RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part C Hull Construction and Equipment

Rules for the Survey and Construction of Steel Ships
Part C 2020 AMENDMENT NO.2
Guidance for the Survey and Construction of Steel Ships
Part C 2020 AMENDMENT NO.2

Rule No.112 / Notice No.61 24 December 2020
Resolved by Technical Committee on 5 August 2020

ClassNK
NIPPON KAIJI KYOKAI

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

RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

RULES

Part C Hull Construction and Equipment

2020 AMENDMENT NO.2

Rule No.112 24 December 2020

Resolved by Technical Committee on 5 August 2020

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

Rule No.112 24 December 2020
AMENDMENT TO THE RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

"Rules for the survey and construction of steel ships" has been partly amended as follows:

Part C HULL CONSTRUCTION AND EQUIPMENT

Chapter 2 STEMS AND STERN FRAMES

2.2 Stern Frames

Paragraph 2.2.8 has been amended as follows.

2.2.8 Rudder trunk

1 The requirements of this paragraph apply to trunk configurations which are extended below stern frame and arranged in such a way that the trunk is stressed by forces due to rudder action.

~~**1**~~**2** Materials, welding and connection to hull

~~This requirement applies to both trunk configurations (extending or not below stern frame).~~

The steel used for the rudder trunk is to be of weldable quality, with a carbon content not exceeding 0.23% on ladle analysis or a carbon equivalent C_{EQ} not exceeding 0.41%.

The weld at the connection between the rudder trunk and the shell or the bottom of the skeg is to be full penetration.

The fillet shoulder radius r (*mm*) (*See* **Fig.C2.4**) is to be as large as practicable and to comply with the following formulae:

$r = 0.1 d_l$

without being less than:

$r = 60$ when $\sigma \geq 40 / K_s$ (N/mm^2)

$r =$ ~~$0.1 d_l$, without being less than~~ 30~~;~~ when $\sigma < 40 / K_s$ (N/mm^2)

Where

d_l: rudder stock diameter axis defined in **3.5.2**.

σ: bending stress in the rudder trunk (N/mm^2).

K_s: material factor as given in **3.1.2**.

The radius may be obtained by grinding. If disk grinding is carried out, score marks are to be avoided in the direction of the weld. The radius is to be checked with a template for accuracy. Four profiles at least are to be checked. A report is to be submitted to the Surveyor.

Rudder trunks comprising of materials other than steel are to be specially considered by the Society.

~~**2**~~**3** Scantlings

~~Where the rudder stock is arranged in a trunk in such a way that the trunk is stressed by forces due to rudder action, t~~The scantlings of the trunk are to be such that:

- the equivalent stress due to bending and shear does not exceed $0.35\,\sigma_Y$,
- the bending stress on welded rudder trunk is to be in compliance with the following formula:

  $\sigma \leq 80 / K_s$ (N/mm^2)

  with:

  σ: As defined in ~~**1**~~**2**.

  K_s: Material factor for the rudder trunk as given in **3.1.2**, not to be taken less than

0.7

σ_Y: Specified minimum ~~¥~~yield stress (N/mm^2) of the material used

For calculation of bending stress, the span to be considered is the distance between the mid-height of the lower rudder stock bearing and the point where the trunk is clamped into the shell or the bottom of the skeg.

Chapter 3 RUDDERS

3.1 General

3.1.2 Materials*

Sub-paragraphs -4 and -5 have been amended as follows.

4 For rudder stocks, pintles, coupling bolts, keys, and edge bars, the specified minimum yield stress is not to be less than $200 N/mm^2$. The requirements in this Chapter are for materials with a specified minimum yield stress of $235 N/mm^2$. If materials having a specified minimum yield stress differing from $235 N/mm^2$ are used, the material factor K is to be determined by the following formula.

$$K = \left(\frac{235}{\sigma_Y}\right)^e$$

Where:

$e = 0.75$ for $\sigma_Y > 235\ N/mm^2$

$e = 1.00$ for $\sigma_Y \leq 235\ N/mm^2$

Where:

σ_Y: Specified minimum ~~¥~~yield stress (N/mm^2) of material used, and is not to be taken as greater than $0.7\sigma_B$ or $450 N/mm^2$, whichever is smaller.

σ_B: Tensile strength (N/mm^2) of material used

5 When the rudder stock diameter is reduced because of using steels with a specified minimum yield stress exceeding $235 N/mm$, special consideration is to be given to deformation of the rudder stock to avoid excessive edge pressures at the edge of bearings.

