Amendment on 29 June 2026
Resolved by Technical Committee on 29 January 2026

Rudder Horns and Rudders

Object of Amendment

Rules for the Survey and Construction of Steel Ships Part C
Guidance for the Survey and Construction of Steel Ships Parts C and CS
Guidance for the Survey and Construction of Inland Waterway Ships

Reason for Amendment

IACS Unified Requirement (UR) S10 stipulates requirements for rudders, sole pieces and rudder horns, and these requirements have already been incorporated into Part C, Part CS and other parts of the NK Rules.

IACS recently reviewed certain requirements of the UR and amended requirement related to rudder horns and rudder trunks as a result. The amended requirements were then adopted as UR S10 (Rev.8) in September 2025.

Accordingly, relevant requirements are amended based on UR S10 (Rev.8).

Outline of the Amendment

The main details of this amendment are as follows:

(1) Amends the calculation method for the sectional areas of rudder horns used in the formulae for evaluating the torsional stress acting on each section and for determining the torsional stiffness factor of the rudder horns.
(2) Amends the reference waterline used for the installation positions of sealing devices on rudder carriers.
(3) Amends various figures and symbols for clarification purposes.

Effective Date and Application

This amendment applies to ships for which the date of contract for construction is on or after 1 January 2027. This includes those ships to which Part C of the Rules for the Survey and Construction of Steel Ships applied prior to its comprehensive revision.

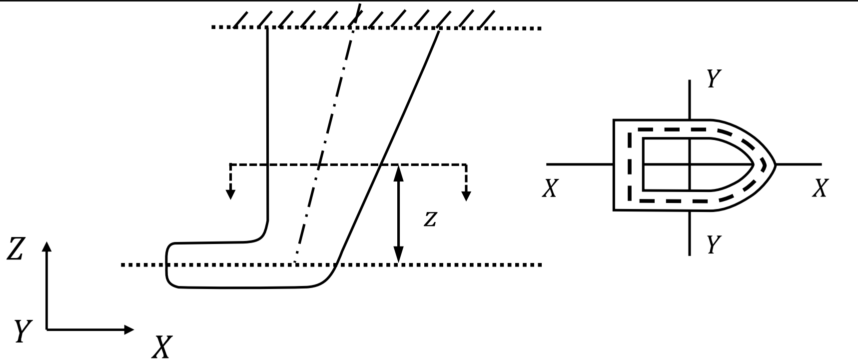
An asterisk (*) after the title of a requirement indicates that there is also relevant information in the corresponding Guidance.

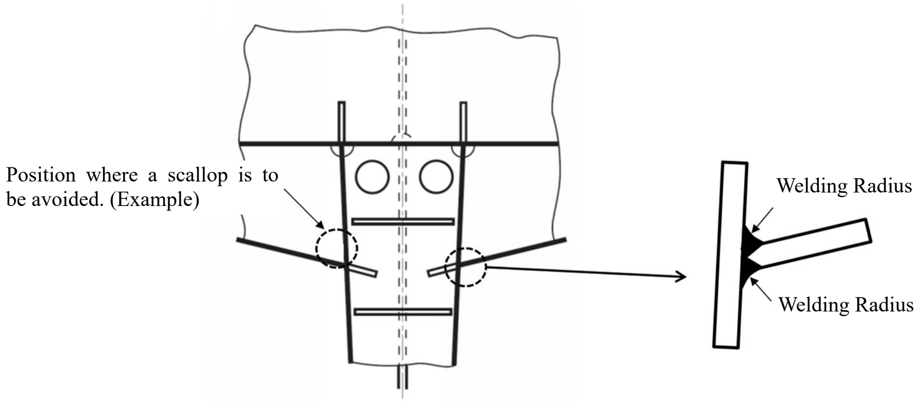
ID:DH25-14

Amended	Original	Remarks
RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS **Part C HULL CONSTRUCTION AND EQUIPMENT** **Part 1 GENERAL HULL REQUIREMENTS** **Chapter 11 STRUCTURES OUTSIDE CARGO REGION** **11.5 Stern Construction** **11.5.1 Stern Frames** **11.5.1.5 Rudder Horns*** **1** The scantlings of each cross section of the rudder horn are to be determined by the following formulae **(1)** to **(3)**, considering the bending moment, shear force and torque acting on the rudder horn when the rudder force specified in **13.2.2** is applied to the rudder. ((1) to (2) are omitted.) (3) At no section within the height of the rudder horn, the equivalent stress is not to exceed $120/K_{rh}$ (N/mm^2). The equivalent stress σ_e is to be obtained from the following formulae: $\sigma_e = \sqrt{\sigma_b{}^2 + 3(\tau^2 + \tau_t{}^2)}$ (N/mm^2)	**RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS** **Part C HULL CONSTRUCTION AND EQUIPMENT** **Part 1 GENERAL HULL REQUIREMENTS** **Chapter 11 STRUCTURES OUTSIDE CARGO REGION** **11.5 Stern Construction** **11.5.1 Stern Frames** **11.5.1.5 Rudder Horns*** **1** The scantlings of each cross section of the rudder horn are to be determined by the following formulae **(1)** to **(3)**, considering the bending moment, shear force and torque acting on the rudder horn when the rudder force specified in **13.2.2** is applied to the rudder. ((1) to (2) are omitted.) (3) At no section within the height of the rudder horn, the equivalent stress is not to exceed $120/K_{rh}$ (N/mm^2). The equivalent stress σ_e is to be obtained from the following formulae: $\sigma_e = \sqrt{\sigma_b{}^2 + 3(\tau^2 + \tau_t{}^2)}$ (N/mm^2)	

Amended	Original	Remarks
σ_b, τ and τ_t: Bending stress, shear stress and torsional stress acting on the rudder horn, respectively, as obtained from the following formulae: Bending stress: $\sigma_b = \frac{M}{Z_{x-gr}}$ (N/mm^2) Shear stress: $\tau = \frac{B}{A_{h-gr}}$ (N/mm^2) Torsional stress: $\tau_t = \frac{1000T_h}{2A_{t-gr}t_{h-gr}}$ (N/mm^2) M and B: As specified in **(1)** and **(2)** above. T_h: Torsional moment, as deemed appropriate by the Society. A_{t-gr}: Area (mm^2) enclosed by a dotted line in **Fig. 11.5.1-4**. This area is calculated as the mean of areas enclosed by the outer and inner boundaries of the thin-walled section of rudder horn at the considered cross-section. t_{h-gr}: Plate thickness (mm) of the rudder horn Z_{x-gr}: As specified in **(1)**. A_{h-gr}: As specified in **(2)**.	σ_b, τ and τ_t: Bending stress, shear stress and torsional stress acting on the rudder horn, respectively, as obtained from the following formulae: Bending stress: $\sigma_b = \frac{M}{Z_{x-gr}}$ (N/mm^2) Shear stress: $\tau = \frac{B}{A_{h-gr}}$ (N/mm^2) Torsional stress: $\tau_t = \frac{1000T_h}{2A_{t-gr}t_{h-gr}}$ (N/mm^2) M and B: As specified in **(1)** and **(2)** above. T_h: Torsional moment, as deemed appropriate by the Society. A_{t-gr}: Area (mm^2) in the horizontal section enclosed by the rudder horn t_{h-gr}: Plate thickness (mm) of the rudder horn Z_{x-gr}: As specified in **(1)**. A_{h-gr}: As specified in **(2)**.	Amendment (1) IACS UR S10(Rev.8) 9.2.1
5 The connection to the hull structure is to be in accordance with the following **(1)** to **(7)**. (1) The rudder horn plating is to be effectively connected to the aft ship structure, e.g. by connecting the plating to the side shell of the hull and transverse or longitudinal girders, in order to achieve a proper transmission of force. (*See* **Fig. 11.5.1-5**) (2) Brackets or stringers are to be fitted internally in the horn, in line with the outside shell plate (*See* **Fig.**	**5** The connection to the hull structure is to be in accordance with the following **(1)** to **(7)**. (1) The rudder horn plating is to be effectively connected to the aft ship structure, e.g. by connecting the plating to the side shell of the hull and transverse or longitudinal girders, in order to achieve a proper transmission of force. (*See* **Fig. 11.5.1-4**) (2) Brackets or stringers are to be fitted internally in the horn, in line with the outside shell plate (*See* **Fig.**	Reference correction Reference correction

Amended	Original	Remarks
11.5.1-5), except in cases where not practicable.	**11.5.1-4**), except in cases where not practicable.	
(3) Transverse webs of the rudder horn are to be led into the hull up to the next deck in a sufficient number.	(3) Transverse webs of the rudder horn are to be led into the hull up to the next deck in a sufficient number.	
(4) Strengthened plate floors are to be fitted in line with the transverse webs of the rudder horn to achieve sufficient connection with the hull.	(4) Strengthened plate floors are to be fitted in line with the transverse webs of the rudder horn to achieve sufficient connection with the hull.	
(5) The centre line bulkhead (wash bulkhead) in the after peak is to be connected to the rudder horn.	(5) The centre line bulkhead (wash bulkhead) in the after peak is to be connected to the rudder horn.	
(6) Scallops are to be avoided in way of the connection between transverse webs and the shell plating. (*See* **Fig. 11.5.1-5**)	(6) Scallops are to be avoided in way of the connection between transverse webs and the shell plating. (*See* **Fig. 11.5.1-4**)	Reference correction
(7) The weld at the connection between the rudder horn plating and the shell plating is to be full penetration. The welding radius is to be as large as practicable and may be obtained by grinding. (*See* **Fig. 11.5.1-5**)	(7) The weld at the connection between the rudder horn plating and the shell plating is to be full penetration. The welding radius is to be as large as practicable and may be obtained by grinding. (*See* **Fig. 11.5.1-4**)	Reference correction
Fig. 11.5.1-4 Cross-sectional View of Thin-walled Section of Rudder Horn		(Newly added) Add a figure to clarify the definition of the sectional areas of rudder horns.



<table>
<tr><th>Amended</th><th>Original</th><th>Remarks</th></tr>
<tr><td colspan="2">Fig. 11.5.1-5~~4~~ Connection of Rudder Horn and Hull

</td><td>Figure number adjustment</td></tr>
<tr><td>

11.5.1.8 Rudder Trunk
2 The material, welding, and connection to the hull are to be in accordance with the following **(1)** to **(4)**.
((1) and (2) are omitted.)
(3) For rudder trunks extending below shell or skeg, the fillet shoulder radius r (*mm*) (*See* **Fig. 11.5.1-6**) is to be as large as practicable and to comply with the following formula:
$r = 0.1d_l/K_T$
However, this value is not to be less than:
When $\sigma \geq 40/K_T$ N/mm^2 $r = 60$ mm
When $\sigma < 40/K_T$ N/mm^2 $r = 30$ mm
d_l: Diameter of the rudder stock defined in **13.2.5.2**.
σ: Bending stress (N/mm^2) of the rudder trunk
K_T: Material factor for the rudder trunk as given in **13.2.1.2**.
The fillet radius may be obtained by grinding. If disk grinding is carried out, score marks are to be avoided

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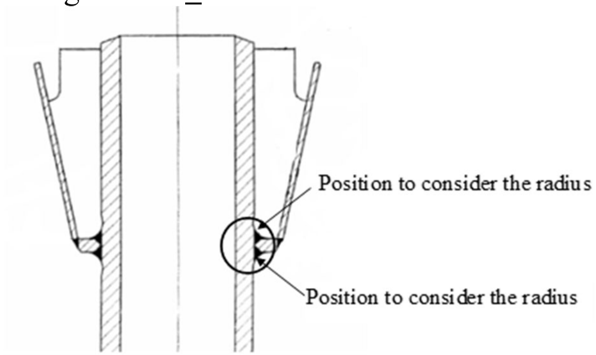
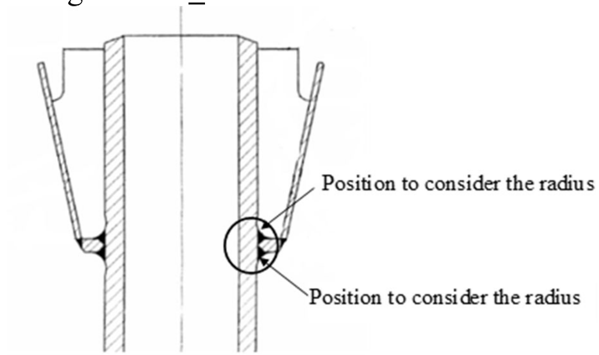
The fillet radius may be obtained by grinding. If disk grinding is carried out, score marks are to be avoided

