (N/mm^2) where, δ = relative deflection between transverse bulkhead and transverse web (m) I = moment of inertia of longitudinal (cm^4) E = elastic modulus, 2.06×10^5 (N/mm^2) for steel. Z_f = section modulus of longitudinal (cm^3) l = spacing of transverse web (m)	$e = \frac{b}{b_f}$ A_f = flange area (cm^2) A_w = web area (cm^2) b = distance from the flange center to the web center (cm) (See **Fig 4**) b_f = breadth of the flange (cm) (See **Fig 4**)  **Fig 4** b **and** b_f (C) Nominal stress due to relative deflection (a) At the connection of a longitudinal to a transverse bulkhead, the additional bending stress, due to the relative deflection between the transverse bulkhead and the adjacent transverse web, is to be considered and defined as $\Delta\sigma_{nom,r} = \frac{6EI\delta}{Z_f l^2} \times 10^{-5}$ (N/mm^2) where, δ = relative deflection between transverse bulkhead and transverse web (m) I = moment of inertia of longitudinal (cm^4) E = elastic modulus, 2.06×10^5 (N/mm^2) for steel. Z_f = section modulus of longitudinal (cm^3) l = spacing of transverse web (m)	

Present	Amendment	Reason
The relative deflection between the transverse bulkhead and the transverse web can be determined by the three dimensional hold analysis. However, when the relative deflection is not known, the nominal stress due to the relative deflection is assumed to be 50% of the nominal stress due to the lateral load as follows: $\underline{\sigma_{nom,r} = 0.5\sigma_{nom,l}}$ Where the longitudinal is fitted with soft toe brackets on both sides of the transverse bulkhead, the additional bending stress due to the relative deflection may not be considered in the fatigue analysis. (b) In case of double side skin construction, nominal stress due to relative deflection may be calculated according to the Rule **Pt 12, Annex C, 1.4.4.11.** (3) Stress concentration factor (A) The stress concentration factor is defined as the ratio of the hot spot stress $\underline{\sigma_{hot}}$ to the nominal stress $\underline{\sigma_{nom}}$. In the weld connection of the longitudinal and transverse (or trans. BHD) stiffeners, the hot spot stress may be calculated using the stress concentration factors $K_{s,l}$, $K_{s,a}$ in **Table 2** as follow: $\underline{\sigma_{hot,g} = K_{s,g}\sigma_{nom,g}}$ $\underline{\sigma_{hot,l} = K_{s,l}\sigma_{nom,l}}$ where, $K_{s,g}$ = the stress concentration factor by axial load $K_{s,l}$ = the stress concentration factor by lateral load $\underline{\sigma_{nom,g}}$ = nominal stress as specified in (2) (A) (c) $\underline{\sigma_{nom,l}}$ = nominal stress as specified in (2) (B) (B) 〈omitted〉 (4) Combined stress range (A) The combined stress used to calculate the fatigue life of a ship structure is the hot spot stress, which is to be de-	The relative deflection between the transverse bulkhead and the transverse web can be determined by the three dimensional hold analysis. However, when the relative deflection is not known, the nominal stress due to the relative deflection is assumed to be 50% of the nominal stress due to the lateral load as follows: $\underline{\Delta\sigma_{nom,r} = 0.5\Delta\sigma_{nom,l}}$ Where the longitudinal is fitted with soft toe brackets on both sides of the transverse bulkhead, the additional bending stress due to the relative deflection may not be considered in the fatigue analysis. (b) In case of double side skin construction, nominal stress due to relative deflection may be calculated according to the Rule **Pt 12, Annex C, 1.4.4.11.** (3) Stress concentration factor (A) The stress concentration factor is defined as the ratio of the hot spot stress $\underline{\Delta\sigma_{hot}}$ to the nominal stress $\underline{\Delta\sigma_{nom}}$. In the weld connection of the longitudinal and transverse (or trans. BHD) stiffeners, the hot spot stress may be calculated using the stress concentration factors $K_{s,l}$, $K_{s,a}$ in **Table 2** as follow: $\underline{\Delta\sigma_{hot,g} = K_{s,g}\Delta\sigma_{nom,g}}$ $\underline{\Delta\sigma_{hot,l} = K_{s,l}\Delta\sigma_{nom,l}}$ where, $K_{s,g}$ = the stress concentration factor by axial load $K_{s,l}$ = the stress concentration factor by lateral load $\Delta\sigma_{nom,g}$ = nominal stress as specified in (2) (A) (c) $\Delta\sigma_{nom,l}$ = nominal stress as specified in (2) (B) (B) 〈same as the current Rules〉 (4) Combined stress range (A) The combined stress used to calculate the fatigue life of a ship structure is the hot spot stress, which is to be de-	

Present	Amendment	Reason
termined from multiplying the nominal stress in (2) by stress concentration factor in (3). The combined stress determined at the probability level of 10^{-4} is to be complied with the following formulae as the combination of the stress component due to the local load, the hull girder bending load and the relative deflection. $\sigma_0 = f_E \times \max\left\{\begin{array}{l}\sigma_{hot,g}+0.6(\sigma_{hot,l}+\sigma_{hot,r})\\ 0.6\sigma_{hot,g}+\sigma_{hot,l}+\sigma_{hot,r}\end{array}\right.$ where, f_E : Reduction factor on derived combined stress range accounting for the long-term sailing routes of a ship, the following values may be used: f_E = 1.0 for shuttle tankers and vessels that frequently operate in the North Atlantic or in other harsh environments Elsewhere : f_E = 0.8 (B) ~ (C) 〈omitted〉 (5) Calculation of fatigue damage ratio (A) According to the Miner-Palmgren linear cumulative damage rule, the fatigue damage ratio D is calculated using numerical integration as follows: $D = \Sigma \frac{n_i}{N_i}$ where, n_i = number of stress cycles in stress block i for long-term distribution of the combined stress range N_i = number of cycles to failure at the i-th constant stress range.	termined from multiplying the nominal stress in (2) by stress concentration factor in (3). The combined stress determined at the probability level of 10^{-4} is to be complied with the following formulae as the combination of the stress component due to the local load, the hull girder bending load and the relative deflection. $\Delta\sigma_0 = f_E \times \max\left\{\begin{array}{l}\Delta\sigma_{hot,g}+0.6(\Delta\sigma_{hot,l}+\Delta\sigma_{hot,r})\\ 0.6\Delta\sigma_{hot,g}+\Delta\sigma_{hot,l}+\Delta\sigma_{hot,r}\end{array}\right.$ where, f_E : Reduction factor on derived combined stress range accounting for the long-term sailing routes of a ship, the following values may be used: f_E = 1.0 for shuttle tankers and vessels that frequently operate in the North Atlantic or in other harsh environments Elsewhere : f_E = 0.8 (B) ~ (C) 〈same as the current Rules〉 (5) Calculation of fatigue damage ratio (A) According to the Miner-Palmgren linear cumulative damage rule, the fatigue damage ratio D is calculated using numerical integration as follows: $D = \Sigma \frac{n_i}{N_i}$ where, n_i = number of stress cycles in stress block i for long-term distribution of the combined stress range N_i = number of cycles to failure at the i-th constant stress range.	