3.1.3 Welding and Design Details

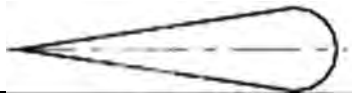
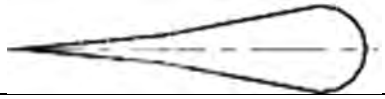
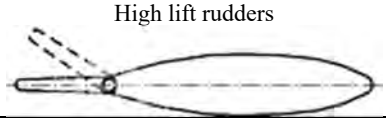
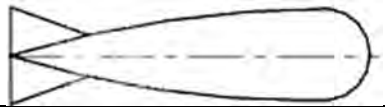
Sub-paragraph -2 has been amended as follows.

2 In way of the rudder horn recess of Type *A*, *D* and *E* rudders the radii in the rudder plating (except in way of solid part in cast steel) are not to be less than 5 *times* the plate thickness, but in no case less than 100 *mm*. Welding in side plate are to be avoided in or at the end of the radii. Edges of side plate and weld adjacent to radii are to be ground smooth.

3.2 Rudder Force

Table C3.1 has been amended as follows.

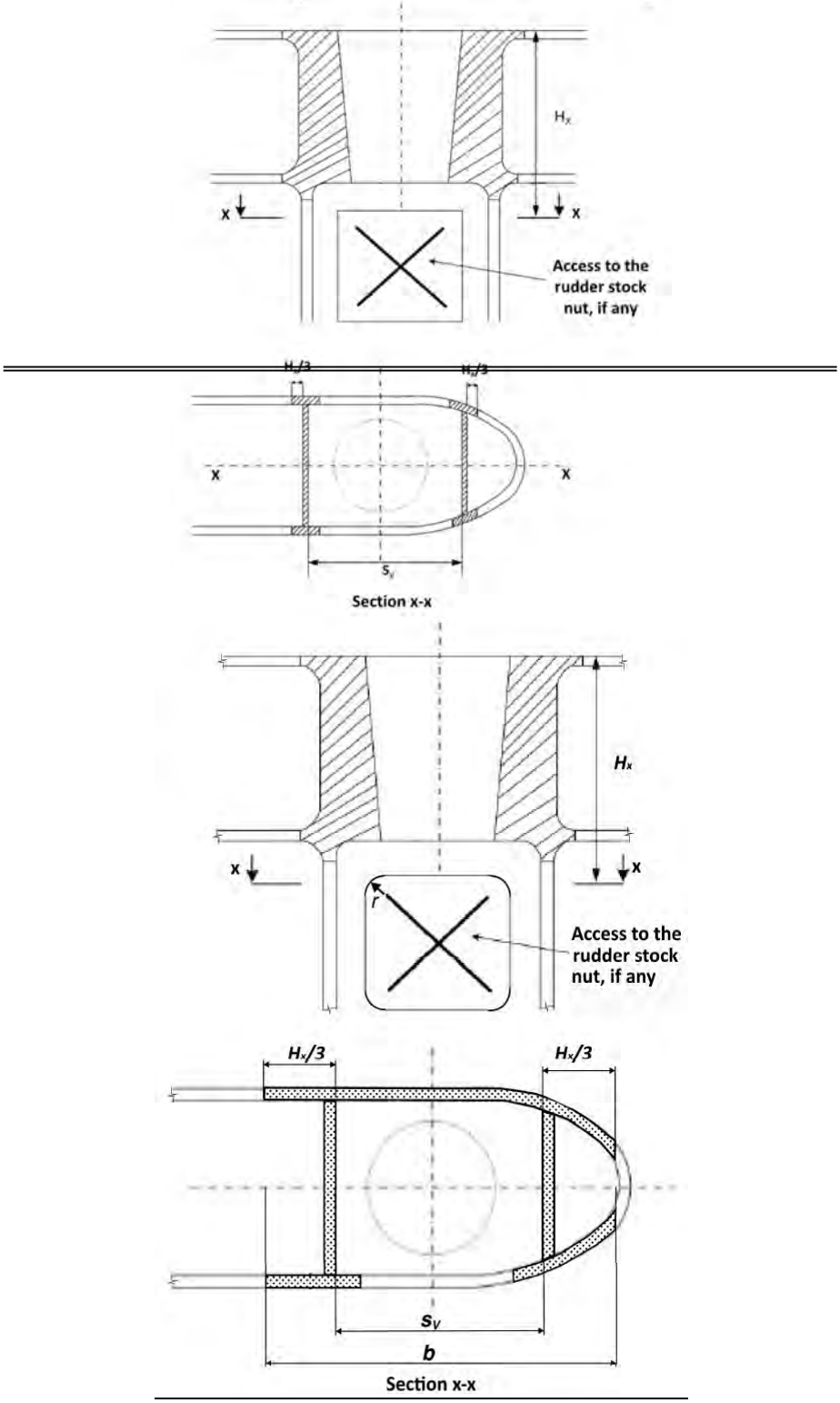
Table C3.1 Factor K_2

Profile Type	K_2	
	Ahead condition	Astern condition
NACA-00 series Göttingen 	1.10	0.80
Flat side 	1.10	0.90
Hollow 	1.35	0.90
High lift rudders 	1.70	~~to be specially considered; if not known:~~ 1.30
Fish tail 	1.40	0.80
Mixed profiles (e.g. HSVA)	1.21	0.90

3.7 Connections of Rudder Blade Structure with Solid Parts

Fig. C3.5 has been amended as follows.

Fig. C3.5 Cross-section of the Connection between rudder blade structure and rudder stock housing (in cases where there is an opening on only one side)



3.8 Couplings between Rudder Stocks and Main Pieces

3.8.3 Cone Couplings with Key*

Sub-paragraphs -1 and -2 have been amended as follows.

1 Tapering and coupling length

Cone couplings that are mounted or dismounted without hydraulic arrangements (e.g. oil injection and hydraulic nut) are to have a taper c on diameter of 1:8～1:12. (*See* **Fig. C3.7** and **Fig. C3.9**)