</td><td>Reference correction</td></tr>
</table>

Amended	Original	Remarks
in the direction of welding. The fillet radius is to be checked with a template for accuracy. At least four profiles are to be checked. A report is to be submitted to the Surveyor. (4) (Omitted)	in the direction of welding. The fillet radius is to be checked with a template for accuracy. At least four profiles are to be checked. A report is to be submitted to the Surveyor. (4) (Omitted)	
Fig. 11.5.1-6 Fillet Radius of Fillet Weld  	Fig. 11.5.1-5 Fillet Radius of Fillet Weld  	Figure number adjustment
Chapter 13 RUDDERS **13.2 Rudders** **13.2.11 Rudder Accessories** **13.2.11.1 Rudder Carriers*** **1** Suitable rudder carriers are to be provided according to the form and the weight of the rudder, and care is to be taken to provide efficient lubrication at the support.	**Chapter 13 RUDDERS** **13.2 Rudders** **13.2.11 Rudder Accessories** **13.2.11.1 Rudder Carriers*** **1** Suitable rudder carriers are to be provided according to the form and the weight of the rudder, and care is to be taken to provide efficient lubrication at the support.	
2 In rudder trunks which are open to the sea, a seal or stuffing box is to be fitted above the waterline at scantling draught (without trim) to prevent water from entering the	**2** In rudder trunks which are open to the sea, a seal or stuffing box is to be fitted above the deepest load waterline to prevent water from entering the steering gear compartment	Amendment (2) IACS UR S10(Rev.8) 1.2.3

Amended	Original	Remarks
steering gear compartment and the lubricant from being washed away from the rudder carrier. If the top of the rudder trunk is below the waterline at scantling draught (without trim), two separate watertight seals or stuffing boxes are to be provided.	and the lubricant from being washed away from the rudder carrier. If the top of the rudder trunk is below the waterline at scantling draught (without trim), two separate watertight seals or stuffing boxes are to be provided.	

Amended	Original	Remarks
GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS **Part C HULL CONSTRUCTION AND EQUIPMENT** **Part 1 GENERAL HULL REQUIREMENTS** **C11 STRUCTURES OUTSIDE CARGO REGION** **C11.5 Stern Structure** **C11.5.1 Stern** **C11.5.1.5 Rudder Horn** In the application of **11.5.1.5, Part C of the Rules**, the bending moment, shear force, torque, and stresses to be considered are to be obtained by the direct calculation or the simple calculation method. Data used in the direct calculation are to be in accordance with **C13.2.4**. The simple calculation method is to be according to the following **(1)** and **(2)**. (1) Rudder horn with single-point elastic support (a) The bending moment M of the cross section under consideration is to be as obtained from the following equation (*See* **Fig. C11.5.1-1**):	**GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS** **Part C HULL CONSTRUCTION AND EQUIPMENT** **Part 1 GENERAL HULL REQUIREMENTS** **C11 STRUCTURES OUTSIDE CARGO REGION** **C11.5 Stern Structure** **C11.5.1 Stern** **C11.5.1.5 Rudder Horn** In the application of **11.5.1.5, Part C of the Rules**, the bending moment, shear force, torque, and stresses to be considered are to be obtained by the direct calculation or the simple calculation method. Data used in the direct calculation are to be in accordance with **C13.2.4**. The simple calculation method is to be according to the following **(1)** and **(2)**. (1) Rudder horn with single point elastic support (a) The bending moment M of the cross section under consideration is to be as obtained from the following equation (*See* **Fig. C11.5.1-1**):	

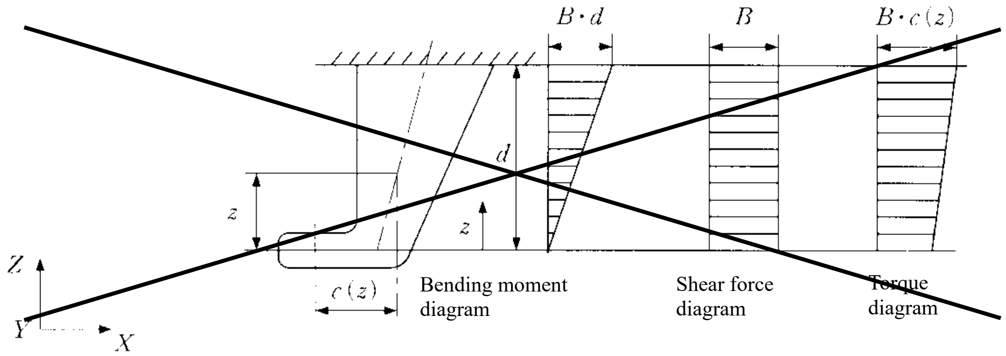
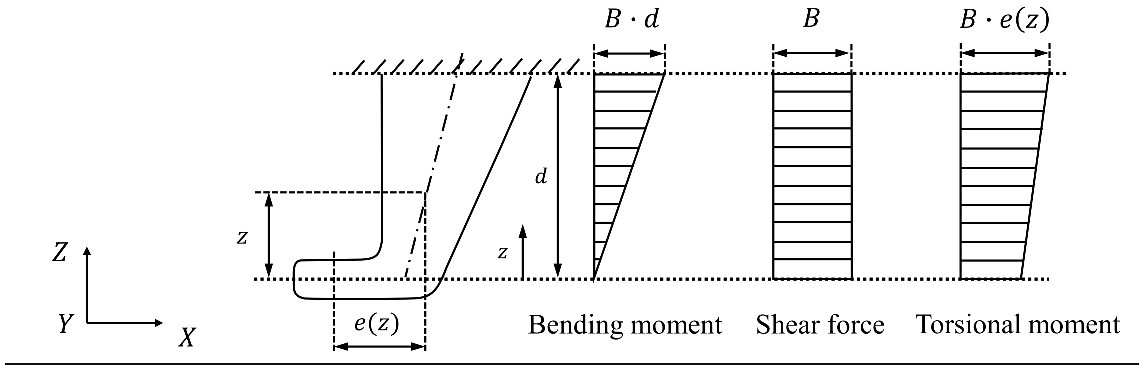
Amended	Original	Remarks
$M = Bz \quad (M_{max} = Bd \times 10^{-3})$ (*N-m*) B: Supporting force (*N*) of the pintle bearing obtained by **13.2.4, Part C of the Rules**. (b) The torsional moment T_h of the cross section under consideration is to be as obtained from the following equation (*See* **Fig. C11.5.1-1**): $\underline{T_h = Be(z)}$ (*N-m*)	$M = Bz \quad (M_{max} = Bd \times 10^{-3})$ (*N-m*) B: Supporting force (*N*) of the pintle bearing obtained by **13.2.4, Part C of the Rules**. (b) The torsional moment T_h of the cross section under consideration is to be as obtained from the following equation (*See* **Fig. C11.5.1-1**): $\underline{T_h = Bc(z)}$ (*N-m*)	Amendment (3) Due to inconsistencies in the symbols for the torsion lever of the ladder horn, the symbols are unified as follows: the torsion lever is denoted by $e(z)$, and specifically, the lever at $z = d/2$ is denoted by c.
(2) Rudder horn with two-point elastic support (a) Bending moment The bending moment (*N-m*) acting on the general cross section of the rudder horn is to be as obtained from the following equations: i) Between the upper and lower supports of the rudder horn $M = F_{A1}z$ ii) Above the upper support of the rudder horn $M = F_{A1}z + F_{A2}(z - d_{lu} \times 10^{-3})$ F_{A1}: Supporting force (*N*) at the lower support of the rudder horn, which is B_1 in **Fig. C13.2.4-8**. F_{A2}: Supporting force (*N*) at the lower support of the rudder horn (*N*), which is B_2 in **Fig. C13.2.4-8**. z: Distance specified (*m*) in **Fig. C11.5.1-2**, which is to be less than the distance d (*mm*) specified in the drawing. d_{lu}: Distance (*mm*) between the bottom bearing and upper bearing of the rudder horn ($d_{lu} = d - \lambda$ in **Fig. C13.2.4-8**). (b) Shear force The shear force B (*N*) acting on the general cross	(2) Rudder horn with two-point elastic support (a) Bending moment The bending moment (*N*) acting on the general cross section of the rudder horn is to be as obtained from the following equations: i) Between the upper and lower supports of the rudder horn $M = F_{A1}z$ ii) Above the upper support of the rudder horn $M = F_{A1}z + F_{A2}(z - d_{lu} \times 10^{-3})$ F_{A1}: Supporting force (*N*) at the lower support of the rudder horn, which is B_1 in **Fig. C13.2.4-7**. F_{A2}: Supporting force (*N*) at the lower support of the rudder horn (*N*), which is B_2 in **Fig. C13.2.4-7**. z: Distance specified (*m*) in **Fig. C11.5.1-2**, which is to be less than the distance d (*mm*) specified in the drawing. d_{lu}: Distance (*mm*) between the bottom bearing and upper bearing of the rudder horn ($d_{lu} = d - \lambda$ in **Fig. C13.2.4-7**). (b) Shear force The shear force B (*N*) acting on the general cross	Reference correction Reference correction Reference correction

Amended	Original	Remarks
section of the rudder horn is to be as obtained from the following equations: i) Between the upper and lower bearings of the rudder horn $B = F_{A1}$ ii) Above the upper bearing of the rudder horn $B = F_{A1} + F_{A2}$ F_{A1}, F_{A2}: Supporting force (*N*) (c) Torque The torque (*N-m*) acting on the general cross section of the rudder horn is to be as obtained from the following equations: i) Between the upper and lower bearings of the rudder horn $T_h = F_{A1}e(z)$ ii) Above the upper bearings of the rudder horn $T_h = F_{A1}e(z) + F_{A2}e(z)$ F_{A1}, F_{A2}: Supporting force (*N*). $e(z)$: Lever arm length (*m*) of the torsional moment specified in **Fig. C11.5.1-2**. (d) Calculation of shearing stress and torsional stress i) Stresses in the general cross section of the rudder horn between the lower bearing and upper bearing are to be obtained from the following equations: τ: Shear stress (*N/mm*^{2}) according to the following equation $\tau = \frac{F_{Al}}{A_h}$ τ_t: Torsional stress (*N/mm*^{2}) for the hollow rudder horn according to the following equation	section of the rudder horn is to be as obtained from the following equations: i) Between the upper and lower bearings of the rudder horn $B = F_{A1}$ ii) Above the upper bearing of the rudder horn $B = F_{A1} + F_{A2}$ F_{A1}, F_{A2}: Supporting force (*N*) (c) Torque The torque (*N-m*) acting on the general cross section of the rudder horn is to be as obtained from the following equations: i) Between the upper and lower bearings of the rudder horn $T_h = F_{A1}e_{(Z)}$ ii) Above the upper bearings of the rudder horn $T_h = F_{A1}e_{(Z)} + F_{A2}e_{(Z)}$ F_{A1}, F_{A2}: Supporting force (*N*). $e_{(Z)}$: Lever arm length (*m*) of the torsional moment specified in **Fig. C11.5.1-2**. (d) Calculation of shearing stress and torsional stress i) Stresses in the general cross section of the rudder horn between the lower bearing and upper bearing are to be obtained from the following equations: τ: Shear stress (*N/mm*^{2}) according to the following equation $\tau = \frac{F_{Al}}{A_h}$ τ_t: Torsional stress (*N/mm*^{2}) for the hollow rudder horn according to the following	

