RULES FOR CLASSIFICATION(STEEL SHIPS)

(Part 2 Materials and Welding)

- For external opinion inquiries -

2020.09.

Machinery Rule Development Team

- Main Amendments -

(1) Enter into force on 1 January 2021 (the date of application for certification of material & welding or the contract date for ship construction)

- Circular -

◉ To reflect IACS UR W31(Rev.2 Dec 2019 CR)

Present	Amendment	reason
CHAPTER 1 MATERIALS **Section 1 ~ Section 2 <Omitted>** **Section 3 Rolled Steels** **301. Rolled steels for hull structural** **1. Application** (1) ~ (5) <Omitted> (6) <New> (6) <Omitted> **2. ~ 13. <Omitted>** **302. ~ 310. <Omitted>** **311. YP47 Steel Plates** **1. Application** (1) This requirements applies to the application of steel plates with thickness of over 50mm and not greater than 100mm and specified yield point of 460 N/mm^2 to longitudinal structural members in the upper deck region of container carriers (such as hatch side coaming, hatch coaming top and the attached longitudinals). (2) For steel plates outside of this thickness range, special consideration is to be given by the Society. (3) The requirements other than those specified in **311.** are applicable to the requirements in **301.** (4) The requirements including brittle crack arrest properties other than those specified in this instruction are to be in accordance with the Guidance relating to the Rules specified by the Society. *(2017)* **2. Kinds** The steel plates are classified as specified in **Table 2.1.42**. **3. Heat treatment** The Heat treatment of steel plates is classified as specified in **Table 2.1.42**.	**CHAPTER 1 MATERIALS** **Section 1 ~ Section 2 <Same as the present Rules>** **Section 3 Rolled Steels** **301. Rolled steels for hull structural** **1. Application** (1) ~ (5) <Same as the present Rules> (6) Brittle crack arrest steels are to be met the additional brittle crack arrest requirements and properties defined in **312.**. *(2021)* (7) <Same as the present Rules> **2. ~ 13. <Same as the present Rules>** **302. ~ 310. <Same as the present Rules>** **311. YP47 Steels** **1. Application** (1) This requirements applies to the application of steels with thickness of over 50mm and not greater than 100mm and specified yield point of 460 N/mm^2 to longitudinal structural members in the upper deck region of container carriers (such as hatch side coaming, hatch coaming top and the attached longitudinals). (2) For YP47 steels outside scope of the said thickness range, special consideration is to be given by the Society. And special consideration is to be given to the application of YP47 steels for other hull structures. *(2021)* (3) The requirements other than those specified in **311.** are applicable to the requirements in **301.** (4) Brittle crack arrest steels are to be met the additional brittle crack arrest requirements and properties defined in **312.**. *(2021)* **2. Kinds** The steels are classified as specified in **Table 2.1.42**. **3. Heat treatment** The Heat treatment of steels is classified as specified in **Table 2.1.42**.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present

5. Chemical composition

The Chemical composition of steel plates is classified as specified in **Table 2.1.43**.

Table 2.1.43 Chemical compositions for YP47 steel plates

Chemical composition	C_{eq} (1)	P_{cm} (2)
As approved by the Society	≤ 0.49%	≤ 0.22%

Note

(1) The carbon equivalent C_{eq} value is to be calculated from the ladle analysis using the following formula.

$$C_{eq} = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}(\%)$$

(2) Cold cracking susceptibility P_{cm} is to be calculated using the following formula.

$$P_{cm} = C + \frac{Si}{30} + \frac{Mn}{20} + \frac{Cu}{20} + \frac{Ni}{60} + \frac{Cr}{20} + \frac{Mo}{15} + \frac{V}{10} + 5B(\%)$$

Amendment

4. Chemical composition

The Chemical composition of steels is classified as specified in **Table 2.1.42**.

Table 2.1.42 Grade and Chemical compositions *(2021)*

Grade	Deoxidation practice	Chemical composition(%)(1)(2)															
		C	Si	Mn	P	S	Ni	Cr	Cu	Mo	Al(3)	Nb(4)	V(4)	Ti(5)	C_{eq}(6)	P_{cm}(7)
EH47-H	Killed and Fine grain treated	0.18 max.	0.55 max.	0.90 ~ 2.00	0.020 max.	0.020 max.	1.0 max.	0.25 max.	0.35 max.	0.08 max.	0.015 min.	0.02 ~ 0.05	0.05 ~ 0.10	0.02 max.	0.49 max.	0.22 max.

Note

(1) Where additions of any other element have been made as part of the steelmaking practice subject to approval by the Society, the content is to be indicated on product inspection certificate.

(2) Variations in the specified chemical composition may be allowed subject to approval of Society.

(3) The total aluminium content may be determined instead of the acid soluble content. In such cases the total aluminium content is to be not less than 0.020%.

(4) The steel is to contain aluminium, niobium, vanadium or other suitable grain refining elements, either singly or in any combination. When used singly the steel is to contain the specified minimum content of the grain refining element. When used in combination, the specified minimum content of a fine graining element is not applicable.

(5) The total niobium, vanadium and titanium content is not to exceed 0.12%.

(6) The carbon equivalent Ceq value is to be calculated from the ladle analysis using the following formula:

$$C_{eq} = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}(\%)$$

(7) Cold cracking susceptibility Pcm value is to be calculated using the following formula:

$$P_{cm} = C + \frac{Si}{30} + \frac{Mn}{20} + \frac{Cu}{20} + \frac{Ni}{60} + \frac{Cr}{20} + \frac{Mo}{15} + \frac{V}{10} + 5B(\%)$$

reason

- To reflect IACS UR W31(Rev.2 CR)

Present

4. Mechanical properties

The Mechanical properties of steel plates are classified as specified in **Table 2.1.42**.

Table 2.1.42 Conditions of supply, grade and mechanical properties for YP47 steel plates

Grade	Mechanical Properties			Impact test				Supply condition
	Yield Strength (N/mm^2)	Tensile Strength (N/mm^2)	Elongation (%) ~~min~~	Test Temp. (℃)	Average Impact Energy(J) ~~min.~~ L			
					$50<t^{(1)}\leq70$	$70<t^{(1)}\leq85$	$85<t^{(1)}\leq100$	
EH47-H	min. 460	570~720	17	-40	53	64	75	TMCP(2)

Note
(1) t : thickness (mm)
(2) Other conditions of supply are to be agreed by the Society.

~~**6. Selection of test samples**~~

~~(1) One test sample is to be taken from every similarly heat treated plate as rolled directly from one slab or ingot.~~
~~(2) The requirements specified in **301. 6** (4) are to be applied to the selection of the test samples.~~

~~**7. Selection of test specimens**~~

~~(1) Tensile test specimens are to comply with the requirements shown in (a) to (c) below:~~
~~(a) Tensile test specimens are to be taken according to the requirements specified in **301. 7** (2).~~
~~(b) Normally flat tensile test specimens are to be prepared in such a manner as to maintain the rolling scale at least at one side.~~
~~(c) When instead a machined round tensile test specimen is used then the axis must be located at a position lying at a distance of t/4 from the surface or as near as possible to this position.~~
~~(2) Impact test specimens are to be taken according to the requirements specified in **304. 7** (3).~~

Amendment

5. Mechanical properties

The Mechanical properties of steels are classified as specified in **Table 2.1.42**.

Table 2.1.42 Conditions of supply and mechanical properties

Grade	Mechanical Properties			Impact test				Supply condition
	Yield Strength (N/mm^2)	Tensile Strength (N/mm^2)	Elongation (%)	Test Temp. (℃)	Average Impact Energy(J) L			
					$50<t^{(1)}\leq70$	$70<t^{(1)}\leq85$	$85<t^{(1)}\leq100$	
EH47-H	460 min.	570~720	17 min.	-40	53 min.	64 min.	75 min.	TMCP(2)

Note
(1) t : thickness (mm)
(2) Other conditions of supply are to be agreed by the Society.

6. ~ 7. <Deleted>

reason

- To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
~~**8. Surface inspection and verification of dimensions**~~ ~~(1) Surface inspection and verification of dimensions are to be in accordance with requirements specified in **301. 8.**~~ ~~(2) If required by the Society the manufacturer is to perform ultrasonic examinations in accordance with an approved standard.~~ ~~(3) If required by the Society, through thickness tensile tests are to be performed in accordance with requirements specified in **310.**~~ ~~**9. Retest procedures**~~ ~~(1) Where the tensile test from the first test specimen selected fails to meet the requirements, additional tests may be conducted according to the requirements given in **109. 1.**~~ ~~(2) Regarding the impact tests, additional tests are to be carried out according to the requirements given in **109. 2.**~~ ~~**10. Marking**~~ ~~Steels which have satisfactorily complied with the required tests are to be marked with the identification mark in accordance with the requirements in **110.** For steels having brittle crack arrest properties to which the requirements given in **1.** (4) have been applied, the "brittle crack arrest *BCA*" is to be suffixed to the marking. (e.g. *EH47-H BCA*) *(2017)*~~	**8. ~ 10.** <Deleted>	- To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
312. <New>	**312. Brittle crack arrest steels *(2021)*** **1. Application** (1) This requirements applies to the application of brittle crack arrest steels(*EH36-BCA*, *EH40-BCA* and *EH47-H-BCA*) with brittle crack arrest properties. (2) This requirements applies to the application of steels with thickness of over 50mm and not greater than 100mm to longitudinal structural members in the upper deck region of container carriers (such as hatch side coaming, upper deck, etc.) specified in **Pt 7**, **Annex 7-8** of the Guidance. **2. Definition** Brittle crack arrest steels are defined as steel plate with the specified brittle crack arrest properties measured by either the brittle crack arrest toughness K_{ca} or Crack Arrest Temperature (CAT). **3. Chemical composition** The Chemical composition of steels is classified as specified in **Table 2.1.44**.	- To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
	Table 2.1.44 Grade and Chemical compositions	- To reflect IACS UR W31(Rev.2 CR)

Grade	Deoxidation practice	Chemical composition(%)(1)(2)														
		C	*Si*	*Mn*	*P*	*S*	*Ni*	*Cr*	*Cu*	*Mo*	*Al*(4)(5)	*Nb*(5)(6)	*V*(5)(6)	*Ti*(6)	C_{eq}(7)	P_{cm}(8)
EH36-BCA	Killed and Fine grain treated	0.18 max.	0.50 max.	0.90 ~ 2.00	0.020 max.	0.020 max.	2.0 max.	0.25 max.	0.50 max.	0.08 max.	0.015 min.	0.02 ~ 0.05	0.05 ~ 0.10	0.02 max.	0.47 max.	-
EH40-BCA															0.49 max.	
EH47-H-BCA		0.18 max.	0.55 max.	0.90 ~ 2.00	0.020 max.	0.020 max.	2.0 max.	0.50 max.	0.50 max.	0.08 max.	0.015 min.	0.02 ~ 0.05	0.05 ~ 0.10	0.02 max.	0.55 max.	0.24 max.

Note

(1) Chemical composition of brittle crack arrest steels shall comply with this Table, regardless of chemical composition specified in **301.** and **311.**.

(2) Where additions of any other element have been made as part of the steelmaking practice subject to approval by the Society, the content is to be indicated on product inspection certificate.

(3) Variations in the specified chemical composition may be allowed subject to approval of the Society.

(4) The total aluminium content may be determined instead of the acid soluble content. In such cases the total aluminium content is to be not less than 0.020%.

(5) The steel is to contain aluminium, niobium, vanadium or other suitable grain refining elements, either singly or in any combination. When used singly the steel is to contain the specified minimum content of the grain refining element. When used in combination, the specified minimum content of a fine graining element is not applicable.

(6) The total niobium, vanadium and titanium content is not to exceed 0.12%.

(7) The carbon equivalent Ceq value is to be calculated from the ladle analysis using the following formula:

$$C_{eq} = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}(\%)$$

(8) Cold cracking susceptibility Pcm value is to be calculated using the following formula:

$$P_{cm} = C + \frac{Si}{30} + \frac{Mn}{20} + \frac{Cu}{20} + \frac{Ni}{60} + \frac{Cr}{20} + \frac{Mo}{15} + \frac{V}{10} + 5B\,(\%)$$

Present	Amendment	reason
	4. Brittle crack arrest properties (1) In addition to the required mechanical properties of **301.** and **311.**, brittle crack arrest steels are to comply with the requirements specified in **Table 2.1.45**. (2) The brittle crack arrest properties specified in **Table 2.1.45** are to be evaluated for the products in accordance with the procedure approved by the Society. Test specimens are to be taken from each piece (means "the rolled product from a single slab or ingot if this is rolled directly into plates"), unless otherwise agreed by the Society. **Table 2.1.45 Requirement of brittle crack arrest properties for brittle crack arrest steels**	- To reflect IACS UR W31(Rev.2 CR)

Suffix to the steel grade(1)	Thickness range (mm)	Brittle crack arrest properties(2)(6)	
		Brittle crack arrest toughness K_{ca} at -10℃ ($N/mm^{3/2}$)(3)	Crack Arrest Temperature CAT (℃)(4)
BCA1	$50 < t \leq 100$	6,000 min.	-10 or below
BCA2	$80 < t \leq 100$	8,000 min.	(5)

Note
(1) Suffix "BCA1" or "BCA2" is to be affixed to the steel grade designation (e.g. *EH40-BCA1*, *EH47-H-BCA1*, *EH47-H-BCA2*, etc.).
(2) Brittle crack arrest properties for brittle crack arrest steels are to be verified by either the brittle crack arrest toughness K_{ca} or Crack Arrest Temperature (CAT).
(3) K_{ca} value is to be in accordance with the Guidance relating to the Rules specified by the Society. **【See Guidance】**
(4) CAT is to be obtained in accordance with the Guidance relating to the Rules specified by the Society. **【See Guidance】**
(5) Criterion of CAT for brittle crack arrest steels corresponding to K_{ca}=8,000 $N/mm^{3/2}$ is to be approved by the Society
(6) Where small-scale alternative tests are used for product testing (batch release testing), these test methods are to be approved by the Society.

5. Marking

For steels having brittle crack arrest properties to which the requirements given in **4.** have been applied, the "brittle crack arrest *BCA*" is to be suffixed to the marking. (e.g. *EH*47-*H-BCA1*)

Present	Amendment	reason
CHAPTER 2 WELDING **Section 1 ~ Section 2 <Omitted>** **Section 3 Welding Work and Inspection** **301. ~ 302. <Omitted>** **303. Application of welding consumables** Welding consumables used for welded joints of hull structure are to be of the grades as specified in the relevant Articles of **Sec 6** according to the following requirements: (1) Application of welding consumables for welded joints of various grades of steel is to be as specified in **Table 2.2.3**. (2) ~ (4) <Omitted>	**CHAPTER 2 WELDING** **Section 1 ~ Section 2 <Same as the present Rules>** **Section 3 Welding Work and Inspection** **301. ~ 302. <Same as the present Rules>** **303. Application of welding consumables** Welding consumables used for welded joints of hull structure are to be of the grades as specified in the relevant Articles of **Sec 6** according to the following requirements: (1) Application of welding consumables for welded joints of various grades of steel is to be as specified in **Table 2.2.3**. (2) ~ (4) <Same as the present Rules>	

Present

Table 2.2.3 Selection of welding consumables(rolled steel plates) ***(2017) (2019)***

Kind and grade of steel to be welded			Grade of applicable welding consumables (1)
Rolled steels for hull	Mild steel	*A*	<Omitted>
		B, D	
		E	
	Higher strength low alloy steel	*AH*32, *AH*36	<Omitted>
		*DH*32, *DH*36	
		*EH*32, *EH*36	
		*FH*32, *FH*36	
		*AH*40, *DH*40	2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40, 3*Y*42, 4*Y*42, 5*Y*42, 2*Y*46, 3*Y*46, 4*Y*46, 5*Y*46
		*EH*40	3*Y*40, 4*Y*40, 5*Y*40, 3*Y*42, 4*Y*42, 5*Y*42, 3*Y*46, 4*Y*46, 5*Y*46
		*FH*40	4*Y*40, 5*Y*40, 4*Y*42, 5*Y*42, 4*Y*46, 5*Y*46
Rolled steels for low temperature services			<Omitted>
High strength steels for welded structures(5)			

NOTES :
(1) ~ (5) <Omitted>

Amendment

Table 2.2.3 Selection of welding consumables(rolled steel plates) ***(2017) (2019) (2021)***

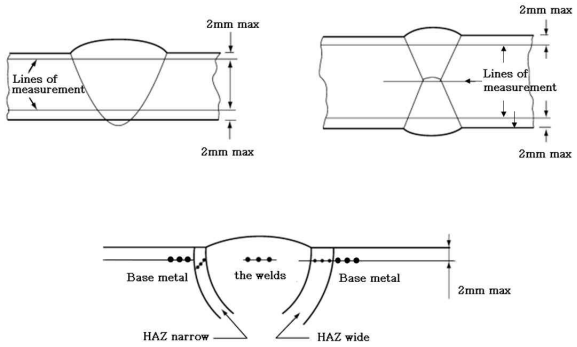
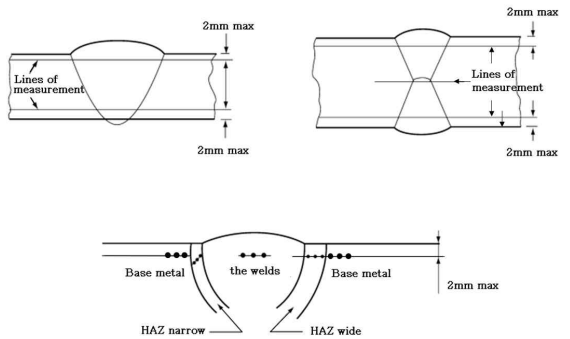
Kind and grade of steel to be welded			Grade of applicable welding consumables (1)
Rolled steels for hull	Mild steel	*A*	<Same as the present Rules>
		B, D	
		E	
	Higher strength low alloy steel	*AH*32, *AH*36	<Same as the present Rules>
		*DH*32, *DH*36	
		*EH*32, *EH*36	
		*FH*32, *FH*36	
		*AH*40, *DH*40	2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40, 3*Y*42, 4*Y*42, 5*Y*42, 2*Y*46, 3*Y*46, 4*Y*46, 5*Y*46
		*EH*40	3*Y*40, 4*Y*40, 5*Y*40, 3*Y*42, 4*Y*42, 5*Y*42, 3*Y*46, 4*Y*46, 5*Y*46
		*FH*40	4*Y*40, 5*Y*40, 4*Y*42, 5*Y*42, 4*Y*46, 5*Y*46
		EH47-H	3*Y*47, 4*Y*46(6), 5*Y*46(6)
Rolled steels for low temperature services			<Same as the present Rules>
High strength steels for welded structures(5)			

NOTES :
(1) ~ (5) <Same as the present Rules>
(6) It can be used in accordance with the Guidance relating to the Rules specified by the Society. **[See Guidance]**

reason

- To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
304. ~ 310. <Omitted> **311. Welding works for YP47 Steel Plates** The welding works for YP47 Steel Plates are to be in accordance with the Guidance in relating to Rules. **【See Guidance】**	**304. ~ 310. <Same as the present Rules>** **311. Welding works for YP47 Steels *(2021)*** **1. Short bead** Short bead length for tack and repairs of welds by welding are not to be less than 50mm. In the case where P_{cm} is less than or equal to 0.19, 25mm of short bead length may be adopted with approval of the Society. **2. Preheating** Preheating is to be 50°C or over when air temperature is 5°C or below. In the case where P_{cm} is less than or equal to 0.19 and the air temperature is below 5°C but above 0°C, alternative preheating requirements may be adopted with approval of the Society. **3. Others** (1) Special care is to be paid to the final welding so that harmful defects do not remain. (2) Jig mountings are to be completely removed with no defects in general, otherwise the treatment of the mounting is to be accepted by the Society. **312. Welding works for Brittle crack arrest steels *(2021)*** Welding work (such as relevant welder's qualification, short bead, preheating, selection of welding consumable, etc.) for brittle crack arrest steels is to be in accordance with the relevant requirements for each steel grade excluding suffix "BCA1" or "BCA2".	- To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
Section 4 Welding Procedure Qualification Tests	**Section 4 Welding Procedure Qualification Tests**	
401. ~ 402. <Omitted>	**401. ~ 402. <Same as the present Rules>**	- To reflect IACS UR W31(Rev.2 CR)
403. Welding procedure qualification tests(WPQT)	**403. Welding procedure qualification tests(WPQT)**	
1. ~ 7. <Omitted>	**1. ~ 7. <Same as the present Rules>**	
8. <New>	**8.** Where Welding Procedure Specification (WPS) for the non-BCA steels has been approved by the Society, the said WPS is applicable to the same welding procedure applied to the same grade with suffix "BCA1" or "BCA2" except high heat input processes over 50kJ/cm. The requirements for welding procedure qualification test for brittle crack arrest steels is to be in accordance with the relevant requirements for each steel grade excluding suffix "BCA1" or "BCA2", except for hardness specified in **404. 9** and **405. 6**. *(2021)*	
404. Tests for butt welded joints	**404. Tests for butt welded joints**	
1. ~ 8. <Omitted>	**1. ~ 8. <Same as the present Rules>**	
(1) Hardness distribution at positions shown in **Fig 2.2.9** is to be measured.	(1) Hardness distribution at positions shown in **Fig 2.2.9** is to be measured.	
		
Note 1. Measuring load is to be 10 kg vickers and measuring intervals are to be 1 mm. 2. For *EH*47-*H*, measurement points are to include mid-thickness position in addition.	Note 1. Measuring load is to be 10 kg vickers and measuring intervals are to be 1 mm. 2. For *EH*47-*H* and brittle crack arrest(BCA) steels, measurement points are to include mid-thickness position in addition. *(2021)*	
Fig 2.2.9 Hardness Test for butt welded joint (Units : mm)	**Fig 2.2.9 Hardness Test for butt welded joint (Units : mm)**	

Present

(2) The results from the hardness test are to be in accordance with **Table 2.2.10**. *(2019)*

Table 2.2.10 Hardness Test Requirements for Butt Welded Joint ***(2019)***

Grades and material symbols of test specimens		Hardness (Hv10)
Rolled steels for hull structural	*AH 36, DH 36, EH 36, FH 36, AH 40, DH 40, EH 40, FH 40*	350 max.
	EH47-H	380 max.
Weldable high strength steel		420 max.
Rolled steels & Steel pipes for low temperature service	<Omitted>	
Rolled steel plates for boiler & pressure vessel The pipes for ordinary piping The pipes used for high temperature and high pressure		320 max.(1)

Note :
(1) For non-heat treated, hardness may be accepted by 380 max.

10. <Omitted>

405. ~ 406. <Omitted>

407. Validity of qualified welding procedure specification

1. <Omitted>

Amendment

(2) The results from the hardness test are to be in accordance with **Table 2.2.10**. *(2019)*

Table 2.2.10 Hardness Test Requirements for Butt Welded Joint ***(2019) (2021)***

Grades and material symbols of test specimens		Hardness (Hv10)
Rolled steels for hull structural	*AH 36, DH 36, EH 36, FH 36, AH 40, DH 40, EH 40, FH 40, EH47-H*	350 max.
	EH47-H-BCA1/2	380 max.
Weldable high strength steel		420 max.
Rolled steels & Steel pipes for low temperature service	<Same as the present Rules>	
Rolled steel plates for boiler & pressure vessel The pipes for ordinary piping The pipes used for high temperature and high pressure		320 max.(1)

Note :
(1) For non-heat treated, hardness may be accepted by 380 max.

10. <Same as the present Rules>

405. ~ 406. <Same as the present Rules>

407. Validity of qualified welding procedure specification

1. <Same as the present Rules>

reason

- To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
2. Validity of variables for qualified WPS is as follows. However, it may be considered as equivalent for the requirements of the standard internationally recognized(*AWS, ASME* etc.) are applied. (1) **Base metal** Kind of base metal and their validity are as follows. Other materials not specified herein is to be in accordance with the requirements of the standard internationally recognized as deemed appropriate by the Society. **【See Guidance】** (a) **Normal and higher strength hull structural steels** ① Normal strength steel(*A*, *B*, *D* and *E*) or equivalent structural steels with tensile strength 400 ~ 520 N/mm^2. ② Higher strength steels and YP47 steel plates(*AH* 32, *DH* 32, *EH* 32, *FH* 32, *AH* 36, *DH* 36, *EH* 36, *FH* 36, *AH* 40, *DH* 40, *EH* 40, *FH* 40 and *EH*47-*H*) or equivalent structural steels with minimum specified yield strength 315 ~ 460 N/mm^2. *(2018)* (i) ~ (iv) <Omitted> (v) <New> (b) ~ (i) <Omitted> (2) ~ (9) <Omitted> **3.** <Omitted>	**2.** Validity of variables for qualified WPS is as follows. However, it may be considered as equivalent for the requirements of the standard internationally recognized(*AWS, ASME* etc.) are applied. (1) **Base metal** Kind of base metal and their validity are as follows. Other materials not specified herein is to be in accordance with the requirements of the standard internationally recognized as deemed appropriate by the Society. **【See Guidance】** (a) **Normal and higher strength hull structural steels** ① Normal strength steel(*A*, *B*, *D* and *E*) or equivalent structural steels with tensile strength 400 ~ 520 N/mm^2. ② Higher strength steels, YP47 steels and brittle crack arrest steels(*AH* 32, *DH* 32, *EH* 32, *FH* 32, *AH* 36, *DH* 36, *EH* 36, *FH* 36, *AH* 40, *DH* 40, *EH* 40, *FH* 40, *EH*47-*H*, *EH* 36-*BCA*1, *EH* 40-*BCA*1/2 and *EH* 47-*H*-*BCA*1/2) or equivalent structural steels with minimum specified yield strength 315 ~ 460 N/mm^2. *(2018) (2021)* (i) ~ (iv) <Same as the present Rules> (v) Where Welding Procedure Specification (WPS) for the non-BCA steels has been approved by the Society, the said WPS is applicable to the same welding procedure applied to the same grade with suffix “BCA1” or “BCA2” except high heat input processes over 50 kJ/cm. *(2021)* (b) ~ (i) <Same as the present Rules> (2) ~ (9) <Same as the present Rules> **3.** <Same as the present Rules>	- To reflect IACS UR W31(Rev.2 CR)

Present

Section 5 <Omitted>
Section 6 Welding Consumables

601. <Omitted>

602. Electrodes for manual arc welding for normal strength steels, higher strength steels and steels for low temperature service

1. <Omitted>

2. Grades and marks of electrode

(1) Electrodes are classified as specified in **Table 2.2.25**.