Present	Amendment	Reason
If the long-term distribution of the stress range follows a Weibull one, the damage ratio D_{air} is given by the following formula:	If the long-term distribution of the stress range follows a Weibull one, the damage ratio D_{air} is given by the following formula:	
$D_{air} = \frac{N_t}{c'}\frac{\sigma_0^{m'}}{(\ln N_0)^{m'/\xi}}\gamma(1+\frac{m'}{\xi},t_7)$ $+\frac{N_t}{c}\frac{\sigma_0^{m}}{(\ln N_0)^{m/\xi}}\Gamma(1+\frac{m}{\xi})-\frac{N_t}{c}\frac{\sigma_0^{m}}{(\ln N_0)^{m/\xi}}\gamma(1+\frac{m}{\xi},t_7)$	$D_{air} = \frac{N_t}{c'}\frac{\Delta\sigma_0^{m'}}{(\ln N_0)^{m'/\xi}}\gamma(1+\frac{m'}{\xi},t_7)$ $+\frac{N_t}{c}\frac{\Delta\sigma_0^{m}}{(\ln N_0)^{m/\xi}}\Gamma(1+\frac{m}{\xi})-\frac{N_t}{c}\frac{\Delta\sigma_0^{m}}{(\ln N_0)^{m/\xi}}\gamma(1+\frac{m}{\xi},t_7)$	
where,	where,	
ξ = Weibull shape parameter	ξ = Weibull shape parameter	
Γ = complete Gamma function given by the following formula	Γ = complete Gamma function given by the following formula	
$\Gamma(z) = \int_0^{\infty} t^{z-1}e^{-t}dt$	$\Gamma(z) = \int_0^{\infty} t^{z-1}e^{-t}dt$	
γ = incomplete Gamma function given by the following formula.	γ = incomplete Gamma function given by the following formula.	
$\gamma(z,x) = \int_0^{x} t^{z-1}e^{-t}dt$	$\gamma(z,x) = \int_0^{x} t^{z-1}e^{-t}dt$	
c, c' and m, m' = as specified in **Table 1**	c, c' and m, m' = as specified in **Table 1**	
t_7 = as specified in the following formula	t_7 = as specified in the following formula	
$t_7 = \left(\frac{\sigma_7}{\sigma_0}\right)^{\xi}\ln N_0$	$t_7 = \left(\frac{\Delta\sigma_7}{\Delta\sigma_0}\right)^{\xi}\ln N_0$	
$\underline{\sigma_7}$ = stress range of the design S-N curve at $N = 10^7$ cycles	$\underline{\Delta\sigma_7}$ = stress range of the design S-N curve at $N = 10^7$ cycles	
N_t = the total number of stress cycles for a design life of	N_t = the total number of stress cycles for a design life of	

Present	Amendment	Reason
ships and considering voyage days of 85% for the design life of Y(years), the total number of stress cycles is given by the following formula. $N_t = \frac{2.68 \times 10^7}{4\log L} \times Y$ (B) For unprotected joints exposed to sea water, the damage ratio D_{cor} is given by $D_{cor} = \frac{N_t}{c_1}\frac{\sigma_0^m}{(\ln N_0)^{m/\xi}}\Gamma(1 + \frac{m}{\xi})$ However, for the structural members protected by effective means in ballast tanks, the damage ratio D is to be calculated as follows: $D = 0.5D_{air} + 0.5D_{cor}$ (C) In case of considering the full loaded condition and the ballast condition as the load condition, the relevant draft is to be applied in the calculation of the local wave pressure range and the fatigue damage ratio at each condition (D_{Full} and $D_{Ballast}$) is to be calculated. Therefore, the formula for calculating the total fatigue damage can be expressed as follow: $D = p_{lF}D_{Full} + p_{lB}D_{Ballast}$ p_{lF} and p_{lB} = probability at the full loaded condition and the ballast condition, where, however, the values are not given, 0.6 and 0.4 may be used	ships and considering voyage days of 85% for the design life of Y(years), the total number of stress cycles is given by the following formula. $N_t = \frac{2.68 \times 10^7}{4\log L} \times Y$ (B) For unprotected joints exposed to sea water, the damage ratio D_{cor} is given by $D_{cor} = \frac{N_t}{c_1}\frac{\Delta\sigma_0^m}{(\ln N_0)^{m/\xi}}\Gamma(1 + \frac{m}{\xi})$ However, for the structural members protected by effective means in ballast tanks, the damage ratio D is to be calculated as follows: $D = 0.5D_{air} + 0.5D_{cor}$ (C) In case of considering the full loaded condition and the ballast condition as the load condition, the relevant draft is to be applied in the calculation of the local wave pressure range and the fatigue damage ratio at each condition (D_{Full} and $D_{Ballast}$) is to be calculated. Therefore, the formula for calculating the total fatigue damage can be expressed as follow: $D = p_{lF}D_{Full} + p_{lB}D_{Ballast}$ p_{lF} and p_{lB} = probability at the full loaded condition and the ballast condition, where, however, the values are not given, 0.5 may be used respectively.	

Present	Amendment	Reason
respectively. But, in case of ore carriers and membrane tank LNG carriers, 50% of the fraction time for both full load condition and ballast condition respectively is to be considered.	However, if deemed necessary by the Society, fatigue strength assessment may be carried out by adjusting the operating ratio in accordance with the loading manual. The following shows the general operating rates for representative ship types. - LNG carrier(Membrane type): Full load condition - 0.5 / Ballast condition - 0.5 - RO-RO ship: Full load condition - 0.7 / Ballast condition - 0.3.	
In case of ore carriers, unless otherwise provided, loading condition with high and low density cargo also has a same probability level. Probability level at heavy ballast condition and normal ballast condition, 0.3 and 0.2 may be used respectively. If no heavy ballast condition, only normal ballast condition is to be considered in fatigue strength assessment.	In case of ore carriers, unless otherwise provided, loading condition with high and low density cargo also has a same probability level. Probability level at heavy ballast condition and normal ballast condition, 0.3 and 0.2 may be used respectively. If no heavy ballast condition, only normal ballast condition is to be considered in fatigue strength assessment.	
(6) 〈omitted〉	(6) 〈same as the current Rules〉	
5. Fatigue analysis by hold analysis	**5. Fatigue analysis by hold analysis**	
〈omitted〉	〈same as the current Rules〉	
(1) Fatigue design load	(1) Fatigue design load	
(A) ~ (B) 〈omitted〉	(A) ~ (B) 〈same as the current Rules〉	
(C) Internal loads	(C) Internal loads	
〈omitted〉	〈same as the current Rules〉	
(a) Loads due to liquid cargo and ballast water	(a) Loads due to liquid cargo and ballast water	
(i) 〈omitted〉	(i) 〈same as the current Rules〉	
(ii) The dynamic internal pressure, p_i , from liquid cargo or ballast water is not to be less than that obtained from the following formulas, which is the greater:	(ii) The dynamic internal pressure, p_i , from liquid cargo or ballast water is not to be less than that obtained from the following formulas, which is the greater:	