Amended	Original	Remarks
$$\tau_t = \frac{T_h}{2A_{t-gr}t_h} \times 10^{-3}$$	equation $$\tau_t = \frac{T_h}{2F_T t_h} \times 10^{-3}$$	Unification of symbols
For solid rudder horns, the calculation method is to be as deemed appropriate by the Society.	For solid rudder horns, the calculation method is to be as deemed appropriate by the Society.	
F_{Al}, F_{A2}: Supporting force (N)	F_{Al}, F_{A2}: Supporting force (N)	
A_h: Effective shear area (mm^2) of the rudder horn in the Y-axis direction.	A_h: Effective shear area (mm^2) of the rudder horn in the Y-axis direction.	
T_h: Torque (N-m)	T_h: Torque (N-m)	
A_{t-gr}: Area (m^2) enclosed by a dotted line in **Fig. C11.5.1-2**. This area is calculated as the mean of areas enclosed by the outer and inner boundaries of the thin-walled section of rudder horn at the considered cross-section.	F_T: Average area (m^2) of the outer wall of the rudder horn	Amendment (1) IACS UR S10(Rev.8) Annex S10.6 Unification of symbols
t_h: Thickness (mm) of the outer wall of the rudder horn. The maximum τ_t in any cross section of the rudder horn is to be calculated at the position where t_h is minimum.	t_h: Thickness (mm) of the outer wall of the rudder horn. The maximum τ_t in any cross section of the rudder horn is to be calculated at the position where t_h is minimum.	
ii) Stresses in the general cross section of the rudder horn above the upper bearing are to be obtained from the following equations.	ii) Stresses in the general cross section of the rudder horn above the upper bearing are to be obtained from the following equations.	
τ: Shear stress (N/mm^2) according to the following equation $$\tau = \frac{F_{Al} + F_{A2}}{A_h}$$	τ: Shear stress (N/mm^2) according to the following equation $$\tau = \frac{F_{Al} + F_{A2}}{A_h}$$	
τ_t: Torsional stress (N/mm^2) for the hollow rudder horn according to the following equation	τ_t: Torsional stress (N/mm^2) for the hollow rudder horn according to the following equation	

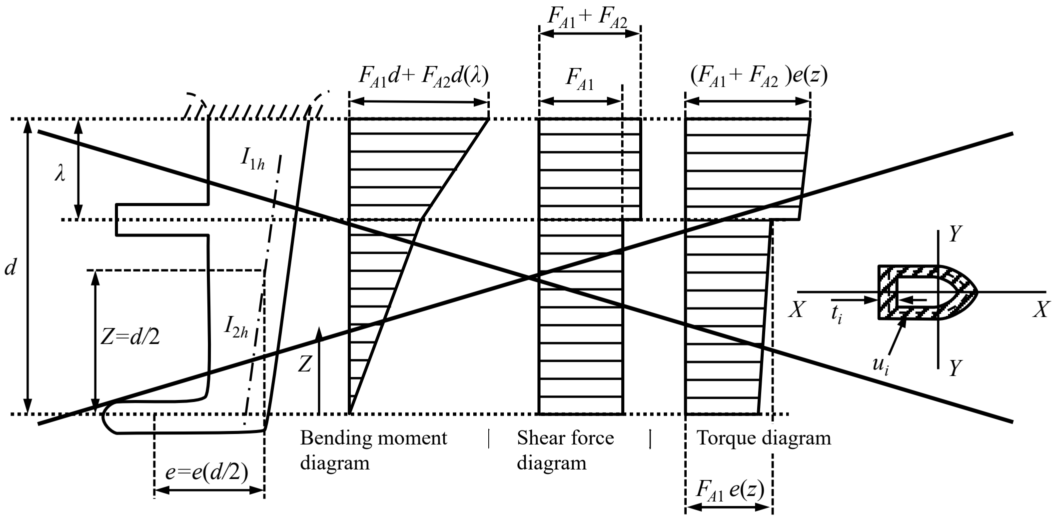
Amended-Original Requirements Comparison Table (Rudder Horns and Rudders)

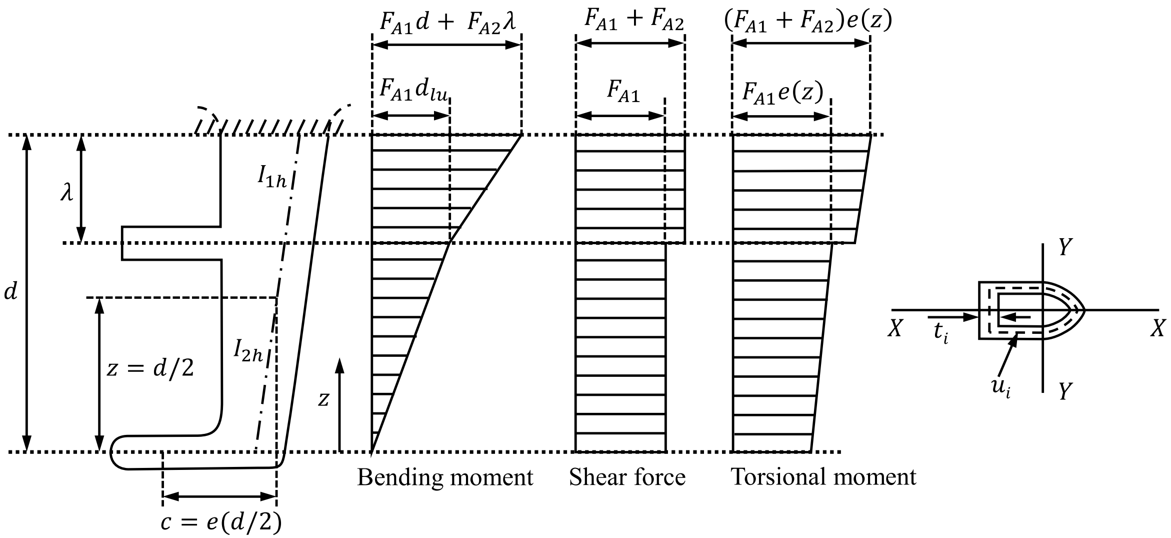
Amended	Original	Remarks
$\tau_t = \frac{T_h}{2A_{t-gr}t_h} \times 10^{-3}$ For solid rudder horns, the calculation method is to be as deemed appropriate by the Society. F_{Al}, F_{A2}, A_h, T_h, A_{t-gr}, t_h: As specified in **i)** above. (e) Calculation of bending stress The stress in the general cross section of the rudder horn within the region of length d is to be obtained according to the following equation: σ_b: Bending stress (*N/mm*^{2}) according to the following equation $\sigma_b = \frac{M}{Z_X}$ M: Bending moment (*N-m*) of the cross section under consideration Z_X: Section modulus (*cm*^{3}) about *X*-axis (*See* **Fig. C11.5.1-2**)	$\tau_t = \frac{T_h}{2F_T t_h} \times 10^{-3}$ For solid rudder horns, the calculation method is to be as deemed appropriate by the Society. F_{Al}, F_{A2}, A_h, T_h, F_T, t_h: As specified in **i)** above. (e) Calculation of bending stress The stress in the general cross section of the rudder horn within the region of length d is to be obtained according to the following equation: σ_b: Bending stress (*N/mm*^{2}) according to the following equation $\sigma_b = \frac{M}{Z_X}$ M: Bending moment (*N-m*) of the cross section under consideration Z_X: Section modulus (*cm*^{3}) about *X*-axis (*See* **Fig. C11.5.1-2**)	Unification of symbols Unification of symbols

Amended	Original	Remarks
Fig. C11.5.1-1 Geometry Parameters of Rudder Horn (Single-p~~P~~oint Elastic Support)  		Amendment (3) Due to inconsistencies in the symbols for the torsion lever of the ladder horn, the symbols are unified as follows: the torsion lever is denoted by $e(z)$, and specifically, the lever at $z = d/2$ is denoted by c.

Amended	Original	Remarks
Fig. C11.5.1-2 Geometry Parameters of Rudder Horn (Two2-point Elastic Support) (figures below)		Amendment (3) Due to inconsistencies in the symbols for the torsion lever of the ladder horn, the symbols are unified as follows: the torsion lever is denoted by $e(z)$, and specifically, the lever at $z = d/2$ is denoted by c.

Fig. C11.5.1-2 Geometry Parameters of Rudder Horn (Two2-point Elastic Support)





Amended	Original	Remarks
C13 RUDDERS **C13.2 Rudders** **C13.2.4 Rudder Strength Calculation** **C13.2.4.1 Rudder Strength Calculation** **1** The bending moment, shear force, and supporting force acting on the rudder and rudder stock may be evaluated using the basic rudder models shown in **Fig. C13.2.4-1** to **Fig. C13.2.4-8**. **2** The bending moment M_R and the shear force Q_1 acting on the rudder body, the bending moment M_b acting on the bearing, and the bending moment M_s acting on the coupling between the rudder stock and the rudder main piece and the supporting forces B_1, B_2, B_3 are to be obtained. These moments and forces are to be used for analysing the stresses in accordance with the requirements in **Chapter 13, Part C of the Rules**. **3** The method of evaluating moments and forces is to be as in the following **(1)** to **(3)** below. Notwithstanding the above, for Type *D* rudders with two-point elastic supports by rudder horns, the method of evaluating moments and forces is to be as in **-4**. (1) General data Data on the basic rudder models shown in **Fig. C13.2.4-1** to **Fig. C13.2.4-7** is as follows: ℓ_{10}~ℓ_{50}: Lengths (*m*) of individual girders of the system I_{10}~I_{50}: Moments (cm^4) of inertia of these girders For rudders supported by a shoe piece, the length l_{20} is the distance between the lower edge of the	**C13 RUDDERS** **C13.2 Rudders** **C13.2.4 Rudder Strength Calculation** **C13.2.4.1 Rudder Strength Calculation** **1** The bending moment, shear force, and supporting force acting on the rudder and rudder stock may be evaluated using the basic rudder models shown in **Fig. C13.2.4-1** to **Fig. C13.2.4-7**. **2** The bending moment M_R and the shear force Q_1 acting on the rudder body, the bending moment M_b acting on the bearing, and the bending moment M_s acting on the coupling between the rudder stock and the rudder main piece and the supporting forces B_1, B_2, B_3 are to be obtained. These moments and forces are to be used for analyzing the stresses in accordance with the requirements in **Chapter 13, Part C of the Rules**. **3** The method of evaluating moments and forces is to be as in the following **(1)** to **(3)** below. Notwithstanding the above, for Type *D* rudders with 2-conjugate elastic supports by rudder horns, the method of evaluating moments and forces is to be as in **4**. (1) General data Data on the basic rudder models shown in **Fig. C13.2.4-1** to **Fig. C13.2.4-6** is as follows: ℓ_{10}~ℓ_{50}: Lengths (*m*) of individual girders of the system I_{10}~I_{50}: Moments (cm^4) of inertia of these girders For rudders supported by a shoe piece, the length l_{20} is the distance between the lower edge of the	Reference correction Reference correction

Amended	Original	Remarks
rudder body and the centre of the shoe piece and I_{20} is the moment of inertia of the pintle in the shoe piece. h_c is the vertical distance (*m*) from the mid-point of the length of that pintle to the centroid of the rudder area. (2) Direct calculation The standard data to be used for direct calculation are as follows: Load acting on rudder body (Type *B* rudder) $P_R = \dfrac{F_R}{1000\ell_{10}}$ (*kN/m*) Load acting on rudder body (Type *C* rudder) $P_R = \dfrac{F_R}{1000\ell_{10}}$ (*kN/m*) Notwithstanding the above, the value is as follows for rudders with rudder trunks supporting rudder stocks. $P_R = \dfrac{F_R}{1000(\ell_{10}+\ell_{20})}$ (*kN/m*) Load acting on rudder body (Type *A* rudder) $P_{R10} = \dfrac{F_{R2}}{1000\ell_{10}}$ (*kN/m*) $P_{R20} = \dfrac{F_{R1}}{1000\ell_{30}}$ (*kN/m*) Load acting on rudder body (Type *D* and *E* rudder) $P_{R10} = \dfrac{F_{R2}}{1000\ell_{10}}$ (*kN/m*) $P_{R20} = \dfrac{F_{R1}}{1000\ell_{20}}$ (*kN/m*) F_R, F_{R1}, F_{R2}: As specified in **13.2.2.1** and **13.2.3, Part C of the Rules** k: Spring constant of the supporting point of the	rudder body and the centre of the shoe piece and I_{20} is the moment of inertia of the pintle in the shoe piece. h_c is the vertical distance (*m*) from the mid-point of the length of that pintle to the centroid of the rudder area. (2) Direct calculation The standard data to be used for direct calculation are as follows: Load acting on rudder body (Type *B* rudder) $P_R = \dfrac{F_R}{1000\ell_{10}}$ (*kN/m*) Load acting on rudder body (Type *C* rudder) $P_R = \dfrac{F_R}{1000\ell_{10}}$ (*kN/m*) Notwithstanding the above, the value is as follows for rudders with rudder trunks supporting rudder stocks. $P_R = \dfrac{F_R}{1000(\ell_{10}+\ell_{20})}$ (*kN/m*) Load acting on rudder body (Type *A* rudder) $P_{R10} = \dfrac{F_{R2}}{1000\ell_{10}}$ (*kN/m*) $P_{R20} = \dfrac{F_{R1}}{1000\ell_{30}}$ (*kN/m*) Load acting on rudder body (Type *D* and *E* rudder) $P_{R10} = \dfrac{F_{R2}}{1000\ell_{10}}$ (*kN/m*) $P_{R20} = \dfrac{F_{R1}}{1000\ell_{20}}$ (*kN/m*) F_R, F_{R1}, F_{R2}: As specified in **13.2.2.1** and **13.2.3, Part C of the Rules** k: Spring constant of the supporting point of the	