Table 2.2.25 Grades and Marks *(2017)*

For normal strength steel	For higher strength steel	For steel for low temperature service
1, 2, 3	2*Y*, 3*Y*, 4*Y*, 5*Y*, 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40	*L* 1, *L* 2, *L* 3, *L* 91

(2) <Omitted>

3. General provisions for tests

(1) ~ (4) <Omitted>
(5) Steel plates to be used in preparation of test assemblies are to be as given in **Table 2.2.28** according to the grades of electrode.
(6) ~ (9) <Omitted>

Amendment

Section 5 <Same as the present Rules>
Section 6 Welding Consumables

601. <Same as the present Rules>

602. Electrodes for manual arc welding for normal strength steels, higher strength steels and steels for low temperature service

1. <Same as the present Rules>

2. Grades and marks of electrode

(1) Electrodes are classified as specified in **Table 2.2.25**.

Table 2.2.25 Grades and Marks *(2017) (2021)*

For normal strength steel	For higher strength steel	For steel for low temperature service
1, 2, 3	2*Y*, 3*Y*, 4*Y*, 5*Y*, 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40, 3*Y*47	*L* 1, *L* 2, *L* 3, *L* 91

(2) <Same as the present Rules>

3. General provisions for tests

(1) ~ (4) <Same as the present Rules>
(5) Steel plates to be used in preparation of test assemblies are to be as given in **Table 2.2.28** according to the grades of electrode.
(6) ~ (9) <Same as the present Rules>

reason

- To reflect IACS UR W31(Rev.2 CR)

Present

Table 2.2.28 Grade of Steels used for Test Assembly *(2017)*

Grade of electrode	Grade of steels used for test assembly(1)(2)
1	*A*
2	*A*, *B* or *D*
3	*A*, *B*, *D* or *E*
2*Y*	*AH* 32, *AH* 36, *DH* 32 or *DH* 36
3*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32 or *EH* 36
4*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
5*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
2*Y*40	*AH* 40 or *DH* 40
3*Y*40	*AH* 40, *DH* 40 or *EH* 40
4*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
5*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
L 1	*E or RL* 24*A*
L 2	*E*, *RL* 235*A*, *RL* 235*B*, *RL* 325*A* or *RL* 325*B*
L 3	*RL* 325*A*, *RL* 325*B* or *RL* 360
L 91	*RL* 9*N*490

NOTES:
(1) Notwithstanding the requirements in this Table normal strength or higher strength steel may be used for the deposited metal test assembly. In this case, test assemblies of grade *L* 91 are to be appropriately buttered.
(2) The tensile strength of higher strength steels *AH* 32, *DH* 32 *EH* 32, and *FH* 32 used in butt weld test assemblies is to be greater than 490 N/mm^2.

Amendment

Table 2.2.28 Grade of Steels used for Test Assembly *(2017)* *(2021)*

Grade of electrode	Grade of steels used for test assembly(1)(2)
1	*A*
2	*A*, *B* or *D*
3	*A*, *B*, *D* or *E*
2*Y*	*AH* 32, *AH* 36, *DH* 32 or *DH* 36
3*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32 or *EH* 36
4*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
5*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
2*Y*40	*AH* 40 or *DH* 40
3*Y*40	*AH* 40, *DH* 40 or *EH* 40
4*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
5*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
3*Y*47	*EH* 47-*H*
L 1	*E or RL* 24*A*
L 2	*E*, *RL* 235*A*, *RL* 235*B*, *RL* 325*A* or *RL* 325*B*
L 3	*RL* 325*A*, *RL* 325*B* or *RL* 360
L 91	*RL* 9*N*490

NOTES:
(1) Notwithstanding the requirements in this Table normal strength or higher strength steel may be used for the deposited metal test assembly. In this case, test assemblies of grade *L* 91 are to be appropriately buttered.
(2) The tensile strength of higher strength steels *AH* 32, *DH* 32 *EH* 32, and *FH* 32 used in butt weld test assemblies is to be greater than 490 N/mm^2.

reason

- To reflect IACS UR W31(Rev.2 CR)

Present

4. Deposited metal test

(1) ~ (2) <Omitted>

(3) *Deposited metal tensile test*

(a) ~ (b) <Omitted>

(c) The tensile strength, yield strength and elongation of each test specimen are to comply with the requirements given in **Table 2.2.29,** where the upper limit of tensile strength is exceeded, special consideration will be given to the approval of the electrode, taking into consideration of the other mechanical properties shown in the test results and the chemical composition of deposited metal.

Table 2.2.29 Tensile and impact Test Requirements for Deposited Metal *(2017)*

Grade of electrode	Tensile strength (N/mm^2)	Yield strength (N/mm^2)	Elongation (%)	Impact test	
				Test temp. (℃)	Average absorbed energy(J)
1	400 ~ 560	305 min.	22 min.	20	47 min.
2				0	
3				-20	
2*Y*	490 ~ 660	375 min.	22 min.	0	
3*Y*				-20	
4*Y*				-40	
5*Y*				-60	
2*Y*40	510 ~ 690	400 min.	22 min.	0	
3*Y*40				-20	
4*Y*40				-40	
5*Y*40				-60	
L 1	400 ~ 560	305 min.	22 min.	-40	34 min.
L 2	440 ~ 610	345 min.	22 min.	-60	
L 3	490 ~ 660	375 min.	21 min.	-60	
L 91	590 min.	375 min.(1)	25 min.	-196	27 min.

NOTE:
(1) 0.2 % Yield strength

Amendment

4. Deposited metal test

(1) ~ (2) <Same as the present Rules>

(3) *Deposited metal tensile test*

(a) ~ (b) <Same as the present Rules>

(c) The tensile strength, yield strength and elongation of each test specimen are to comply with the requirements given in **Table 2.2.29,** where the upper limit of tensile strength is exceeded, special consideration will be given to the approval of the electrode, taking into consideration of the other mechanical properties shown in the test results and the chemical composition of deposited metal.

Table 2.2.29 Tensile and impact Test Requirements for Deposited Metal *(2017) (2021)*

Grade of electrode	Tensile strength (N/mm^2)	Yield strength (N/mm^2)	Elongation (%)	Impact test	
				Test temp. (℃)	Average absorbed energy(J)
1	400 ~ 560	305 min.	22 min.	20	47 min.
2				0	
3				-20	
2*Y*	490 ~ 660	375 min.	22 min.	0	
3*Y*				-20	
4*Y*				-40	
5*Y*				-60	
2*Y*40	510 ~ 690	400 min.	22 min.	0	
3*Y*40				-20	
4*Y*40				-40	
5*Y*40				-60	
3*Y*47	570 ~ 720	460 min.	19 min.	-20	64 min.
L 1	400 ~ 560	305 min.	22 min.	-40	34 min.
L 2	440 ~ 610	345 min.	22 min.	-60	
L 3	490 ~ 660	375 min.	21 min.	-60	
L 91	590 min.	375 min.(1)	25 min.	-196	27 min.

NOTE:
(1) 0.2 % Yield strength

reason

- To reflect IACS UR W31(Rev.2 CR)

Present

(4) <Omitted>

5. Butt weld test

(1) <Omitted>

(2) *Butt weld tensile tests*

(a) ~ (b) <Omitted>

(c) The tensile strength of test specimen is to comply with the requirements given in **Table 2.2.30**.

Table 2.2.30 Tensile and impact Test Requirements for butt weld *(2017)*

Grade of electrode	Tensile strength (N/mm^2)	Impact test		
		Test temp. (℃)	Average absorbed energy (J)	
			Flat, Horizontal, Overhead	Vertical upward Vertical downward
1	400 min.	20	47 min.	34 min.
2		0		
3		-20		
2*Y*	490 min.	0		
3*Y*		-20		
4*Y*		-40		
5*Y*		-60		
2*Y*40	510 min.	0		39 min.
3*Y*40		-20		
4*Y*40		-40		
5*Y*40		-60		
L 1	400 min.	-40	27 min.	27 min.
L 2	440 min.	-60		
L 3	490 min.	-60		
L 91	630 min.	-196		

Amendment

(4) <Same as the present Rules>

5. Butt weld test

(1) <Same as the present Rules>

(2) *Butt weld tensile tests*

(a) ~ (b) <Same as the present Rules>

(c) The tensile strength of test specimen is to comply with the requirements given in **Table 2.2.30**.

Table 2.2.30 Tensile and impact Test Requirements for butt weld *(2017) (2021)*

Grade of electrode	Tensile strength (N/mm^2)	Impact test		
		Test temp. (℃)	Average absorbed energy (J)	
			Flat, Horizontal, Overhead	Vertical upward Vertical downward
1	400 min.	20	47 min.	34 min.
2		0		
3		-20		
2*Y*	490 min.	0		
3*Y*		-20		
4*Y*		-40		
5*Y*		-60		
2*Y*40	510 min.	0		39 min.
3*Y*40		-20		
4*Y*40		-40		
5*Y*40		-60		
3*Y*47	570 min.	-20	64 min.	64 min.
L 1	400 min.	-40	27 min.	27 min.
L 2	440 min.	-60		
L 3	490 min.	-60		
L 91	630 min.	-196		

reason

- To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
(3) *Butt weld bend test* (a) ~ (b) <Omitted> (c) The test specimens are to be capable of withstanding, without crack exceeding 3 mm long on the outer surface of other defects, being bent through an angle of 120 *degrees* over a former having a radius of 1.5 times the thickness of test specimen. The radius and angle of the former for *L* 91, however, are to be 2 *times* the thickness of the specimen and 180 *degrees* respectively. (4) <Omitted> **6. ~ 9. <Omitted>**	(3) *Butt weld bend test* (a) ~ (b) <Same as the present Rules> (c) The test specimens are to be capable of withstanding, without crack exceeding 3 mm long on the outer surface of other defects, being bent through an angle of 120 *degrees* over a former having a radius of 1.5 times(2 times for 3*Y*47) the thickness of test specimen. The radius and angle of the former for *L* 91, however, are to be 2 *times* the thickness of the specimen and 180 *degrees* respectively. (4) <Same as the present Rules> **6. ~ 9. <Same as the present Rules>**	- To reflect IACS UR W31(Rev.2 CR)
603. Automatic welding consumables for normal strength steels, higher strength steels and steels for low temperature service **1. <Omitted>** **2. Grades and marks** (1) The automatic welding consumables are classified as specified in **Table 2.2.35**. **Table 2.2.35 Grade and Marks *(2017)*** For normal strength steel: 1, 2, 3 For higher strength steel: 1*Y*, 2*Y*, 3*Y*, 4*Y*, 5*Y*, 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40 For steel for low temperature service: *L* 1, *L* 2, *L* 3, *L* 91 (2) ~ (3) <Omitted> **3. General provisions for tests** (1) Steel plates to be used for test assemblies are to be as given in **Table 2.2.38,** appropriate to the kind of automatic welding consumables. (2) ~ (8) <Omitted>	**603. Automatic welding consumables for normal strength steels, higher strength steels and steels for low temperature service** **1. <Same as the present Rules>** **2. Grades and marks** (1) The automatic welding consumables are classified as specified in **Table 2.2.35**. **Table 2.2.35 Grade and Marks *(2017) (2021)*** For normal strength steel: 1, 2, 3 For higher strength steel: 1*Y*, 2*Y*, 3*Y*, 4*Y*, 5*Y*, 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40, 3*Y*47 For steel for low temperature service: *L* 1, *L* 2, *L* 3, *L* 91 (2) ~ (3) <Same as the present Rules> **3. General provisions for tests** (1) Steel plates to be used for test assemblies are to be as given in **Table 2.2.38,** appropriate to the kind of automatic welding consumables. (2) ~ (8) <Same as the present Rules>	

Present

Table 2.2.38 Grades of Steel used for Test Assembly *(2017)*

Grade of welding consumable	Grade of steel used for test assembly(1)(2)
1	*A*
2	*A*, *B* or *D*
3	*A*, *B*, *D* or *E*
1*Y*	*AH* 32 or *AH* 36
2*Y*	*AH* 32, *AH* 36, *DH* 32 or *DH* 36
3*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32 or *EH* 36
4*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
5*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
2*Y*40	*AH* 40 or *DH* 40
3*Y*40	*AH* 40, *DH* 40 or *EH* 40
4*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
5*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
L 1	*E or RL* 235*A*
L 2	*E*, *RL* 235*A*, *RL* 235*B*, *RL* 325*A* or *RL* 325*B*
L 3	*RL* 325*A*, *RL* 325*B* or *RL* 360
L 91	*RL* 9*N*490

NOTES:

(1) Notwithstanding the requirements in this Table, normal strength steel or higher strength steels may be used for deposited metal test assembly In this case, test assemblies of grade *L* 91 are to be appropriately buttered.

(2) The tensile strength of higher strength steels *AH* 32, *DH* 32, *EH* 32 and *FH* 32 used in butt weld test assemblies is to be greater than 490 N/mm^2

Amendment

Table 2.2.38 Grades of Steel used for Test Assembly *(2017)* *(2021)*

Grade of welding consumable	Grade of steel used for test assembly(1)(2)
1	*A*
2	*A*, *B* or *D*
3	*A*, *B*, *D* or *E*
1*Y*	*AH* 32 or *AH* 36
2*Y*	*AH* 32, *AH* 36, *DH* 32 or *DH* 36
3*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32 or *EH* 36
4*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
5*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
2*Y*40	*AH* 40 or *DH* 40
3*Y*40	*AH* 40, *DH* 40 or *EH* 40
4*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
5*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
3*Y*47	*EH* 47-*H*
L 1	*E or RL* 235*A*
L 2	*E*, *RL* 235*A*, *RL* 235*B*, *RL* 325*A* or *RL* 325*B*
L 3	*RL* 325*A*, *RL* 325*B* or *RL* 360
L 91	*RL* 9*N*490

NOTES:

(1) Notwithstanding the requirements in this Table, normal strength steel or higher strength steels may be used for deposited metal test assembly In this case, test assemblies of grade *L* 91 are to be appropriately buttered.

(2) The tensile strength of higher strength steels *AH* 32, *DH* 32, *EH* 32 and *FH* 32 used in butt weld test assemblies is to be greater than 490 N/mm^2

reason

- To reflect IACS UR W31(Rev.2 CR))

Present

4. Deposited metal test with multi-run technique

(1) ~ (2) <Omitted>

(3) *Deposited metal tensile test with multi-run technique*

(a) <Omitted>

(b) The tensile strength, yield point and elongation of each test specimen are to comply with the requirements given in **Table 2.2.40**, where the upper limit of tensile strength is exceeded, special consideration will be given to the approval of the electrode, taking into consideration of the other mechanical properties shown in the test results and the chemical composition of deposited metal.

Table 2.2.40 Tensile and Impact Test Requirements for Deposited Metal test *(2017)*

Grade of welding material	Tensile strength (N/mm^2)	Yield strength (N/mm^2)	Elongation (%)	Impact test	
				Test temp. (℃)	Average absorbed energy (*J*)
1	400 ~ 560	305 min.	22 min.	20	34 min.
2				0	
3				-20	
1*Y*	490 ~ 660	375 min.	22 min.	20	
2*Y*				0	
3*Y*				-20	
4*Y*				-40	
5*Y*				-60	
2*Y*40	510 ~ 690	400 min.	22 min.	0	39 min.
3*Y*40				-20	
4*Y*40				-40	
5*Y*40				-60	
L 1	400 ~ 560	305 min.	22 min.	-40	27 min.
L 2	440 ~ 610	345 min.	22 min.	-60	
L 3	490 ~ 660	375 min.	21 min.	-60	
L 91	590 min.	375 min.(1)	25 min.	-196	

NOTE:
(1) 0.2 % yield stress

Amendment

4. Deposited metal test with multi-run technique

(1) ~ (2) <Same as the present Rules>

(3) *Deposited metal tensile test with multi-run technique*

(a) <Same as the present Rules>

(b) The tensile strength, yield point and elongation of each test specimen are to comply with the requirements given in **Table 2.2.40**, where the upper limit of tensile strength is exceeded, special consideration will be given to the approval of the electrode, taking into consideration of the other mechanical properties shown in the test results and the chemical composition of deposited metal.

Table 2.2.40 Tensile and Impact Test Requirements for Deposited Metal test *(2017) (2021)*

Grade of welding material	Tensile strength (N/mm^2)	Yield strength (N/mm^2)	Elongation (%)	Impact test	
				Test temp. (℃)	Average absorbed energy (*J*)
1	400 ~ 560	305 min.	22 min.	20	34 min.
2				0	
3				-20	
1*Y*	490 ~ 660	375 min.	22 min.	20	
2*Y*				0	
3*Y*				-20	
4*Y*				-40	
5*Y*				-60	
2*Y*40	510 ~ 690	400 min.	22 min.	0	39 min.
3*Y*40				-20	
4*Y*40				-40	
5*Y*40				-60	
3*Y*47	570 ~ 720	460 min.	19 min.	-20	64 min.
L 1	400 ~ 560	305 min.	22 min.	-40	27 min.
L 2	440 ~ 610	345 min.	22 min.	-60	
L 3	490 ~ 660	375 min.	21 min.	-60	
L 91	590 min.	375 min.(1)	25 min.	-196	

NOTE:
(1) 0.2 % yield stress

reason

- To reflect IACS UR W31(Rev.2 CR)

Present

(c) <Omitted>

(4) <Omitted>

5. Butt weld test with multi-run technique

(1) <Omitted>

(2) *Butt weld tensile test with multi-run technique*

(a) ~ (b) <Omitted>

(c) The tensile strength of test specimen is to comply with the requirements given in **Table 2.2.41**.

Table 2.2.41 Tensile and Impact Test Requirements for butt weld test with multi-run technique *(2017)*

Grade of welding material	Tensile strength(N/mm²)	Impact test	
		Test temp. (℃)	Average absorbed energy (J)
1	400 min.	20	34 min.
2		0	
3		− 20	
1*Y*	490 min.	20	
2*Y*		0	
3*Y*		− 20	
4*Y*		− 40	
5*Y*		− 60	
2*Y*40	510 min.	0	39 min.
3*Y*40		− 20	
4*Y*40		− 40	
5*Y*40		− 60	
L 1	400 min.	− 40	27 min.
L 2	440 min.	− 60	
L 3	490 min.	− 60	
L 91	630 min.	− 196	

Amendment

(c) <Same as the present Rules>

(4) <Same as the present Rules>

5. Butt weld test with multi-run technique

(1) <Same as the present Rules>

(2) *Butt weld tensile test with multi-run technique*

(a) ~ (b) <Same as the present Rules>

(c) The tensile strength of test specimen is to comply with the requirements given in **Table 2.2.41**.

Table 2.2.41 Tensile and Impact Test Requirements for butt weld test with multi-run technique *(2017) (2021)*

Grade of welding material	Tensile strength(N/mm²)	Impact test	
		Test temp. (℃)	Average absorbed energy (J)
1	400 min.	20	34 min.
2		0	
3		− 20	
1*Y*	490 min.	20	
2*Y*		0	
3*Y*		− 20	
4*Y*		− 40	
5*Y*		− 60	
2*Y*40	510 min.	0	39 min.
3*Y*40		− 20	
4*Y*40		− 40	
5*Y*40		− 60	
3*Y*47	570 min.	− 20	64 min.
L 1	400 min.	− 40	27 min.
L 2	440 min.	− 60	
L 3	490 min.	− 60	
L 91	630 min.	− 196	

reason

- To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
(3) *Butt weld bend test with multi-run technique* (a) <Omitted> (b) The test specimens are to be capable of withstanding, without crack exceeding 3 mm long on the outer surface of other defects, being bent through an angle of 120 *degrees* over a former having a radius of 1.5 *times* the thickness of test specimen. The radius and angle of the former for *L* 91, however, are to be 2 *times* the thickness of the specimen and 180 *degrees* respectively. *(2017)* (4) <Omitted>	(3) *Butt weld bend test with multi-run technique* (a) <Same as the present Rules> (b) The test specimens are to be capable of withstanding, without crack exceeding 3 mm long on the outer surface of other defects, being bent through an angle of 120 *degrees* over a former having a radius of 1.5 *times*(2 *times* for 3*Y*47)the thickness of test specimen. The radius and angle of the former for *L* 91, however, are to be 2 *times* the thickness of the specimen and 180 *degrees* respectively. *(2017) (2021)* (4) <Same as the present Rules>	- To reflect IACS UR W31(Rev.2 CR)
6. ~ 7. <Omitted>	**6. ~ 7. <Same as the present Rules>**	
8. Annual inspections (1) <Omitted> (2) The kinds of test, etc. involved in the annual inspections are to be as given in **Table 2.2.42**. (3) <Omitted>	**8. Annual inspections** (1) <Same as the present Rules> (2) The kinds of test, etc. involved in the annual inspections are to be as given in **Table 2.2.42**. (3) <Same as the present Rules>	
9. <Omitted>	**9. <Same as the present Rules>**	

Present

Table 2.2.42 Kinds of Test for Annual Inspection *(2017)*

Grade of welding consumables	Welding technique[(1)]	Kind of test		Test assembly			Kinds and no. of test specimens taken from test assembly
				Number	Dimensions	Thickness (mm)	
1, 2, 3 1*Y*, 2*Y*, 3*Y*, 4*Y*, 5*Y* 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40 *L*1, *L*2, *L*3, *L*91	Multi-run technique	Deposited metal test		1	**Fig 2.2.27**	20	Tensile test specimen: 1 Impact test specimen: 3
	Two-run technique	But weld test	Submerged arc welding	1	**Fig 2.2.29**	20	Tensile test specimen: 1 Longitudinal tensile test specimen: 1 Face bend test specimen: 1 Root bend test specimen: 1 Impact test specimen: 3
			Gas shielded and self shielded arc welding	1		20~25	Tensile test specimen: 1 Longitudinal tensile test specimen: 1 Face bend test specimen: 1 Root bend test specimen: 1 Impact test specimen: 3

NOTE:
(1) Tests on both multi-run and two run technique are to be conducted for multi-run and two run welding respectively. However, longitudinal tensile test of two run technique are not required.

Amendment

Table 2.2.42 Kinds of Test for Annual Inspection *(2017)* *(2021)*

Grade of welding consumables	Welding technique[(1)]	Kind of test		Test assembly			Kinds and no. of test specimens taken from test assembly
				Number	Dimensions	Thickness (mm)	
1, 2, 3 1*Y*, 2*Y*, 3*Y*, 4*Y*, 5*Y* 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40, 3*Y*47 *L*1, *L*2, *L*3, *L*91	Multi-run technique	Deposited metal test		1	**Fig 2.2.27**	20	Tensile test specimen: 1 Impact test specimen: 3
	Two-run technique	But weld test	Submerged arc welding	1	**Fig 2.2.29**	20	Tensile test specimen: 1 Longitudinal tensile test specimen: 1 Face bend test specimen: 1 Root bend test specimen: 1 Impact test specimen: 3
			Gas shielded and self shielded arc welding	1		20~25	Tensile test specimen: 1 Longitudinal tensile test specimen: 1 Face bend test specimen: 1 Root bend test specimen: 1 Impact test specimen: 3

NOTE:
(1) Tests on both multi-run and two run technique are to be conducted for multi-run and two run welding respectively. However, longitudinal tensile test of two run technique are not required.

reason

- To reflect IACS UR W31(Rev.2 CR)

Present

604. Semi-automatic welding consumables for normal strength steels, higher strength steels and steels for low temperature service

1. <Omitted>

2. Grades and marks

(1) The semi-automatic welding consumables are classified as specified in **Table 2.2.43**.