Where:

~~$c = (d_0 - d_u)/\ell$~~

$c = (d_0 - d_u)/\ell_c$

The diameters d_0 and d_u are shown in **Fig. C3.7** and the cone length ℓ_c is defined in **Fig. C3.9**.

The cone coupling is to be secured by a slugging nut. The nut is to be secured, e.g. by a securing plate.

The cone shapes are to fit exactly. The coupling length ℓ is to be, in general, not less than $1.5d_0$.

2 For couplings between stock and rudder a key is to be provided, the shear area of which is not to be less than:

$$a_s = \frac{17.55 M_Y}{d_k \sigma_{Y1}} \ (cm^2)$$

where:

M_Y : Design yield moment of rudder stock (N-m)

$$M_Y = 0.02664 \frac{{d_u}^3}{K_S}$$

Where the actual diameter d_{ua} is greater than the calculated diameter d_u, the diameter d_{ua} is to be used. However, d_{ua} applied to the above formula need not be taken greater than 1.145 d_u.

d_u: Stock diameter (mm) according to **3.5.1**

K_S : Material factor for stock as given in **3.1.2**

d_k: Mean diameter of the conical part of the rudder stock (mm) at the key

σ_{Y1} : Specified ~~M~~minimum yield stress of the key material (N/mm^2)

The effective surface area (cm^2) of the key (without rounded edges) between key and rudder stock or cone coupling is not to be less than:

$$a_k = \frac{5 M_Y}{d_k \sigma_{Y2}} \ (cm^2)$$

Where:

σ_{Y2} : Specified ~~M~~minimum yield stress of the key, stock or coupling material (N/mm^2) whichever is less.

Fig. C3.7 has been amended as follows.