Amended	Original	Remarks
shoe piece or rudder horn respectively, as shown below For the supporting point of the shoe piece: $k = \frac{6.18 I_{50}}{\ell_{50}{}^3}$ (*kN/m*) (*See* **Fig. C13.2.4-1** and **Fig. C13.2.4-2**) I_{50}: The moment (cm^4) of inertia of shoe piece around the *Z*-axis ℓ_{50}: Effective length (*m*) of shoe piece For the supporting point of rudder horn: $k = \frac{1}{f_b + f_t}$ (*kN/m*) (*See* **Fig. C13.2.4-1**, **Fig. C13.2.4-4** and **Fig. C13.2.4-5**) Where: f_b: Unit displacement of rudder horn due to a unit force of 1 *kN* acting in the centre of support as shown below. $f_b = 1.3 \frac{d^3}{6.18 I_n}$ (*m/kN*) Where: I_n: The moment (cm^4) of inertia of rudder horn around the *X*-axis f_t: Unit displacement due to torsion, as shown below. $f_t = \frac{d c^2 \sum u_i / t_i}{3.14 A_{t-gr}{}^2} \times 10^{-8}$ (*m/kN*) A_{t-gr}: Area (m^2) enclosed by a dotted line in Fig. C11.5.1-2. This area is calculated as the mean of areas enclosed by the outer and inner boundaries of the thin-walled section of rudder horn at the considered cross-section.	shoe piece or rudder horn respectively, as shown below For the supporting point of the shoe piece: $k = \frac{6.18 I_{50}}{\ell_{50}{}^3}$ (*kN/m*) (*See* **Fig. C13.2.4-1** and **Fig. C13.2.4-2**) I_{50}: The moment (cm^4) of inertia of shoe piece around the *Z*-axis ℓ_{50}: Effective length (*m*) of shoe piece For the supporting point of rudder horn: $k = \frac{1}{f_b + f_t}$ (*kN/m*) (*See* **Fig. C13.2.4-1**, **Fig. C13.2.4-4** and **Fig. C13.2.4-5**) Where: f_b : Unit displacement of rudder horn due to a unit force of 1 *kN* acting in the centre of support as shown below. $f_b = 1.3 \frac{d^3}{6.18 I_n}$ (*m/kN*) Where: I_n : The moment (cm^4) of inertia of rudder horn around the *X*-axis f_t : Unit displacement due to torsion, as shown below. $f_t = \frac{d c^2 \sum u_i / t_i}{3.14 F_T{}^2} \times 10^{-8}$ (*m/kN*) F_T : Mean sectional area (m^2) of the rudder horn	Unification of symbols Amendment (1) IACS UR S10(Rev.8) Annex S10.5

Amended	Original	Remarks
u_i: Breadth (*mm*) of the individual plates forming the mean horn sectional area A_{t-gr} t_i: Plate thickness (*mm*) within the individual breadth u_i For c and d, *See* **Fig. C13.2.4-4** and **Fig. C13.2.4-5** (For the rudder horn of Type *A* rudders, the same values are to be also applied.) (3) (Omitted) **4** For Type *D* rudders with two-point elastic supports by rudder horns, the method of evaluating moments and forces is to be as in **(1)** and **(2)** below. (1) General data K_{11}, K_{22}, K_{12}: Rudder horn compliance constants calculated for rudder horn with two-point elastic supports (*See* **Fig. C13.2.4-8**). The two-point elastic supports are defined in terms of horizontal displacements, y_i, by the following equations: at the lower rudder horn bearing: $y_1 = -K_{12}B_2 - K_{22}B_1$ at the upper rudder horn bearing: $y_2 = -K_{11}B_2 - K_{12}B_1$ y_1, y_2: Horizontal displacements (*m*) at the lower and upper rudder horn bearings, respectively B_1, B_2: Horizontal support forces (*kN*) at the lower and upper rudder horn bearings, respectively K_{11}, K_{22}, K_{12}: Obtained (*m/kN*) from the following	u_1 : Breadth (*mm*) of the individual plates forming the mean sectional area of the rudder horn t_1 : Plate thickness (*mm*) within the individual breadth u_1 For c and d, *See* **Fig. C13.2.4-4** and **Fig. C13.2.4-5** (For the rudder horn of Type *A* rudders, the same values are to be also applied.) (3) (Omitted) **4** For Type *D* rudders with 2-conjugate elastic supports by rudder horns, the method of evaluating moments and forces is to be as in **(1)** and **(2)** below. (1) General data K_{11}, K_{22}, K_{12}: Rudder horn compliance constants calculated for rudder horn with 2-conjugate elastic supports (*See* **Fig. C13.2.4-7**). The 2-conjugate elastic supports are defined in terms of horizontal displacements, y_i, by the following equations: at the lower rudder horn bearing: $y_1 = -K_{12}B_2 - K_{22}B_1$ at the upper rudder horn bearing: $y_2 = -K_{11}B_2 - K_{12}B_1$ y_1, y_2: Horizontal displacements (*m*) at the lower and upper rudder horn bearings, respectively B_1, B_2: Horizontal support forces (*kN*) at the lower and upper rudder horn bearings, respectively K_{11}, K_{22}, K_{12}: Obtained (*m/kN*) from the	Unification of symbols Reference correction

<table>
<tr><th>Amended</th><th>Original</th><th>Remarks</th></tr>
<tr><td>formulae:
$K_{11} = 1.3 \cdot \frac{\lambda^3}{3EI_{1h}} + \frac{c^2\lambda}{GI_{th}}$
$K_{12} = 1.3\left[\frac{\lambda^3}{3EI_{1h}} + \frac{\lambda^2(d-\lambda)}{2EI_{1h}}\right] + \frac{c^2\lambda}{GI_{th}}$
$K_{22} = 1.3\left[\frac{\lambda^3}{3EI_{1h}} + \frac{\lambda^2(d-\lambda)}{EI_{1h}} + \frac{\lambda(d-\lambda)^2}{EI_{1h}} + \frac{(d-\lambda)^3}{3EI_{2h}}\right] + \frac{c^2 d}{GI_{th}}$</td><td>following formulae:
$K_{11} = 1.3 \cdot \frac{\lambda^3}{3EI_{1h}} + \frac{e^2\lambda}{GI_{th}}$
$K_{12} = 1.3\left[\frac{\lambda^3}{3EI_{1h}} + \frac{\lambda^2(d-\lambda)}{2EI_{1h}}\right] + \frac{e^2\lambda}{GI_{th}}$
$K_{22} = 1.3\left[\frac{\lambda^3}{3EI_{1h}} + \frac{\lambda^2(d-\lambda)}{EI_{1h}} + \frac{\lambda(d-\lambda)^2}{EI_{1h}} + \frac{(d-\lambda)^3}{3EI_{2h}}\right] + \frac{e^2 d}{GI_{th}}$</td><td>Amendment (3)
Due to inconsistencies in the symbols for the torsion lever of the ladder horn, the symbols are unified as follows: the torsion lever is denoted by $e(z)$, and specifically, the lever at $z = d/2$ is denoted by c.</td></tr>
<tr><td>d: Height of the rudder horn (m) defined in Fig. C13.2.4-8. This value is measured downwards from the upper rudder horn end, at the point of curvature transition, till the mid-line of the lower rudder horn pintle.</td><td>d: Height of the rudder horn (m) defined in Fig. C13.2.4-7. This value is measured downwards from the upper rudder horn end, at the point of curvature transition, till the mid-line of the lower rudder horn pintle</td><td>Reference correction</td></tr>
<tr><td>λ: Length (m) as defined in Fig. C13.2.4-8. This length is measured downwards from the upper rudder horn end, at the point of curvature transition, till the mid-line of the upper rudder horn bearing. For $\lambda = 0$, the above formulae converge to those of spring constant Z for a rudder horn with single-point elastic support, and assuming a hollow cross section for this part.</td><td>λ: Length (m) as defined in Fig. C13.2.4-7. This length is measured downwards from the upper rudder horn end, at the point of curvature transition, till the mid-line of the upper rudder horn bearing. For $\lambda = 0$, the above formulae converge to those of spring constant Z for a rudder horn with 1-elastic support, and assuming a hollow cross section for this part</td><td>Reference correction

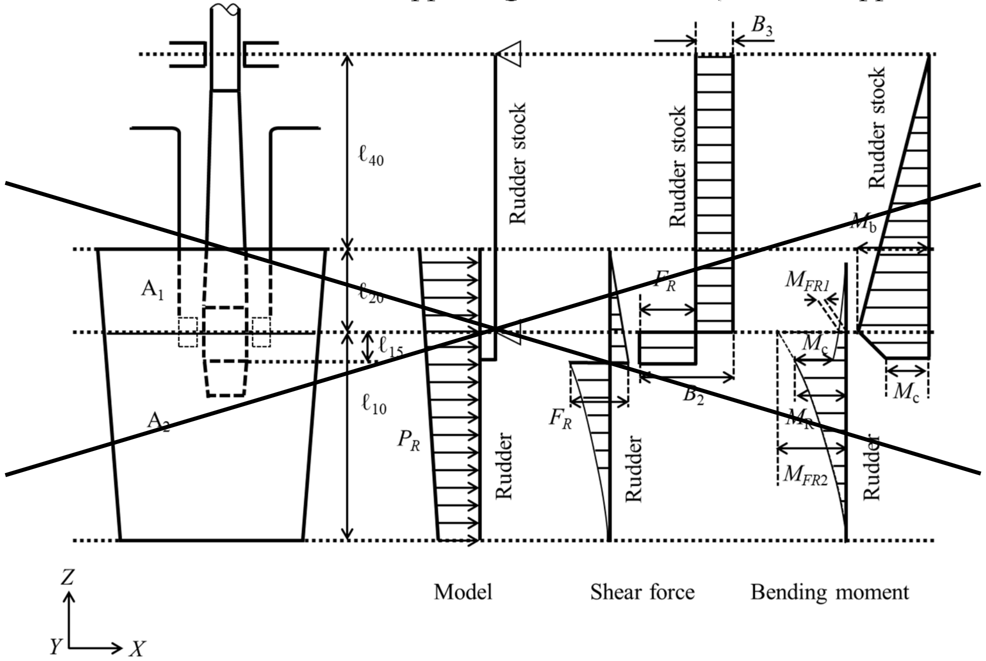
Reference correction</td></tr>
<tr><td>c: Rudder-horn torsion lever (m) as defined in Fig.</td><td>e: Rudder-horn torsion lever (m) as defined in Fig.</td><td>Amendment (3)
Due to inconsistencies</td></tr>
</table>