Table 2.2.43 Grades and Marks *(2017)*

For normal strength steel	For higher strength steel	For steel for low temperature service
1, 2, 3	1*Y*, 2*Y*, 3*Y*, 4*Y* 5*Y* 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40	*L*1, *L*2, *L*3, *L*91

(2) ~ (4) <Omitted>

3. General provisions for tests

(1) ~ (2) <Omitted>

(3) Steel plates to be used for test assemblies are to be as given in **Table 2.2.45**, appropriate to the kind of semi-automatic welding consumables.

(4) ~ (8) <Omitted>

Amendment

604. Semi-automatic welding consumables for normal strength steels, higher strength steels and steels for low temperature service

1. <Same as the present Rules>

2. Grades and marks

(1) The semi-automatic welding consumables are classified as specified in **Table 2.2.43**.

Table 2.2.43 Grades and Marks *(2017) (2021)*

For normal strength steel	For higher strength steel	For steel for low temperature service
1, 2, 3	1*Y*, 2*Y*, 3*Y*, 4*Y* 5*Y* 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40, 3*Y*47	*L*1, *L*2, *L*3, *L*91

(2) ~ (4) <Same as the present Rules>

3. General provisions for tests

(1) ~ (2) <Same as the present Rules>

(3) Steel plates to be used for test assemblies are to be as given in **Table 2.2.45**, appropriate to the kind of semi-automatic welding consumables.

(4) ~ (8) <Same as the present Rules>

reason

- To reflect IACS UR W31(Rev.2 CR)

Present

Table 2.2.45 Grades of Steel for Test Assembly *(2017)*

Grade of welding consumables	Grade of steel for test assembly(1)(2)
1S	*A*
2S	*A*, *B* or *D*
3S	*A*, *B*, *D* or *E*
1*Y*S	*AH* 32 or *AH* 36
2*Y*S	*AH* 32, *AH* 36, *DH* 32 or *DH* 36
3*Y*S	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32 or *EH* 36
4*Y*S	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
5*Y*S	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
2*Y*40S	*AH* 40 or *DH* 40
3*Y*40S	*AH* 40, *DH* 40 or *EH* 40
4*Y*40S	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
5*Y*40S	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
L 1S	*E or RL* 235*A*
L 2S	*E*, *RL* 235*A*, *RL* 235*B*, *RL* 325*A* or *RL* 325*B*
L 3S	*RL* 325*A*, *RL* 325*B* or *RL* 360
L 91S	*RL* 9*N*490

NOTES;
(1) Notwithstanding the requirements in this Table, normal or higher strength steels may be used for deposited metal test assembly. In this case, test assemblies of grade *L* 91 are to be appropriately buttered.
(2) The tensile strength of higher strength steels *AH* 32, *DH* 32, *EH* 32 and *FH* 32 used in butt weld test assemblies is to be greater than 490 N/mm^2.

Amendment

Table 2.2.45 Grades of Steel for Test Assembly *(2017) (2021)*

Grade of welding consumables	Grade of steel for test assembly(1)(2)
1S	*A*
2S	*A*, *B* or *D*
3S	*A*, *B*, *D* or *E*
1*Y*S	*AH* 32 or *AH* 36
2*Y*S	*AH* 32, *AH* 36, *DH* 32 or *DH* 36
3*Y*S	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32 or *EH* 36
4*Y*S	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
5*Y*S	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
2*Y*40S	*AH* 40 or *DH* 40
3*Y*40S	*AH* 40, *DH* 40 or *EH* 40
4*Y*40S	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
5*Y*40S	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
3*Y*47S	*EH* 47-*H*
L 1S	*E or RL* 235*A*
L 2S	*E*, *RL* 235*A*, *RL* 235*B*, *RL* 325*A* or *RL* 325*B*
L 3S	*RL* 325*A*, *RL* 325*B* or *RL* 360
L 91S	*RL* 9*N*490

NOTES;
(1) Notwithstanding the requirements in this Table, normal or higher strength steels may be used for deposited metal test assembly. In this case, test assemblies of grade *L* 91 are to be appropriately buttered.
(2) The tensile strength of higher strength steels *AH* 32, *DH* 32, *EH* 32 and *FH* 32 used in butt weld test assemblies is to be greater than 490 N/mm^2.

reason

- To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
4. Deposited metal test (1) ~ (2) <Omitted> (3) *Deposited metal tensile test* (a) ~ (b) <Omitted> (c) The tensile strength, yield strength and elongation of each test specimen are to comply with the requirements given in **Table 2.2.46**, where the upper limit of tensile strength is exceeded, special consideration will be given to the approval of the electrode, taking into consideration of the other mechanical properties shown in the test results and the chemical composition of deposited metal. (4) <Omitted>	**4. Deposited metal test** (1) ~ (2) <Same as the present Rules> (3) *Deposited metal tensile test* (a) ~ (b) <Same as the present Rules> (c) The tensile strength, yield strength and elongation of each test specimen are to comply with the requirements given in **Table 2.2.46**, where the upper limit of tensile strength is exceeded, special consideration will be given to the approval of the electrode, taking into consideration of the other mechanical properties shown in the test results and the chemical composition of deposited metal. (4) <Same as the present Rules>	

Present

Table 2.2.46 Tensile and Impact Test Requirements for Deposited Metal test *(2017)*

Grade of welding consumables	Tensile strength (N/mm^2)	Yield strength (N/mm^2)	Elongation (%)	Impact test	
				Test temp. (℃)	Average absorbed energy (J)
1*S*	400 ~ 560	305 min.	22 min.	20	47 min.
2*S*				0	
3*S*				− 20	
1*YS*	490 ~ 660	375 min.	22 min.	20	
2*YS*				0	
3*YS*				− 20	
4*YS*				− 40	
5*YS*				− 60	
2*Y*40*S*	510 ~ 690	400 min.	22 min.	0	
3*Y*40*S*				− 20	
4*Y*40*S*				− 40	
5*Y*40*S*				− 60	
L 1*S*	400 ~ 560	305 min.	22 min.	− 40	34 min.
L 2*S*	440 ~ 610	345 min.	22 min.	− 60	
L 3*S*	490 ~ 660	375 min.	21 min.	− 60	
L 91*S*	590 min	375 min.(1)	25 min.	− 196	27 min.

NOTE:
(1) 0.2 % yield stress

Amendment

Table 2.2.46 Tensile and Impact Test Requirements for Deposited Metal test *(2017) (2021)*

Grade of welding consumables	Tensile strength (N/mm^2)	Yield strength (N/mm^2)	Elongation (%)	Impact test	
				Test temp. (℃)	Average absorbed energy (J)
1*S*	400 ~ 560	305 min.	22 min.	20	47 min.
2*S*				0	
3*S*				− 20	
1*YS*	490 ~ 660	375 min.	22 min.	20	
2*YS*				0	
3*YS*				− 20	
4*YS*				− 40	
5*YS*				− 60	
2*Y*40*S*	510 ~ 690	400 min.	22 min.	0	
3*Y*40*S*				− 20	
4*Y*40*S*				− 40	
5*Y*40*S*				− 60	
<u>3*Y*47*S*</u>	<u>570 ~ 720</u>	<u>460 min.</u>	<u>19 min.</u>	<u>− 20</u>	<u>64 min.</u>
L 1*S*	400 ~ 560	305 min.	22 min.	− 40	34 min.
L 2*S*	440 ~ 610	345 min.	22 min.	− 60	
L 3*S*	490 ~ 660	375 min.	21 min.	− 60	
L 91*S*	590 min	375 min.(1)	25 min.	− 196	27 min.

NOTE:
(1) 0.2 % yield stress

reason

- To reflect IACS UR W31(Rev.2 CR)

Present

5. Butt weld test

(1) <Omitted>

(2) *Butt weld tensile tests*

(a) ~ (b) <Omitted>

(c) The tensile strength of test specimen is to comply with the requirements given in **Table 2.2.47**.

Table 2.2.47 Tensile and Impact Test Requirements for Butt weld test *(2017)*

Grade of welding consumables	Tensile strength (N/mm^2)	Impact test		
		Test temp. (℃)	Average absorbed energy (J)	
			Flat, Horizontal Overhead	Vertical upward, Vertical downward
1*S*	400 min.	20	47 min.	34 min.
2*S*		0		
3*S*		− 20		
1*YS*	490 min.	20		
2*YS*		0		
3*YS*		− 20		
4*YS*		− 40		
5*YS*		− 60		
2*Y*40*S*	510 min.	0		39 min.
3*Y*40*S*		− 20		
4*Y*40*S*		− 40		
5*Y*40*S*		− 60		
L 1*S*	400 min.	− 40	27 min.	27 min.
L 2*S*	440 min.	− 60		
L 3*S*	490 min.	− 60		
L 91*S*	630 min.	− 196		

Amendment

5. Butt weld test

(1) <Same as the present Rules>

(2) *Butt weld tensile tests*

(a) ~ (b) <Same as the present Rules>

(c) The tensile strength of test specimen is to comply with the requirements given in **Table 2.2.47**.

Table 2.2.47 Tensile and Impact Test Requirements for Butt weld test *(2017) (2021)*

Grade of welding consumables	Tensile strength (N/mm^2)	Impact test		
		Test temp. (℃)	Average absorbed energy (J)	
			Flat, Horizontal Overhead	Vertical upward, Vertical downward
1*S*	400 min.	20	47 min.	34 min.
2*S*		0		
3*S*		− 20		
1*YS*	490 min.	20		
2*YS*		0		
3*YS*		− 20		
4*YS*		− 40		
5*YS*		− 60		
2*Y*40*S*	510 min.	0		39 min.
3*Y*40*S*		− 20		
4*Y*40*S*		− 40		
5*Y*40*S*		− 60		
3*Y*47*S*	570 min.	− 20	64 min.	64 min.
L 1*S*	400 min.	− 40	27 min.	27 min.
L 2*S*	440 min.	− 60		
L 3*S*	490 min.	− 60		
L 91*S*	630 min.	− 196		

reason

- To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
(3) *Butt weld bend test* (a) <Omitted> (b) The test specimens are to be capable of withstanding, without crack exceeding 3 mm long on the outer surface of other defects, being bent through an angle of 120 degrees over a former having a radius of 1.5 times the thickness of test specimen. The radius and angle of the former for *L* 91, however, are to be 2 times the thickness of the specimen and 180 degrees respectively. *(2017)* (4) <Omitted> **6. ~ 9. <Omitted>**	(3) *Butt weld bend test* (a) <Same as the present Rules> (b) The test specimens are to be capable of withstanding, without crack exceeding 3 mm long on the outer surface of other defects, being bent through an angle of 120 degrees over a former having a radius of 1.5 times(2 times for 3*Y*47) the thickness of test specimen. The radius and angle of the former for *L* 91, however, are to be 2 times the thickness of the specimen and 180 degrees respectively. *(2017) (2021)* (4) <Same as the present Rules> **6. ~ 9. <Same as the present Rules>**	- To reflect IACS UR W31(Rev.2 CR)
605. Electro-slag and electro-gas welding consumables **1. <Omitted>** **2. Grades and marks** Welding consumables are classified as specified in **Table 2.2.49**. **Table 2.2.49 Grades and Marks** For normal strength steel: *1V*, *2V*, *3V* For higher strength steel: *1YV*, *2YV*, *3YV*, *4YV*, *5YV*, *2Y40V*, *3Y40V*, *4Y40V*, *5Y40V* **3. General provisions for tests** (1) <Omitted> (2) Steel plates to be used for test assemblies are to be as given in **Table 2.2.51,** appropriate to the kind of welding consumables.	**605. Electro-slag and electro-gas welding consumables** **1. <Same as the present Rules>** **2. Grades and marks** Welding consumables are classified as specified in **Table 2.2.49**. **Table 2.2.49 Grades and Marks *(2021)*** For normal strength steel: *1V*, *2V*, *3V* For higher strength steel: *1YV*, *2YV*, *3YV*, *4YV*, *5YV*, *2Y40V*, *3Y40V*, *4Y40V*, *5Y40V*, *3Y47V* **3. General provisions for tests** (1) <Same as the present Rules> (2) Steel plates to be used for test assemblies are to be as given in **Table 2.2.51,** appropriate to the kind of welding consumables.	

Present

Table 2.2.51 Grades of Steel used for Test Assembly

Grade of welding material	Grade of steel used for test assembly(1)(2)
1*V*	*A*
2*V*	*A*, *B* or *D*
3*V*	*A*, *B*, *D* or *E*
1*YV*	*AH* 32 or *AH* 36
2*YV*	*AH* 32, *AH* 36, *DH* 32 or *DH* 36
3*YV*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32 or *EH* 36
4*YV*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
5*YV*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
2*Y*40*V*	*AH* 40 or *DH* 40
3*Y*40*V*	*AH* 40, *DH* 40 or *EH* 40
4*Y*40*V*	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
5*Y*40*V*	*AH* 40, *DH* 40, *EH* 40 or *FH* 40

NOTE:
(1) The tensile strength of higher strength steels of *AH* 32, *DH* 32, *EH* 32 and *FH* 32 used in the test assemblies is to be greater than 490 N/mm^2.
(2) This is in respect of the content of grain refining elements, and if general approval is required, a niobium treated steel is to be used for the approval tests.

(3) ~ (6) <Omitted>

4. Butt weld test

(1) <Omitted>
(2) *Tensile test*
(a) ~ (b) <Omitted>

Amendment

Table 2.2.51 Grades of Steel used for Test Assembly *(2021)*

Grade of welding material	Grade of steel used for test assembly(1)(2)
1*V*	*A*
2*V*	*A*, *B* or *D*
3*V*	*A*, *B*, *D* or *E*
1*YV*	*AH* 32 or *AH* 36
2*YV*	*AH* 32, *AH* 36, *DH* 32 or *DH* 36
3*YV*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32 or *EH* 36
4*YV*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
5*YV*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
2*Y*40*V*	*AH* 40 or *DH* 40
3*Y*40*V*	*AH* 40, *DH* 40 or *EH* 40
4*Y*40*V*	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
5*Y*40*V*	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
3*Y*47*V*	*EH* 47-*H*

NOTE:
(1) The tensile strength of higher strength steels of *AH* 32, *DH* 32, *EH* 32 and *FH* 32 used in the test assemblies is to be greater than 490 N/mm^2.
(2) This is in respect of the content of grain refining elements, and if general approval is required, a niobium treated steel is to be used for the approval tests.

(3) ~ (6) <Same as the present Rules>

4. Butt weld test

(1) <Same as the present Rules>
(2) *Tensile test*
(a) ~ (b) <Same as the present Rules>

reason

- To reflect IACS UR W31(Rev.2 CR)

Present

(c) Tensile strength of each test specimen R2A and tensile strength, yield strength and elongation of each longitudinal test specimen R14A are to comply with the requirements in **Table 2.2.52**. Where the upper limit of tensile strength is exceeded, special consideration will be given to the approval of the welding consumables, taking into consideration of the other mechanical properties shown in the test results and chemical composition of deposited metal.

Table 2.2.52 Tensile and Impact Test Requirements for Butt weld test

Grade of welding consumables	Tensile strength (N/mm^2)	Longitudinal Tensile Test			Impact test	
		Tensile strength (N/mm^2)	Yield strength (N/mm^2)	Elongation (%)	Test temp. (℃)	Average absorbed energy (J)
1*V*	400 min.	400 ~ 560	305 min.	22 min.	20	34 min.
2*V*					0	
3*V*					-20	
1*YV*	490 min.	490 ~ 660	375 min.	22 min.	20	
2*YV*					0	
3*YV*					-20	
4*YV*					-40	
5*YV*					-60	
2*Y*40*V*	510 min.	510 ~ 690	400 min.	22 min.	0	39 min.
3*Y*40*V*					-20	
4*Y*40*V*					-40	
5*Y*40*V*					-60	

(3) ~ (5) <Omitted>

5. ~ 6. <Omitted>

Amendment

(c) Tensile strength of each test specimen R2A and tensile strength, yield strength and elongation of each longitudinal test specimen R14A are to comply with the requirements in **Table 2.2.52**. Where the upper limit of tensile strength is exceeded, special consideration will be given to the approval of the welding consumables, taking into consideration of the other mechanical properties shown in the test results and chemical composition of deposited metal.

Table 2.2.52 Tensile and Impact Test Requirements for Butt weld test *(2021)*

Grade of welding consumables	Tensile strength (N/mm^2)	Longitudinal Tensile Test			Impact test	
		Tensile strength (N/mm^2)	Yield strength (N/mm^2)	Elongation (%)	Test temp. (℃)	Average absorbed energy (J)
1*V*	400 min.	400 ~ 560	305 min.	22 min.	20	34 min.
2*V*					0	
3*V*					-20	
1*YV*	490 min.	490 ~ 660	375 min.	22 min.	20	
2*YV*					0	
3*YV*					-20	
4*YV*					-40	
5*YV*					-60	
2*Y*40*V*	510 min.	510 ~ 690	400 min.	22 min.	0	39 min.
3*Y*40*V*					-20	
4*Y*40*V*					-40	
5*Y*40*V*					-60	
3*Y*47*V*	570 min.	570 ~ 720	460 min.	19 min.	-20	64 min.

(3) ~ (5) <Same as the present Rules>

5. ~ 6. <Same as the present Rules>

reason

- To reflect IACS UR W31(Rev.2 CR)

Present

606. One side welding consumables for normal strength steels, higher strength steels and steels for low temperature service.

1. ~ 2. <Omitted>

3. General provisions for tests

(1) Kinds of test, number, thickness and dimensions of test assemblies, grades and number of test specimens to be taken from each test assembly for one side automatic welding consumables are to be as given in **Table 2.2.55**.

(2) Steel plates to be used for test assemblies are to be as given in **Table 2.2.56**.

(3) ~ (8) <Omitted>

Table 2.2.55 Kinds of Test for One-side Automatic Welding Consumables *(2017)*

Grade of welding consumables	Welding technique	Kind of test(4)	Test assembly			Kind and number of test specimens taken from test assembly
			Number	Thickness (mm) (1)	Dimension	
1, 2, 3, 1*Y*, 2*Y*, 3*Y*, 4*Y*, 5*Y*, 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40, *L*1, *L*2, *L*3, *L*91	<Omitted>					

NOTES:
(1) Where thickness is restricted by welding process, thickness of test assemblies may be changed upon approval of the Society. In this case, the maximum test thickness is to be taken as the maximum applicable thickness.
(2) Thickness of test assembly for one run technique.
(3) Thickness of test assembly for multi-run technique.
(4) The hydrogen test may be carried out according to the manufacturer's request.

Amendment

606. One side welding consumables for normal strength steels, higher strength steels and steels for low temperature service.

1. ~ 2. <Same as the present Rules>

3. General provisions for tests

(1) Kinds of test, number, thickness and dimensions of test assemblies, grades and number of test specimens to be taken from each test assembly for one side automatic welding consumables are to be as given in **Table 2.2.55**.

(2) Steel plates to be used for test assemblies are to be as given in **Table 2.2.56**.

(3) ~ (8) <Same as the present Rules>

Table 2.2.55 Kinds of Test for One-side Automatic Welding Consumables *(2017) (2021)*

Grade of welding consumables	Welding technique	Kind of test(4)	Test assembly			Kind and number of test specimens taken from test assembly
			Number	Thickness (mm) (1)	Dimension	
1, 2, 3, 1*Y*, 2*Y*, 3*Y*, 4*Y*, 5*Y*, 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40, 3*Y*47, *L*1, *L*2, *L*3, *L*91	<Same as the present Rules>					

NOTES:
(1) Where thickness is restricted by welding process, thickness of test assemblies may be changed upon approval of the Society. In this case, the maximum test thickness is to be taken as the maximum applicable thickness.
(2) Thickness of test assembly for one run technique.
(3) Thickness of test assembly for multi-run technique.
(4) The hydrogen test may be carried out according to the manufacturer's request.

reason

- To reflect IACS UR W31(Rev.2 CR)

Present

Table 2.2.56 Grades of Steel used for Test Assembly *(2017)*

Grade of welding consumables	Grade of steel used for test assembly(1)
1	*A*
2	*A*, *B* or *D*
3	*A*, *B*, *D* or *E*
1*Y*	*AH* 32 or *AH* 36
2*Y*	*AH* 32, *AH* 36, *DH* 32 or *DH* 36
3*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32 or *EH* 36
4*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
5*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
2*Y*40	*AH* 40 or *DH* 40
3*Y*40	*AH* 40, *DH* 40 or *EH* 40
4*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
5*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
L 1	*E or RL* 235*A*
L 2	*E*, *RL* 235*A*, *RL* 235*B*, *RL* 325*A* or *RL* 325*B*
L 3	*RL* 325*A*, *RL* 325*B* or *RL* 360
L 91	*RL* 9*N*490

NOTE:
(1) The tensile strength of higher strength steels *AH* 32, *DH* 32, *EH* 32 and *FH* 32 used in the test assemblies is to be greater than 490 N/mm^2

4. ~ 5. <Omitted>

Amendment

Table 2.2.56 Grades of Steel used for Test Assembly *(2017)* *(2021)*

Grade of welding consumables	Grade of steel used for test assembly(1)
1	*A*
2	*A*, *B* or *D*
3	*A*, *B*, *D* or *E*
1*Y*	*AH* 32 or *AH* 36
2*Y*	*AH* 32, *AH* 36, *DH* 32 or *DH* 36
3*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32 or *EH* 36
4*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
5*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
2*Y*40	*AH* 40 or *DH* 40
3*Y*40	*AH* 40, *DH* 40 or *EH* 40
4*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
5*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
3*Y*47	*EH* 47-*H*
L 1	*E or RL* 235*A*
L 2	*E*, *RL* 235*A*, *RL* 235*B*, *RL* 325*A* or *RL* 325*B*
L 3	*RL* 325*A*, *RL* 325*B* or *RL* 360
L 91	*RL* 9*N*490

NOTE:
(1) The tensile strength of higher strength steels *AH* 32, *DH* 32, *EH* 32 and *FH* 32 used in the test assemblies is to be greater than 490 N/mm^2

4. ~ 5. <Same as the present Rules>

reason

- To reflect IACS UR W31(Rev.2 CR)

Present

6. Annual inspections

(1) <Omitted>

(2) The kinds of test, etc. in the annual inspection are to be as given in **Table 2.2.58**.

(3) <Omitted>

7. <Omitted>

Table 2.2.58 Kinds of Test for Annual Inspection *(2017)*

Grade of welding consumables	Welding technique	Kind of test	Test assembly			Kind and number of test specimens taken from test assembly
			Number	Dimension	Thickness (mm)(1)	
1, 2, 3, 1*Y*, 2*Y*, 3*Y*, 4*Y*, 5*Y*, 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40, *L*1, *L*2, *L*3, *L*91	<Omitted>					

NOTES:

(1) Where the thickness of test assemblies is changed according to Note (1) of **Table 2.2.55**, the maximum test thickness for approval test is to be applied.

(2) The butt weld tests for one-run and multi-run technique are to be carried out by one-run technique.

(3) The positions of notch and selection of impact test specimens are to be as given in **Fig 2.2.35** (b).

<hereafter, omitted>

Amendment

6. Annual inspections

(1) <Same as the present Rules>

(2) The kinds of test, etc. in the annual inspection are to be as given in **Table 2.2.58**.

(3) <Same as the present Rules>

7. <Same as the present Rules>

Table 2.2.58 Kinds of Test for Annual Inspection *(2017)* *(2021)*

Grade of welding consumables	Welding technique	Kind of test	Test assembly			Kind and number of test specimens taken from test assembly
			Number	Dimension	Thickness (mm)(1)	
1, 2, 3, 1*Y*, 2*Y*, 3*Y*, 4*Y*, 5*Y*, 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40, 3*Y*47, *L*1, *L*2, *L*3, *L*91	<Same as the present Rules>					

NOTES:

(1) Where the thickness of test assemblies is changed according to Note (1) of **Table 2.2.55**, the maximum test thickness for approval test is to be applied.

(2) The butt weld tests for one-run and multi-run technique are to be carried out by one-run technique.

(3) The positions of notch and selection of impact test specimens are to be as given in **Fig 2.2.35** (b).