Fig. C3.7 Cone Coupling with Key

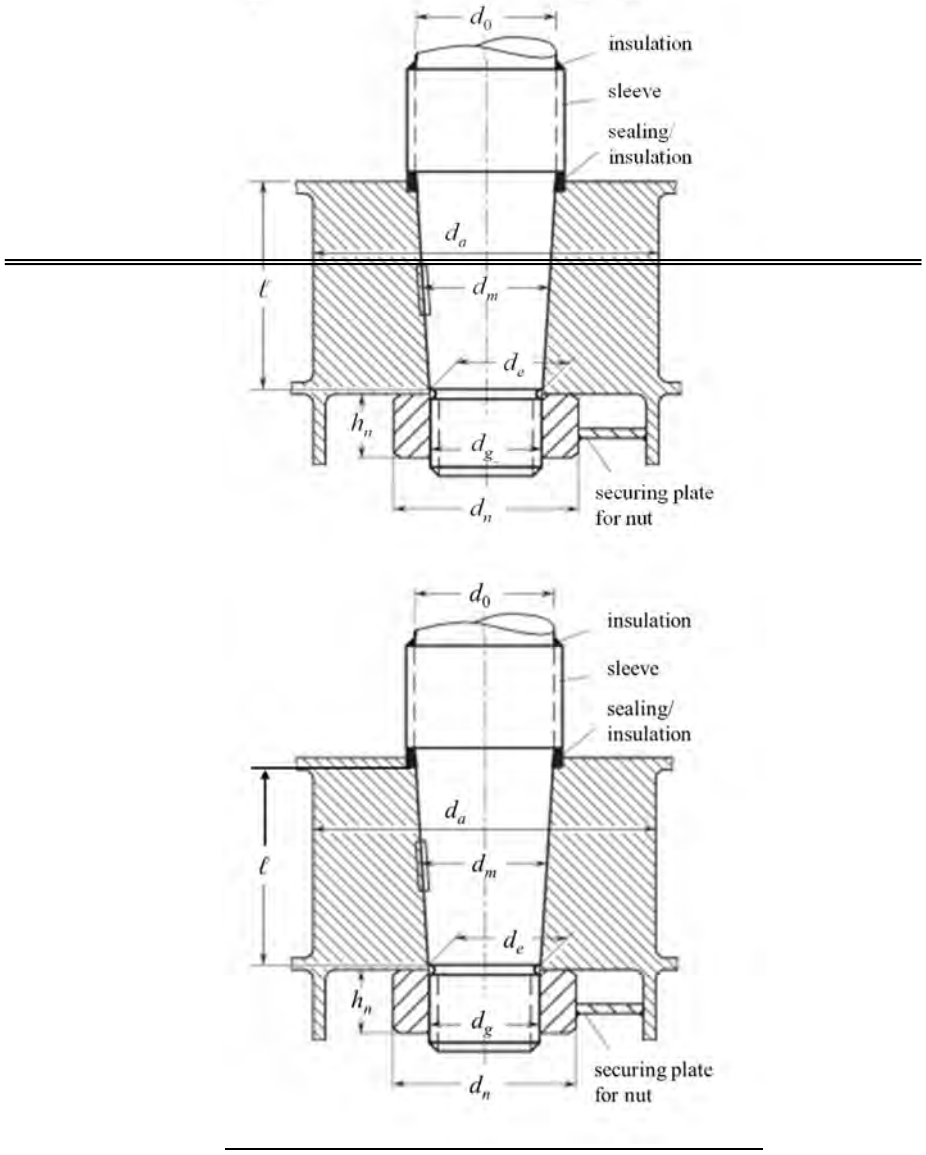


Fig. C3.8 has been renumbered to Fig. C3.10, and Fig. C3.8 and Fig. C3.9 have been added as follows.