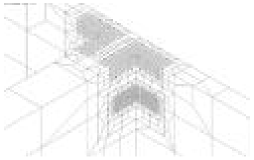
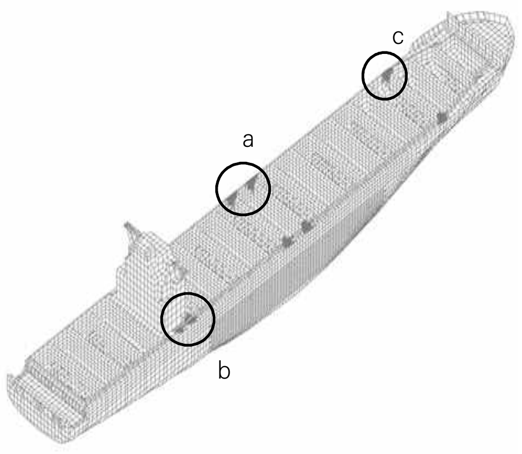
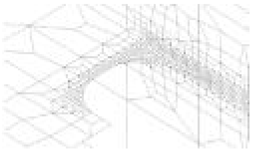
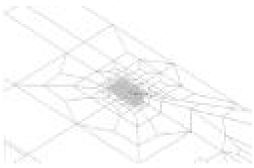
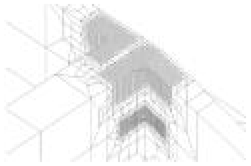
Present	Amendment	Reason
$p_{id} = f\rho_c C_v a_v h_s \quad (\mathrm{kN/m^2})$ $p_{id} = f\rho_c C_t a_t \lvert y_s \rvert \quad (\mathrm{kN/m^2})$ $f,\ \rho_c,\ h_s\ y_s,\ a_v,\ a_t$: as specified in **Par 4** (1) (C) (a). $C_v,\ C_t$: as specified in **Table 6** and **Table 7**. (b) 〈omitted〉 (2) ~ (4) 〈omitted〉 **6. Spectral fatigue analysis** (1) General 〈omitted〉 〈newly added〉 (2) Calculation of hot spot stress is to be in accordance with the requirements in **Par 5** (2) (D). (3) Short-term response (A) ~ (B) 〈omitted〉 (C) The area under the response spectrum and the second moment of the response spectrum can be calculated as follows. $m_0 = \int_{\omega} \sum_{\theta_0 - 90^\circ}^{\theta_0 + 90^\circ} f_s(\theta)\, S(\omega \vert H_s,\ T_z, \theta)$ $m_2 = \int_{\omega} \sum_{\theta_0 - 90^\circ}^{\theta_0 + 90^\circ} f_s(\theta)\, \omega^2 S(\omega \vert H_s,\ T_z, \theta)$ using a spreading function usually defined as $f_s(\theta) = k\cos^2(\theta)$ where k is selected such that :	$p_{id} = f\rho_c C_v a_v h_s \quad (\mathrm{kN/m^2})$ $p_{id} = f\rho_c C_t a_t \lvert y_s \rvert \quad (\mathrm{kN/m^2})$ $f,\ \rho_c,\ h_s\ y_s,\ a_v,\ a_t$: as specified in **Par 4** (1) (C) (a). $C_v,\ C_t$: as specified in **Table 5** and **Table 6**. (b) 〈same as the current Rules〉 (2) ~ (4) 〈same as the current Rules〉 **6. Spectral fatigue analysis** (1) General 〈same as the current Rules〉 (2) Wave load analysis is to comply with **Annex 3-2, II. Direct Global Structural Analysis, 5** of the **Guidance**. (3) Calculation of hot spot stress is to be in accordance with the requirements in **Par 5** (2) (D). (4) Short-term response (A) ~ (B) 〈same as the current Rules〉 (C) The area under the response spectrum and the second moment of the response spectrum can be calculated as follows. $m_0 = \int_{\omega} \sum_{\theta_0 - 90^\circ}^{\theta_0 + 90^\circ} f_s(\theta)\, S(\omega \vert H_s,\ T_z, \theta)$ $m_2 = \int_{\omega} \sum_{\theta_0 - 90^\circ}^{\theta_0 + 90^\circ} f_s(\theta) \left\lvert \omega - \frac{\omega^2 V}{g} cos\theta \right\rvert^2 S(\omega \vert H_s,\ T_z, \theta)$ using a spreading function usually defined as $f_s(\theta) = k\cos^2(\theta)$ where k is selected such that :	

Present	Amendment	Reason
$\sum_{\theta_0-90^\circ}^{\theta_0+90^\circ} f_s(\theta)=1$ where, θ_0 : Main wave heading θ : Relative spreading around the main wave heading (4) ~ (5) 〈omitted〉 (6) Structural members to be assessed for fatigue strength (A) General 〈omitted〉 (B) Structural members subject to the fatigue strength assessment according to ship type (a) Structural members being of possible assessment for the fatigue strength according to ship type (i) Tankers : as specified in **Table 7** (ii) Bulk carriers : as specified in **Table 8** (iii) Container carriers : as specified in **Table 9** (iv) Ore carriers : as specified in **Table 10** (v) LNG ships(Membrane Tank) : as specified in **Table 11** 〈newly added〉 (b) Locations with high stresses are selected from the locations mentioned in (a) above and the fatigue strength is assessed. (c) Notwithstanding the requirements in (a) and (b), additional fatigue assessment may be required for other locations where deemed necessary by the Society.	$\sum_{\theta_0-90^\circ}^{\theta_0+90^\circ} f_s(\theta)=1$ where, θ_0 : Main wave heading θ : Relative spreading around the main wave heading (5) ~ (6) 〈same as the current Rules〉 (7) Structural members to be assessed for fatigue strength (A) General 〈same as the current Rules〉 (B) Structural members subject to the fatigue strength assessment according to ship type (a) Structural members being of possible assessment for the fatigue strength according to ship type (i) Tankers : as specified in **Table 7** (ii) Bulk carriers : as specified in **Table 8** (iii) Container carriers : as specified in **Table 9** (iv) Ore carriers : as specified in **Table 10** (v) LNG ships(Membrane Tank) : as specified in **Table 11** (vi) RO-RO ships : **Table 12** (b) Locations with high stresses are selected from the locations mentioned in (a) above and the fatigue strength is assessed. (c) Notwithstanding the requirements in (a) and (b), additional fatigue assessment may be required for other locations where deemed necessary by the Society.	

Present	Amendment	Reason

Table 7 ~ Table 8 〈omitted〉

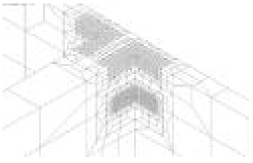
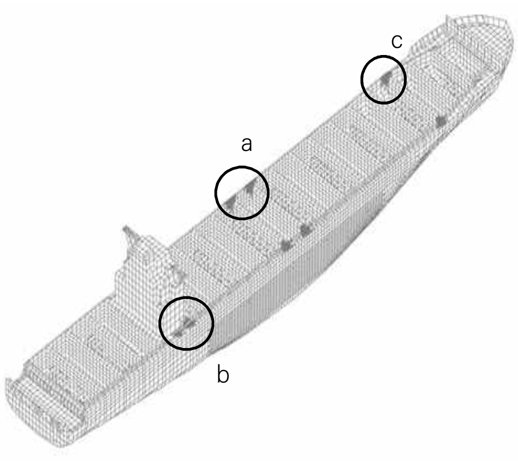
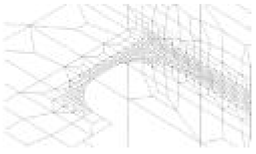
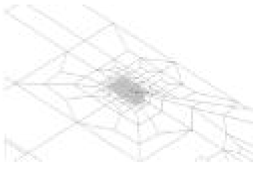
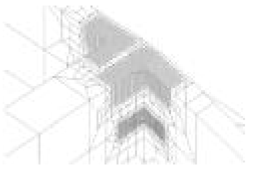
Table 9 Structural members of container carriers for the fatigue strength assessment

<table>
<tr><th>Symbol</th><th>Members</th><th colspan="3">Locations</th></tr>
<tr><td>a</td><td rowspan="4">Hatch</td><td>Typical hatch coaming and corner in the midship</td><td></td><td rowspan="4"> </td></tr>
<tr><td rowspan="2">d</td><td rowspan="2">After hatch coaming and corner in the after cargo hold (in front of engine room forward bulkhead)</td><td></td></tr>
<tr><td></td></tr>
<tr><td>c</td><td>Hatch coaming and corner within the forward part of the cargo area</td><td></td></tr>
<tr><td colspan="5">〈newly added〉</td></tr>
</table>