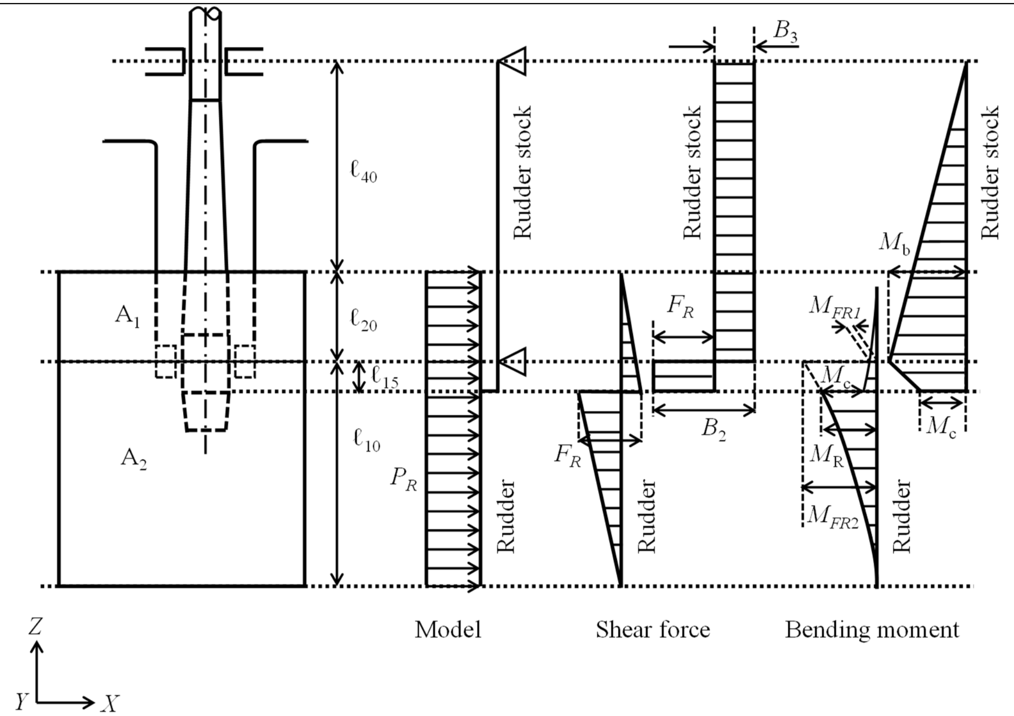
Amended	Original	Remarks
C13.2.4-8 (value taken at $z = d/2$). I_{1h}: Moment of inertia of rudder horn about the *X* axis (m^4) for the region above the upper rudder horn bearing. Note that I_{1h} is an average value over the length λ (*See* **Fig. C13.2.4-8**). I_{2h}: Moment of inertia of rudder horn about the *X* axis (m^4) for the region between the upper and lower rudder horn bearings. Note that I_{2h} is an average value over the length $d - \lambda$ (*See* **Fig. C13.2.4-8**). I_{th}: Torsional stiffness factor of the rudder horn for any thin wall closed section (m^4) is as follows: $I_{th} = \frac{4{A_{t-gr}}^2}{\sum_i \frac{u_i}{t_i}}$ A_{t-gr}: Area (m^2) enclosed by a dotted line in **Fig. C11.5.1-2**. This area is calculated as the mean of areas enclosed by the outer and inner boundaries of the thin-walled section of rudder horn at the considered cross-section. u_i: Length (*mm*) of the individual plates forming the mean horn sectional area A_{t-gr} t_i: Thickness (*mm*) of the individual plates mentioned above Note that the I_{th} value is taken as an average value, valid over the rudder horn height. (2) Direct calculation The standard data to be used for direct calculation are as follows:	**C13.2.4-7** (value taken at $z = d/2$) I_{1h}: Moment of inertia of rudder horn about the *X* axis (m^4) for the region above the upper rudder horn bearing. Note that I_{1h} is an average value over the length λ (*See* **Fig. C13.2.4-7**) I_{2h}: Moment of inertia of rudder horn about the *X* axis (m^4) for the region between the upper and lower rudder horn bearings. Note that I_{2h} is an average value over the length $d - \lambda$ (*See* **Fig. C13.2.4-7**) I_{th}: Torsional stiffness factor of the rudder horn for any thin wall closed section (m^4) is as follows: $I_{th} = \frac{4{F_T}^2}{\sum_i \frac{u_i}{t_i}}$ F_T: Mean of areas enclosed by outer and inner boundaries of the thin walled section of rudder horn (m^2) u_i: Length (*mm*) of the individual plates forming the mean horn sectional area t_i: Thickness (*mm*) of the individual plates mentioned above Note that the I_{th} value is taken as an average value, valid over the rudder horn height. (2) Direct calculation The standard data to be used for direct calculation are as follows:	in the symbols for the torsion lever of the ladder horn, the symbols are unified as follows: the torsion lever is denoted by $e(z)$, and specifically, the lever at $z = d/2$ is denoted by c. Reference correction Unification of symbols Amendment (1) IACS UR S10(Rev.8) Annex S10.6

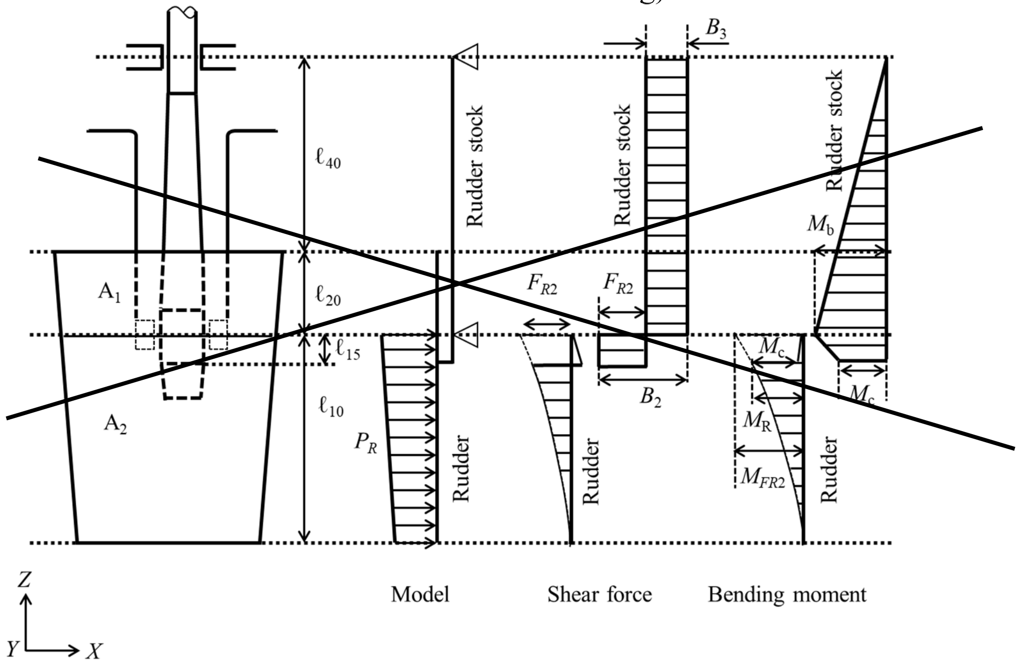
Amended-Original Requirements Comparison Table (Rudder Horns and Rudders)

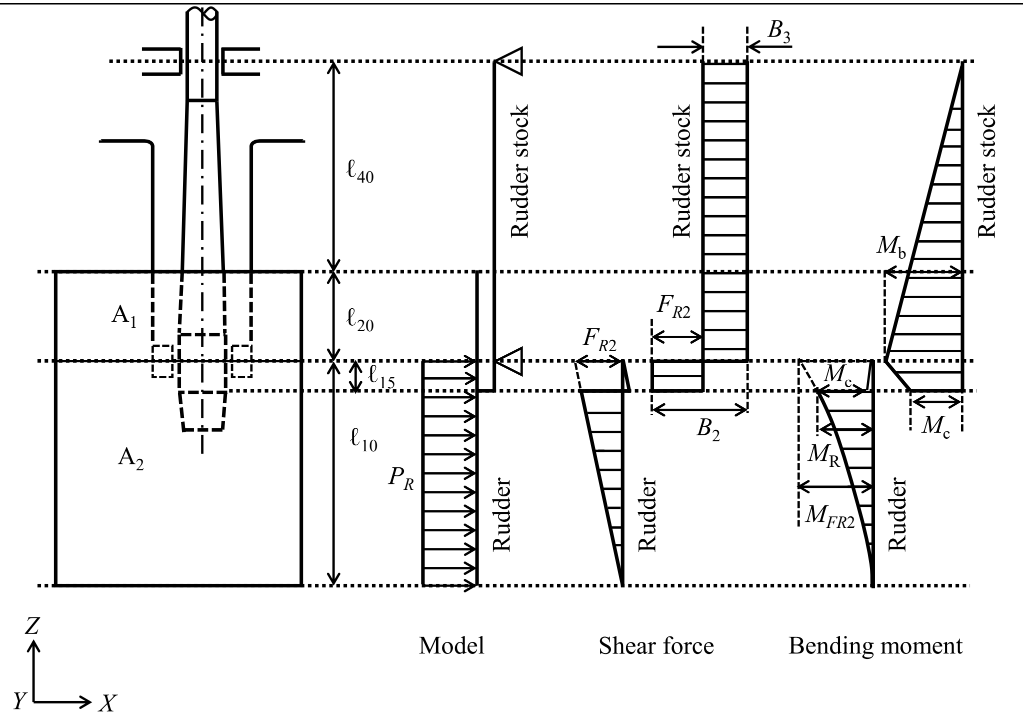
Amended	Original	Remarks
Load acting on rudder body (*kN/m*) $p_{R10} = \frac{F_{R2}}{\ell_{10} \cdot 10^3}$ $p_{R20} = \frac{F_{R1}}{\ell_{20} \cdot 10^3}$ F_R, F_{R1}, F_{R2}: As defined in **13.2.3.2**	Load acting on rudder body (*kN/m*) $p_{R10} = \frac{F_{R2}}{\ell_{10} \cdot 10^3}$ $p_{R20} = \frac{F_{R1}}{\ell_{20} \cdot 10^3}$ F_R, F_{R1}, F_{R2}: As defined in **13.2.3.2**	

Amended	Original	Remarks
Fig. C13.2.4-6 Type *C* Rudder with Rudder Trunk Supporting Rudder Stock (Pressure Applied on the Entire Rudder Area)		Amendment (3) Harmonize the figure with UR S10 Annex S10.3



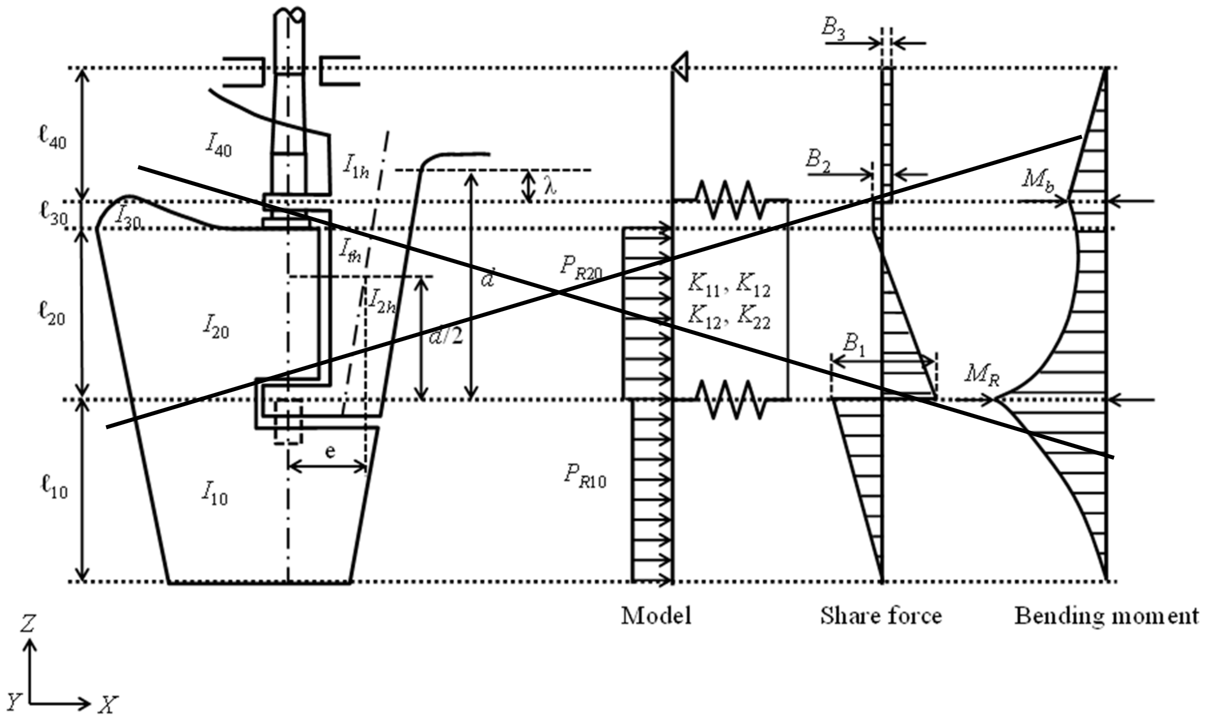
Amended	Original	Remarks
 Note: Full rudder force $F_R = F_{R1} + F_{R2}$ and total rudder torque $T_R = T_{R1} + T_{R2}$, with rudder stock bending moment $M_b = M_{FR2} - M_{FR1}$		