Fig. C3.8 Gudgeon Outer Diameter

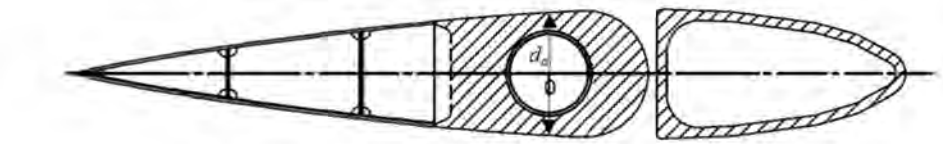


Fig. C3.9 Cone Length and Coupling Length

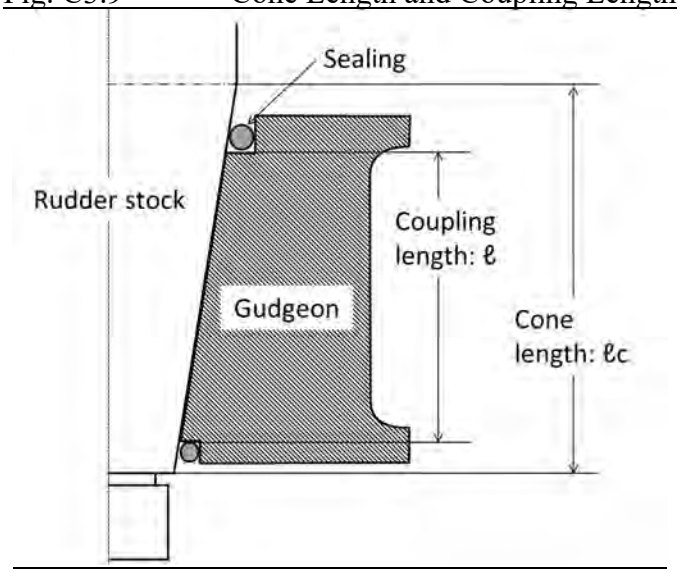
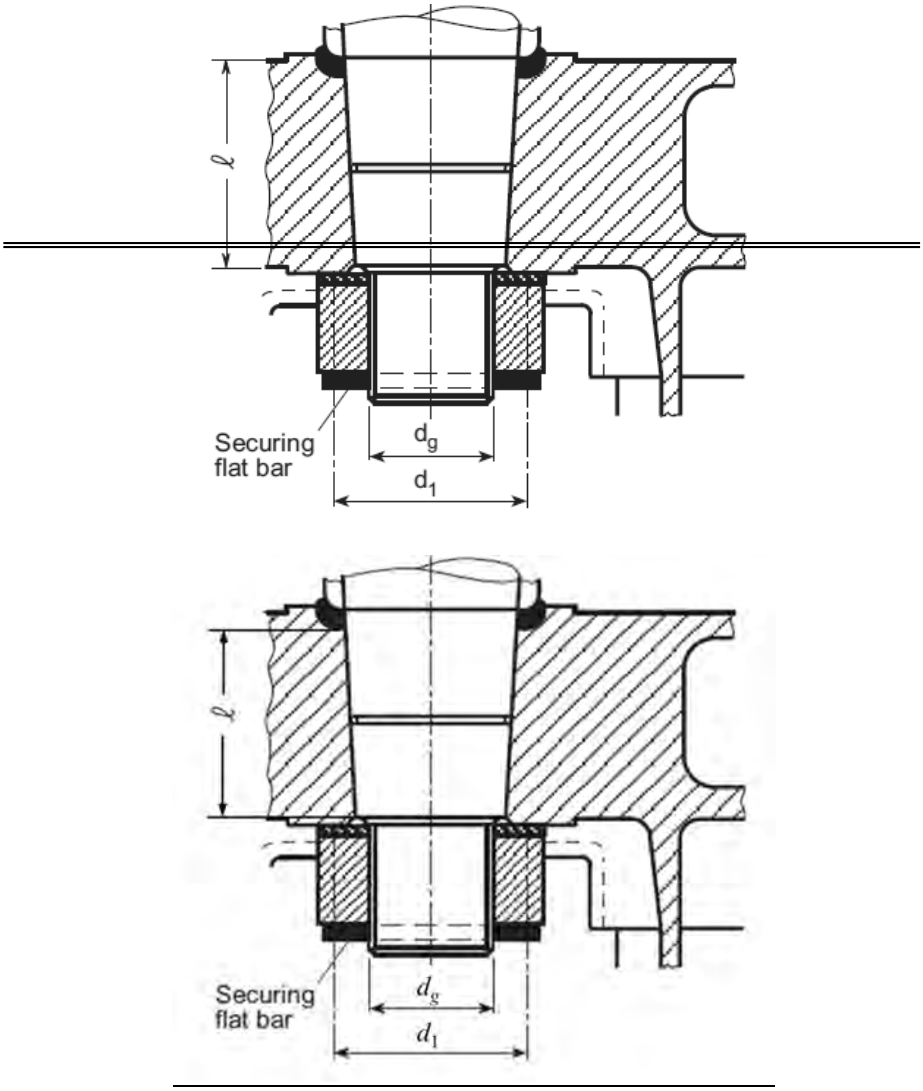


Fig. C3.10 has been amended as follows.

Fig. C3.~~8~~10 Cone Coupling without Key



3.8.4 Cone Couplings with Special Arrangements for Mounting and Dismounting the Couplings

Sub-paragraph -2 has been amended as follows.