Present	Amendment	Reason

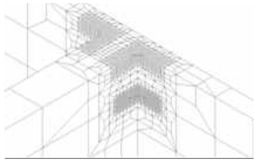
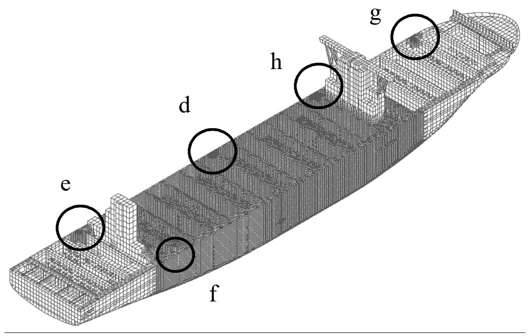
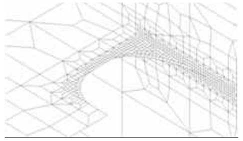
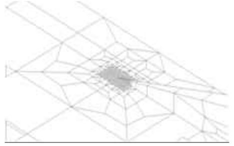
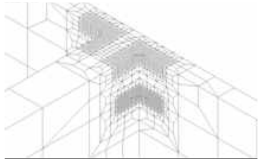
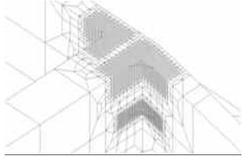
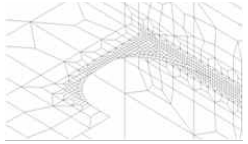
Table 7 ~ **Table 8** 〈same as the current Rules〉

Table 9 Structural members of container carriers for the fatigue strength assessment

Symbol	Members	Locations		
a	Hatch	Typical hatch coaming and corner in the midship		
d		After hatch coaming and corner in the after cargo hold (in front of engine room forward bulkhead)	 	
c		Hatch coaming and corner within the forward part of the cargo area		

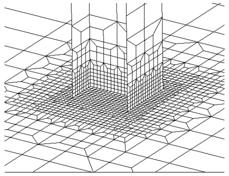
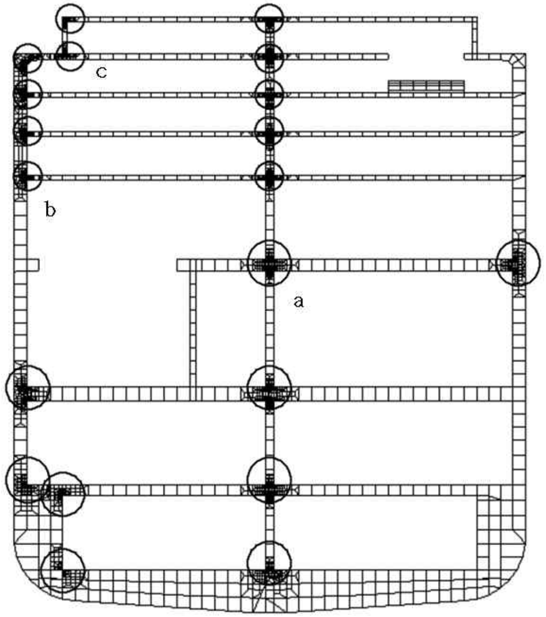
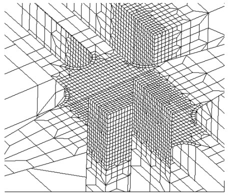
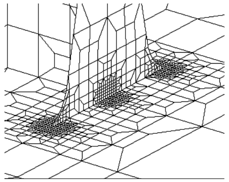
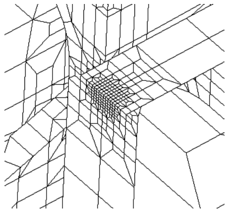
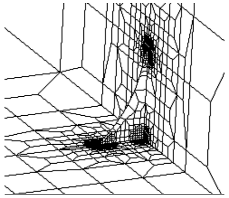
Present	Amendment	Reason

Table 9 Structural members of container carriers for the fatigue strength assessment(continued)

d	Hatch	Typical hatch coaming and corner in the midship		
e		Hatch coaming and corner located behind engine room forward bulkhead	 	
f		Hatch coaming and corner in first bulkhead in front of engine room forward bulkhead		
g		Hatch coaming and corner adjacent to the collision bulkhead		
h		Hatch coaming and corner adjacent to the deckhouse.		

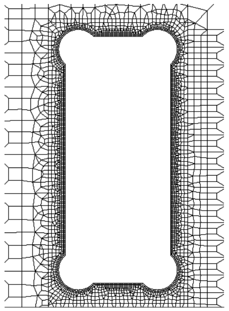
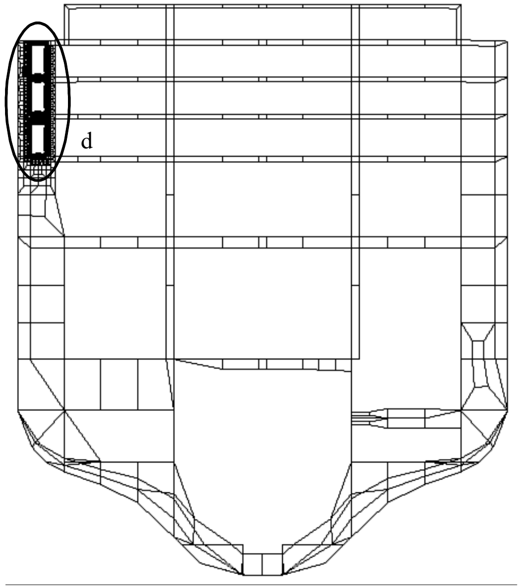
Present	Amendment	Reason
Table 10 ~ Table 11 ⟨omitted⟩ ⟨newly added⟩	Table 10 ~ Table 11 ⟨same as the current Rules⟩ Table 12 Structural members of RO-RO ships for the fatigue strength assessment	

Table 12 Structural members of RO-RO ships for the fatigue strength assessment

Symbol	Members	Locations		
a	Pillar and deck	Connections between deck and pillar (top)		
		Connections between deck and pillar (bottom)		
b	Side transverse, deck	Connections between side transverse and deck (top)		
		Connections between side transverse and deck (bottom)		
c	Bracket, deck	Connections between superstructure and deck		

<table>
<tr><th>Present</th><th>Amendment</th><th>Reason</th></tr>
<tr><td></td><td>

Table 12 Structural members of RO-RO ships for the fatigue strength assessment

<table>
<tr><th>Symbol</th><th>Members</th><th colspan="3">Locations</th></tr>
<tr><td>d</td><td>Opening</td><td>Openings in engine room</td><td></td><td>
</td></tr>
</table>

</td><td></td></tr>
<tr><td>7. Transfer function method 〈omitted〉 ⚓</td><td>7. Transfer function method 〈same as the current Rules〉 ⚓</td><td></td></tr>
</table>

Amendments of Guidance

(For external opinion inquiry)

Pt. 3 Hull Structures

2020. 2.

Hull Rule Development Team

Present	Amendment	Reason
Annex 3-3 Guidance for the Fatigue Strength Assessment of Ship Structures *(2017)* **1. ~ 2. 〈omitted〉** **3. Fatigue life assessment** (1) Hot spot stress approach 〈omitted〉 (2) Design S-N curve (A) ~ (B) 〈omitted〉 (C) The design S-N curves are defined as the mean(the curves of (A) above) minus two standard deviations and thus correspond to survival probability of 97.6 %. The slopes of these curves are changed beyond $N=10^7$ cycles considering Haibach effect. (see **Fig 2**) $\log N = \log c - m log \sigma$ for $N \le 10^7$ $\log N = \log c' - m' \log \sigma$ for $N > 10^7$ where, $\log c$ and $\log c'$ = the life intercepts of the S-N curve (See **Table 1**) m and m' = the negative inverse slopes of the S-N curve (See **Table 1**)	**Annex 3-3 Guidance for the Fatigue Strength Assessment of Ship Structures** **1. ~ 2. 〈same as the current Rules〉** **3. Fatigue life assessment** (1) Hot spot stress approach 〈same as the current Rules〉 (2) Design S-N curve (A) ~ (B) 〈same as the current Rules〉 (C) The design S-N curves are defined as the mean(the curves of (A) above) minus two standard deviations and thus correspond to survival probability of 97.6 %. The slopes of these curves are changed beyond $N=10^7$ cycles considering Haibach effect. (see **Fig 2**) $\log N = \log K_2 - m \log \triangle\sigma$ $\log K_2 = \log K_1 - 2 \log \delta$ where, K_1 : Constant related to mean S-N curve, as given in **Table 1.** K_2 : Constant related to design S-N curve, as given in **Table 1.** δ : Standard deviation of log (N), as given in **Table 1.** $\triangle\sigma$: Stress range at $N=10^7$ cycles related to design S-N curve, in N/mm^2, as given in **Table 1.**	