<table>
<tr><th>Amended</th><th>Original</th><th>Remarks</th></tr>
<tr><td colspan="2">Fig. C13.2.4-7 Type C Rudder with Rudder Trunk Supporting Rudder Stock (Pressure Applied only on Rudder Area below the Middle of Neck Bearing)

</td><td>Amendment (3)
Harmonize the figure with UR S10 Annex S10.3</td></tr>
</table>

Amended	Original	Remarks
		

Note:

Rudder force F_{R2} corresponding to rudder torque T_{R2} acting at rudder blade area A_2, with rudder stock bending moment $M_b = M_{FR2}$

<table>
<tr><th>Amended</th><th>Original</th><th>Remarks</th></tr>
<tr><td colspan="2">Fig. C13.2.4-8 Type *D* Rudder with ~~2-conjugate~~ <u>Two-point</u> Elastic Support~~s~~

</td><td>Amendment (3)
Due to inconsistencies in the symbols for the torsion lever of the ladder horn, the symbols are unified as follows: the torsion lever is denoted by $e(z)$, and specifically, the lever at $z = d/2$ is denoted by c.</td></tr>
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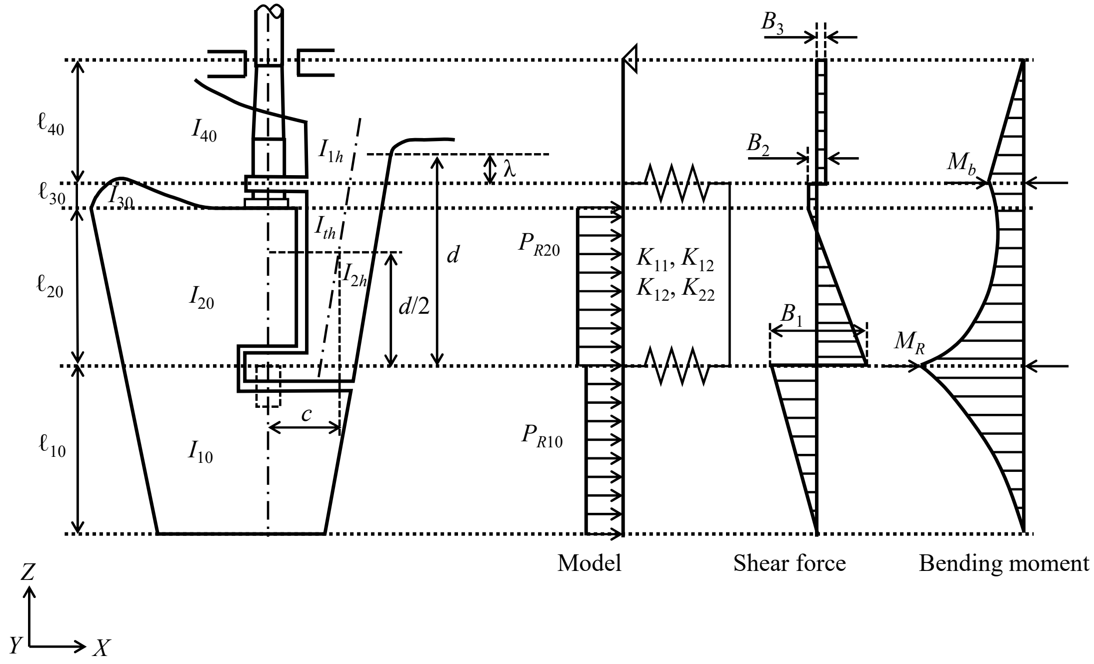
Amended	Original	Remarks
		

<table>
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GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part CS HULL CONSTRUCTION AND EQUIPMENT OF SMALL SHIPS

CS3 RUDDERS

CS3.4 Rudder Strength Calculation

CS3.4.1 Rudder Strength Calculation

1 General

The bending moment, shear force, and supporting force acting on the rudder and rudder stock may be evaluated using the basic rudder models shown in **Fig. CS3.4.1-1** to **Fig. CS3.4.1-5**.

2 Moments and forces to be evaluated

The bending moment M_R and the shear force Q_1 acting on the rudder body, the bending moment M_b acting on the bearing, and the bending moment M_s acting on the coupling between the rudder stock and the rudder main piece and the supporting forces B_1, B_2 and B_3 are to be obtained. These moments and forces are to be used for analysing the stresses in accordance with the requirements in **Chapter 3, Part CS of the Rules**.

3 Method of evaluating moments and forces

The method of evaluating moments and forces is to be as in the following **(1)** to **(3)** below.

(1) General data

</td><td>

GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part CS HULL CONSTRUCTION AND EQUIPMENT OF SMALL SHIPS

CS3 RUDDERS

CS3.4 Rudder Strength Calculation

CS3.4.1 Rudder Strength Calculation

1 General

The bending moment, shear force, and supporting force acting on the rudder and rudder stock may be evaluated using the basic rudder models shown in **Fig. CS3.4.1-1** to **Fig. CS3.4.1-4**.

2 Moments and forces to be evaluated

The bending moment M_R and the shear force Q_1 acting on the rudder body, the bending moment M_b acting on the bearing, and the bending moment M_s acting on the coupling between the rudder stock and the rudder main piece and the supporting forces B_1, B_2, B_3 are to be obtained. These moments and forces are to be used for analyzing the stresses in accordance with the requirements in **Chapter 3, Part CS** of the Rules.

3 Method of evaluating moments and forces

The method of evaluating moments and forces is to be as in the following **(1)** to **(3)** below.

(1) General data

</td><td>

Reference correction

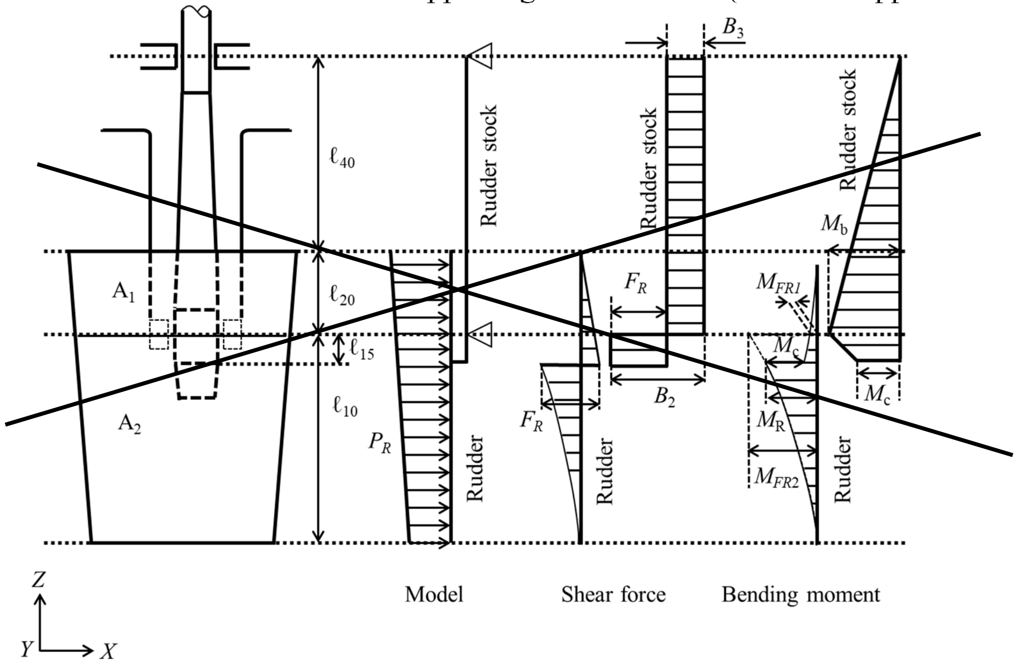
</td></tr>
</table>

Amended	Original	Remarks
Data on the basic rudder models shown in **Fig. CS3.4.1-1** to **Fig. CS3.4.1-5** is as follows: l_{10}~l_{50}: Lengths (m) of individual girders of the system I_{10}~I_{50}: Moments (cm^4) of inertia of these girders For rudders supported by a shoe piece, the length l_{20} is the distance between the lower edge of the rudder body and the centre of the shoe piece and I_{20} is the moment of inertia of the pintle in the shoe piece. h_c is the vertical distance (m) from the mid-point of the length of that pintle to the centroid of the rudder area. (2) Direct calculation The standard data to be used for direct calculation are as follows: Load acting on rudder body (Type B rudder) $P_R = \frac{F_R}{1000 l_{10}}$ (kN/m) Load acting on rudder body (Type C rudder) $P_R = \frac{F_R}{1000 l_{10}}$ (kN/m) Notwithstanding the above, the value is as follows for rudders with rudder trunks supporting rudder stocks. $P_R = \frac{F_R}{1000(l_{10}+l_{20})}$ (kN/m) Load acting on rudder body (Type A rudder) $P_{R10} = \frac{F_{R2}}{1000 l_{10}}$ (kN/m) $P_{R20} = \frac{F_{R1}}{1000 l_{30}}$ (kN/m) Where:	Data on the basic rudder models shown in **Fig. CS3.4.1-1** to **Fig. CS3.4.1-4** is as follows: l_{10}~l_{50} : Lengths (m) of individual girders of the system I_{10}~I_{50} : Moments (cm^4) of inertia of these girders For rudders supported by a shoe piece, the length l_{20} is the distance between the lower edge of the rudder body and the centre of the shoe piece and I_{20} is the moment of inertia of the pintle in the shoe piece. h_c is the vertical distance (m) from the mid-point of the length of that pintle to the centroid of the rudder area. (2) Direct calculation The standard data to be used for direct calculation are as follows: Load acting on rudder body (Type B rudder) $P_R = \frac{F_R}{1000 l_{10}}$ (kN/m) Load acting on rudder body (Type C rudder) $P_R = \frac{F_R}{1000 l_{10}}$ (kN/m) Notwithstanding the above, the value is as follows for rudders with rudder trunks supporting rudder stocks. $P_R = \frac{F_R}{1000(l_{10}+l_{20})}$ (kN/m) Load acting on rudder body (Type A rudder) $P_{R10} = \frac{F_{R2}}{1000 l_{10}}$ (kN/m) $P_{R20} = \frac{F_{R1}}{1000 l_{30}}$ (kN/m) Where:	Reference correction

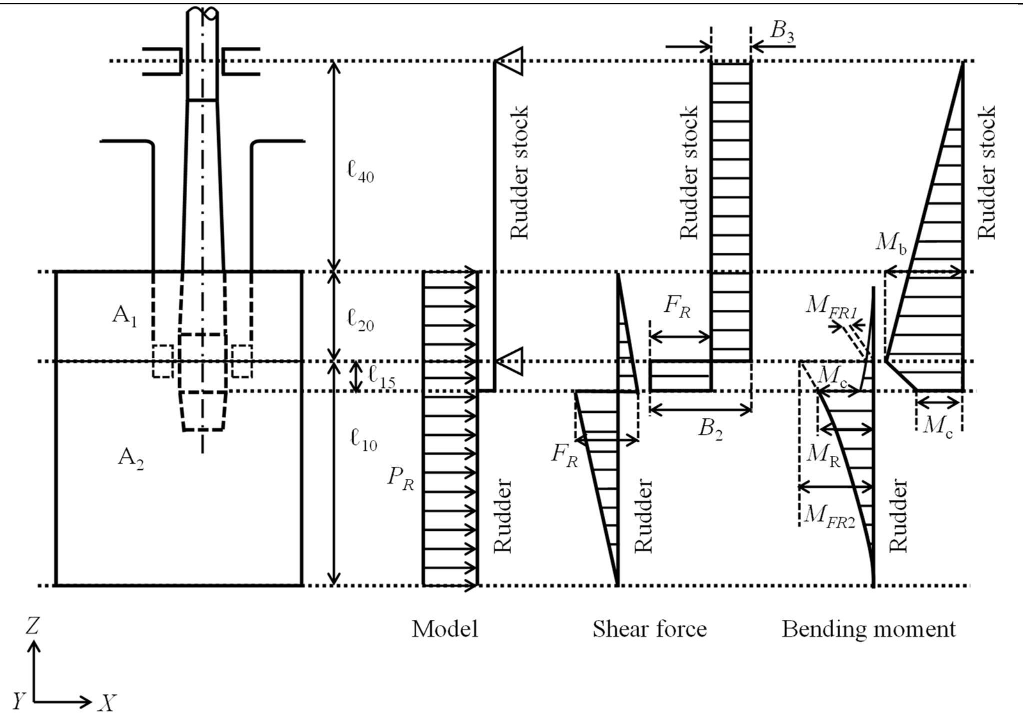
Amended-Original Requirements Comparison Table (Rudder Horns and Rudders)