2 Push-up pressure

The push-up pressure is not to be less than the greater of the two following values:

$$p_{req1} = \frac{2M_Y}{d_m^2 \ell \pi \mu_0} 10^3 \quad (N/mm^2)$$

$$p_{req2} = \frac{6M_b}{\ell^2 d_m} 10^3 \quad (N/mm^2)$$

Where:

M_Y : Design yield moment of rudder stock, as defined in **3.8.3-2** (*N-m*)

d_m : Mean cone diameter (*mm*) (*See* **Fig. C3.7**)

ℓ : ~~Cone~~Coupling length (*mm*)

μ_0 : Frictional coefficient, equal to 0.15

M_b : Bending moment in the cone coupling (e.g. in case of spade rudders) (*N-m*)

It has to be proved by the designer that the push-up pressure does not exceed the permissible surface pressure in the cone. The permissible surface pressure is to be determined by the following formula:

$$p_{perm} = \frac{0.95\sigma_Y(1-\alpha^2)}{\sqrt{3+\alpha^4}} - p_b$$

$$p_b = \frac{3.5M_b}{d_m\ell^2}10^3$$

Where:

σ_Y : Specified ~~M~~minimum yield stress (N/mm^2) of the material of the gudgeon

$$\alpha = \frac{d_m}{d_a}$$

d_m : Mean cone diameter (*mm*) (*See* **Fig. C3.7**)

d_a : Outer diameter of the gudgeon (*See* **Fig. C3.7** and **Fig. C3.8**. The least diameter is to be considered.) (*mm*)

The outer diameter of the gudgeon is not to be less than 1.25 d_0, with d_0 defined in **Fig. C3.7**.

3.10 Bearings of Rudder Stocks and Pintles

Table C3.3 has been amended as follows.

Table C3.3 Allowable Surface Pressure q_a

Bearing material	q_a (N/mm^2)
Lignum vitae	2.5
White metal (oil-lubricated)	4.5
Synthetic material with hardness ~~between~~greater than 60 ~~and 70,~~ Shore *D* [1)]	5.5[2)]
Steel[3)], bronze and hotpressed bronze graphite materials	7.0

Notes:

1: Indentation hardness test at the temperature of 23°C and the humidity of 50%, is to be carried out according to a recognized standard. Synthetic bearings are to be of the type as deemed appropriate by the Society.

2: Surface pressures exceeding 5.5 N/mm^2 may be accepted in accordance with bearing manufacturer's specification and tests, but in no case more than 10 N/mm^2.

3: Stainless and wear-resistant steel in an approved combination with a stock liner.

Chapter 32 CONTAINER CARRIERS

32.13 Special Requirements for Container Carriers Applying Extremely Thick Steel Plates

Paragraph 32.13.1 has been amended as follows.

32.13.1 General

This section gives measures for identification and prevention of brittle fractures in container carriers to which extremely thick steel plates are applied for longitudinal structural members in the upper deck region (the upper deck plating, hatch side coaming (including top plating) and their attached longitudinals). These include measures to prevent brittle crack initiation and to arrest brittle crack propagation in case brittle crack initiates.

32.13.2 Application

Sub-paragraph -1 has been amended as follows.

1 This section is applied ~~to which~~when using any of *KA*36, *KD*36 ,*KE*36, *KA*40, *KD*40, *KE*40 and *KE*47 steel plates having thicknesses of over 50 *mm* and not greater than 100*mm* for longitudinal structural members in the upper deck regions of container carriers.

Paragraph 32.13.4 has been amended as follows.

32.13.4 Brittle Crack Arrest Design*

1 The brittle crack arrest design using brittle crack arrest steels specified in this section may be applied when *HT*36 or *HT*40 is used for the upper deck plating. In other cases, however, appropriate measures to prevent the initiation and propagation of brittle cracks deemed appropriate by the Society are to be applied.

~~**1**~~**2** Brittle crack arrest design is to be utilized to prevent large scale fractures of the hull girder by arresting propagation of the brittle crack at a proper position, even in case where brittle crack initiation occurs within the cargo hold region.

~~**2**~~**3** Following **(1)** and **(2)** are to be considered as the points of brittle crack initiation.

(1) Block-to-block butt joints both of hatch side coaming and strength deck; and

(2) Any welds other than **(1)** above.

~~**3**~~**4** Following **(1)** to **(3)** are to be considered as the cases of brittle crack propagation.

(1) Cases where the brittle crack initiates from block-to-block butt joint and runs straight along the butt joint;

(2) Cases where the brittle crack initiates from block-to-block butt joint and deviate away from butt joint and runs into base metal; and

(3) Cases where the brittle crack initiates from any welds other than **(1)** and **(2)** above and runs into base metal.

~~**4**~~**5** With the consideration of the requirements in ~~-3~~**4** above, measures specified in the following **(1)** to **(3)** are to be applied as brittle crack arrest design to prevent brittle crack propagation.