Present	Amendment	Reason

Table 1 Value of $\log c, \log c'$ and m, m'

curves	$N \le 10^7$		$N > 10^7$	
	$\log c$	m	$\log c'$	m'
B	15.006	4.0	17.006	6.0
C	13.626	3.5	16.466	5.5
D	12.182	3.0	15.627	5.0

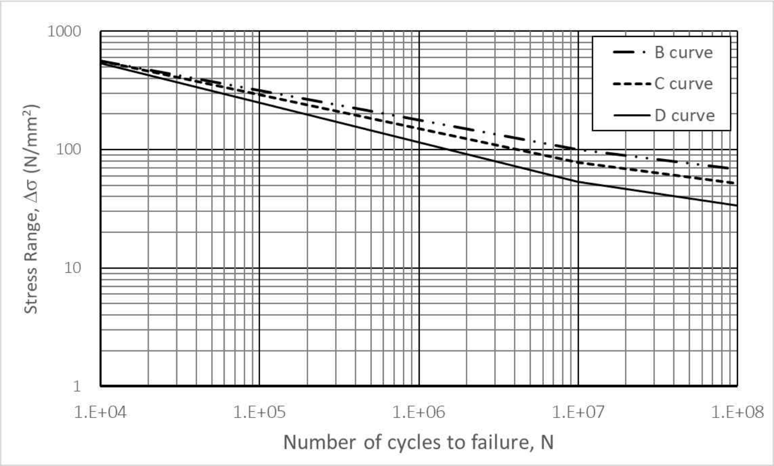
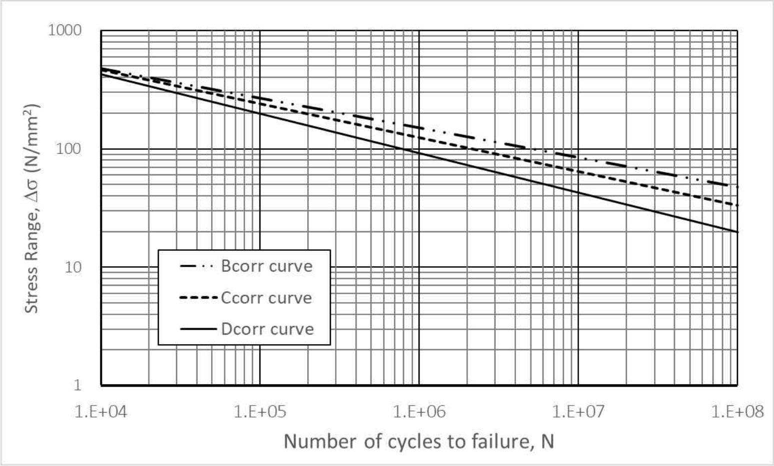
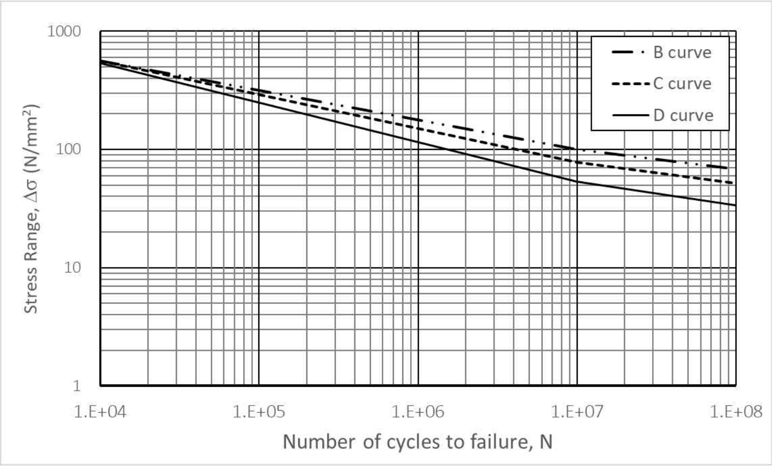
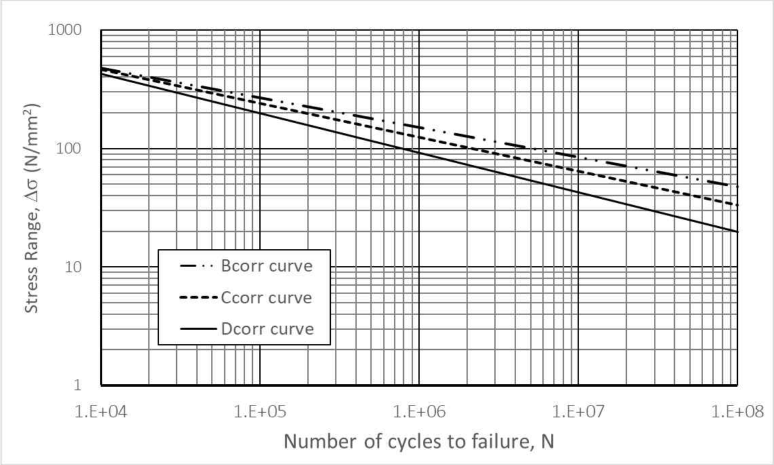
Table 1 Basic S-N curve data

(a) In-air environment

Class	K_1		m	Standard deviaton, δ	K_2	Design stress range (N/mm^2)	
	K_1	$\log_{10}K_1$		$\log_{10}\delta$		$\triangle\sigma$, 10^7 cycles	2×10^6 cycles
B	2.343E15	15.3697	4.0	0.1821	1.013E15	100.2	149.9
C	1.082E14	14.0342	3.5	0.2041	4.227E13	78.2	123.9
D	3.988E12	12.6007	3.0	0.2095	1.519E12	53.4	91.3

(b) Corrosive environment

Curve	K_2	m	Design stress range at 2×10^6 cycles, N/mm^2
B	5.05E14	4.0	126.1
C	2.12E13	3.5	101.6
D	7.60E11	3.0	72.4

Present	Amendment	Reason
 (a) In-air environment  (b) Corrosive environment Fig 2 Design S-N curve	 (a) In-air environment  (b) Corrosive environment Fig 2 Design S-N curve	

Present	Amendment	Reason
(3) Corrosion effect For unprotected joints exposed to sea water, the design S-N curve is to be modified with half life time of S-N curve in air. However, no slope change is incorporated in the S-N curve at 10^7 cycles: $\log N = \log c_1 - m \log \sigma$ where, ⟨newly added⟩ $\log c_1 = \log c - \log 2$ the values of $\log c$ and m are to be as given in Table 1. However, in case that the hull structure members in ballast tanks are protected against the corrosion by effective means, the design S-N curve in air is to be applied for the first half of the design life and the free-corrosion S-N curve for the remainder of the design life. In calculation, the stresses are determined with as-built scantlings. (4) ~ (7) ⟨omitted⟩ **4. Simplified fatigue analysis** ⟨omitted⟩ (1) ~ (4) ⟨omitted⟩ (5) Calculation of fatigue damage ratio (A) According to the Miner-Palmgren linear cumulative damage rule, the fatigue damage ratio D is calculated using numerical integration as follows: $D = \Sigma \frac{n_i}{N_i}$ where, n_i = number of stress cycles in stress block i for long-term distribution of the combined stress range	(3) Corrosion effect For unprotected joints exposed to sea water shown in Figure 2, the design S-N curve is to be modified with half life time of S-N curve in air. However, no slope change is incorporated in the S-N curve at 10^7 cycles: $\log N = \log K_2 - m \log \Delta\sigma$ where, N : Predicted number of cycles to failure under stress range $\Delta\sigma$. K_2 : Constant related to design S-N curve as given in Table 1 (b). However, in case that the hull structure members in ballast tanks are protected against the corrosion by effective means, the design S-N curve in air is to be applied for the first half of the design life and the free-corrosion S-N curve for the remainder of the design life. In calculation, the stresses are determined with as-built scantlings. (4)~ (7) ⟨same as the current Rules⟩ **4. Simplified fatigue analysis** ⟨same as the current Rules⟩ (1) ~ (4)⟨same as the current Rules⟩ (5) Calculation of fatigue damage ratio (A) According to the Miner-Palmgren linear cumulative damage rule, the fatigue damage ratio D is calculated using numerical integration as follows: $D = \Sigma \frac{n_i}{N_i}$ where, n_i = number of stress cycles in stress block i for long-term distribution of the combined stress range	