<hereafter, same as the present Rules>

reason

- To reflect IACS UR W31(Rev.2 CR))

- Main Amendments -

(1) Enter into force on 1 July 2021 (the date of application for certification of material & welding or the contract date for ship construction)

◉ To reflect IACS UR W24(Rev.4 July 2020)
◉ To reflect IACS UR W27(Rev.2 July 2020)
◉ To reflect Request for Establishment/Revision of Classification Technical Rules

Present	Amendment	reason

CHAPTER 1 MATERIALS

Section 1 ~ Section 2 <Omitted>
Section 3 Rolled Steels

301. Rolled steels for hull structural

1. ~ **2.** <Omitted>

3. Manufacturing process

(1) <Omitted>

(2) The deoxidation practice and chemical composition of each grade are to comply with the requirements given in **Table 2.1.6.** For steel plates and wide flats over 50mm thick and When thermo-mechanical controlled processing (hereinafter referred to as "TMCP") is used as heat treatment, slight deviations in the chemical composition may be allowed as approved by the Society. **【See Guidance】**

Table 2.1.6 Deoxidation Practice and Chemical Composition

Kinds	Grade	Thickness, t(mm)	Deoxidation Practice	Chemical Composition (%) (5)
Normal strength steels	<Omitted>			
Higher strength steels (13)	*AH* 32	$t \leq 100$	Killed and Fine grain treated	<Omitted>
	DH 32			
	EH 32			
	AH 36			
	DH 36			
	EH 36			
	AH 40	$t \leq 50$		
	DH 40			
	EH 40			
	FH 32			
	FH 36			
	FH 40			
NOTES: <Omitted>				

4. <Omitted>

CHAPTER 1 MATERIALS

Section 1 ~ Section 2 <Same as the present Rules>
Section 3 Rolled Steels

301. Rolled steels for hull structural

1. ~ **2.** <Same as the present Rules>

3. Manufacturing process

(1) <Same as the present Rules>

(2) The deoxidation practice and chemical composition of each grade are to comply with the requirements given in **Table 2.1.6.** For steel plates and wide flats over 50mm thick and When thermo-mechanical controlled processing (hereinafter referred to as "TMCP") is used as heat treatment, slight deviations in the chemical composition may be allowed as approved by the Society. **【See Guidance】**

Table 2.1.6 Deoxidation Practice and Chemical Composition

Kinds	Grade	Thickness, t(mm)	Deoxidation Practice	Chemical Composition (%) (5)
Normal strength steels	<Same as the present Rules>			
Higher strength steels (13)	*AH* 32	$t \leq 100$	Killed and Fine grain treated	<Same as the present Rules>
	DH 32			
	EH 32			
	AH 36			
	DH 36			
	EH 36			
	AH 40	$t \leq 100$		
	DH 40			
	EH 40			
	FH 32			
	FH 36			
	FH 40			
NOTES: <Same as the present Rules>				

4. <Same as the present Rules>

* Request for Establishment/Revision of Classification Technical Rules (MET4800-427-2020)

* Match to IACS UR W11 -typo

Present	Amendment	reason
5. Mechanical properties The mechanical properties of steels are to comply with the requirements given in **Table 2.1.7**. **6.** ~ **13.** <Omitted> **302.** ~ **304.** **<Omitted>**	**5. Mechanical properties** The mechanical properties of steels are to comply with the requirements given in **Table 2.1.7**. **6.** ~ **13.** <Same as the present Rules> **302.** ~ **304.** **<Same as the present Rules>**	* Request for Establishment/Revision of Classification Technical Rules (MET4800-427-2020) * Match to IACS UR W11 -typo

<Present>

Table 2.1.7 Mechanical Properties

Grade	Tensile test			Impact test						
	Yield strength (N/mm^2)	Tensile strength (N/mm^2)	Elongation[6] ($L=5.65\sqrt{A}$) (%)	test temp (℃)	Average absorbed energy (1)(J)					
					Thickness, t (mm)					
					$t \leq 50$		$50 < t \leq 70$		$70 < t \leq 100$	
					L[2]	T(2)	L(2)	T(2)	L(2)	T(2)
A	235 min.	400~520(3)	22 min.	+20	-	-	(4)	(4)	(4)	(4)
B				0[5]	27 min.	20 min.	34 min.	24 min.	41 min.	27 min.
D				-20						
E				-40						
AH 32	315 min.	440~570	22 min.	0	31 min.	22 min.	38 min.	26 min.	46 min.	31 min.
DH 32				-20						
EH 32				-40						
FH 32				-60						
AH 36	355 min.	490~630	21 min.	0	34 min.	24 min.	41 min.	27 min.	50 min.	34 min.
DH 36				-20						
EH 36				-40						
FH 36				-60						
AH 40	390 min.	510~660	20 min.	0	39 min.	26 min.	46 min.	31 min.	55 min.	37 min.
DH 40				-20						
EH 40				-40						
FH 40				-60						

NOTE:

(1) When the absorbed energy of two or more test specimens among a set of test specimens is less in value than the specified average absorbed energy or when the absorbed energy of a single test specimen is less in value than 70 % of the specified average absorbed energy, the test is considered to be failed.

(2) L (or T) denotes that the longitudinal axis of the test specimen is arranged parallel (or transverse) to the final direction of rolling.

(3) For all thickness of Grade A section, the upper limit of the specified tensile strength, may be exceeded.

(4) For Grade A steel over 50 mm in thickness with *ARS* or *CRS* heat treatment, impact tests are required. In this case, the average absorbed energy is to comply with the requirements of Grade B steel.

(5) For Grade B steels up to 25 mm in thickness, generally no impact testing is required.

(6) The minimum elongation for R 1*B* test specimen (L=200mm) is to be in compliance with the requirement given in the Table below.

Grade \ Thickness t (mm)	$3 \leq t \leq 5$	$5 < t \leq 10$	$10 < t \leq 15$	$15 < t \leq 20$	$20 < t \leq 25$	$25 < t \leq 30$	$30 < t \leq 40$	$40 < t \leq 100$
A, B, D, E, AH 32, *DH* 32, *EH* 32, *FH* 32	14	16	17	18	19	20	21	22
AH 36, *DH* 36, *EH* 36, *FH* 36	13	15	16	17	18	19	20	21
AH 40, *DH* 40, *EH*40, *FH* 40	12	14	15	16	17	18	19	20

<Amendment>

Table 2.1.7 Mechanical Properties

Grade	Tensile test			Impact test						
	Yield strength (N/mm^2)	Tensile strength (N/mm^2)	Elongation[6] ($L=5.65\sqrt{A}$) (%)	test temp (℃)	Average absorbed energy (1)(J)					
					Thickness, t (mm)					
					$t \leq 50$		$50 < t \leq 70$		$70 < t \leq 100$	
					L[2]	T(2)	L(2)	T(2)	L(2)	T(2)
A	235 min.	400~520(3)	22 min.	+20	-	-	(4)	(4)	(4)	(4)
B				0[5]	27 min.	20 min.	34 min.	24 min.	41 min.	27 min.
D				-20						
E				-40						
AH 32	315 min.	440~570	22 min.	0	31 min.	22 min.	38 min.	26 min.	46 min.	31 min.
DH 32				-20						
EH 32				-40						
FH 32				-60						
AH 36	355 min.	490~630	21 min.	0	34 min.	24 min.	41 min.	27 min.	50 min.	34 min.
DH 36				-20						
EH 36				-40						
FH 36				-60						
AH 40	390 min.	510~660	20 min.	0	39 min.	26 min.	46 min.	31 min.	55 min.	37 min.
DH 40				-20						
EH 40				-40						
FH 40				-60						

NOTE:

(1) When the absorbed energy of two or more test specimens among a set of test specimens is less in value than the specified average absorbed energy or when the absorbed energy of a single test specimen is less in value than 70 % of the specified average absorbed energy, the test is considered to be failed.

(2) L (or T) denotes that the longitudinal axis of the test specimen is arranged parallel (or transverse) to the final direction of rolling.

(3) For all thickness of Grade A section, the upper limit of the specified tensile strength, may be exceeded.

(4) For Grade A steel over 50 mm in thickness with *ARS* or *CRS* heat treatment, impact tests are required. In this case, the average absorbed energy is to comply with the requirements of Grade B steel.

(5) For Grade B steels up to 25 mm in thickness, generally no impact testing is required.

(6) The minimum elongation for R 1*B* test specimen (L=200mm) is to be in compliance with the requirement given in the Table below.

Grade \ Thickness t (mm)	$3 \leq t \leq 5$	$5 < t \leq 10$	$10 < t \leq 15$	$15 < t \leq 20$	$20 < t \leq 25$	$25 < t \leq 30$	$30 < t \leq 40$	$40 < t \leq 50$
A, B, D, E, AH 32, *DH* 32, *EH* 32, *FH* 32	14	16	17	18	19	20	21	22
AH 36, *DH* 36, *EH* 36, *FH* 36	13	15	16	17	18	19	20	21
AH 40, *DH* 40, *EH*40, *FH* 40	12	14	15	16	17	18	19	20

Present

305. Rolled stainless steels

1. ~ **3.** <Omitted>

4. Chemical composition

The chemical composition of steels is to comply with the requirements given in **Table 2.1.19.**

Table 2.1.19 Grades and Chemical Composition of Stainless Steels *(2020)*

Grade	Chemical composition (%)									
	C	*Si*	*Mn*	*P*	*S*	*Ni*	*Cr*	*Mo*	*N*	Others
RSTS 304	0.08 max.	1.00 max.	2.00 max.	0.040 max.	0.030 max.	8.00~10.50	18.00~20.00	-	-	-
RSTS 304*L*	0.030 max.					9.00~13.00				
RSTS 304*N*1	0.08 max.		2.50 max.			7.00~10.50			0.10~0.25	
<Omitted>										

5. ~ **10.** <Omitted>

306. ~ 311. <Omitted>

Amendment

305. Rolled stainless steels

1. ~ **3.** <Same as the present Rules>

4. Chemical composition

The chemical composition of steels is to comply with the requirements given in **Table 2.1.19.**

Table 2.1.19 Grades and Chemical Composition of Stainless Steels *(2020) (2021)*

Grade	Chemical composition (%)									
	C	*Si*	*Mn*	*P*	*S*	*Ni*	*Cr*	*Mo*	*N*	Others
RSTS 304	0.08 max.	1.00 max.	2.00 max.	0.040 max.	0.030 max.	8.00~10.50	18.00~20.00	-	-	-
RSTS 304*L*	0.030 max.					8.00~13.00				
RSTS 304*N*1	0.08 max.		2.50 max.			7.00~10.50			0.10~0.25	
<Same as the present Rules>										

5. ~ **10.** <Same as the present Rules>

306. ~ 311. <Same as the present Rules>

reason

* Request for Establishment/Revision of Classification Technical Rules (MET4800-279-2020)

- ASTM A240(S30403)
  Ni : 8~12

Present

Section 4 Steel Tubes and Pipes

401. <Omitted>

402. Steel pipes for pressure piping

1. ~ 2. <Omitted>

3. Heat treatment

The heat treatment of steel pipes is to comply with the requirements given in **Table 2.1.53**.

Table 2.1.53 Heat treatment

Grade		Seamless steel pipe		Electric-resistance welded steel pipe		
		Hot finished	Cold drawn	As drawn	Hot finished	Cold finished
Grade 1	*RST* 138 *RST* 142	As drawn	Annealed	As drawn	As drawn	Annealed
Grade 2	*RST* 238		Low temperature annealed or Normalized	-		
	RST 242					
	RST 249					
Grade 3	*RST* 338 *RST* 342	As drawn	Low temperature annealed or Normalized	Low temperature annealed or Normalized	As drawn	Low temperature annealed or Normalized
	RST 349			-		
<Omitted>						

4. ~ 9. <Omitted>

403. ~ 405. <Omitted>

Amendment

Section 4 Steel Tubes and Pipes

401. <Same as the present Rules>

402. Steel pipes for pressure piping

1. ~ 2. <Same as the present Rules>

3. Heat treatment

The heat treatment of steel pipes is to comply with the requirements given in **Table 2.1.53**.

Table 2.1.53 Heat treatment

Grade		Seamless steel pipe		Electric-resistance welded steel pipe		
		Hot finished	Cold drawn	As drawn	Hot finished	Cold finished
Grade 1	*RST* 138 *RST* 142	As drawn	Annealed	As drawn	As drawn	Annealed
Grade 2	*RST* 238		Low temperature annealed or Normalized	-		
	RST 242					
	RST 249					
Grade 3	*RST* 338 *RST* 342	As drawn	Low temperature annealed or Normalized	Low temperature annealed or Normalized	As drawn	Low temperature annealed or Normalized
	RST 349			-		
<Same as the present Rules>						

NOTE:
(1) In the case of Grade 2 & Grade 3, low temperature annealed or normalized may be applied if necessary. *(2021)*

4. ~ 9. <Same as the present Rules>

403. ~ 405. <Same as the present Rules>

reason

* Request for Establishment/Revision of Classification Technical Rules (MET4800-284-2020)

* To reflect KS D 3564

Present	Amendment	reason
Section 5 Castings	**Section 5 Castings**	
501. ~ 504. <Omitted>	**501. ~ 504. <Same as the present Rules>**	* Request for Establishment/Revision of Classification Technical Rules (MET4800-110-2020) - To reflect IACS UR W27(Rev.2, July 2020)
505. Stainless steel casting for propeller	**505. Stainless steel casting for propeller**	
1. Application (1) These requirements are applicable to the manufacture of stainless steel casting(hereinafter referred to as "**steel propeller casting**") for propellers, blades and bosses. These requirements may also be used for the repair of propellers damaged in service, subject to prior agreement with the Society. **[See Guidance]** (2) Steel propeller castings having characteristics differing from those specified in **505.** are to comply with the requirements in **101. 2**.	**1. Application** (1) These requirements are applicable to the manufacture, inspection and repair procedures of stainless steel casting(hereinafter referred to as "**steel propeller casting**") for propellers, blades and bosses. These requirements may also be used for the repair of propellers damaged in service, subject to prior agreement with the Society. **[See Guidance]** (2) Steel propeller castings having characteristics differing from those specified in **505.** are to comply with the requirements in **101. 2**.	
2. Kinds Steel propeller castings are classified as specified in **Table 2.1.80**.	**2. Kinds** Steel propeller castings are classified as specified in **Table 2.1.80**.	
3. Chemical composition Chemical composition is classified as specified in **Table 2.1.80**. (1) ~ (2) <New>	**3. Chemical composition** ***(2021)*** (1) Chemical composition is classified as specified in **Table 2.1.80**. Cast steel whose chemical composition deviate from the typical values of **Table 2.1.80** must be specially approved by the Society. (2) The manufacturer is to maintain records of the chemical analyses of the production casts, which are to be made available to the Surveyor so that he can satisfy himself that the chemical composition of each casting is within the specified limits.	
Table 2.1.80 <Omitted>	**Table 2.1.80 <Same as the present Rules>**	
4. <Omitted>	**4. <Same as the present Rules>**	

Present

5. Mechanical properties

(1) The mechanical properties are to meet the requirements in **Table 2.1.81** These values refer to the test specimens machined from integrally cast test bars attached to the hub or on the blade.

Table 2.1.81 Mechanical Properties

Types	Tensile test				Impact test
	Yield strength (1) (N/mm^2)	Tensile strength (N/mm^2)	Elongation (%)	Reduction area (%)	Average absorbed energy (*J*) (3)
12*Cr* 1*Ni*	440 Min.	590 Min.	15 Min.	30 Min.	20 Min.
13*Cr* 4*Ni*	550 Min.	750 Min.	15 Min.	35 Min.	30 Min.
16*Cr* 5*Ni*	540 Min.	760 Min.	15 Min.	35 Min.	30 Min.
19*Cr* 11Ni	180 Min.(2)	440 Min.	30 Min.	40 Min.	-

NOTES
(1) 0.2 % yield strength
(2) 1.0 % yield strength is min. 205 N/mm^2.
(3) Not required for general service and the lowest Ice class notation(Grade ID). For other Ice class notations, tests are to be made -10℃.

Amendment

5. Mechanical properties

(1) The mechanical properties are to meet the requirements in **Table 2.1.81** These values refer to the test specimens machined from integrally cast test bars attached to the hub or on the blade. The thickness of test coupon is to be in accordance with a recognized standard. *(2021)*

Table 2.1.81 Mechanical Properties

Types	Tensile test				Impact test
	Yield strength (1) (N/mm^2)	Tensile strength (N/mm^2)	Elongation (%)	Reduction area (%)	Average absorbed energy (*J*) (3)
12*Cr* 1*Ni*	440 Min.	590 Min.	15 Min.	30 Min.	20 Min.
13*Cr* 4*Ni*	550 Min.	750 Min.	15 Min.	35 Min.	30 Min.
16*Cr* 5*Ni*	540 Min.	760 Min.	15 Min.	35 Min.	30 Min.
19*Cr* 11Ni	180 Min.(2)	440 Min.	30 Min.	40 Min.	-

NOTES
(1) 0.2 % yield strength
(2) 1.0 % yield strength is min. 205 N/mm^2.
(3) Not required for general service and the lowest Ice class notation(Grade ID). For other Ice class notations, tests are to be made -10℃.

reason

- To reflect IACS UR W27(Rev.2, July 2020)

Present	Amendment	reason
6. <Omitted>	**6. <Same as the present Rules>**	
7. <New>	**7. Quality of castings *(2021)***	- To reflect IACS UR W27(Rev.2, July 2020)
	(1) All castings are to have a workmanlike finish and are to be free from imperfections defects which would be prejudicial to their proper application in service.	
	(2) Minor casting defects which may still be visible after machining such as small sand and slag inclusions, small cold shuts and scabs shall be trimmed off by the manufacturer in accordance with **10.**.	
	(3) Casting defects which may impair the serviceability of the castings, e.g. major non-metallic inclusions, shrinkage cavities, blow holes and cracks, are not permitted. They may be removed by one of the methods described in **10.** and repaired within the limits and restrictions for the severity zones. Full description and documentation must be available for the surveyor.	
7. Surface and dimension inspection	**8. Surface and dimension inspection**	
(1) Steel propeller castings are to be subjected to the surface inspection by the Society at the final process and other proper processing stages if necessary. The surveyor may require areas to be etched for the purpose of investigating weld repairs.	(1) All finished castings are to be 100% visually inspected by the manufacturer. A general visual examination is to be carried out by the Surveyor. *(2021)*	
(2) Steel propeller castings are to be free from cracks, hot tears or other imperfections which, due to their nature, degree or extent, will interfere with the use of the castings.	(2) Steel propeller castings are to be free from cracks, hot tears or other imperfections which, due to their nature, degree or extent, will interfere with the use of the castings.	
(3) The dimensions are the responsibility of the manufacturer and the report on the dimensional inspection is to be handed over to the Surveyor, who may require checks to be made in his presence.	(3) The verification of dimensions, the dimensional and geometrical tolerances is the responsibility of the manufacturer. The report on the relevant examinations is to be submitted to the Surveyor, who may require checks to be made in his presence. *(2021)*	

Present	Amendment	reason
8. Non-destructive inspection	**9. Non-destructive inspection**	
(1) <Omitted>	(1) <Same as the present Rules>	
(2) <New>	(2) Qualification of personnel involved in NDT is in accordance with **Appendix Pt B 1.4**, **1.5** and **1.9** of **Guidance for Approval of Service Suppliers**. *(2021)*	- To reflect IACS UR W27(Rev.2, July 2020)
(2) The division of severity zones of steel propeller casting is to be in accordance with the Guidance relating to Rules specified by the Society. **【See Guidance】**	(3) The division of severity zones of steel propeller casting is to be in accordance with the Guidance relating to Rules specified by the Society. **【See Guidance】**	
(3) Where serious doubt exists that the castings are not free from internal defects, further non-destructive inspections are to be carried out upon request of the Surveyor, e.g. radiographic and/or ultrasonic tests. The acceptance criteria are then to be agreed between the manufacturer and the Society.	(4) Where serious doubt exists that the castings are not free from internal defects, further non-destructive inspections are to be carried out upon request of the Surveyor, e.g. radiographic and/or ultrasonic tests. The acceptance criteria are then to be agreed between the manufacturer and the Society.	
(4) The foundry is to maintain records of inspections traceable to each propeller casting. These records are to be reviewed by the Surveyor. The foundry is also to provide the Surveyor with a statement confirming that non-destructive tests have been carried out with satisfactory results.	(5) The foundry is to maintain records of inspections traceable to each propeller casting. These records are to be reviewed by the Surveyor. The foundry is also to provide the Surveyor with a statement confirming that non-destructive tests have been carried out with satisfactory results.	
9. Repair of defects	**9. Repair of defects**	
(1) In general the repairs are to be carried out by mechanical means, e.g. by grinding or milling. Where the steel propeller castings from which defects where removed are used in that condition, the steel propeller castings are to be approved by the Surveyor.	(1) In general the repairs are to be carried out by mechanical means, e.g. by grinding, chipping or milling. Where the steel propeller castings from which defects where removed are used in that condition, the steel propeller castings are to be approved by the Surveyor. *(2021)*	
(2) The resulting grooves are to be blended into the surrounding surface so as to avoid any sharp contours. Complete elimination of the defective material is to be verified by liquid penetrant testing.	(2) The resulting grooves are to be blended into the surrounding surface so as to avoid any sharp contours. Complete elimination of the defective material is to be verified by liquid penetrant testing, or magnetic particle testing if applicable. *(2021)*	
(3) Weld repairs are to be undertaken only when they are considered to be necessary and have prior approval of the Surveyor. Welds having an area less than 5 cm^2 are to be avoided.	(3) Weld repairs are to be undertaken only when they are considered to be necessary and have prior approval of the Surveyor. Welds having an area less than 5 cm^2 are to be avoided.	
(4) The repair welding procedures are to have prior approval of the Surveyor in accordance with the Guidance relating to the Rules specified by the Society. **【See Guidance】**	(4) The repair welding procedures are to have prior approval of the Surveyor in accordance with the Guidance relating to the Rules specified by the Society. **【See Guidance】**	
(5) All weld repairs are to be documented by means of sketches or photographs showing the location and major dimensions of the grooves prepared for welding. The documentation is to be presented to the Surveyor prior to repair welding.	(5) The foundry is to maintain records of inspections, welding, and any subsequent heat treatment, traceable to each casting. Before welding is started, full details of the extent and location of the repair, the proposed welding procedure, heat treatment and subsequent inspection procedures are to be submitted to the Society for approval. *(2021)*	

Present	Amendment	reason
10. Retest procedure Where the results of tensile tests fail to meet the requirements, additional test may be carried out in accordance with the requirements of **109**.	**11. Retest procedure** Where the results of tensile tests fail to meet the requirements, additional test may be carried out in accordance with the requirements of **109**.	- To reflect IACS UR W27(Rev.2, July 2020)
11. Marking Steel propeller castings which have satisfactorily complied with the required tests are to be marked with the identification mark in accordance with the requirements in **110**. (1) ~ (2) <New>	**12. Marking** ***(2021)*** (1) The manufacturer is to adopt a system for the identification of all castings, which enable the material to be traced to its original cast. The Surveyor is to be given full facilities for so tracing the castings when required. (2) Steel propeller castings which have satisfactorily complied with the required tests are to be marked with the identification mark in accordance with the requirements in **110.** and as follows. (a) Heat number or other marking which will enable the full history of the casting to be traced (b) Grade of cast material or corresponding abbreviated designation (c) Ice class symbol, where applicable (d) Skew angle for high skew propellers (e) Date of final inspection	
12. Test certificates (2017) The manufacturer is to provide the Surveyor with an inspection certificate giving the following particulars for each casting which has been accepted: (1) Purchaser's name and order number (2) Vessel identification, where known (3) Description of the casting with drawing number (4) Diameter, number of blades, pitch, direction of turning (5) Skew angle for high skew propellers (6) Final mass (7) Alloy type, heat number and chemical composition (8) Casting identification number (9) Details of time and temperature of heat treatment (10) Results of the mechanical tests (11) Results of non-destructive tests, where applicable	**13. Test certificates (2017)** The manufacturer is to provide the Surveyor with an inspection certificate giving the following particulars for each casting which has been accepted: (1) Purchaser's name and order number (2) Vessel identification, where known (3) Description of the casting with drawing number (4) Diameter, number of blades, pitch, direction of turning (5) Skew angle for high skew propellers (6) Final weight (7) Alloy type, heat number and chemical composition (8) Casting identification number (9) Details of time and temperature of heat treatment (10) Results of the mechanical tests (11) Results of non-destructive tests and details of test procedure where applicable *(2021)*	
505. ~ 507. <Omitted>	**505. ~ 507. <Same as the present Rules>**	

Present

Section 6 Steel Forgings

601. Steel forgings

1. ~ 4. <Omitted>

5. Chemical composition

(1) The chemical composition of steel forgings is to comply with the requirements given in **Table 2.1.85**.

Table 2.1.85 Chemical Composition *(2017)*

Steel type		Chemical composition (%)									
		C	Si	Mn	P	S	Cr	Mo	Ni	Cu(3)	Total residual
Hull and General purpose steel forging(5)	Carbon steel	0.23(1)(2) max.	0.45 max.	0.30-1.50	0.035 max.	0.035 max.	0.30(3) max.	0.15(3) max.	0.40(3) max.	0.30 max.	0.85 max.
	Alloy steel	(4) —	0.45 max.	(4) —	0.035 max.	0.035 max.	(4) —	(4) —	(4) —	0.30 max.	-
Machinery steel forging	Carbon steel	0.65(1) max.	0.45 max.	0.30-1.50	0.035 max.	0.035 max.	0.30(3) max.	0.15(3) max.	0.40(3) max.	0.30 max.	0.85 max.
	Alloy steel(6)	0.45 max.	0.45 max.	0.30-1.00	0.035 max.	0.035 max.	0.40(7) min.	0.15(7) min.	0.40(7) min.	0.30 max.	-

NOTES :

(1) ~ (3) <Omitted>

~~(4) Specification is to be submitted for approval.~~

(5) Rudder stocks and pintles should be of weldable quality.

(6) Where alloy steel forgings are intended for welded constructions, the proposed chemical composition is subject to approval by the Society.

(7) One or more of the elements is to comply with the minimum content.