(1) Brittle crack arrest steel is to be provided for strength deck.

(2) Brittle crack arrest steel is to be provided for hatch side coaming; however, such steel is not necessary to be provided in the attached top plate and longitudinal stiffeners.

(3) Appropriate measures is to be provided at a point of block-to-block butt joint between hatch side coaming and strength deck in order to arrest brittle crack propagation running straight along the butt joint.

~~**5**~~**6** Notwithstanding the provisions in ~~-4~~**5** above, where the equivalency is verified through

technical data and/or brittle fracture tests, etc., brittle crack arrest design other than those specified in ~~**-4**~~**5** above may be accepted by the Society.

~~**6 Brittle crack arrest steel specified in -4(1) and (2) above is to be a steel which have brittle crack arrest properties for *A*600 or equivalent as specified in 3.12, Part K of the Rules**. Where the steel plate having thickness of over 80 *mm* is provided as brittle crack arrest steel, brittle crack arrest properties of such steel are to be at the discretion of the Society.~~

Paragraph 32.13.5 has been added as follows.

32.13.5 Selection of Brittle Crack Arrest Steels*

1 The brittle crack arrest steel specified in **32.13.4-5(1)** and **(2)** is to be steel plates which are considered to have the brittle crack arrest properties specified in **3.12, Part K of the Rules**.

2 Brittle crack arrest steel properties are to comply with **Table C32.28** depending on the structural member for which it is being used and plate thickness.

3 When the brittle crack arrest steels specified in **Table C32.28** are used, the weld joints between hatch side coamings and upper decks are to be fillet welds at each side without grooves or are to be partial penetration welds. Alternative weld details may be accepted only in the vicinity of ship block-to-block butt weld joints provided additional means for preventing brittle crack propagation are implemented and its validity may be confirmed by technical data or brittle fracture tests, etc. by the Society.

Table C32.28 Brittle Crack Arrest Steel Requirement in Function of Structural Members and Thickness

Structural Members Plating(1)	Thickness t (*mm*)	Brittle Crack Arrest Properties
Upper Deck	$50 < t \leq 100$	Steel with suffix *BCA*6000 or above
Hatch Side Coaming	$50 < t \leq 80$	
	$80 < t \leq 100$	Steel with suffix *BCA*8000 or above

Note:

(1) Excludes attached longitudinals.

EFFECTIVE DATE AND APPLICATION

1. The effective date of the amendments is 1 January 2021.

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

* "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.

GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

GUIDANCE

Part C Hull Construction and Equipment

2020 AMENDMENT NO.2

Notice No.61 24 December 2020

Resolved by Technical Committee on 5 August 2020

Notice No.61 24 December 2020
AMENDMENT TO THE GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

"Guidance for the survey and construction of steel ships" has been partly amended as follows:

Part C HULL CONSTRUCTION AND EQUIPMENT

C3 RUDDERS

C3.8 Couplings between Rudder Stocks and Main Pieces

Paragraph C3.8.4 has been added as follows.

C3.8.4 Cone Couplings with Special Arrangements for Mounting and Dismounting the Couplings

The outer diameter of gudgeon (d_a) is recommended to be taken at the same plane in which the mean cone diameter (d_m).

C32 CONTAINER CARRIERS

C32.13 Special Requirements for Container Carriers Applying Extremely Thick Steel Plates

C32.13.3 Measures for Prevention of Brittle Fracture

Sub-paragraph -2 has been amended as follows.

2 Where the measures specified in **-1** above is applied, it may be considered as equivalent in effectiveness as measures specified **32.13.4-~~3~~45(2)** and **(3), Part C of the Rules**.

Paragraph C32.13.4 has been amended as follows.

C32.13.4 Brittle Crack Arrest Design

1 "Other weld areas" in **32.13.4-~~3~~45(3), Part C of the Rules** includes the following (refer to **Fig.C32.13.4-1**):
((1) to (7) are omitted.)

2 "Appropriate measure" in **32.13.4-~~3~~45(3), Part C of the Rules** means that the block-to-block butt welds of the hatch side coaming are to be shifted from those of the strength deck, this shift is to be greater than or equal to 300*mm* in principle ~~and welded joints between hatch side coaming and strength deck are to be fillet weld at each side without groove for an appropriate region~~.