Present	Amendment	Reason
N_i = number of cycles to failure at the i-th constant stress range. If the long-term distribution of the stress range follows a Weibull one, the damage ratio D_{air} is given by the following formula: $D_{air} = \frac{N_t}{c'} \frac{\sigma_0^{m'}}{(\ln N_0)^{m'/\xi}} \gamma(1+\frac{m'}{\xi}, t_7) + \frac{N_t}{c} \frac{\sigma_0^{m}}{(\ln N_0)^{m/\xi}} \Gamma(1+\frac{m}{\xi}) - \frac{N_t}{c} \frac{\sigma_0^{m}}{(\ln N_0)^{m/\xi}} \gamma(1+\frac{m}{\xi}, t_7)$ where, 〈newly added〉 ξ = Weibull shape parameter Γ = complete Gamma function given by the following formula $\Gamma(z) = \int_0^\infty t^{z-1} e^{-t} dt$ γ = incomplete Gamma function given by the following formula. $\gamma(z,x) = \int_0^x t^{z-1} e^{-t} dt$ c, c' and m, m' = as specified in **Table 1** 〈newly added〉	N_i = number of cycles to failure at the i-th constant stress range. If the long-term distribution of the stress range follows a Weibull one, the damage ratio D_{air} is given by the following formula: $D_{air} = \frac{N_t}{K_2} \frac{\Delta\sigma_0^{m}}{(\ln N_0)^{m/\xi}} \bullet \mu_7 \bullet \Gamma\left(1+\frac{m}{\xi}\right)$ where, K_2 = Constant of the design S-N curve, as given in Table 1 (a) for in-air environment. ξ = Weibull shape parameter Γ = complete Gamma function given by the following formula $\Gamma(z) = \int_0^\infty t^{z-1} e^{-t} dt$ γ = incomplete Gamma function given by the following formula. $\gamma(z,x) = \int_0^x t^{z-1} e^{-t} dt$ μ_7 = Coefficient taking into account the change of inverse slope of the S-N curve, m,	

Present	Amendment	Reason
	$\mu_7 = 1 - \dfrac{\left\{ \gamma\left(1+\dfrac{m}{\xi}, t_7\right) - t_7^{-\frac{2}{\xi}} \bullet \gamma\left(1+\dfrac{m+2}{\xi}, t_7\right) \right\}}{\Gamma\left(1+\dfrac{m}{\xi}\right)}$	
t_7 = as specified in the following formula	t_7 = as specified in the following formula	
$t_7 = \left(\dfrac{\Delta\sigma_7}{\Delta\sigma_0}\right)^{\xi} \ln N_0$	$t_7 = \left(\dfrac{\Delta\sigma_7}{\Delta\sigma_0}\right)^{\xi} \ln N_0$	
$\Delta\sigma_7$ = stress range of the design S-N curve at $N = 10^7$ cycles	$\Delta\sigma_7$ = stress range of the design S-N curve at $N = 10^7$ cycles	
N_t = the total number of stress cycles for a design life of ships and considering voyage days of 85% for the design life of Y(years), the total number of stress cycles is given by the following formula.	N_t = the total number of stress cycles for a design life of ships and considering voyage days of 85% for the design life of Y(years), the total number of stress cycles is given by the following formula.	
$N_t = \dfrac{2.68 \times 10^7}{4 \log L} \times Y$	$N_t = \dfrac{2.68 \times 10^7}{4 \log L} \times Y$	
(B) For unprotected joints exposed to sea water, the damage ratio D_{cor} is given by	(B) For unprotected joints exposed to sea water, the damage ratio D_{cor} is given by	
$D_{cor} = \dfrac{N_t}{c_1} \dfrac{\sigma_0^m}{(\ln N_0)^{m/\xi}} \Gamma(1 + \dfrac{m}{\xi})$	$D_{cor} = \dfrac{N_t}{K_2} \dfrac{\Delta\sigma_0^m}{(\ln N_0)^{m/\xi}} \Gamma(1 + \dfrac{m}{\xi})$	
〈newly added〉	K_2 = Constant of the design S−N curve, as given in Table 1 (b) for corrosive environment.	
However, for the structural members protected by effective means in ballast tanks, the damage ratio D is to be calculated as follows:	However, for the structural members protected by effective means in ballast tanks, the damage ratio D is to be calculated as follows:	

Present	Amendment	Reason
$D = 0.5D_{air} + 0.5D_{cor}$ (C) In case of considering the full loaded condition and the ballast condition as the load condition, the relevant draft is to be applied in the calculation of the local wave pressure range and the fatigue damage ratio at each condition (D_{Full} and $D_{Ballast}$) is to be calculated. Therefore, the formula for calculating the total fatigue damage can be expressed as follow: $D = p_{lF}D_{Full} + p_{lB}D_{Ballast}$ p_{lF} and p_{lB} = probability at the full loaded condition and the ballast condition, where, however, the values are not given, 0.5 may be used respectively. However, if deemed necessary by the Society, fatigue strength assessment may be carried out by adjusting the operating ratio in accordance with the loading manual. The following shows the general operating rates for representative ship types. - LNG carrier(Membrane type): Full load condition - 0.5 / Ballast condition - 0.5 - RO-RO ship: Full load condition - 0.7 / Ballast condition - 0.3. In case of ore carriers, unless otherwise provided, loading condition with high and low density cargo also has a same probability level. Probability level at heavy ballast con-	$D = 0.5D_{air} + 0.5D_{cor}$ (C) In case of considering the full loaded condition and the ballast condition as the load condition, the relevant draft is to be applied in the calculation of the local wave pressure range and the fatigue damage ratio at each condition (D_{Full} and $D_{Ballast}$) is to be calculated. Therefore, the formula for calculating the total fatigue damage can be expressed as follow: $D = p_{lF}D_{Full} + p_{lB}D_{Ballast}$ p_{lF} and p_{lB} = probability at the full loaded condition and the ballast condition, where, however, the values are not given, 0.5 may be used respectively. However, if deemed necessary by the Society, fatigue strength assessment may be carried out by adjusting the operating ratio in accordance with the loading manual. The following shows the general operating rates for representative ship types. - LNG carrier(Membrane type): Full load condition - 0.5 / Ballast condition - 0.5 - RO-RO ship: Full load condition - 0.7 / Ballast condition - 0.3. In case of ore carriers, unless otherwise provided, loading condition with high and low density cargo also has a same probability level. Probability level at heavy ballast con-	