Amended	Original	Remarks
F_R, F_{R1}, F_{R2}: As specified in **3.2** and **3.3, Part CS** of the Rules k: Spring constant of the supporting point of the shoe piece or rudder horn respectively, as shown below For the supporting point of the shoe piece: $k = \frac{6.18 I_{50}}{{l_{50}}^3}$ (kN/m) (*See* **Fig. CS3.4.1-1** and **Fig. CS3.4.1-2**) Where: I_{50}: The moment (cm^4) of inertia of shoe piece around the Z-axis l_{50}: Effective length (m) of shoe piece For the supporting point of rudder horn: $k = \frac{1}{f_b + f_t}$ (kN/m) (*See* **Fig. CS3.4.1-1**) Where: f_b: Unit displacement of rudder horn due to a unit force of 1 kN acting in the centre of support as shown below. $f_b = 1.3 \frac{d^3}{6.18 I_n}$ (m/kN) Where: I_n: The moment (cm^4) of inertia of rudder horn around the X-axis f_t: Unit displacement due to torsion, as shown below. $f_t = \frac{dc^2 \Sigma u_i/t_i}{3.14 {A_{t-gr}}^2} \times 10^{-8}$ (m/kN) A_{t-gr}: Area (m^2) enclosed by a dotted line in **Fig.**	F_R, F_{R1}, F_{R2}: As specified in **3.2** and **3.3, Part CS** of the Rules k: Spring constant of the supporting point of the shoe piece or rudder horn respectively, as shown below For the supporting point of the shoe piece: $k = \frac{6.18 I_{50}}{{l_{50}}^3}$ (kN/m) (*See* **Fig. CS3.4.1-1** and **Fig. CS3.4.1-2**) Where: I_{50}: The moment (cm^4) of inertia of shoe piece around the Z-axis l_{50}: Effective length (m) of shoe piece For the supporting point of rudder horn: $k = \frac{1}{f_b + f_t}$ (kN/m) (*See* **Fig. CS3.4.1-1**) Where: f_b: Unit displacement of rudder horn due to a unit force of 1 kN acting in the centre of support as shown below. $f_b = 1.3 \frac{d^3}{6.18 I_n}$ (m/kN) Where: I_n: The moment (cm^4) of inertia of rudder horn around the X-axis f_t: Unit displacement due to torsion, as shown below. $f_t = \frac{dc^2 \Sigma u_i/t_i}{3.14 {F_T}^2} \times 10^{-8}$ (m/kN) F_T: Mean sectional area (m^2) of the rudder horn	Unification of symbols Amendment (1) IACS UR S10(Rev.8)

Amended	Original	Remarks
CS3.4.1-6. This area is calculated as the mean of areas enclosed by the outer and inner boundaries of the thin-walled section of rudder horn at the considered cross-section. u_i: Breadth (mm) of the individual plates forming the mean horn sectional area A_{t-gr} t_i: Plate thickness (mm) within the individual breadth u_i (3) (Omitted)	u_i: Breadth (mm) of the individual plates forming the mean sectional area of the rudder horn t_i: Plate thickness (mm) within the individual breadth u_i (3) (Omitted)	Annex S10.5 Unification of symbols

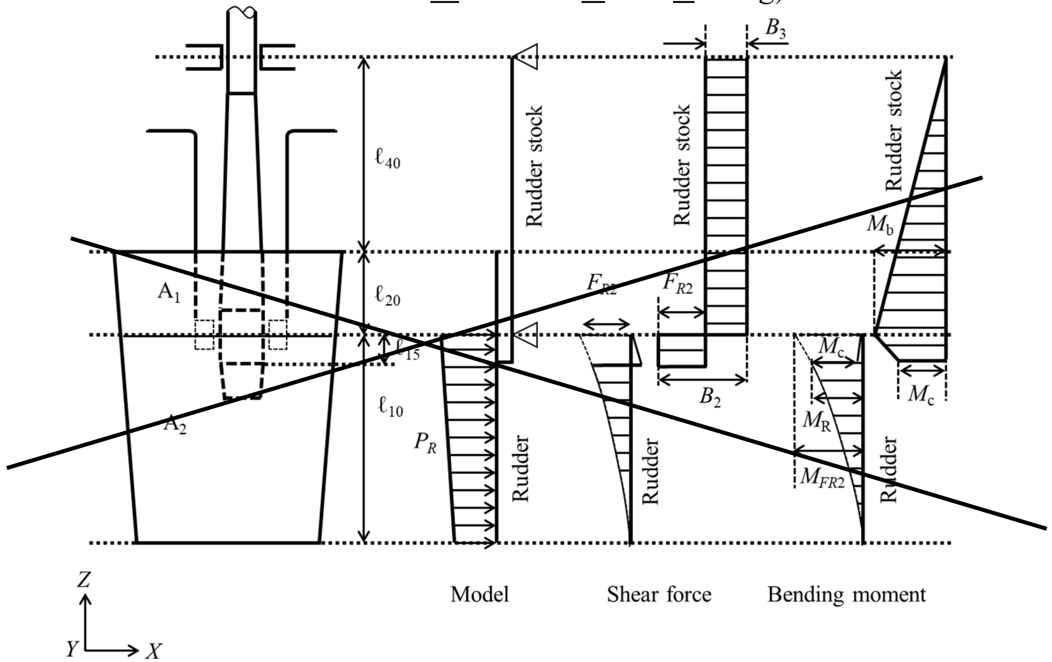
Amended	Original	Remarks
Fig. CS3.4.1-4 Type *C* Rudder with Rudder Trunk Supporting Rudder Stock (Pressure Applied on the Entire Rudder Area) 		Amendment (3) Harmonize the figure with UR S10 Annex S10.3

Amended	Original	Remarks

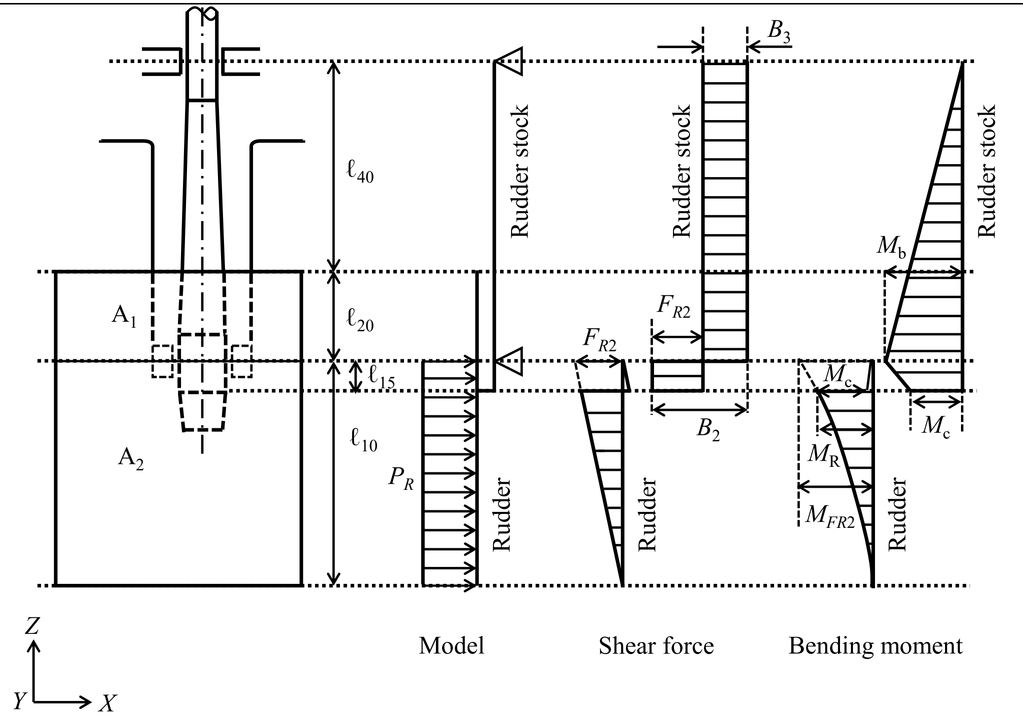


Note:

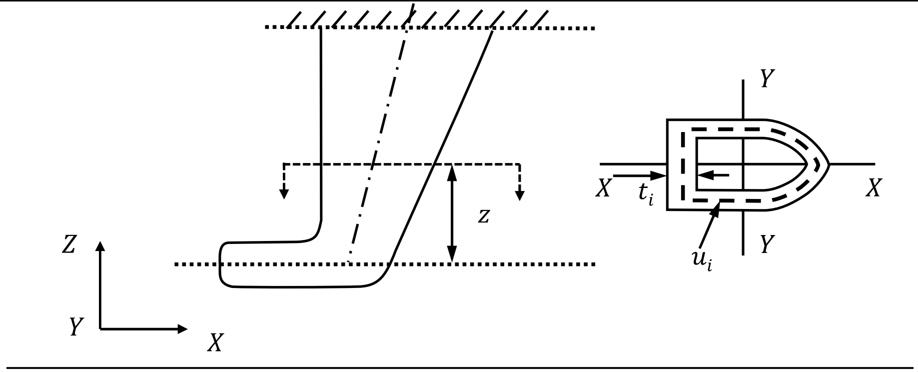
Full rudder force $F_R = F_{R1} + F_{R2}$ and total rudder torque $T_R = T_{R1} + T_{R2}$, with rudder stock bending moment $M_b = M_{FR2} - M_{FR1}$

Amended	Original	Remarks
Fig. CS3.4.1-5 Type *C* Rudder with Rudder Trunk Supporting Rudder Stock (Pressure ~~a~~Applied only on ~~r~~Rudder ~~a~~Area below the ~~m~~Middle of ~~n~~Neck ~~b~~Bearing)  		Amendment (3) Harmonize the figure with UR S10 Annex S10.3

Amended	Original	Remarks



Note:
Rudder force F_{R2} corresponding to rudder torque T_{R2} acting at rudder blade area A_2, with rudder stock bending moment $M_b = M_{FR2}$

Amended	Original	Remarks
Fig. CS3.4.1-6 Cross-sectional View of Thin-walled Section of Rudder Horn  		(Newly added) Add a figure to clarify the definition of the sectional areas of rudder horns.
CS3.12 Rudder Accessories	**CS3.12 Rudder Accessories**	
CS3.12.1 Rudder Carriers **3** Watertightness of rudder carrier part (1) In rudder trunks which are open to the sea, a seal or stuffing box is to be fitted above the waterline at scantling draught (without trim) to prevent water from entering the steering gear compartment and the lubricant from being washed away from the rudder carrier. If the top of the rudder trunk is below the waterline at scantling draught (without trim), two separate watertight seals or stuffing boxes are to be provided. (2) It is recommended that the packing gland in the stuffing box have an appropriate clearance from the rudder stock corresponding to the position of the stuffing box. The standard clearance is to be 4 *mm* for the stuffing box provided at the neck or intermediate bearing, and 2 *mm* for the stuffing box at the upper stock bearing.	**CS3.12.1 Rudder Carriers** **3** Watertightness of rudder carrier part (1) In rudder trunks which are open to the sea, a seal or stuffing box is to be fitted above the deepest load waterline to prevent water from entering the steering gear compartment and the lubricant from being washed away from the rudder carrier. If the top of the rudder trunk is below the waterline at scantling draught (without trim), two separate watertight seals or stuffing boxes are to be provided. (2) It is recommended that the packing gland in the stuffing box have an appropriate clearance from the rudder stock corresponding to the position of the stuffing box. The standard clearance is to be 4 *mm* for the stuffing box provided at the neck or intermediate bearing, and 2 *mm* for the stuffing box at the upper stock bearing.	Amendment (2) IACS UR S10(Rev.8) 1.2.3