(2) ~ (3) <Omitted>

6. ~ 8. <Omitted>

602. ~ 604. <Omitted>

Amendment

Section 6 Steel Forgings

601. Steel forgings

1. ~ 4. <Same as the present Rules>

5. Chemical composition

(1) The chemical composition of steel forgings is to comply with the requirements given in **Table 2.1.85**.

Table 2.1.85 Chemical Composition *(2017) (2021)*

Steel type		Chemical composition (%)									
		C	Si	Mn	P	S	Cr	Mo	Ni	Cu(3)	Total residual
Hull and General purpose steel forging(4)	Carbon steel	0.23(1)(2) max.	0.45 max.	0.30-1.50	0.035 max.	0.035 max.	0.30(3) max.	0.15(3) max.	0.40(3) max.	0.30 max.	0.85 max.
	Alloy steel	0.23 max.	0.45 max.	0.30-1.00	0.035 max.	0.035 max.	0.40(6) min.	0.15(6) min.	0.40(6) min.	0.30 max.	-
Machinery steel forging	Carbon steel	0.65(1) max.	0.45 max.	0.30-1.50	0.035 max.	0.035 max.	0.30(3) max.	0.15(3) max.	0.40(3) max.	0.30 max.	0.85 max.
	Alloy steel(5)	0.45 max.	0.45 max.	0.30-1.00	0.035 max.	0.035 max.	0.40(6) min.	0.15(6) min.	0.40(6) min.	0.30 max.	-

NOTES :

(1) ~ (3) <Same as the present Rules>

(4) <Deleted>

(4) Rudder stocks and pintles should be of weldable quality.

(5) Where alloy steel forgings are intended for welded constructions, the proposed chemical composition is subject to approval by the Society.

(6) One or more of the elements is to comply with the minimum content.

(2) ~ (3) <Same as the present Rules>

6. ~ 8. <Same as the present Rules>

602. ~ 604. <Same as the present Rules>

reason

* Request for Establishment/Revision of Classification Technical Rules (MET4800-553-2020)

-Chemical composition values are defined based on the approval results.

Present

Section 7 Copper and Copper Alloy

701. <Omitted>

702. Copper alloy castings

1. Application

(1) These requirements are to apply to the copper alloy castings to be used for propellers and propeller blades (hereinafter referred to as "propeller castings"). Also, upon special consideration of the Society, these requirements may also be applied for the repair and inspection of propellers becoming damaged during service. **[See Guidance]**

(2) Copper alloy castings to be used for important parts differing from those specified in **702.** are to comply with the requirements of KS or equivalent thereto. The tests and inspections need in general to be made in the presence of the Surveyor where special requirements are given in connection with the design.

(3) Copper alloy castings characteristics differing from those specified in **702.** are to comply with the requirements in **101. 2**.

2. Kinds Propeller castings are classified as specified in **Table 2.1.98.**

Table 2.1.98 Kinds and Grades

Kinds	Grade
High strength brass casting, Grade 1	*CU* 1
High strength brass casting, Grade 2	*CU* 2
Aluminium bronze casting, Grade 3	*CU* 3
Aluminium bronze casting, Grade 4	*CU* 4

Amendment

Section 7 Copper and Copper Alloy

701. <Same as the present Rules>

702. Copper alloy castings

1. Application

(1) These requirements are to apply to the manufacture, inspection and repair procedures of copper alloy castings to be used for propellers and propeller blades (hereinafter referred to as "propeller castings"). Also, upon special consideration of the Society, these requirements may also be applied for the repair and inspection of propellers becoming damaged during service. **[See Guidance]**

(2) Copper alloy castings to be used for important parts differing from those specified in **702.** are to comply with the requirements of KS or equivalent thereto. The tests and inspections need in general to be made in the presence of the Surveyor where special requirements are given in connection with the design.

(3) Copper alloy castings characteristics differing from those specified in **702.** are to comply with the requirements in **101. 2**.

2. Kinds Propeller castings are classified as specified in **Table 2.1.98.**

Table 2.1.98 Kinds and Grades

Kinds	Grade
High strength brass casting, Grade 1	*CU* 1
High strength brass casting, Grade 2	*CU* 2
Aluminium bronze casting, Grade 3	*CU* 3
Aluminium bronze casting, Grade 4	*CU* 4

reason

* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020)

- To reflect IACS UR W24(Rev.4, July 2020)

Present

3. <Omitted>

4. Chemical composition

(1) The chemical composition of propeller castings is to comply with the requirements given in **Table 2.1.99**.

Table 2.1.99 Chemical Composition ~~(%)~~

Grade	Cu	Al	Mn	Zn	Fe	Sn	Ni	Pb
CU 1	52~62	0.5~3.0	0.5~4.0	35~40	0.5~2.5	1.5 max	1.0 max.	0.5 max.
CU 2	50~57	0.5~2.0	1.0~4.0	33~38	0.5~2.5	1.5 max	3.0~8.0	0.5 max.
CU 3	77~82	7.0~11.0	0.5~4.0	1.0 max.	2.0~6.0	0.1 max.	3.0~6.0	0.03 max.
CU 4	70~80	6.5~9.0	8.0~20.0	6.0 max.	2.0~5.0	1.0 max.	1.5~3.0	0.05 max.

(2) <New>

(2) For *CU* 1 and *CU* 2, it is also to comply with the followings:

(a) The zinc equivalent as specified below is not to exceed 45 %

$$\text{Zinc equivalent} = 100 - \frac{100 \times Cu(\%)}{100 + A}$$

Where A : Sn + 5Al − 0.5Mn − 0.1Fe − 2.3Ni (%)

(b) <New>

(b) Each tensile test specimen is to be examined metalographically, and the proportion of alpha-phase determined from an average of five counts is not to be less than 25 %.

5. ~ **6.** <Omitted>

Amendment

3. <Same as the present Rules>

4. Chemical composition

(1) The chemical composition of propeller castings is to comply with the requirements given in **Table 2.1.99**.

Table 2.1.99 Chemical Composition

Grade	Cu(%)	Al(%)	Mn(%)	Zn(%)	Fe(%)	Sn(%)	Ni(%)	Pb(%)
CU 1	52~62	0.5~3.0	0.5~4.0	35~40	0.5~2.5	1.5 max	1.0 max.	0.5 max.
CU 2	50~57	0.5~2.0	1.0~4.0	33~38	0.5~2.5	1.5 max	3.0~8.0	0.5 max.
CU 3	77~82	7.0~11.0	0.5~4.0	1.0 max.	2.0~6.0	0.1 max.	3.0~6.0	0.03 max.
CU 4	70~80	6.5~9.0	8.0~20.0	6.0 max.	2.0~5.0	1.0 max.	1.5~3.0	0.05 max.

(2) The manufacturer is to maintain records of the chemical analyses of the production casts, which are to be made available to the Surveyor. *(2021)*

(3) For *CU* 1 and *CU* 2, it is also to comply with the followings:

(a) The zinc equivalent as specified below is not to exceed 45 %

$$\text{Zinc equivalent} = 100 - \frac{100 \times Cu(\%)}{100 + A}$$

Where A : Sn + 5Al − 0.5Mn − 0.1Fe − 2.3Ni (%)

(b) The micro structure is to be verified by determining the proportion of alpha phase. For this purpose, at least one specimen is to be taken from each heat. The proportion of alpha phase is to be determined as the average value of 5 counts. *(2021)*

(c) Each tensile test specimen is to be examined metalographically, and the proportion of alpha-phase determined from an average of five counts is not to be less than 25 %.

5. ~ **6.** <Same as the present Rules>

reason

- To reflect IACS UR W24(Rev.4, July 2020)

Present	Amendment	reason
7. Surface and dimension Inspection (1) Propeller casting is to be subjected to a comprehensive visual inspection by the Surveyor at final process and other proper processing stages if necessary. (2) <New> (2) <Omitted> (3) The Surveyor may be require areas to be etched (e.g. by iron chloride) for the purpose of investigating weld repairs.	**7. Surface and dimension Inspection** (1) All finished castings are to be 100% visually inspected by the manufacturer. A general visual examination is to be carried out by the Surveyor. *(2021)* (2) Castings are to be free from cracks, hot tears or other imperfections which, due to their nature, degree or extent, will interfere with the use of the castings. *(2021)* (3) <Same as the present Rules> (4) The Surveyor may be require areas to be etched (e.g. by iron chloride) for the purpose of investigating weld repairs.	- To reflect IACS UR W24(Rev.4, July 2020)
8. Quality All castings must have a workman like finish and must be free from defects liable to impair their use. Minor casting defects which may still be visible after machining such as small sand and slag inclusions, small cold shuts and scabs shall be trimmed off by the manufacturer.	**8. Quality** All castings must have a workman like finish and must be free from defects liable to impair their use. Minor casting defects which may still be visible after machining such as small sand and slag inclusions, small cold shuts and scabs shall be trimmed off by the manufacturer in accordance with **10.** (5).	
9. Non-destructive inspection (1) The important parts of propeller castings are to be subjected to the liquid penetrant test in accordance with the Guidance relating to Rules specified by the Society. **【See Guidance】** (2) <New> (2) The division of severity zones of propeller casting is to be in accordance with the Guidance relating to Rules specified by the Society. **【See Guidance】** (3) Where serious doubts exist that the castings are not free from internal defects, further nondestructive inspections are to be carried out upon request of the Surveyor, e.g. radiographic and/or ultrasonic tests. For this purpose, the acceptance criteria are to be agreed between the manufacturer and the Society in accordance with a recognized standard. (4) All defects requiring welding repair on the propeller castings are to be documented preferably on drawings or special sketches showing their dimensions and locations. Furthermore, the inspection procedure is to be reported. The documentation is to be presented to the Surveyor prior to any repair weldings will be carried out.	**9. Non-destructive inspection** (1) The important parts of propeller castings are to be subjected to the liquid penetrant test in accordance with the Guidance relating to Rules specified by the Society. **【See Guidance】** (2) Qualification of personnel involved in NDT is in accordance with **Appendix Pt B 1.4**, **1.5** and **1.9** of **Guidance for Approval of Service Suppliers**. *(2021)* (3) The division of severity zones of propeller casting is to be in accordance with the Guidance relating to Rules specified by the Society. **【See Guidance】** (4) When required by the Society or when deemed necessary by the manufacturer, further nondestructive testing(e.g. radiographic and/or ultrasonic testing) are to be carried out. The acceptance criteria or applied quality levels are to be agreed between the manufacturer and the Society in accordance with a recognized standard. *(2021)* (5) All defects requiring welding repair on the propeller castings are to be documented preferably on drawings or special sketches showing their dimensions and locations. Furthermore, the inspection procedure is to be reported. The documentation is to be presented to the Surveyor prior to any repair weldings will be carried out.	

Present	Amendment	reason
10. Repair of defects (1) In the event of finding defects in the propeller castings, the defects may be removed by grinding, etc. After removing the defects, liquid penetrant tests are to be carried out to ensure that all defects have been completely removed. (2) Where the propeller castings from which defects where removed are used in that condition or after repaired by welding, the propeller castings are to be approved by the Surveyor. (3) After weld repairs, the portions repaired by welding are to be subjected to the stress-relieving treatments. (4) It is to be confirmed that the portions repaired by welding are free from harmful defects by the non-destructive inspections such as liquid penetrant test, etc. (5) The repair welding procedures are to have prior approval of the Surveyor in accordance with the Guidance relating to the Rules specified by the Society. **【See Guidance】** (6) <New>	**10. Repair of defects** (1) In the event of finding defects in the propeller castings, the defects may be removed by grinding, etc. After removing the defects, liquid penetrant tests are to be carried out to ensure that all defects have been completely removed. (2) Where the propeller castings from which defects where removed are used in that condition or after repaired by welding, the propeller castings are to be approved by the Surveyor. (3) After weld repairs, the portions repaired by welding are to be subjected to the stress-relieving treatments. (4) It is to be confirmed that the portions repaired by welding are free from harmful defects by the non-destructive inspections such as liquid penetrant test, etc. (5) The repair welding procedures are to have prior approval of the Surveyor in accordance with the Guidance relating to the Rules specified by the Society. **【See Guidance】** (6) The foundry is to maintain records of inspections, welding, and any subsequent heat treatment, traceable to each casting. Before welding is started, full details of the extent and location of the repair, the proposed welding procedure, heat treatment and subsequent inspection procedures are to be submitted to the Society for approval. *(2021)*	- To reflect IACS UR W24(Rev.4, July 2020)
11. <Omitted>	**11. <Same as the present Rules>**	
12. Marking (1) <New> (1) Prior to final inspection by the Surveyor each casting shall be marked by the manufacturer at least with the following symbols: (a) ~ (c) <Omitted> ~~(d) Specimen number~~ (e) Date of final inspection (f) Number of the Society's test certificate (g) Ice class symbol, where applicable (h) Skew angle for high skew propellers. ~~(i) Manufacturer's certificate~~	**12. Identification and Marking** (1) The manufacturer is to adopt a system for the identification of all castings, which enable the material to be traced to its original cast. The Surveyor is to be given full facilities for so tracing the castings when required. (2) Each finished casting propeller shall be marked by the manufacturer at least with the following particulars: (a) ~ (c) <Same as the present Rules> (d) <Deleted> (d) Date of final inspection (e) Number of the Society's test certificate (f) Ice class symbol, where applicable (g) Skew angle for high skew propellers. (i) <Deleted>	

Present	Amendment	reason
13. <New> (2) For each propeller the manufacturer must supply to the Surveyor a certificate containing the following details: (a) Purchaser and order number (b) Shipbuilding project number, if known (c) Description of the casting with drawing number (d) Diameter, number of blades, pitch, direction of turning (e) Grade of alloy and chemical composition of each heat (f) Heat or casting number (g) Final weight (h) Results of non-destructive tests and details of test procedure where applicable (i) Portion of alpha-structure for CU 1 and CU 2 alloys (j) Results of the mechanical tests (k) Casting identification No. (l) Skew angle for high skew propellers	**13. Test certificates** For each propeller the manufacturer is to supply to the Surveyor a certificate containing the following details: (1) Purchaser and order number (2) Shipbuilding project number, if known (3) Description of the casting with drawing number (4) Diameter, number of blades, pitch, direction of turning (5) Grade of alloy and chemical composition of each heat (6) Heat or casting number (7) Final weight (8) Results of non-destructive tests and details of test procedure where applicable (9) Portion of alpha-structure for CU 1 and CU 2 alloys (10) Results of the mechanical tests (11) Casting identification No. (12) Skew angle for high skew propellers	- To reflect IACS UR W24(Rev.4, July 2020)

Present

Section 8 Aluminium Alloys

801. Aluminium alloys

1. ~ **4.** <Omitted>

5. Mechanical properties

(1) The mechanical properties in tension tests are to comply with the requirements given in **Tables 2.1.103** and **2.1.104**.

Table 2.1.103 Mechanical Properties for Rolled Products(1)

Grades	Temper condition (2)	Thickness, t (mm)	Tensile test			
			Yield strength (N/mm^2)	Tensile strength (N/mm^2)	Elongation(%)	
					($L=5.65\sqrt{A}$)	($L=5d$)
5083P	<Omitted>					
5383P						
5059P						
5086P	*O*	$3 \le t \le 50$	95 min.	305 min.	16 min.	14 min.
	*H*111	$3 \le t \le 50$	95 min.	305 min.	16 min.	14 min.
	*H*112	$3 \le t \le 12.5$	125 min.	250 min.	8 min.	-
		$12.5 < t \le 50$	105 min.	240 min.	-	9 min.
	*H*116	$3 \le t \le 50$	195 min.	275 min.	10 min.(3)	9 min.
5754P	<Omitted>					
5456P						
NOTES : <Omitted>						

(2) <Omitted>

6. ~ **14.** <Omitted>

Amendment

Section 8 Aluminium Alloys

801. Aluminium alloys

1. ~ **4.** <Same as the present Rules>

5. Mechanical properties

(1) The mechanical properties in tension tests are to comply with the requirements given in **Tables 2.1.103** and **2.1.104**.

Table 2.1.103 Mechanical Properties for Rolled Products(1)

Grades	Temper condition (2)	Thickness, t (mm)	Tensile test			
			Yield strength (N/mm^2)	Tensile strength (N/mm^2)	Elongation(%)	
					($L=5.65\sqrt{A}$)	($L=5d$)
5083P	<Same as the present Rules>					
5383P						
5059P						
5086P	*O*	$3 \le t \le 50$	95 min.	240~305	16 min.	14 min.
	*H*111	$3 \le t \le 50$	95 min.	240~305	16 min.	14 min.
	*H*112	$3 \le t \le 12.5$	125 min.	250 min.	8 min.	-
		$12.5 < t \le 50$	105 min.	240 min.	-	9 min.
	*H*116	$3 \le t \le 50$	195 min.	275 min.	10 min.(3)	9 min.
5754P	<Same as the present Rules>					
5456P						
NOTES : <Same as the present Rules>						

(2) <Same as the present Rules>

6. ~ **14.** <Same as the present Rules>

reason

* Request for Establishment/Revision of Classification Technical Rules (MET4800-336-2020)

- To reflect IACS UR W25(Rev.5, June 14)
- Typo

Present

CHAPTER 2 WELDING

Section 1 ~ Section 2 <Omitted>
Section 3 Welding Work and Inspection

301. ~ 302. <Omitted>

303. Application of welding consumables

Welding consumables used for welded joints of hull structure are to be of the grades as specified in the relevant Articles of **Sec 6** according to the following requirements:

(1) Application of welding consumables for welded joints of various grades of steel is to be as specified in **Table 2.2.3**.

Table 2.2.3 Selection of welding consumables(rolled steel plates) ***(2017) (2019)***

Kind and grade of steel to be welded			Grade of applicable welding consumables [1]
Rolled steels for hull	Mild steel	<Omitted>	
	Higher strength low alloy steel		
Rolled steels for low temperature services		*RL235A*	4*Y*, 4*Y*40, *L*1, *L*2, *L*3
		RL235B, RL325A, RL325B	5*Y*42, *L*2, *L*3[4]
		RL360	5*Y*42, *L*3
		RL9N490	*L*91
High strength steels for welded structures[5]		<Omitted>	

(2) ~ (4) <Omitted>

304. ~ 311. <Omitted>

Amendment

CHAPTER 2 WELDING

Section 1 ~ Section 2 <Same as the present Rules>
Section 3 Welding Work and Inspection

301. ~ 302. <Same as the present Rules>

303. Application of welding consumables

Welding consumables used for welded joints of hull structure are to be of the grades as specified in the relevant Articles of **Sec 6** according to the following requirements:

(1) Application of welding consumables for welded joints of various grades of steel is to be as specified in **Table 2.2.3**.

Table 2.2.3 Selection of welding consumables(rolled steel plates) ***(2017) (2019) (2021)***

Kind and grade of steel to be welded			Grade of applicable welding consumables [1]
Rolled steels for hull	Mild steel	<Same as the present Rules>	
	Higher strength low alloy steel		
Rolled steels for low temperature services		*RL235A*	4*Y*, 4*Y*40, *L*1, *L*2, *L*3
		RL235B, RL325A, RL325B	5*Y*42, *L*2, *L*3[4]
		RL360	5*Y*42, *L*3
		RL5N390	*L*51, *L*91
		RL9N490	*L*91
High strength steels for welded structures[5]		<Same as the present Rules>	

(2) ~ (4) <Same as the present Rules>

304. ~ 311. <Same as the present Rules>

reason

* Request for Establishment/Revision of Classification Technical Rules (MET4800-448-2019)

- Addition of Welding consumables for RL5N390(5%Ni alloy steel)

Present

Section 4 Welding Procedure Qualification Tests

401. ~ 403. <Omitted>

404. Tests for butt welded joints

1. ~ 8. <Omitted>

9. Hardness test *(2019)*

(1) <Omitted>

(2) The results from the hardness test are to be in accordance with **Table 2.2.10**. *(2019)*

Table 2.2.10 Hardness Test Requirements for Butt Welded Joint *(2019)*

Grades and material symbols of test specimens		Hardness (Hv10)
Rolled steels for hull structural	*AH 36, DH 36, EH 36, FH 36, AH 40, DH 40, EH 40, FH 40*	350 max.
	EH47-H	380 max.
Weldable high strength steel		420 max.
Rolled steels & Steel pipes for low temperature service	*RL 235A, RL 235B, RL 325A, RL 325B, RLPA, RLPB, RLPC*	320 max.
	RL 360	380 max.
	RL 1N355, RL 2N255, RLP 2	300 max.
	RL 3N355, RL 5N390, RLP 3	350 max.
	RL 9N490, RLP 9	
Rolled steel plates for boiler & pressure vessel The pipes for ordinary piping The pipes used for high temperature and high pressure		320 max.(1)

~~Note :~~

~~(1) For non-heat treated, hardness may be accepted by 380 max.~~

10. <Omitted>

405. ~ 407. <Omitted>

Amendment

Section 4 Welding Procedure Qualification Tests

401. ~ 403. <Same as the present Rules>

404. Tests for butt welded joints

1. ~ 8. <Same as the present Rules>

9. Hardness test *(2019)*

(1) <Same as the present Rules>

(2) The results from the hardness test are to be in accordance with **Table 2.2.10**. *(2019)*

Table 2.2.10 Hardness Test Requirements for Butt Welded Joint *(2019) (2021)*

Grades and material symbols of test specimens		Hardness (Hv10)
Rolled steels for hull structural	*AH 36, DH 36, EH 36, FH 36, AH 40, DH 40, EH 40, FH 40*	350 max.
	EH47-H	380 max.
Weldable high strength steel	*AH 43 ~ FH 70*	420 max.
	AH 90, DH 90, EH 90, AH 97, DH 97, EH 97	450 max.
Rolled steels & Steel pipes for low temperature service	*RL 235A, RL 235B, RL 325A, RL 325B, RLPA, RLPB, RLPC*	380 max.
	RL 360	450 max.
	RL 1N355, RL 2N255, RLP 2	350 max.
	RL 3N355, RL 5N390, RLP 3	450 max.
	RL 9N490, RLP 9	
Rolled steel plates for boiler & pressure vessel The pipes for ordinary piping The pipes used for high temperature and high pressure		380 max.

10. <Same as the present Rules>

405. ~ 407. <Same as the present Rules>

reason

* Request for Establishment/Revision of Classification Technical Rules (MET4800-151-2020)

- To reflect IACS UR W16 & W28

- To reflect ISO 15614-1

Present

Section 5 <Omitted>
Section 6 Welding Consumables

601. <Omitted>

602. Electrodes for manual arc welding for normal strength steels, higher strength steels and steels for low temperature service

1. <Omitted>

2. Grades and marks of electrode

(1) Electrodes are classified as specified in **Table 2.2.25**.

Table 2.2.25 Grades and Marks *(2017)*

For normal strength steel	For higher strength steel	For steel for low temperature service
1, 2, 3	2*Y*, 3*Y*, 4*Y*, 5*Y*, 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40	*L* 1, *L* 2, *L* 3, *L* 91

(2) <Omitted>

3. General provisions for tests

(1) ~ (4) <Omitted>
(5) Steel plates to be used in preparation of test assemblies are to be as given in **Table 2.2.28** according to the grades of electrode.
(6) ~ (9) <Omitted>

Amendment

Section 5 <Same as the present Rules>
Section 6 Welding Consumables

601. <Same as the present Rules>

602. Electrodes for manual arc welding for normal strength steels, higher strength steels and steels for low temperature service

1. <Same as the present Rules>

2. Grades and marks of electrode

(1) Electrodes are classified as specified in **Table 2.2.25**.

Table 2.2.25 Grades and Marks *(2017) (2021)*

For normal strength steel	For higher strength steel	For steel for low temperature service
1, 2, 3	2*Y*, 3*Y*, 4*Y*, 5*Y*, 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40	*L* 1, *L* 2, *L* 3, *L* 51, *L* 91

(2) <Same as the present Rules>

3. General provisions for tests

(1) ~ (4) <Same as the present Rules>
(5) Steel plates to be used in preparation of test assemblies are to be as given in **Table 2.2.28** according to the grades of electrode.
(6) ~ (9) <Same as the present Rules>

reason

* Request for Establishment/Revision of Classification Technical Rules (MET4800-448-2019)

- Addition of Welding consumables for RL5N390(5%Ni alloy steel)

Present

Table 2.2.28 Grade of Steels used for Test Assembly *(2017)*

Grade of electrode	Grade of steels used for test assembly(1)(2)
1	*A*
2	*A*, *B* or *D*
3	*A*, *B*, *D* or *E*
2*Y*	*AH* 32, *AH* 36, *DH* 32 or *DH* 36
3*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32 or *EH* 36
4*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
5*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
2*Y*40	*AH* 40 or *DH* 40
3*Y*40	*AH* 40, *DH* 40 or *EH* 40
4*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
5*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
L 1	*E or RL* 24*A*
L 2	*E*, *RL* 235*A*, *RL* 235*B*, *RL* 325*A* or *RL* 325*B*
L 3	*RL* 325*A*, *RL* 325*B* or *RL* 360
L 91	*RL* 9*N*490

NOTES:
(1) Notwithstanding the requirements in this Table normal strength or higher strength steel may be used for the deposited metal test assembly. In this case, test assemblies of grade *L* 91 are to be appropriately buttered.
(2) The tensile strength of higher strength steels *AH* 32, *DH* 32 *EH* 32, and *FH* 32 used in butt weld test assemblies is to be greater than 490 N/mm^2.