Present	Amendment	Reason
dition and normal ballast condition, 0.3 and 0.2 may be used respectively. If no heavy ballast condition, only normal ballast condition is to be considered in fatigue strength assessment.	dition and normal ballast condition, 0.3 and 0.2 may be used respectively. If no heavy ballast condition, only normal ballast condition is to be considered in fatigue strength assessment.	
(6) 〈omitted〉	(6) 〈same as the current Rules〉	
5. Fatigue analysis by hold analysis 〈omitted〉	**5. Fatigue analysis by hold analysis 〈same as the current Rules〉**	
6. Spectral fatigue analysis	**6. Spectral fatigue analysis**	
(1) ~ (4) 〈omitted〉 (5) Short-term fatigue damage (A) 〈omitted〉 (B) The part fatigue damage D_{ij} for a sea state (i,j) can be calculated from,	(1) ~ (4) 〈same as the current Rules〉 (5) Short-term fatigue damage (A) 〈same as the current Rules〉 (B) The part fatigue damage D_{ij} for a sea state (i,j) can be calculated from,	
$D_{ij} = \frac{n_T}{c} r_{ij} p_{ij} \int_0^\infty s^m g_{ij} ds$	$D_{ij} = \frac{n_T}{K_2} r_{ij} p_{ij} \int_0^\infty s^m g_{ij} ds$	
n_T = total stress cycles for a life time of a ship given by the following formula	n_T = total stress cycles for a life time of a ship given by the following formula	
$n_T = f\ T$	$n_T = f\ T$	
c, m = life intercepts and negative inverse slopes of the S-N curve as specified in **Table 2**, respectively	K_2, m = life intercepts and negative inverse slopes of the design S-N curve, as given in **Table 1** (a) for in-air environment and in **Table 1** (b) for corrosive environment	
p_{ij} = as specified in (A) above	p_{ij} = as specified in (A) above	
r_{ij} = ratio of the response zero up-crossing frequency in a given sea state to the average crossing frequency given by the following formula	r_{ij} = ratio of the response zero up-crossing frequency in a given sea state to the average crossing frequency given by the following formula	

Present	Amendment	Reason
$r_{ij} = \frac{f_{ij}}{f}$ f = average frequency given by the following formula $f \; = \sum_i \sum_j p_{ij} f_{ij}$ g_{ij} = probability density function of the stress range for a sea state (i,j) expressed as follows $g_{ij} = \frac{s}{4m_{0ij}} \exp\left(-\frac{s^2}{8m_{0ij}}\right)$ $m_{0ij},\ m_{2ij}$ = as specified in (A) above where a bi-linear S-N curve is used to consider Haibach effect, the short-term fatigue damage ratio may be calculated from, $\underline{D_{ij} \; = \; 2^{\frac{3m}{2}} \; \frac{n_T}{c} \; \Gamma\left(\frac{m}{2}+1\right) \; \lambda_{ij} \; \mu_{ij} \; r_{ij} \; p_{ij} \; m_{0ij}^{\frac{m}{2}}}$ where, μ_{ij} = as specified in the following formula $\underline{\mu_{ij} \; = \; 1 - \frac{\gamma\left(\frac{m}{2}+1,\, t_{ij}\right) - \; t_{ij}^{\frac{m-m'}{2}} \gamma\left(\frac{m'}{2}+1,\, t_{ij}\right)}{\Gamma\left(\frac{m}{2}+1\right)}}$ $\underline{m,\, m',\, c,\, n_T, r_{ij}, p_{ij}, m_{0ij}}$ = as specified in (B)	$r_{ij} = \frac{f_{ij}}{f}$ f = average frequency given by the following formula $f \; = \sum_i \sum_j p_{ij} f_{ij}$ g_{ij} = probability density function of the stress range for a sea state (i,j) expressed as follows $g_{ij} = \frac{s}{4m_{0ij}} \exp\left(-\frac{s^2}{8m_{0ij}}\right)$ $m_{0ij},\ m_{2ij}$ = as specified in (A) above where a bi-linear S-N curve is used to consider Haibach effect, the short-term fatigue damage ratio may be calculated from, $\underline{D_{ij} \; = \; 2^{\frac{3m}{2}} \; \frac{n_T}{K_2} \; \Gamma\left(\frac{m}{2}+1\right) \; \lambda_{ij} \; \mu_{ij} \; r_{ij} \; p_{ij} \; m_{0ij}^{\frac{m}{2}}}$ where, μ_{ij} = as specified in the following formula $\underline{\mu_{ij} \; = \; 1 - \frac{\gamma\left(\frac{m}{2}+1,\, t_{ij}\right) - \frac{1}{t_{ij}} \gamma\left(\frac{m+2}{2}+1,\, t_{ij}\right)}{\Gamma\left(\frac{m}{2}+1\right)}}$ $\underline{m,\, K_2,\, n_T, r_{ij}, p_{ij}, m_{0ij}}$ = as specified in (B)	

Present	Amendment	Reason
$t_{ij} = \frac{s_7^2}{8m_{0ij}}$	$t_{ij} = \frac{s_7^2}{8m_{0ij}}$	
s_7 = the stress range of the design S-N curve at $N = 10^7$ cycles	s_7 = the stress range of the design S-N curve at $N = 10^7$ cycles	
Γ and γ = complete Gamma function and incomplete Gamma function, respectively	Γ and γ = complete Gamma function and incomplete Gamma function, respectively	
λ_{ij} = Rain flow correction factor in a given sea state	λ_{ij} = Rain flow correction factor in a given sea state	
$\lambda_{ij} = a + (1-a)(1-\epsilon_{ij})^b$	$\lambda_{ij} = a + (1-a)(1-\epsilon_{ij})^b$	
$a = 0.926 - 0.033m$ $b = 1.587m - 2.323$ $\epsilon_{ij} = \sqrt{1 - \frac{m_{2ij}^2}{m_{0ij}m_{4ij}}}$	$a = 0.926 - 0.033m$ $b = 1.587m - 2.323$ $\epsilon_{ij} = \sqrt{1 - \frac{m_{2ij}^2}{m_{0ij}m_{4ij}}}$	
(6) Long-term cumulative fatigue damage (A) Taking account of all heading directions and loading conditions, the long-term cumulative fatigue damage ratio in air is calculated as follows.	(6) Long-term cumulative fatigue damage (A) Taking account of all heading directions and loading conditions, the long-term cumulative fatigue damage ratio in air is calculated as follows.	
$D_{air} = 2^{\frac{3m}{2}} \frac{n_T}{c} \Gamma\left(\frac{m}{2}+1\right) \sum_i \sum_j \sum_k \sum_l \lambda_{ijkl} \mu_{ijkl} r_{ijkl} p_{ijkl} m_{0ijkl}^{\frac{m}{2}}$	$D_{air} = 2^{\frac{3m}{2}} \frac{n_T}{K_2} \Gamma\left(\frac{m}{2}+1\right) \sum_i \sum_j \sum_k \sum_l \lambda_{ijkl} \mu_{ijkl} r_{ijkl} p_{ijkl} m_{0ijkl}^{\frac{m}{2}}$	
⟨newly added⟩	K_2, m : life intercepts and negative inverse slopes of the design S-N curve, as given in **Table 1** (a)	
p_{ijkl} = combined probability given by the following formula	p_{ijkl} = combined probability given by the following formula	

Present	Amendment	Reason
$p_{ijkl} = p_{ij}\, p_k\, p_l$ $p_k,\ p_l$ = probability for the heading angle and the loading condition, respectively (B) For unprotected joints exposed to sea water, the damage ratio D_{cor} is given by $D_{cor} = 2^{\frac{3m}{2}} \frac{n_T}{c_1} \Gamma\left(\frac{m}{2}+1\right) \sum_i \sum_j \sum_k \sum_l \lambda_{ijkl}\gamma_{ijkl}p_{ijkl}m_{0ijkl}^{\frac{m}{2}}$ ⟨newly added⟩ However, for the structural members protected by effective means in ballast tanks, the damage ratio D is to be calculated as follows: $D = 0.5\, D_{air} + 0.5\, D_{cor}$ (7) ⟨omitted⟩ **7. Transfer function method ⟨omitted⟩** ⚓	$p_{ijkl} = p_{ij}\, p_k\, p_l$ $p_k,\ p_l$ = probability for the heading angle and the loading condition, respectively (B) For unprotected joints exposed to sea water, the damage ratio D_{cor} is given by $D_{cor} = 2^{\frac{3m}{2}} \frac{n_T}{K_2} \Gamma\left(\frac{m}{2}+1\right) \sum_i \sum_j \sum_k \sum_l \lambda_{ijkl}\gamma_{ijkl}p_{ijkl}m_{0ijkl}^{\frac{m}{2}}$ $K_2,\ m$: life intercepts and negative inverse slopes of the design S-N curve, as given in **Table 1** (b) However, for the structural members protected by effective means in ballast tanks, the damage ratio D is to be calculated as follows: $D = 0.5\, D_{air} + 0.5\, D_{cor}$ (7) ⟨same as the current Rules⟩ **7. Transfer function method ⟨same as the current Rules⟩** ⚓	

Amendments of Guidance

(External review)

Pt. 3 Hull Structures

2019. 11.