Amended	Original	Remarks
GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF INLAND WATERWAY SHIPS **Part 1 GENERAL RULES** **Part 4 HULL CONSTRUCTION AND EQUIPMENT OF TUGS AND PUSHERS** **Chapter 2 RUDDERS AND STERN FRAMES** **2.1 Rudders** **2.1.6 Rudder Strength Calculation** **1** General The bending moment, shear force, and supporting force acting on the rudder and rudder stock may be evaluated using the basic rudder models shown in **Fig. 4.2.1.6-1** to **Fig. 4.2.1.6-5**. **2** Moments and forces to be evaluated The bending moment M_R and the shear force Q_1 acting on the rudder body, the bending moment M_b acting on the bearing, and the bending moment M_s acting on the coupling between the rudder stock and the rudder main piece and the supporting forces B_1, B_2 and B_3 are to be obtained. These moments and forces are to be used for analysing the stresses	**GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF INLAND WATERWAY SHIPS** **Part 1 GENERAL RULES** **Part 4 HULL CONSTRUCTION AND EQUIPMENT OF TUGS AND PUSHERS** **Chapter 2 RUDDERS AND STERN FRAMES** **2.1 Rudders** **2.1.6 Rudder Strength Calculation** **1** General The bending moment, shear force, and supporting force acting on the rudder and rudder stock may be evaluated using the basic rudder models shown in **Fig. 4.2.1.6-1** to **Fig. 4.2.1.6-5**. **2** Moments and forces to be evaluated The bending moment M_R and the shear force Q_1 acting on the rudder body, the bending moment M_b acting on the bearing, and the bending moment M_s acting on the coupling between the rudder stock and the rudder main piece and the supporting forces B_1, B_2, B_3 are to be obtained. These moments and forces are to be used for analyzing the stresses	

<table>
<tr><th>Amended</th><th>Original</th><th>Remarks</th></tr>
<tr><td>in accordance with the requirements in Chapter 2, Part 4 of the Rules.
3 Method of evaluating moments and forces
(1) General data
Data on the basic rudder models shown in Fig. 4.2.1.6-1 to Fig. 4.2.1.6-5 is as follows:
l_{10}~l_{50}: Lengths (m) of individual girders of the system
I_{10}~I_{50}: Moments (cm^4) of inertia of these girders
For rudders supported by a shoe piece, the length l_{20} is the distance between the lower edge of the rudder body and the centre of the shoe piece and I_{20} is the moment of inertia of the pintle in the shoe piece.
h_c is the vertical distance (m) from the mid-point of the length of that pintle to the centroid of the rudder area.
(2) Direct calculation
The standard data to be used for direct calculation are as follows:
Load acting on rudder body (Type B and C rudders)
$P_R = \frac{F_R}{1000 l_{10}}$ (kN/m)
Load acting on rudder body (Type A rudder)
$P_{R10} = \frac{F_{R2}}{1000 l_{10}}$ (kN/m)
$P_{R20} = \frac{F_{R1}}{1000 l_{30}}$ (kN/m)
Load acting on rudder body (Type D and E rudders)
$P_{R10} = \frac{F_{R2}}{1000 l_{10}}$ (kN/m)
$P_{R20} = \frac{F_{R1}}{1000 l_{20}}$ (kN/m)</td><td>in accordance with the requirements in Chapter 2, Part 4 of the Rules.
3 Method of evaluating moments and forces
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Data on the basic rudder models shown in Fig. 4.2.1.6-1 to Fig. 4.2.1.6-5 is as follows:
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$P_{R20} = \frac{F_{R1}}{1000 l_{20}}$ (kN/m)</td><td></td></tr>
</table>

Amended-Original Requirements Comparison Table (Rudder Horns and Rudders)

<table>
<tr><th>Amended</th><th>Original</th><th>Remarks</th></tr>
<tr><td>Where:
F_R: As specified in **2.1.4, Part 4 of the Rules**
F_{R1}, F_{R2}: As specified in **2.1.5, Part 4 of the Rules**
k: Spring constant of the supporting point of the shoe piece or rudder horn respectively, as shown below
For the supporting point of the shoe piece:
$k = \frac{6.18 I_{50}}{{l_{50}}^3}$ (*kN/m*)
(*See* **Fig. 4.2.1.6-1** and **Fig. 4.2.1.6-2**)
Where:
I_{50}: The moment (cm^4) of inertia of shoe piece around the *Z*-axis
l_{50}: Effective length (*m*) of shoe piece
For the supporting point of rudder horn:
$k = \frac{1}{f_b + f_t}$ (*kN/m*)
(*See* **Fig. 4.2.1.6-1**, **Fig. 4.2.1.6-4** and **Fig. 4.2.1.6-5**)
Where:
f_b: Unit displacement of rudder horn due to a unit force of 1 *kN* acting in the centre of support as shown below.
$f_b = 1.3 \frac{d^3}{6.18 I_n}$ (*m/kN*)
Where:
I_n: The moment of inertia (cm^4) of rudder horn around the *X*-axis
f_t: Unit displacement due to torsion, as shown below.
$f_t = \frac{d c^2 \Sigma u_i / t_i}{3.14 {A_{t-gr}}^2} \times 10^{-8}$ (*m/kN*)</td><td>Where:
F_R: As specified in **2.1.4, Part 4 of the Rules**
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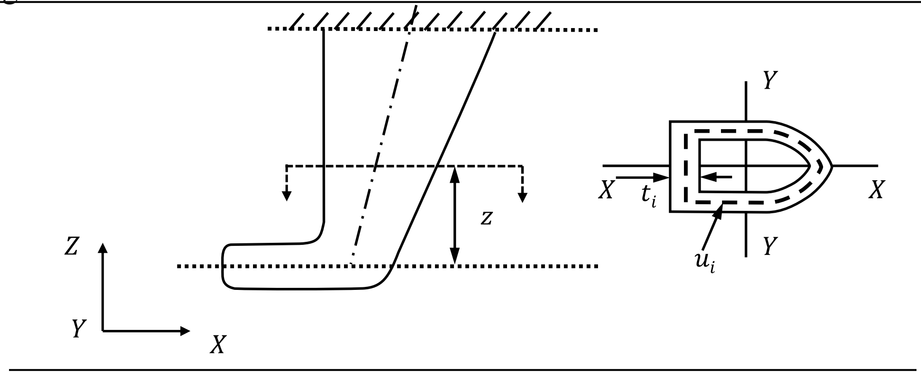
Amendment (1)
IACS UR S10(Rev.8)
Annex S10.5</td></tr>
</table>

Amended	Original	Remarks
A_{t-gr}: Area (m^2) enclosed by a dotted line in **Fig. 4.2.1.6-6**. This area is calculated as the mean of areas enclosed by the outer and inner boundaries of the thin-walled section of rudder horn at the considered cross-section. u_i: Breadth (mm) of the individual plates forming the mean horn sectional area A_{t-gr} t_i: Plate thickness (mm) within the individual breadth u_i For c and d, *see* **Fig. 4.2.1.6-4** and **Fig. 4.2.1.6-5**. (For the rudder horn of Type A rudders, the same values are to be also applied.) (3) (Omitted)	F_T: Mean sectional area (m^2) of the rudder horn u_i: Breadth (mm) of the individual plates forming the mean sectional area of the rudder horn t_i: Plate thickness (mm) within the individual breadth u_i For c and d, *see* **Fig. 4.2.1.6-4** and **Fig. 4.2.1.6-5**. (For the rudder horn of Type A rudders, the same values are to be also applied.) (3) (Omitted)	Unification of symbols
Fig. 4.2.1.6-6 Cross-sectional View of Thin-walled Section of Rudder Horn  		(Newly added) Add a figure to clarify the definition of the sectional areas of rudder horns.
2.1.14 Rudder Accessories **3** Watertightness of rudder carrier part (1) In rudder trunks which are open to the water, a seal or stuffing box is to be fitted above the waterline at scantling draught (without trim) to prevent water from entering the steering gear compartment and the	**2.1.14 Rudder Accessories** **3** Watertightness of rudder carrier part (1) In rudder trunks which are open to the water, a seal or stuffing box is to be fitted above the deepest designed maximum load line to prevent water from entering the steering gear compartment and the	Amendment (2) IACS UR S10(Rev.8) 1.2.3

Amended	Original	Remarks
lubricant from being washed away from the rudder carrier. If the top of the rudder trunk is below the waterline at scantling draught (without trim), two separate watertight seals or stuffing boxes are to be provided. (2) It is recommended that the packing gland in the stuffing box have an appropriate clearance from the rudder stock corresponding to the position of the stuffing box. The standard clearance is to be 4 *mm* for the stuffing box provided at the neck or intermediate bearing, and 2 *mm* for the stuffing box at the upper stock bearing.	lubricant from being washed away from the rudder carrier. (2) It is recommended that the packing gland in the stuffing box have an appropriate clearance from the rudder stock corresponding to the position of the stuffing box. The standard clearance is to be 4 *mm* for the stuffing box provided at the neck or intermediate bearing, and 2 *mm* for the stuffing box at the upper stock bearing.	

EFFECTIVE DATE AND APPLICATION

1. The effective date of the amendments is 1 January 2027.

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

3. For ships subject to Part C of the Rules for the Survey and Construction of Steel Ships and the Guidance for the Survey and Construction of Steel Ships prior to its comprehensive revision by Rule No.62 on 1 July 2022 and Notice No.47 on 1 July 2022 (herein after referred to as "old Part C of the Rules" and "old Part C of the Guidance"), and which the date of contract for construction* is on and after the effective date, this amendment also applies to following requirements.

C2.2.5, old Part C of the Guidance
Fig. C2.2.5-1, old Part C of the Guidance
Fig. C2.2.5-2, old Part C of the Guidance
C3.4.1-1, old Part C of the Guidance
C3.4.1-3, old Part C of the Guidance
C3.4.1-4, old Part C of the Guidance
Fig. C3.4.1-6, old Part C of the Guidance
Fig. C3.4.1-7, old Part C of the Guidance
Fig. C3.4.1-8, old Part C of the Guidance
C3.11.1-3, old Part C of the Guidance

Amended-Original Requirements Comparison Table (Rudder Horns and Rudders)

Amended	Original	Remarks
* "contract for construction" is defined in the latest version of IACS Procedural Requirement (PR) No.29. IACS PR No.29 (Rev.0, July 2009) **1.** The date of "contract for construction" of a vessel is the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. This date and the construction numbers (i.e. hull numbers) of all the vessels included in the contract are to be declared to the classification society by the party applying for the assignment of class to a newbuilding. **2.** The date of "contract for construction" of a series of vessels, including specified optional vessels for which the option is ultimately exercised, is the date on which the contract to build the series is signed between the prospective owner and the shipbuilder. For the purpose of this Procedural Requirement, vessels built under a single contract for construction are considered a "series of vessels" if they are built to the same approved plans for classification purposes. However, vessels within a series may have design alterations from the original design provided: (1) such alterations do not affect matters related to classification, or (2) If the alterations are subject to classification requirements, these alterations are to comply with the classification requirements in effect on the date on which the alterations are contracted between the prospective owner and the shipbuilder or, in the absence of the alteration contract, comply with the classification requirements in effect on the date on which the alterations are submitted to the Society for approval. The optional vessels will be considered part of the same series of vessels if the option is exercised not later than 1 year after the contract to build the series was signed. **3.** If a contract for construction is later amended to include additional vessels or additional options, the date of "contract for construction" for such vessels is the date on which the amendment to the contract, is signed between the prospective owner and the shipbuilder. The amendment to the contract is to be considered as a "new contract" to which **1.** and **2.** above apply. **4.** If a contract for construction is amended to change the ship type, the date of "contract for construction" of this modified vessel, or vessels, is the date on which revised contract or new contract is signed between the Owner, or Owners, and the shipbuilder. Note: This Procedural Requirement applies from 1 July 2009.		