3 If detailed documentation (including information such as construction procedure, application and procedure of non-destructive inspections at joints, etc.) which demonstrates the applicability as an alternative measure to **-2** above is submitted to and approved by the Society, the following **(1)** and **(2)** may be applied instead. In such cases, where deemed necessary by the Society, brittle fracture tests may be required to confirm the effectiveness of the alternative measure.

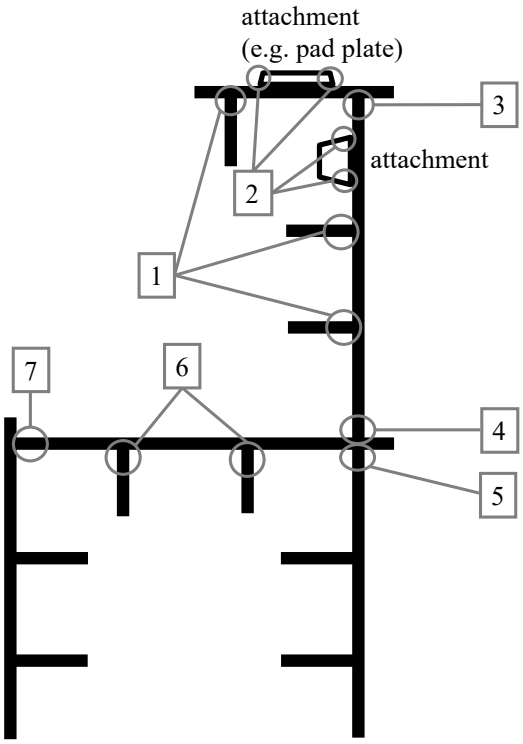
(1) Where crack arrest holes are provided in way of the block-to-block butt welds at the region

where hatch side coaming weld meets the deck weld, the fatigue strength of the lower end of the butt weld is to be assessed.

(2) Where arrest insert plates of brittle crack arrest steel or weld metal inserts with high crack arrest toughness properties are provided in way of the block-to-block butt welds at the region where hatch side coaming weld meets the deck weld.

~~**4** In **32.13.4-6, Part C of the Rules**, where steel plate being evaluated using the manner of assessment other than specified in **3.12, Part K of the Rules** is for use as crack arresting steel, documents related to the manner of assessment and the applicability which the measure has equivalent with brittle crack arrest properties for *A*600 are submitted to the Society for approval. In this case, where deemed necessary by the Society, additional test may be required.~~

Fig.C32.13.4-1 Other Weld Areas



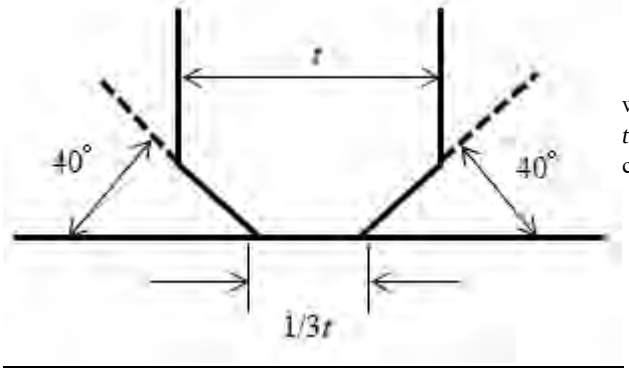
Paragraph C32.13.5 has been added as follows.

C32.13.5 Selection of Brittle Crack Arrest Steels*

1 In **32.13.5-1, Part C of the Rules**, when the steels evaluated by an evaluation method other than that specified in **3.12, Part K of the Rules** are to be brittle crack arrest steels, technical documents showing the validity of the evaluation method and the brittle crack arrest properties equivalent to the *BCA*6000 or *BCA*8000 specified in **3.12, Part K of the Rules** are to be submitted to the Society for approval. If necessary, additional tests may be required.

2 An example of "partial penetration weld" specified in **32.13.5-3, Part C of the Rules** is shown in **Fig. C32.13.5-1**. In this figure, the standard welding leg length is 5 *mm* and the standard root surface is 1/3 or more of the thickness *t* of the hatch side coaming.

Fig. C32.13.5-1 Example Partial Penetration Weld Between Hatch Side Coaming and Upper Deck



welding leg length：5 *mm*
t : thickness of hatch side coaming

3 The "alternative weld details" specified in **32.13.5-3, Part C of the Rules** refers to a full penetration weld.

EFFECTIVE DATE AND APPLICATION

1. The effective date of the amendments is 1 January 2021.

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

* "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.