Amendment

Table 2.2.28 Grade of Steels used for Test Assembly *(2017) (2021)*

Grade of electrode	Grade of steels used for test assembly(1)(2)
1	*A*
2	*A*, *B* or *D*
3	*A*, *B*, *D* or *E*
2*Y*	*AH* 32, *AH* 36, *DH* 32 or *DH* 36
3*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32 or *EH* 36
4*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
5*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
2*Y*40	*AH* 40 or *DH* 40
3*Y*40	*AH* 40, *DH* 40 or *EH* 40
4*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
5*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
L 1	*E or RL* 24*A*
L 2	*E*, *RL* 235*A*, *RL* 235*B*, *RL* 325*A* or *RL* 325*B*
L 3	*RL* 325*A*, *RL* 325*B* or *RL* 360
L 51	*RL* 5*N*390
L 91	*RL* 9*N*490

NOTES:
(1) Notwithstanding the requirements in this Table normal strength or higher strength steel may be used for the deposited metal test assembly. In this case, test assemblies of grade *L* 91 are to be appropriately buttered.
(2) The tensile strength of higher strength steels *AH* 32, *DH* 32 *EH* 32, and *FH* 32 used in butt weld test assemblies is to be greater than 490 N/mm^2.

reason

- Addition of Welding consumables for RL5N390(5%Ni alloy steel)

Present

4. Deposited metal test

(1) ~ (2) <Omitted>

(3) *Deposited metal tensile test*

(a) ~ (b) <Omitted>

(c) The tensile strength, yield strength and elongation of each test specimen are to comply with the requirements given in **Table 2.2.29,** where the upper limit of tensile strength is exceeded, special consideration will be given to the approval of the electrode, taking into consideration of the other mechanical properties shown in the test results and the chemical composition of deposited metal.

Table 2.2.29 Tensile and impact Test Requirements for Deposited Metal *(2017)*

Grade of electrode	Tensile strength (N/mm^2)	Yield strength (N/mm^2)	Elongation (%)	Impact test	
				Test temp. (℃)	Average absorbed energy(J)
1	400 ~ 560	305 min.	22 min.	20	47 min.
2				0	
3				-20	
2*Y*	490 ~ 660	375 min.	22 min.	0	
3*Y*				-20	
4*Y*				-40	
5*Y*				-60	
2*Y*40	510 ~ 690	400 min.	22 min.	0	
3*Y*40				-20	
4*Y*40				-40	
5*Y*40				-60	
L 1	400 ~ 560	305 min.	22 min.	-40	34 min.
L 2	440 ~ 610	345 min.	22 min.	-60	
L 3	490 ~ 660	375 min.	21 min.	-60	
L 91	590 min.	375 min.(1)	25 min.	-196	27 min.

NOTE:
(1) 0.2 % Yield strength

Amendment

4. Deposited metal test

(1) ~ (2) <Omitted>

(3) *Deposited metal tensile test*

(a) ~ (b) <Omitted>

(c) The tensile strength, yield strength and elongation of each test specimen are to comply with the requirements given in **Table 2.2.29,** where the upper limit of tensile strength is exceeded, special consideration will be given to the approval of the electrode, taking into consideration of the other mechanical properties shown in the test results and the chemical composition of deposited metal.

Table 2.2.29 Tensile and impact Test Requirements for Deposited Metal *(2017) (2021)*

Grade of electrode	Tensile strength (N/mm^2)	Yield strength (N/mm^2)	Elongation (%)	Impact test	
				Test temp. (℃)	Average absorbed energy(J)
1	400 ~ 560	305 min.	22 min.	20	47 min.
2				0	
3				-20	
2*Y*	490 ~ 660	375 min.	22 min.	0	
3*Y*				-20	
4*Y*				-40	
5*Y*				-60	
2*Y*40	510 ~ 690	400 min.	22 min.	0	
3*Y*40				-20	
4*Y*40				-40	
5*Y*40				-60	
L 1	400 ~ 560	305 min.	22 min.	-40	34 min.
L 2	440 ~ 610	345 min.	22 min.	-60	
L 3	490 ~ 660	375 min.	21 min.	-60	
L 51	530 min.	375 min.(1)	25 min.	-120	27 min.
L 91	590 min.	375 min.(1)	25 min.	-196	27 min.

NOTE:
(1) 0.2% Yield strength

reason

- Addition of Welding consumables for RL5N390(5%Ni alloy steel)

Present

(d) <Omitted>

5. Butt weld test

(1) <Omitted>

(2) *Butt weld tensile tests*

(a) ~ (b) <Omitted>

(c) The tensile strength of test specimen is to comply with the requirements given in **Table 2.2.30**.

Table 2.2.30 Tensile and impact Test Requirements for butt weld *(2017)*

Grade of electrode	Tensile strength (N/mm^2)	Impact test		
		Test temp. (℃)	Average absorbed energy (J)	
			Flat, Horizontal, Overhead	Vertical upward Vertical downward
1	400 min.	20	47 min.	34 min.
2		0		
3		-20		
2*Y*	490 min.	0		
3*Y*		-20		
4*Y*		-40		
5*Y*		-60		
2*Y*40	510 min.	0		39 min.
3*Y*40		-20		
4*Y*40		-40		
5*Y*40		-60		
L 1	400 min.	-40	27 min.	27 min.
L 2	440 min.	-60		
L 3	490 min.	-60		
L 91	630 min.	-196		

(3) ~ (4) <Omitted>

6. <Omitted>

Amendment

(d) <Same as the present Rules>

5. Butt weld test

(1) <Same as the present Rules>

(2) *Butt weld tensile tests*

(a) ~ (b) <Same as the present Rules>

(c) The tensile strength of test specimen is to comply with the requirements given in **Table 2.2.30**.

Table 2.2.30 Tensile and impact Test Requirements for butt weld *(2017) (2021)*

Grade of electrode	Tensile strength (N/mm^2)	Impact test		
		Test temp. (℃)	Average absorbed energy (J)	
			Flat, Horizontal, Overhead	Vertical upward Vertical downward
1	400 min.	20	47 min.	34 min.
2		0		
3		-20		
2*Y*	490 min.	0		
3*Y*		-20		
4*Y*		-40		
5*Y*		-60		
2*Y*40	510 min.	0		39 min.
3*Y*40		-20		
4*Y*40		-40		
5*Y*40		-60		
L 1	400 min.	-40	27 min.	27 min.
L 2	440 min.	-60		
L 3	490 min.	-60		
L 51	530 min.	-120		
L 91	630 min.	-196		

(3) ~ (4) <Same as the present Rules>

6. <Same as the present Rules>

reason

- Addition of Welding consumables for RL5N390(5%Ni alloy steel)

Present

603. Automatic welding consumables for normal strength steels, higher strength steels and steels for low temperature service

1. <Omitted>

2. Grades and marks

(1) The automatic welding consumables are classified as specified in **Table 2.2.35**.

Table 2.2.35 Grade and Marks *(2017)*

For normal strength steel	For higher strength steel	For steel for low temperature service
1, 2, 3	1*Y*, 2*Y*, 3*Y*, 4*Y*, 5*Y* 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40	*L* 1, *L* 2, *L* 3, *L* 91

(2) ~ (3) <Omitted>

3. General provisions for tests

(1) Steel plates to be used for test assemblies are to be as given in **Table 2.2.38,** appropriate to the kind of automatic welding consumables.

(2) Kinds of test, number, thickness and dimensions of test assemblies, grades and number of test specimens to be taken from each test assembly for automatic welding consumables are to be as given in **Table 2.2.39**.

(3) ~ (8) <Omitted>

Amendment

603. Automatic welding consumables for normal strength steels, higher strength steels and steels for low temperature service

1. <Same as the present Rules>

2. Grades and marks

(1) The automatic welding consumables are classified as specified in **Table 2.2.35**.

Table 2.2.35 Grade and Marks *(2017) (2021)*

For normal strength steel	For higher strength steel	For steel for low temperature service
1, 2, 3	1*Y*, 2*Y*, 3*Y*, 4*Y*, 5*Y* 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40	*L* 1, *L* 2, *L* 3, *L* 51, *L* 91

(2) ~ (3) <Same as the present Rules>

3. General provisions for tests

(1) Steel plates to be used for test assemblies are to be as given in **Table 2.2.38,** appropriate to the kind of automatic welding consumables.

(2) Kinds of test, number, thickness and dimensions of test assemblies, grades and number of test specimens to be taken from each test assembly for automatic welding consumables are to be as given in **Table 2.2.39**.

(3) ~ (8) <Same as the present Rules>

reason

- Addition of Welding consumables for RL5N390(5%Ni alloy steel)

Present

Table 2.2.38 Grades of Steel used for Test Assembly *(2017)*

Grade of welding consumable	Grade of steel used for test assembly(1)(2)
1	*A*
2	*A*, *B* or *D*
3	*A*, *B*, *D* or *E*
1*Y*	*AH* 32 or *AH* 36
2*Y*	*AH* 32, *AH* 36, *DH* 32 or *DH* 36
3*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32 or *EH* 36
4*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
5*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
2*Y*40	*AH* 40 or *DH* 40
3*Y*40	*AH* 40, *DH* 40 or *EH* 40
4*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
5*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
L 1	*E or RL* 235*A*
L 2	*E*, *RL* 235*A*, *RL* 235*B*, *RL* 325*A* or *RL* 325*B*
L 3	*RL* 325*A*, *RL* 325*B* or *RL* 360
L 91	*RL* 9*N*490

NOTES:
(1) Notwithstanding the requirements in this Table, normal strength steel or higher strength steels may be used for deposited metal test assembly In this case, test assemblies of grade *L* 91 are to be appropriately buttered.
(2) The tensile strength of higher strength steels *AH* 32, *DH* 32, *EH* 32 and *FH* 32 used in butt weld test assemblies is to be greater than 490 N/mm^2

Amendment

Table 2.2.38 Grades of Steel used for Test Assembly *(2017) (2021)*

Grade of welding consumable	Grade of steel used for test assembly(1)(2)
1	*A*
2	*A*, *B* or *D*
3	*A*, *B*, *D* or *E*
1*Y*	*AH* 32 or *AH* 36
2*Y*	*AH* 32, *AH* 36, *DH* 32 or *DH* 36
3*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32 or *EH* 36
4*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
5*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
2*Y*40	*AH* 40 or *DH* 40
3*Y*40	*AH* 40, *DH* 40 or *EH* 40
4*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
5*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
L 1	*E or RL* 235*A*
L 2	*E*, *RL* 235*A*, *RL* 235*B*, *RL* 325*A* or *RL* 325*B*
L 3	*RL* 325*A*, *RL* 325*B* or *RL* 360
L 51	*RL* 5*N*390
L 91	*RL* 9*N*490

NOTES:
(1) Notwithstanding the requirements in this Table, normal strength steel or higher strength steels may be used for deposited metal test assembly In this case, test assemblies of grade *L* 91 are to be appropriately buttered.
(2) The tensile strength of higher strength steels *AH* 32, *DH* 32, *EH* 32 and *FH* 32 used in butt weld test assemblies is to be greater than 490 N/mm^2

reason

- Addition of Welding consumables for RL5N390(5%Ni alloy steel)

Present

Table 2.2.39 Kinds of Test of Automatic Welding Consumables *(2017)*

Welding technique[7]	Kind of test[8]	Grade of welding consumables	Test assembly: Number	Test assembly: Dimensions	Test assembly: Thickness (mm)[3]	Kinds and no. of test specimens taken from test assembly
Multi-run technique	Deposited metal test	1, 2, 3 1*Y*, 2*Y*, 3*Y*, 4*Y*, 5*Y* 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40 *L*1, *L*2, *L*3, *L*91	1	**Fig 2.2.27**	20	Tensile test specimen: 2 Impact test specimen: 3
	Butt weld test		1[4]	**Fig 2.2.28**	20~25	Tensile test specimen: 2[4] Face bend test specimen: 2[4][6] Root bend test specimen: 2[4][6] Impact test specimen: 3
Two-run technique	<Omitted>			**Fig 2.2.29**	<Omitted>	
	Butt weld test	*L*1, *L*2, *L*3, *L*91	1 1		12~15 20 or acceptable maximum thickness	Tensile test specimen: 2 Longitudinal tensile test specimen: 1[5] Face bend test specimen: 1 Root bend test specimen: 1 Impact test specimen: 3

NOTES:
<Omitted>

Amendment

Table 2.2.39 Kinds of Test of Automatic Welding Consumables *(2017) (2021)*

Welding technique[7]	Kind of test[8]	Grade of welding consumables	Test assembly: Number	Test assembly: Dimensions	Test assembly: Thickness (mm)[3]	Kinds and no. of test specimens taken from test assembly
Multi-run technique	Deposited metal test	1, 2, 3 1*Y*, 2*Y*, 3*Y*, 4*Y*, 5*Y* 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40 *L*1, *L*2, *L*3, *L*51, *L*91	1	**Fig 2.2.27**	20	Tensile test specimen: 2 Impact test specimen: 3
	Butt weld test		1[4]	**Fig 2.2.28**	20~25	Tensile test specimen: 2[4] Face bend test specimen: 2[4][6] Root bend test specimen: 2[4][6] Impact test specimen: 3
Two-run technique	<Same as the present Rules>			**Fig 2.2.29**	<Same as the present Rules>	
	Butt weld test	*L*1, *L*2, *L*3, *L*51, *L*91	1 1		12~15 20 or acceptable maximum thickness	Tensile test specimen: 2 Longitudinal tensile test specimen: 1[5] Face bend test specimen: 1 Root bend test specimen: 1 Impact test specimen: 3

NOTES:
<Same as the present Rules>

reason

- Addition of Welding consumables for RL5N390(5%Ni alloy steel)

- Addition of Welding consumables for RL5N390(5%Ni alloy steel)

Present	Amendment	reason
4. Deposited metal test with multi-run technique (1) ~ (2) <Omitted> (3) *Deposited metal tensile test with multi-run technique* (a) <Omitted> (b) The tensile strength, yield point and elongation of each test specimen are to comply with the requirements given in **Table 2.2.40**, where the upper limit of tensile strength is exceeded, special consideration will be given to the approval of the electrode, taking into consideration of the other mechanical properties shown in the test results and the chemical composition of deposited metal.	**4. Deposited metal test with multi-run technique** (1) ~ (2) <Same as the present Rules> (3) *Deposited metal tensile test with multi-run technique* (a) <Same as the present Rules> (b) The tensile strength, yield point and elongation of each test specimen are to comply with the requirements given in **Table 2.2.40**, where the upper limit of tensile strength is exceeded, special consideration will be given to the approval of the electrode, taking into consideration of the other mechanical properties shown in the test results and the chemical composition of deposited metal.	

Present

Table 2.2.40 Tensile and Impact Test Requirements for Deposited Metal test *(2017)*

Grade of welding material	Tensile strength (N/mm^2)	Yield strength (N/mm^2)	Elongation (%)	Impact test	
				Test temp. (℃)	Average absorbed energy (*J*)
1	400 ~ 560	305 min.	22 min.	20	34 min.
2				0	
3				-20	
1*Y*	490 ~ 660	375 min.	22 min.	20	
2*Y*				0	
3*Y*				-20	
4*Y*				-40	
5*Y*				-60	
2*Y*40	510 ~ 690	400 min.	22 min.	0	39 min.
3*Y*40				-20	
4*Y*40				-40	
5*Y*40				-60	
L 1	400 ~ 560	305 min.	22 min.	-40	27 min.
L 2	440 ~ 610	345 min.	22 min.	-60	
L 3	490 ~ 660	375 min.	21 min.	-60	
L 91	590 min.	375 min.(1)	25 min.	-196	

NOTE:
(1) 0.2 % yield stress

(c) <Omitted>
(4) <Omitted>

Amendment

Table 2.2.40 Tensile and Impact Test Requirements for Deposited Metal test *(2017) (2021)*

Grade of welding material	Tensile strength (N/mm^2)	Yield strength (N/mm^2)	Elongation (%)	Impact test	
				Test temp. (℃)	Average absorbed energy (*J*)
1	400 ~ 560	305 min.	22 min.	20	34 min.
2				0	
3				-20	
1*Y*	490 ~ 660	375 min.	22 min.	20	
2*Y*				0	
3*Y*				-20	
4*Y*				-40	
5*Y*				-60	
2*Y*40	510 ~ 690	400 min.	22 min.	0	39 min.
3*Y*40				-20	
4*Y*40				-40	
5*Y*40				-60	
L 1	400 ~ 560	305 min.	22 min.	-40	27 min.
L 2	440 ~ 610	345 min.	22 min.	-60	
L 3	490 ~ 660	375 min.	21 min.	-60	
<u>*L* 51</u>	<u>530 min.</u>	<u>375 min.(1)</u>	<u>25 min.</u>	<u>-120</u>	
L 91	590 min.	375 min.(1)	25 min.	-196	

NOTE:
(1) 0.2 % yield stress

(c) <Same as the present Rules>
(4) <Same as the present Rules>

reason

- Addition of Welding consumables for RL5N390(5%Ni alloy steel)

Present

5. Butt weld test with multi-run technique

(1) <Omitted>

(2) *Butt weld tensile test with multi-run technique*

(a) ~ (b) <Omitted>

(c) The tensile strength of test specimen is to comply with the requirements given in **Table 2.2.41**.

Table 2.2.41 Tensile and Impact Test Requirements for butt weld test with multi-run technique *(2017)*

Grade of welding material	Tensile strength(N/mm²)	Impact test	
		Test temp. (℃)	Average absorbed energy (J)
1	400 min.	20	34 min.
2		0	
3		− 20	
1*Y*	490 min.	20	
2*Y*		0	
3*Y*		− 20	
4*Y*		− 40	
5*Y*		− 60	
2*Y*40	510 min.	0	39 min.
3*Y*40		− 20	
4*Y*40		− 40	
5*Y*40		− 60	
L 1	400 min.	− 40	27 min.
L 2	440 min.	− 60	
L 3	490 min.	− 60	
L 91	630 min.	− 196	

(3) ~ (4) <Omitted>

6. ~ 7. <Omitted>

Amendment

5. Butt weld test with multi-run technique

(1) <Same as the present Rules>

(2) *Butt weld tensile test with multi-run technique*

(a) ~ (b) <Same as the present Rules>

(c) The tensile strength of test specimen is to comply with the requirements given in **Table 2.2.41**.

Table 2.2.41 Tensile and Impact Test Requirements for butt weld test with multi-run technique *(2017) (2021)*

Grade of welding material	Tensile strength(N/mm²)	Impact test	
		Test temp. (℃)	Average absorbed energy (J)
1	400 min.	20	34 min.
2		0	
3		− 20	
1*Y*	490 min.	20	
2*Y*		0	
3*Y*		− 20	
4*Y*		− 40	
5*Y*		− 60	
2*Y*40	510 min.	0	39 min.
3*Y*40		− 20	
4*Y*40		− 40	
5*Y*40		− 60	
L 1	400 min.	− 40	27 min.
L 2	440 min.	− 60	
L 3	490 min.	− 60	
L 51	530 min.	− 120	
L 91	630 min.	− 196	

(3) ~ (4) <Same as the present Rules>

6. ~ 7. <Same as the present Rules>

reason

- Addition of Welding consumables for RL5N390(5%Ni alloy steel)

Present

8. Annual inspections

(1) <Omitted>

(2) The kinds of test, etc. involved in the annual inspections are to be as given in **Table 2.2.42**.

(3) <Omitted>

Table 2.2.42 Kinds of Test for Annual Inspection *(2017)*

Grade of welding consumables	Welding technique[1]	Kind of test		Test assembly: Number	Test assembly: Dimensions	Test assembly: Thickness (mm)	Kinds and no. of test specimens taken from test assembly
1, 2, 3 1*Y*, 2*Y*, 3*Y*, 4*Y*, 5*Y* 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40 *L*1, *L*2, *L*3, *L*91	Multi-run technique	Deposited metal test		1	**Fig 2.2.27**	20	Tensile test specimen: 1 Impact test specimen: 3
	Two-run technique	Butt weld test	Submerged arc welding	1	**Fig 2.2.29**	20	Tensile test specimen: 1 Longitudinal tensile test specimen: 1 Face bend test specimen: 1 Root bend test specimen: 1 Impact test specimen: 3
			Gas shielded and self shielded arc welding	1		20~25	Tensile test specimen: 1 Longitudinal tensile test specimen: 1 Face bend test specimen: 1 Root bend test specimen: 1 Impact test specimen: 3
NOTE: <Omitted>							

9. <Omitted>

Amendment

8. Annual inspections

(1) <Same as the present Rules>

(2) The kinds of test, etc. involved in the annual inspections are to be as given in **Table 2.2.42**.

(3) <Same as the present Rules>

Table 2.2.42 Kinds of Test for Annual Inspection *(2017) (2021)*

Grade of welding consumables	Welding technique[1]	Kind of test		Test assembly: Number	Test assembly: Dimensions	Test assembly: Thickness (mm)	Kinds and no. of test specimens taken from test assembly
1, 2, 3 1*Y*, 2*Y*, 3*Y*, 4*Y*, 5*Y* 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40 *L*1, *L*2, *L*3, *L*51, *L*91	Multi-run technique	Deposited metal test		1	**Fig 2.2.27**	20	Tensile test specimen: 1 Impact test specimen: 3
	Two-run technique	Butt weld test	Submerged arc welding	1	**Fig 2.2.29**	20	Tensile test specimen: 1 Longitudinal tensile test specimen: 1 Face bend test specimen: 1 Root bend test specimen: 1 Impact test specimen: 3
			Gas shielded and self shielded arc welding	1		20~25	Tensile test specimen: 1 Longitudinal tensile test specimen: 1 Face bend test specimen: 1 Root bend test specimen: 1 Impact test specimen: 3
NOTE: <Same as the present Rules>							

9. <Same as the present Rules>

reason

- Addition of Welding consumables for RL5N390(5%Ni alloy steel)

Present

604. Semi-automatic welding consumables for normal strength steels, higher strength steels and steels for low temperature service

1. <Omitted>

2. Grades and marks

(1) The semi-automatic welding consumables are classified as specified in **Table 2.2.43**.

Table 2.2.43 Grades and Marks *(2017)*

For normal strength steel	For higher strength steel	For steel for low temperature service
1, 2, 3	1*Y*, 2*Y*, 3*Y*, 4*Y* 5*Y* 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40	*L*1, *L*2, *L*3, *L*91

(2) ~ (4) <Omitted>

3. General provisions for tests

(1) ~ (2) <Omitted>

(3) Steel plates to be used for test assemblies are to be as given in **Table 2.2.45**, appropriate to the kind of semi-automatic welding consumables.

(4) ~ (8) <Omitted>

Amendment

604. Semi-automatic welding consumables for normal strength steels, higher strength steels and steels for low temperature service

1. <Same as the present Rules>

2. Grades and marks

(1) The semi-automatic welding consumables are classified as specified in **Table 2.2.43**.

Table 2.2.43 Grades and Marks *(2017)*

For normal strength steel	For higher strength steel	For steel for low temperature service
1, 2, 3	1*Y*, 2*Y*, 3*Y*, 4*Y* 5*Y* 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40	*L*1, *L*2, *L*3, *L*51, *L*91

(2) ~ (4) <Same as the present Rules>

3. General provisions for tests

(1) ~ (2) <Same as the present Rules>

(3) Steel plates to be used for test assemblies are to be as given in **Table 2.2.45**, appropriate to the kind of semi-automatic welding consumables.

(4) ~ (8) <Same as the present Rules>

reason

- Addition of Welding consumables for RL5N390(5%Ni alloy steel)

Present

Table 2.2.45 Grades of Steel for Test Assembly *(2017)*

Grade of welding consumables	Grade of steel for test assembly(1)(2)
1S	*A*
2S	*A*, *B* or *D*
3S	*A*, *B*, *D* or *E*
1*Y*S	*AH* 32 or *AH* 36
2*Y*S	*AH* 32, *AH* 36, *DH* 32 or *DH* 36
3*Y*S	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32 or *EH* 36
4*Y*S	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
5*Y*S	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
2*Y*40S	*AH* 40 or *DH* 40
3*Y*40S	*AH* 40, *DH* 40 or *EH* 40
4*Y*40S	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
5*Y*40S	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
L 1S	*E or RL* 235*A*
L 2S	*E*, *RL* 235*A*, *RL* 235*B*, *RL* 325*A* or *RL* 325*B*
L 3S	*RL* 325*A*, *RL* 325*B* or *RL* 360
L 91S	*RL* 9*N*490

NOTES;
(1) Notwithstanding the requirements in this Table, normal or higher strength steels may be used for deposited metal test assembly. In this case, test assemblies of grade *L* 91 are to be appropriately buttered.
(2) The tensile strength of higher strength steels *AH* 32, *DH* 32, *EH* 32 and *FH* 32 used in butt weld test assemblies is to be greater than 490 N/mm^2.