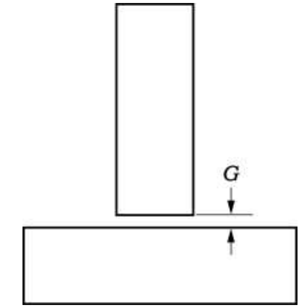
Hull Rule Development Team

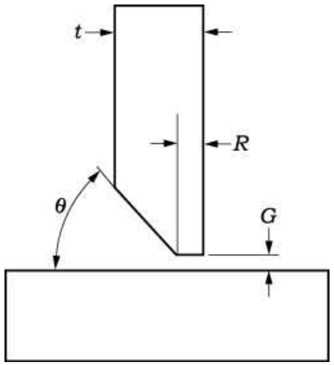
<table>
<tr><th>Present</th><th>Amendment</th><th>Note</th></tr>
<tr>
<td>

Annex 3-4 Guidance for the Hull Construction Monitoring Procedure

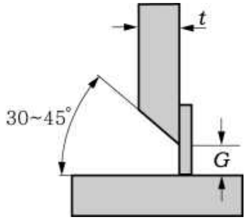
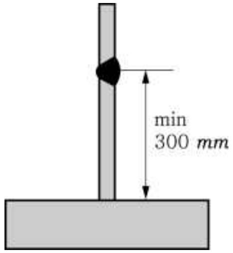
1. ~ 6. <omit>

Table 5 Fillet weld fit-up repair

<table>
<tr><th>Detail</th><th>Repair Standard</th><th>Note</th></tr>
<tr>
<td rowspan="3">


</td>
<td>2 mm < $G \le$ 5 mm :
length of weld to Rule leg by + $(G-2)$</td>
<td rowspan="3">~~For cruciform joints :~~

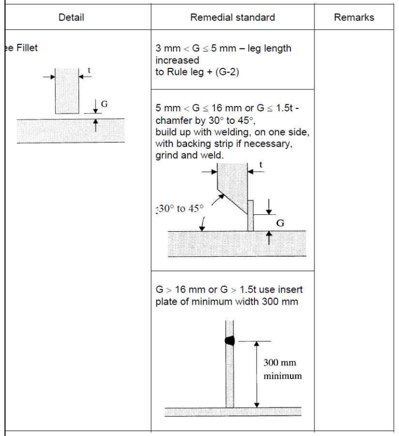
~~1) 3 mm < $G \le$ 6 mm~~
~~The weld should be full penetration and subject to additional ultrasonic NDE using both 45° and 70° probes, to the satisfaction of the surveyor.~~

~~2) $G >$ 6 mm~~
~~The joint is to be adjusted until compliance is reached or an insert plate is to be fitted to the satisfaction of the surveyor.~~</td>
</tr>
<tr>
<td>5 mm < $G \le$ 16 mm :
champer to 30°- 45°, build up with welding on one side, with or without backing bar, remove backing strip if used, back gouge and seal with weld.

</td>
</tr>
<tr>
<td>$G \le$ 16 mm or
$G >$ 1.5t
Insert plate of min width 300 mm to be used

</td>
</tr>
</table>

</td>
<td></td>
<td>

- IACS Rec. 47 참조

TABLE 9.6 - Typical Fillet Weld Plate Edge Preparation Remedial



Detail	Remedial standard	Remarks
e Fillet	3 mm < G ≤ 5 mm – leg length increased to Rule leg + (G-2)	
	5 mm < G ≤ 16 mm or G ≤ 1.5t - chamfer by 30° to 45°, build up with welding, on one side, with backing strip if necessary, grind and weld.	
	G > 16 mm or G > 1.5t use insert plate of minimum width 300 mm	

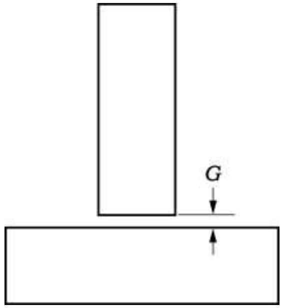
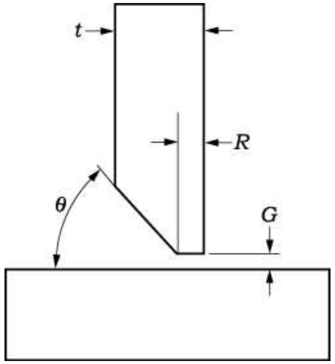
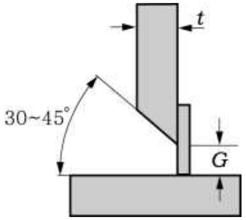
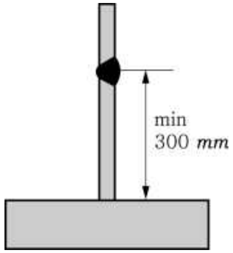
</td>
</tr>
</table>

Present	Amendment	Note

Annex 3-4 Guidance for the Hull Construction Monitoring Procedure

1. ~ 6. <same as current>

Table 5 Fillet weld fit-up repair

Detail	Repair Standard	Note
 	3 mm $<$ G $\leq$ 5 mm : length of weld to Rule leg by + $(G-2)$	-
	5 mm $<$ G $\leq$ 16 mm : champer to 30°- 45°, build up with welding on one side, with or without backing bar, remove backing strip if used, back gouge and seal with weld. 	
	G $\leq$ 16 mm or G $>$ $1.5t$ Insert plate of min width 300 mm to be used 	

- refer IACS Rec. 47

Amendments of the Guidance

Pt. 3 Hull Structures

(External review)

2019. 11.

Hull Rule Development Team

Present	Amendment	Note
CHAPTER 15 DEEP TANKS <Guidance>	**CHAPTER 15 DEEP TANKS <Guidance>**	
Section 1 <omit>	**Section 1 <same as current>**	
Section 2 Bulkheads of Deep Tank	**Section 2 Bulkheads of Deep Tank**	
202. Bulkhead plates 【See Rule】	**202. Bulkhead plates 【See Rule】**	
1. ~ **3.** <omit>	**1.** ~ **3.** <same as current>	
4. For the thickness of deep tank bulkhead plating in Type A independent tanks, the following value of C_2 and h is to be used for the formula specified in **202.** in the Rules	**4.** For the thickness of deep tank bulkhead plating in Type A independent tanks, the following value of C_2 and h is to be used for the formula specified in **202.** in the Rules	
C_2 = 3.6	C_2 = 3.6	
h = water head, equal to internal pressure in **Pt 7, Ch 5, 403. 2. is to be calculated by dividing 10.**	h = water head(m), equal to internal pressure in **Pt 7, Ch 5, 413. 2.** is to be calculated by multiplying 100.	
203. ~ 209. <omit>	**203. ~ 209. <same as current>**	
⚓	⚓	