Amendment

Table 2.2.45 Grades of Steel for Test Assembly *(2017) (2021)*

Grade of welding consumables	Grade of steel for test assembly(1)(2)
1S	*A*
2S	*A*, *B* or *D*
3S	*A*, *B*, *D* or *E*
1*Y*S	*AH* 32 or *AH* 36
2*Y*S	*AH* 32, *AH* 36, *DH* 32 or *DH* 36
3*Y*S	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32 or *EH* 36
4*Y*S	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
5*Y*S	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
2*Y*40S	*AH* 40 or *DH* 40
3*Y*40S	*AH* 40, *DH* 40 or *EH* 40
4*Y*40S	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
5*Y*40S	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
L 1S	*E or RL* 235*A*
L 2S	*E*, *RL* 235*A*, *RL* 235*B*, *RL* 325*A* or *RL* 325*B*
L 3S	*RL* 325*A*, *RL* 325*B* or *RL* 360
<u>*L* 51S</u>	<u>*RL* 5*N*390</u>
L 91S	*RL* 9*N*490

NOTES;
(1) Notwithstanding the requirements in this Table, normal or higher strength steels may be used for deposited metal test assembly. In this case, test assemblies of grade *L* 91 are to be appropriately buttered.
(2) The tensile strength of higher strength steels *AH* 32, *DH* 32, *EH* 32 and *FH* 32 used in butt weld test assemblies is to be greater than 490 N/mm^2.

reason

- Addition of Welding consumables for RL5N390(5%Ni alloy steel)

Present

4. Deposited metal test

(1) ~ (2) <Omitted>

(3) *Deposited metal tensile test*

(a) ~ (b) <Omitted>

(c) The tensile strength, yield strength and elongation of each test specimen are to comply with the requirements given in **Table 2.2.46**, where the upper limit of tensile strength is exceeded, special consideration will be given to the approval of the electrode, taking into consideration of the other mechanical properties shown in the test results and the chemical composition of deposited metal.

Table 2.2.46 Tensile and Impact Test Requirements for Deposited Metal test *(2017)*

Grade of welding consumables	Tensile strength (N/mm^2)	Yield strength (N/mm^2)	Elongation (%)	Impact test	
				Test temp. (℃)	Average absorbed energy (J)
<Omitted>					
L 1*S*	400 ~ 560	305 min.	22 min.	− 40	34 min.
L 2*S*	440 ~ 610	345 min.	22 min.	− 60	
L 3*S*	490 ~ 660	375 min.	21 min.	− 60	
L 91*S*	590 min	375 min.(1)	25 min.	− 196	27 min.

NOTE:
(1) 0.2 % yield stress

(4) <Omitted>

Amendment

4. Deposited metal test

(1) ~ (2) <Same as the present Rules>

(3) *Deposited metal tensile test*

(a) ~ (b) <Same as the present Rules>

(c) The tensile strength, yield strength and elongation of each test specimen are to comply with the requirements given in **Table 2.2.46**, where the upper limit of tensile strength is exceeded, special consideration will be given to the approval of the electrode, taking into consideration of the other mechanical properties shown in the test results and the chemical composition of deposited metal.

Table 2.2.46 Tensile and Impact Test Requirements for Deposited Metal test *(2017) (2021)*

Grade of welding consumables	Tensile strength (N/mm^2)	Yield strength (N/mm^2)	Elongation (%)	Impact test	
				Test temp. (℃)	Average absorbed energy (J)
<Same as the present Rules>					
L 1*S*	400 ~ 560	305 min.	22 min.	− 40	34 min.
L 2*S*	440 ~ 610	345 min.	22 min.	− 60	
L 3*S*	490 ~ 660	375 min.	21 min.	− 60	
L 51*S*	530 min	375 min.(1)	25 min.	− 120	27 min.
L 91*S*	590 min	375 min.(1)	25 min.	− 196	

NOTE:
(1) 0.2 % yield stress

(4) <Same as the present Rules>

reason

- Addition of Welding consumables for RL5N390(5%Ni alloy steel)

Present

5. Butt weld test

(1) <Omitted>

(2) *Butt weld tensile tests*

(a) ~ (b) <Omitted>

(c) The tensile strength of test specimen is to comply with the requirements given in **Table 2.2.47**.

Table 2.2.47 Tensile and Impact Test Requirements for Butt weld test *(2017)*

Grade of welding consumables	Tensile strength (N/mm^2)	Impact test		
		Test temp. (℃)	Average absorbed energy (J)	
			Flat, Horizontal Overhead	Vertical upward, Vertical downward
1*S*	400 min.	20	47 min.	34 min.
2*S*		0		
3*S*		− 20		
1*YS*	490 min.	20		
2*YS*		0		
3*YS*		− 20		
4*YS*		− 40		
5*YS*		− 60		
2*Y*40*S*	510 min.	0		39 min.
3*Y*40*S*		− 20		
4*Y*40*S*		− 40		
5*Y*40*S*		− 60		
L 1*S*	400 min.	− 40	27 min.	27 min.
L 2*S*	440 min.	− 60		
L 3*S*	490 min.	− 60		
L 91*S*	630 min.	− 196		

Amendment

5. Butt weld test

(1) <Same as the present Rules>

(2) *Butt weld tensile tests*

(a) ~ (b) <Same as the present Rules>

(c) The tensile strength of test specimen is to comply with the requirements given in **Table 2.2.47**.

Table 2.2.47 Tensile and Impact Test Requirements for Butt weld test *(2017) (2021)*

Grade of welding consumables	Tensile strength (N/mm^2)	Impact test		
		Test temp. (℃)	Average absorbed energy (J)	
			Flat, Horizontal Overhead	Vertical upward, Vertical downward
1*S*	400 min.	20	47 min.	34 min.
2*S*		0		
3*S*		− 20		
1*YS*	490 min.	20		
2*YS*		0		
3*YS*		− 20		
4*YS*		− 40		
5*YS*		− 60		
2*Y*40*S*	510 min.	0		39 min.
3*Y*40*S*		− 20		
4*Y*40*S*		− 40		
5*Y*40*S*		− 60		
L 1*S*	400 min.	− 40	27 min.	27 min.
L 2*S*	440 min.	− 60		
L 3*S*	490 min.	− 60		
L 51*S*	530 min.	− 120		
L 91*S*	630 min.	− 196		

reason

- Addition of Welding consumables for RL5N390(5%Ni alloy steel)

Present

(3) ~ (4) <Omitted>

6. ~ 9. <Omitted>

605. <Omitted>

606. One side welding consumables for normal strength steels, higher strength steels and steels for low temperature service.

1. ~ 2. <Omitted>

3. General provisions for tests

(1) Kinds of test, number, thickness and dimensions of test assemblies, grades and number of test specimens to be taken from each test assembly for one side automatic welding consumables are to be as given in **Table 2.2.55**.

(2) Steel plates to be used for test assemblies are to be as given in **Table 2.2.56**.

(3) ~ (8) <Omitted>

Table 2.2.55 Kinds of Test for One-side Automatic Welding Consumables *(2017)*

Grade of welding consumables	Welding technique	Kind of test(4)	Test assembly			Kind and number of test specimens taken from test assembly
			Number	Thickness (mm)(1)	Dimension	
1, 2, 3, 1*Y*, 2*Y*, 3*Y*, 4*Y*, 5*Y*, 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40, *L*1, *L*2, *L*3, *L*91	<Omitted>					
NOTES: <Omitted>						

Amendment

(3) ~ (4) <Same as the present Rules>

6. ~ 9. <Same as the present Rules>

605. <Same as the present Rules>

606. One side welding consumables for normal strength steels, higher strength steels and steels for low temperature service.

1. ~ 2. <Same as the present Rules>

3. General provisions for tests

(1) Kinds of test, number, thickness and dimensions of test assemblies, grades and number of test specimens to be taken from each test assembly for one side automatic welding consumables are to be as given in **Table 2.2.55**.

(2) Steel plates to be used for test assemblies are to be as given in **Table 2.2.56**.

(3) ~ (8) <Same as the present Rules>

Table 2.2.55 Kinds of Test for One-side Automatic Welding Consumables *(2017) (2021)*

Grade of welding consumables	Welding technique	Kind of test(4)	Test assembly			Kind and number of test specimens taken from test assembly
			Number	Thickness (mm)(1)	Dimension	
1, 2, 3, 1*Y*, 2*Y*, 3*Y*, 4*Y*, 5*Y*, 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40, *L*1, *L*2, *L*3, *L*51, *L*91	<Same as the present Rules>					
NOTES: <Same as the present Rules>						

reason

- Addition of Welding consumables for RL5N390(5%Ni alloy steel)

Present

Table 2.2.56 Grades of Steel used for Test Assembly *(2017)*

Grade of welding consumables	Grade of steel used for test assembly(1)
1	*A*
2	*A*, *B* or *D*
3	*A*, *B*, *D* or *E*
1*Y*	*AH* 32 or *AH* 36
2*Y*	*AH* 32, *AH* 36, *DH* 32 or *DH* 36
3*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32 or *EH* 36
4*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
5*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
2*Y*40	*AH* 40 or *DH* 40
3*Y*40	*AH* 40, *DH* 40 or *EH* 40
4*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
5*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
L 1	*E or RL* 235*A*
L 2	*E*, *RL* 235*A*, *RL* 235*B*, *RL* 325*A* or *RL* 325*B*
L 3	*RL* 325*A*, *RL* 325*B* or *RL* 360
L 91	*RL* 9*N*490

NOTE:
(1) The tensile strength of higher strength steels *AH* 32, *DH* 32, *EH* 32 and *FH* 32 used in the test assemblies is to be greater than 490 N/mm^2

4. ~ 5. <Omitted>

Amendment

Table 2.2.56 Grades of Steel used for Test Assembly *(2017) (2021)*

Grade of welding consumables	Grade of steel used for test assembly(1)
1	*A*
2	*A*, *B* or *D*
3	*A*, *B*, *D* or *E*
1*Y*	*AH* 32 or *AH* 36
2*Y*	*AH* 32, *AH* 36, *DH* 32 or *DH* 36
3*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32 or *EH* 36
4*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
5*Y*	*AH* 32, *AH* 36, *DH* 32, *DH* 36, *EH* 32, *EH* 36, *FH* 32 or *FH* 36
2*Y*40	*AH* 40 or *DH* 40
3*Y*40	*AH* 40, *DH* 40 or *EH* 40
4*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
5*Y*40	*AH* 40, *DH* 40, *EH* 40 or *FH* 40
L 1	*E or RL* 235*A*
L 2	*E*, *RL* 235*A*, *RL* 235*B*, *RL* 325*A* or *RL* 325*B*
L 3	*RL* 325*A*, *RL* 325*B* or *RL* 360
L 51	*RL* 5*N*390
L 91	*RL* 9*N*490

NOTE:
(1) The tensile strength of higher strength steels *AH* 32, *DH* 32, *EH* 32 and *FH* 32 used in the test assemblies is to be greater than 490 N/mm^2

4. ~ 5. <Same as the present Rules>

reason

- Addition of Welding consumables for RL5N390(5%Ni alloy steel)

Present

6. Annual inspections

(1) <Omitted>

(2) The kinds of test, etc. in the annual inspection are to be as given in **Table 2.2.58**.

Table 2.2.58 Kinds of Test for Annual Inspection *(2017)*

Grade of welding consumables	Welding technique	Kind of test	Test assembly			Kind and number of test specimens taken from test assembly
			Number	Dimension	Thickness (mm)(1)	
1, 2, 3, 1*Y*, 2*Y*, 3*Y*, 4*Y*, 5*Y*, 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40, *L*1, *L*2, *L*3, *L*91	<Omitted>					

NOTES:

(1) Where the thickness of test assemblies is changed according to Note (1) of **Table 2.2.55**, the maximum test thickness for approval test is to be applied.

(2) The butt weld tests for one-run and multi-run technique are to be carried out by one-run technique.

(3) The positions of notch and selection of impact test specimens are to be as given in **Fig 2.2.35** (b).

7. <Omitted>

Amendment

6. Annual inspections

(1) <Same as the present Rules>

(2) The kinds of test, etc. in the annual inspection are to be as given in **Table 2.2.58**.

Table 2.2.58 Kinds of Test for Annual Inspection *(2017) (2021)*

Grade of welding consumables	Welding technique	Kind of test	Test assembly			Kind and number of test specimens taken from test assembly
			Number	Dimension	Thickness (mm)(1)	
1, 2, 3, 1*Y*, 2*Y*, 3*Y*, 4*Y*, 5*Y*, 2*Y*40, 3*Y*40, 4*Y*40, 5*Y*40, *L*1, *L*2, *L*3, *L*51, *L*91	<Same as the present Rules>					

NOTES:

(1) Where the thickness of test assemblies is changed according to Note (1) of **Table 2.2.55**, the maximum test thickness for approval test is to be applied.

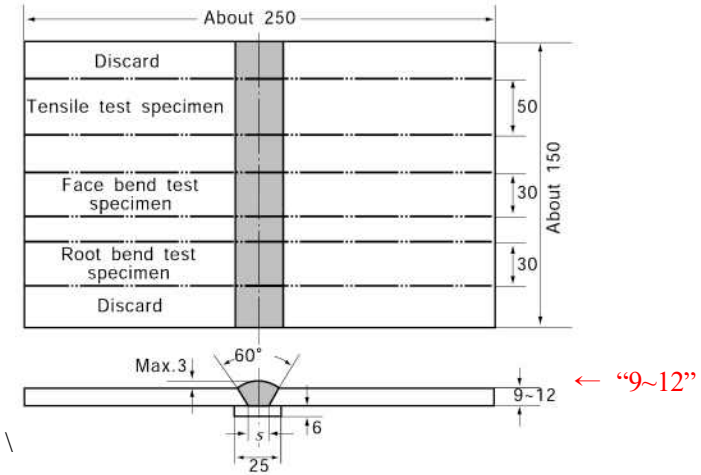
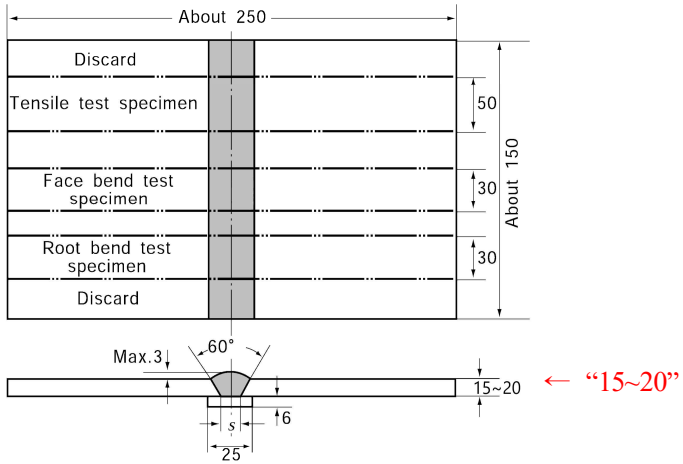
(2) The butt weld tests for one-run and multi-run technique are to be carried out by one-run technique.

(3) The positions of notch and selection of impact test specimens are to be as given in **Fig 2.2.35** (b).

7. <Same as the present Rules>

reason

- Addition of Welding consumables for RL5N390(5%Ni alloy steel)

Present	Amendment	reason
607. Welding consumables for stainless steel **1. ~ 4. <Omitted>** **5. Butt weld test** (1) *Welding of butt weld test assemblies* (a) Test assemblies as shown in **Figs 2.2.37** and **2.2.38** are to be welded in each welding position (flat, horizontal, vertical upward, vertical downward and overhead) which is recommended by the manufacturer.  | Kind of welding consum-ables | Electrode for manual arc welding | Elec-trode for TIG welding | Wire for MIG welding | Flux cored wire for semi-auto-matic welding | | --- | --- | --- | --- | --- | | *s*(*mm*) | Max. dia. of electrode | Max.5 | Max.5 | Max.6 | **Fig. 2.2.37 Butt Weld Test Assembly for Stainless Steel(Except for Submerged arc welding, Unit : mm)** (b) <Omitted> (2) ~ (3) <Omitted> **6. <Omitted>** **608. ~ 609. <Omitted>**	**607. Welding consumables for stainless steel** **1. ~ 4. <Same as the present Rules>** **5. Butt weld test** (1) *Welding of butt weld test assemblies* (a) Test assemblies as shown in **Figs 2.2.37** and **2.2.38** are to be welded in each welding position (flat, horizontal, vertical upward, vertical downward and overhead) which is recommended by the manufacturer.  | Kind of welding consum-ables | Electrode for manual arc welding | Elec-trode for TIG welding | Wire for MIG welding | Flux cored wire for semi-auto-matic welding | | --- | --- | --- | --- | --- | | *s*(*mm*) | Max. dia. of electrode | Max.5 | Max.5 | Max.6 | **Fig. 2.2.37 Butt Weld Test Assembly for Stainless Steel(Except for Submerged arc welding, Unit : mm)** (b) <Same as the present Rules> (2) ~ (3) <Same as the present Rules> **6. <Same as the present Rules>** **608. ~ 609. <Same as the present Rules>**	* Request for Establishment/Revision of Classification Technical Rules (MET4800-308-2020) Resolving the discrepancy between the Rules for thickness of test samples

GUIDANCE RELATING TO THE RULES FOR THE CLASSIFICATION OF STEEL SHIPS

(Guidance Part 2 Materials and Welding)

- For external opinion -

2020. 10.

Machinery Rule Development Team

- Main Amendments -

(1) Enter into force on 1 January 2021 (the date of application for certification of material & welding or the contract date for ship construction)

- Circular -

◉ To reflect IACS UR W31(Rev.2 Dec 2019 CR)

Present	Amendment	reason
CHAPTER 1 MATERIALS **Section 1** <Omitted> **Section 2 Test Specimens and Testing Procedures** **201. ~ 202. <Omitted>** **203. Testing procedure *(2017)*** **1. Standard ESSO Test** [See Rule] (1) Scope In application to **203.** of the Rules, the ESSO test method is used to estimate the brittle crack arrest toughness value K_{ca} of rolled steel plates for hull of thickness 100 mm or less.	**CHAPTER 1 MATERIALS** **Section 1** <Same as the present Guidance> **Section 2 Test Specimens and Testing Procedures** **201. ~ 202. <Same as the present Guidance>** **203. Testing procedure *(2017) (2021)*** **1. Test method for Brittle crack arrest toughness, K_{ca}** [See Rule] (1) Scope (A) In application to **203.** of the Rules, this test method for brittle crack arrest toughness(i.e. K_{ca}) of steel using fracture mechanics parameter is applicable to hull structural steels with the thickness over 50 mm and not greater than 100 mm. (B) Setting a temperature gradient in the width direction of a test specimen, and applying uniform stress to the test specimen, strike the test specimen to initiate a brittle crack from the mechanical notch at the side of the test specimen and causes crack arrest (temperature gradient type arrest testing). Using the stress intensity factor, calculate the brittle crack arrest toughness, K_{ca}, from the applied stress and the arrest crack length. This value is the brittle crack arrest toughness at the temperature of the point of crack arrest (arrest temperature). To obtain K_{ca} at a specific temperature followed by the necessary evaluation, the method specified in **2.** can be used. (C) As a method for initiating a brittle crack, a secondary loading mechanism can also be used (see "Double tension type arrest test" specified in **3.**).	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present

(2) Symbols

Table 2.1.3 Nomenclature

Symbol	unit	Meaning
t_s	mm	Thickness of test specimen
W_S	mm	Width of test specimen
L_S	mm	Length of test specimen
t_r	mm	Thickness of tab plate
W_r	mm	Width of tab plate
L_r	mm	Length of tab plate
L_P	mm	Distance between pins
a	mm	Length of crack projected on surface normal to the line of load
a_a	mm	Maximum crack length at brittle crack arrest position
T	℃	Temperature of test specimen
dT/da	℃/mm	Temperature gradient of test specimen
σ	N/mm^2	Gross stress in tested part ($load/W_S \cdot t_S$)
K_{ca}	$N/mm^{3/2}$	Brittle crack arrest toughness value

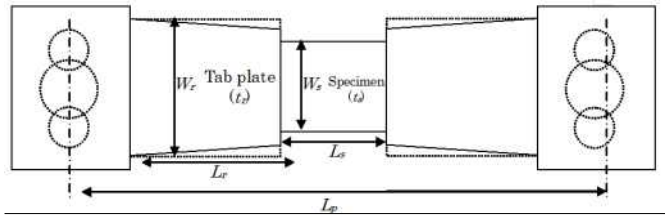


Fig 2.1.2 Conceptual view of test specimen, tab and load jig

Amendment

(2) Symbols and their significance

Table 2.1.3 symbols and their significance

Symbol	Unit	Significance
a	mm	Crack length or arrest crack length
E	N/mm^2	Modulus of longitudinal elasticity
E_i	J	Impact energy
E_s	J	Strain energy stored in a test specimen
E_t	J	Total strain energy stored in tab plates and pin chucks
F	MN	Applied load
K	$N/mm^{3/2}$	Stress intensity factor
K_{ca}	$N/mm^{3/2}$	Arrest toughness
L	mm	Test specimen length
L_p	mm	Distance between the loading pins
L_{pc}	mm	Pin chuck length
L_{tb}	mm	Tab plate length
T	℃	Temperature or arrest temperature
t	mm	Test specimen thickness
t_{tb}	mm	Tab plate thickness
t_{pc}	mm	Pin chuck thickness
W	mm	Test specimen width
W_{tb}	mm	Tab plate width
W_{pc}	mm	Pin chuck width
x_a	mm	Coordinate of a main crack tip in the width direction
x_{br}	mm	Coordinate of the longest branch crack tip in the width direction
y_a	mm	Coordinate of a main crack tip in the stress loading direction
y_{br}	mm	Coordinate of the longest branch crack tip in the stress loading direction
σ	N/mm^2	Applied stress
σ_{y0}	N/mm^2	Yield stress at room temperature

reason

* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020)

- To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
~~(3) Purpose~~ ~~The purpose of this test is to encourage the performance of a standard test for assessment of brittle crack arrest toughness with temperature gradient and to obtain the corresponding brittle crack arrest toughness value K_{ca}.~~	(3) Testing equipment The following specifies the testing machine needed for conducting the brittle crack arrest test. Testing machine is used to apply tensile force to an integrated specimen, and impact equipment is used to generate a brittle crack on the test specimen. (A) Testing machine (a) Loading method Tensile load to an integrated specimen shall be hydraulically applied. The loading method to an integrated specimen using the testing machine shall be of a pin type. The stress distribution in the plate width direction shall be made uniform by aligning the centres of the loading pins of both sides and the neutral axis of the integrated specimen. (b) Loading directions The loading directions shall be either vertical or horizontal. In the case of the horizontal direction, test specimen surfaces shall be placed either perpendicular to the ground. (c) Distance between the loading pins The distance between the loading pins shall be approximately 3.4W or more, where W is the width of the test specimen. Since the distance between the loading pins sometimes has an effect on the load drop associated with crack propagation, the validity of the test results is determined by the judgment method described in (7) (A). (B) Impact equipment (a) Impact methods Methods to apply an impact load to an integrated specimen shall be of a drop weight type or of an air gun type. The wedge shall be hard enough to prevent significant plastic deformation caused by the impact. The wedge thickness shall be equal to or greater than that of the test specimen, and the wedge angle shall be greater than that of the notch formed in the test specimen and have a shape capable of opening up the notch of the test specimen.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present

(4) Standard test specimen

(A) **Fig 2.1.3** shows the shape and size of the standard test specimen.

(B) The thickness and width of the test specimen are to be in accordance with **Table 2.1.4**

Table 2.1.4 Thickness and width of test specimen

Thickness of test specimen t_s	100 mm and below
Width of test specimen W_s	500 mm
Note: If the width of the test specimen cannot be made at 500 mm, it may be taken as 600 mm.	

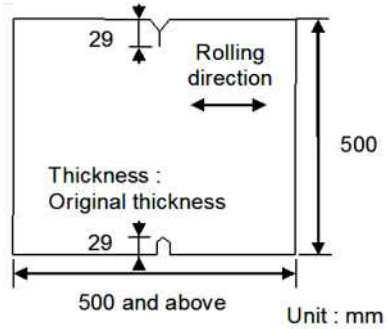


Fig 2.1.3 Shape and size of specimen

Amendment

(4) Test specimens

(A) Test specimen shapes

The standard test specimen shape is shown in **Fig 2.1.2**. **Table 2.1.4** shows the ranges of test specimen thicknesses, widths and width-to-thickness ratios. The test specimen length shall be, in principle, equal to or greater than its width.

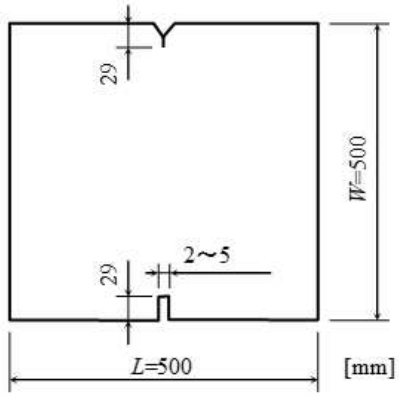


Fig 2.1.2 Standard test specimen shape

Table 2.1.4 Thickness and width of test specimen

Test specimen thickness, t	50 mm ≤ t ≤ 100 mm
Test specimen width, W	350 mm ≤ W ≤ 1000 mm (Standard width: W = 500 mm)
Test specimen width/test specimen thickness, W/t	W/t ≥ 5

reason

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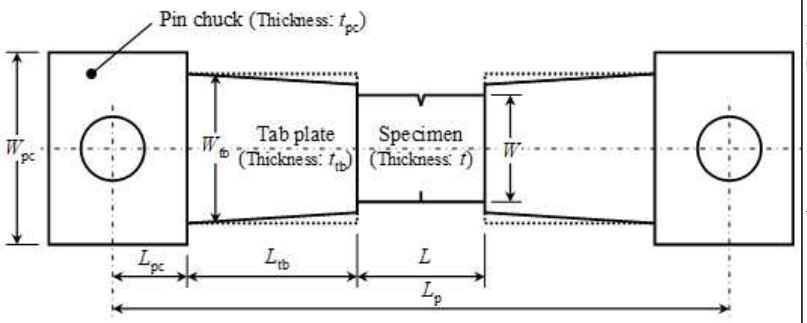
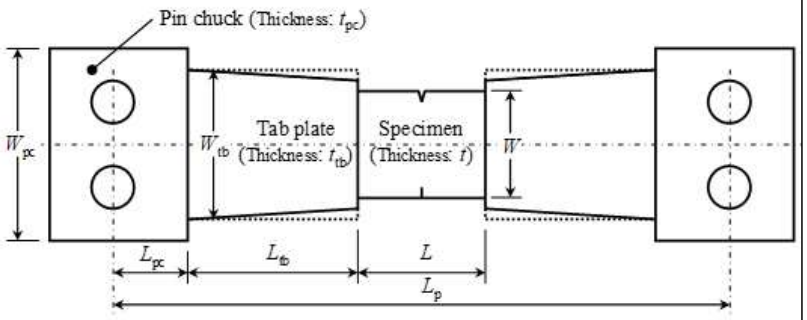
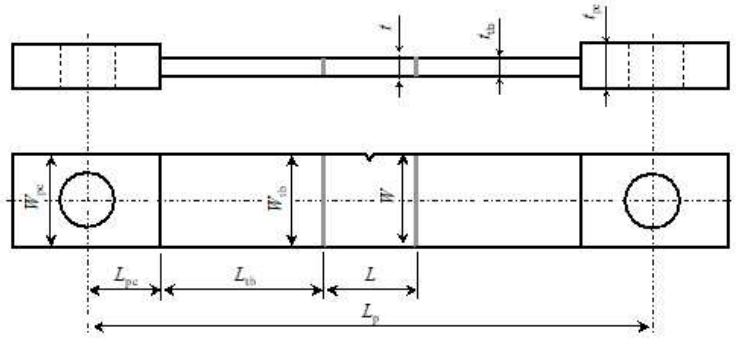
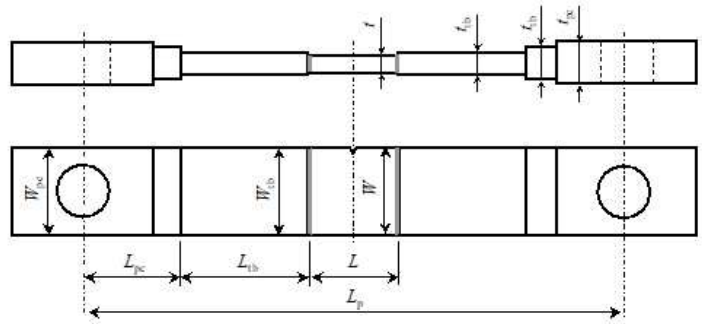
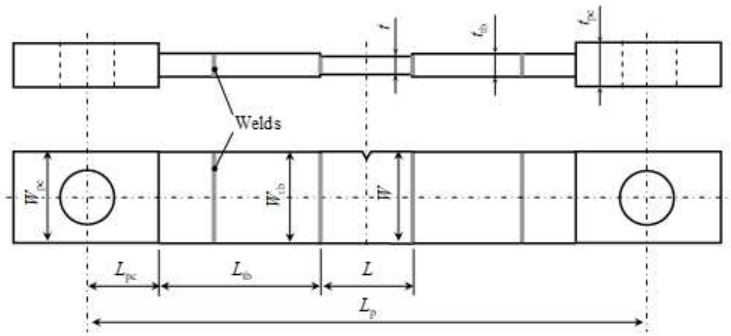
~~(C) The test specimens are to be taken from the same steel plate.~~ ~~(D) Test specimens are to be taken in such a way that the axial direction of the load is parallel to the rolling direction of the steel plate.~~ ~~(E) The thickness of the test specimen is to be the same as the thickness of the steel plate to be used in the vessel structure.~~ ~~(5) Test equipment~~ ~~(A) The test equipment to be used is to consist of pin load type hydraulic test equipment capable of tensile tests.~~ ~~(B) The distance between the pins is to be not less than 2,000 mm. The distance between pins refers to the distance between the centres of the pin diameters.~~ ~~(C) Drop weight type or air gun type impact equipment may be used for the impact energy required for generating brittle cracks.~~ ~~(D) The wedge is to have an angle greater than the upper notch of the test specimen, and an opening force is to be applied on the notch.~~ ~~(6) Test preparations~~ ~~(A) The test piece is to be fixed directly to the pin load jig or by means of weld joint through the tab plate. The overall length of the test specimen and tab plate is to be not less than $3W_s$. The thickness and width of the tab plate are to be in accordance with **Table 2.1.5**.~~ ~~(B) Thermocouples are to be fitted at 50 mm pitch on the notch extension line of the test specimen.~~	(B) Shapes of tab plates and pin chucks The definitions of the dimensions of the tab plates and pin chucks are shown in **Fig 2.1.4**. Typical examples are shown in **Fig 2.1.5**.  **(a) Single-pin type**  **(b) Double-pin type** **Fig 2.1.4 Definitions of dimensions of tab plates and pin chucks**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
(C) If the brittle crack is estimated to deviate from its presumed course, thermocouples are to be fitted at two points separated by 100 mm on the line of load from the notch extension line at the centre of width of the test specimen. **Table 2.1.5 Allowable dimensions of tab plate** Thickness(t_r) / Width(W_r) Dimensions of tab plate: $0.8t_s$ (1)(2) $\leq t_r \leq 1.5\ t_s$ / $W_s \leq W_r \leq 2\ W_s$ Note: (1) t_s : Thickness of test specimen (2) If the tab plate has a thickness smaller than the test specimen, the reflection of stress wave will be on the safer side for the assessment; therefore, considering the actual circumstances for conducting the test, the lower limit of thickness is taken as $0.8t_s$. (D) If dynamic measurements are necessary, strain gauges and crack gauges are to be fitted at specific locations. (E) The test specimen is to be fixed to the testing machine together with the tab plate after welding and the pin load jig. (F) The impact equipment is to be mounted. The construction of the impact equipment is to be such that the impact energy is correctly transmitted. An appropriate jig is to be arranged to minimize the effect of bending load due to the impact equipment. (7) Test method (A) To eliminate the effect of residual stress or correct the angular deformation of tab welding, a preload less than the test load may be applied before cooling. (B) Cooling and heating may be implemented from one side on the side opposite the side on which the thermocouple is fitted, or from both sides. (C) The temperature gradient is to be controlled in the range of 0.25 ℃/mm to 0.35 ℃/mm in the range of width from $0.3\ W_s$ to $0.7\ W_s$ at the central part of the test specimen. (D) When the specific temperature gradient is reached, the temperature is to be maintained for more than 10 minutes, after which the specified test load may then be applied.	 (a) Example 1  (b) Example 2  (c) Example 3	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

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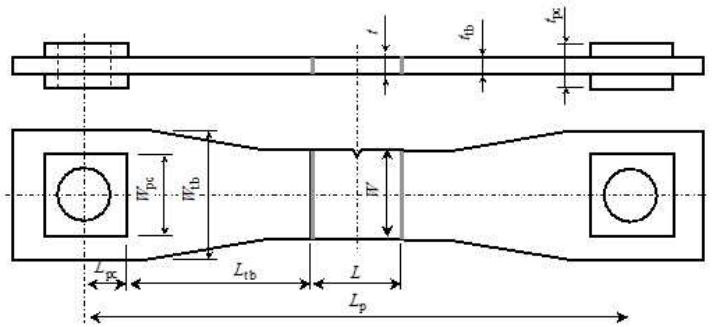
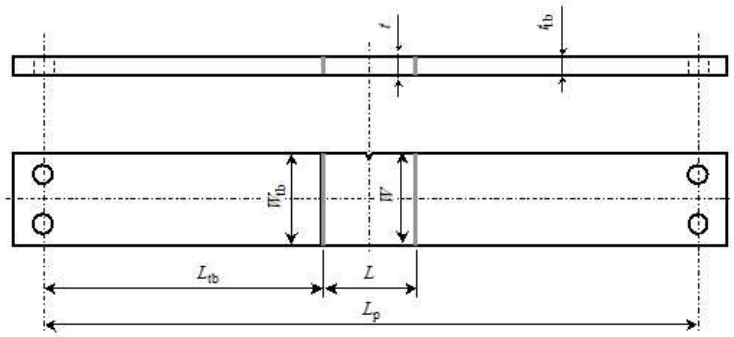
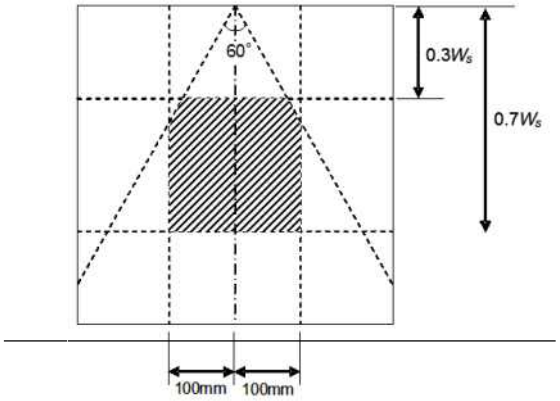
(E) After maintaining the test load for at least 30 seconds, a brittle crack is to be generated by impact. The standard impact energy is taken as 20 to 60 J per 1 mm plate thickness. If the brittle crack initiation characteristics of the base metal are high, and it is difficult to generate a brittle crack, the impact energy may be increased to the upper limit of 120 J per 1 mm plate thickness. (F) Loading is stopped when the initiation, propagation, and arrest of crack have been confirmed. Normal temperature is restored, and if necessary, the ligament is broken by gas cutting and forcibly the specimen is broken by using the testing machine. Or, after the ductile crack has been propagated to an adequate length with the testing machine, the ligament is broken by gas cutting. (G) After forcing the fracture, photos of the fractured surface and the propagation route are to be taken, and the crack length is to be measured. (8) Test results (A) The distance from the top of the test specimen including the notch to the maximum length in the plate thickness direction of the arrested crack tip is to be measured. If the crack surface deviates from the surface normal to the line of load of the test specimen, the projected length on the surface normal to the line of load is to be measured. In this case, if the trace of brittle crack arrest is clearly visible on the fractured surface, the first crack arrest position is taken as the arrest crack position. (B) From the results of thermocouple measurement, the temperature distribution curve is to be plotted, and the arrest crack temperature is to be measured corresponding to the arrest crack length. (C) The brittle crack arrest toughness value (K_{ca} value) of each test is to be determined by using the following formula: $K_{ca} = \sigma\sqrt{\pi a}\sqrt{(\frac{2W_s}{\pi a})\tan(\pi a/2W_s)}$	 (d) Example 4  (e) Example 5 Fig 2.1.5 Examples of the shapes of tab plates and pin chucks	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
~~(9) Report~~ ~~(A) The following items are to be reported:~~ ~~(a) Testing machine specifications; testing machine capacity, distance between pins (L_p)~~ ~~(b) Load jig dimensions; tab plate thickness (t_r),tab plate width(W_r), test specimen length including tab plate (L_s+2L_r)~~ ~~(c) Test specimen dimensions; plate thickness (t_s); test specimen width(W_s) and length(L_s)~~ ~~(d) Test conditions; preload stress, test stress, temperature distribution (figure or table) impact energy~~ ~~(e) Test results; crack arrest length (a_a), temperature gradient at arrest position, brittle crack arrest toughness (K_{ca})~~ ~~(f) Dynamic measurement results (if measurement is carried out); crack growth rate, strain change~~ ~~(g) Test specimen photos; fracture route, fractured surface~~ ~~(B) If the conditions below are not satisfied, the test results are to be treated as reference values.~~ ~~(a) The brittle crack arrest position is to be in the range of the hatched part shown in **Fig 2.1.4**. In this case, if the brittle crack arrest position is more than 50 mm away from the centre of the test specimen in the longitudinal direction of the test specimen, the temperature of the thermocouple at the ±100 mm position is to be within ±3 ℃ of the thermocouple at the centre.~~  **Fig 2.1.4 Necessary conditions of arrest crack position**	(a) Tab plates The tolerances of tab plate dimensions are shown in **Table 2.1.5**. When the lengths of the tab plates attached to both ends of a test specimen are different, the shorter length shall be used as the tab length, L_{tb}. **Table 2.1.5 Tolerances of tab plate dimensions** |	
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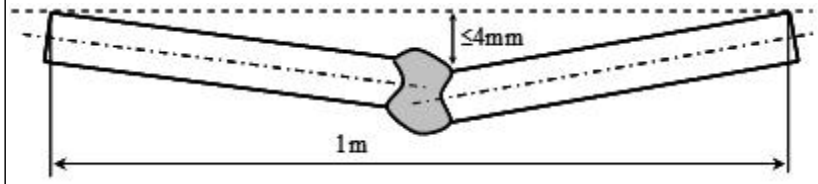
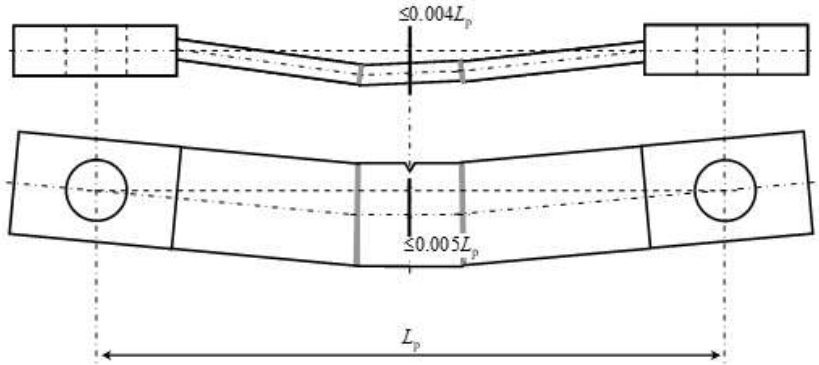
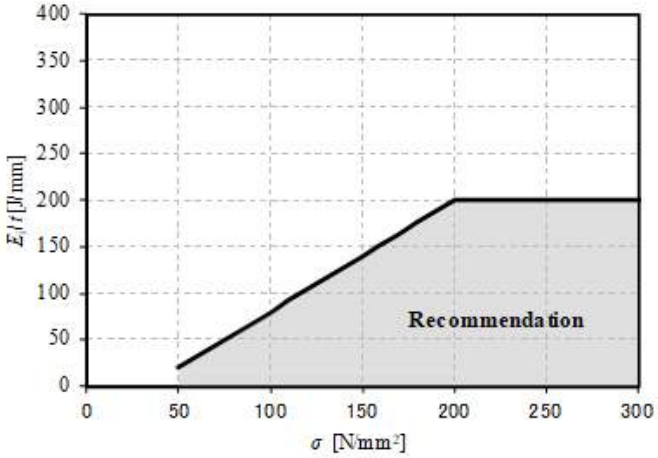
Tab plate thickness, t_{tb}	$0.8t \leq t_{tb} \leq 1.5t$
Tab plate width, W_{tb}	$W \leq W_{tb} \leq 2.0W$
Total length of a test specimen and tab plates, $L+2L_{tb}$ (Total length of a test specimen and a single tab plate, $L+L_{tb}$)	$3.0W \leq L+2L_{tb}$ $(2.0W \leq L+L_{tb})$
Tab plate length(L_{tb})/Tab plate width(W_{tb})	$1.0 \leq L_{tb}/W_{tb}$ | (b) Pin chucks The pin chuck width, W_{pc}, shall be in principle equal to or more than the tab plate width, W_{tb}. The pin chucks shall be designed to have a sufficient load bearing strength. When pin chucks attached to both ends of an integrated specimen are asymmetric, the length of the shorter one shall be used as the pin chuck length, L_{pc}. The distance between the pins, L_p, is obtained from the equation below. In the case as shown in **Fig 2.1.5** (e), Example 5, L_p is obtained by setting $L_{pc} = 0$. $$L_p = L+2L_{tb}+2L_{pc}$$	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
~~(b) The brittle crack should not have a distinct crack bifurcation while it propagates~~ ~~(C) From effective test results measured at more than 3 points, the linear approximation equation is to be determined on the Arrhenius plot, and K_{ca} at the desired temperature is to be calculated. In this case, data should exist on both sides, that is, the high temperature and low temperature sides around the assessed temperature.~~ ~~(10) Marking~~ ~~Marking for steel is generally to comply with the requirements given in **203. 1.** of the Guidance has been applied, "BCA(Brittle Crack Arrest)" is to be suffixed to the marking.(e.g. *EH40TM-BCA*, *EH47-H-BCA*)~~	(C) Welding of test specimen and tab plates (a) Test specimen, tab plates, and pin chucks shall be connected by welding. The welds shall have a sufficient force bearing strength. (b) As shown in **Fig 2.1.6** (a), the flatness (angular distortion, linear misalignment) of the weld between a test specimen and a tab plate shall be 4 mm or less per 1 m. In the case of preloading, however, it is acceptable if the value after preloading satisfies this condition. (c) As shown in **Fig 2.1.6** (b), the accuracy of the in-plane loading axis shall be 0.5 % or less of the distance between the pins, and the accuracy of the out-of-plane loading axis shall be 0.4 % or less of the distance between the pins.  **(a) Flatness of weld between test specimen and tab plate**  **(b) Accuracy of in-plane and out-of-plane loading axes** **Fig 2.1.6 Dimensional accuracy of weld between test specimen and tab plate**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
<New>	(5) Test methods (A) Temperature control methods (a) A predetermined temperature gradient shall be established across a test specimen width by soldering at least nine thermocouples to the test specimen for temperature measurement and control. (b) Temperature gradient shall be established in accordance with the following conditions (i) through (iii). (i) A temperature gradient of 0.25 ~ 0.35°C/mm shall be established in a test specimen width range of 0.3W ~ 0.7W. When measuring the temperatures at the centre position of the test specimen thickness, it shall be kept within ± 2°C for 10 minutes or more, whereas when measuring the temperatures on the front and back surface positions of the test specimen, it shall be kept within ± 2°C for (10 + 0.1t [mm]) minutes or more taking account of the time needed for soaking to the centre. If the temperature gradient at 0.3W ~ 0.7W is less than 0.25 °C/mm, crack arrest may become difficult, and if the gradient is larger than 0.35°C/mm, the obtained arrest toughness may be too conservative. (ii) At the test specimen width centre position (i.e., 0.5W), and in the range of ± 100 mm in the test specimen length direction, the deviation from the temperature at the centre position in the length direction shall be controlled within ± 5 °C. However, when temperature measurement is not performed at the centre position in the length direction, the average temperature at the closest position shall be used as the temperature at the centre position in the length direction. (iii) At the same position in the width direction, the deviation of the temperature on the front and back surfaces shall be controlled within ± 5 °C.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

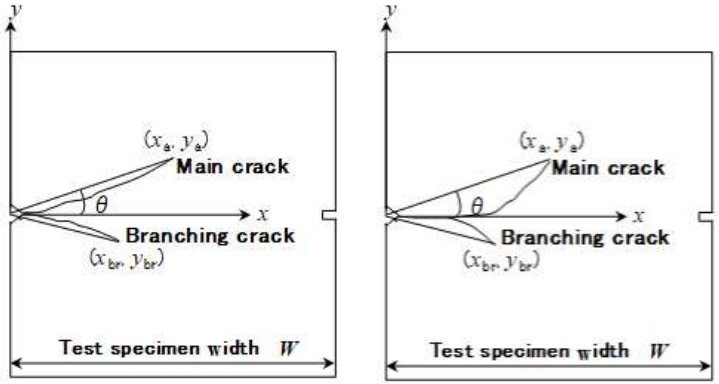
Present	Amendment	reason
<New>	(B) Crack initiation methods (a) Impact energy shall be applied to a test specimen to initiate a crack. However, if the energy is excessive, it may influence on the test results. In that case, the results shall be treated as invalid data in accordance with the judgment criteria specified in (7) (B). (b) It is desirable to use equation below and **Fig 2.1.7** as guides for obtaining valid data. $\frac{E_i}{t} \leq \min(1.2\sigma - 40,\ 200)$ Units : E_i[J], t[mm], $\sigma[N/mm^2]$ Definition : min[the minimum of the two values]  **Fig 2.1.7 Recommended range of impact energy**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
<New>	(6) Test procedures (A) Pretest procedures (a) Install an integrated specimen in the testing machine. (b) Mount a cooling device on the test specimen. A heating device may also be mounted on the test specimen. (c) Install an impact apparatus specified in (3) (B), on the testing machine. Place an appropriate reaction force receiver as necessary. (d) The above procedures (a) through (c) do not necessarily specify the order of implementation, and they may be completed, for example, on the day before the test. (e) After checking that all measured values of the thermocouples indicate room temperature, start cooling. The temperature distribution and the holding time shall be as provided in the specifications in (5) (A). (f) Set an impact apparatus, as specified in (3) (B) so that it can supply predetermined energy to the test specimen. (g) Apply force to the test specimen until it reaches the predetermined value. This force is applied after temperature control to prevent autonomous crack initiation during force increase. Alternatively, temperature control may be implemented after loading. The loading rate and applied stress shall satisfy the conditions (ⅰ) and (ⅱ) described below, respectively. (ⅰ) Loading rate There is no specification of loading rate, but it shall be determined considering that an excessively slow loading rate may prolong the temperature control period, thereby allowing the temperature distribution to depart from the desired condition and an excessively fast loading rate may cause over-shooting of the load. (ⅱ) Applied stress/yield stress ratio Applied stress shall be within the range shown by equation. $\sigma \leq \frac{2}{3}\sigma_{Y0}$	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
<New>	As a guide, a value equal to 1/6 of σ_{YD} or more is desirable. If applied stress is larger than that specified by above equation, the test may give a non-conservative result. (h) To initiate a crack, the notch may be cooled further immediately before impact on the condition that the cooling does not disturb the temperature in the range of 0.3W ~ 0.7W. The test temperature in this case shall be the measured temperature obtained from the temperature record immediately before the further notch cooling. (i) Record the force value measured by a force recorder. (B) Loading procedures (a) After holding a predetermined force for 30 seconds or more, apply an impact to the wedge using the impact apparatus. If a crack initiates autonomously and the exact force value at the time of the crack initiation cannot be obtained, the test is invalid. (b) After the impact, record the force value measured by the force recorder. (c) When the force after the impact is smaller than the test force, consider that crack initiation has occurred. (d) An increase in the number of times of impact may cause a change in the shape of the notch of the test specimen. Since the number of impact has no effect on the value of brittle crack arrest toughness, no limit is specified for the number of impact. However, because the temperature gradient is often distorted by impact, the test shall be conducted again, beginning from temperature control when applying repeated impact to the wedge. (e) When crack initiation, propagation, and arrest are observed, remove the force. (C) Procedures after testing (a) Remove the impact apparatus. (b) Remove the cooling device, thermocouples, and strain gauges.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
<New>	(c) Return the temperature of the test specimen to room temperature. For that purpose, the test specimen may be heat-tinted using a gas burner or the like. If it is necessary to prevent heating of the fracture surface, this method shall be avoided. (d) After gas-cutting an uncracked ligament, use the testing machine to cause ductile fracture, as necessary. Alternatively, it is also possible to gas-cut the uncracked ligament after using the testing machine to develop a ductile crack to a sufficient length. (D) Observation of fracture surfaces (a) Photograph the fracture surfaces and propagation path. (b) Measure the longest length of the arrest crack tip in the plate thickness direction, and record the result as the arrest crack length. The arrest crack length shall include the notch length. In the case where a crack deviates from the direction vertical to the loading direction, the length projected to the plane vertical to the loading line is defined as the arrest crack length. In the following cases, however, judge the results according to the methods described for each case. (ⅰ) Crack re-initiation In the case where a brittle crack has re-initiated from an arrested crack, the original arrest position is defined as the arrest crack position. Here re-initiation is defined as the case where a crack and re-initiated cracks are completely separated by a stretched zone and brittle crack initiation from the stretched zone can be clearly observed. In the case where a crack continuously propagates partially in the thickness direction, the position of the longest brittle crack is defined as the arrest position.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

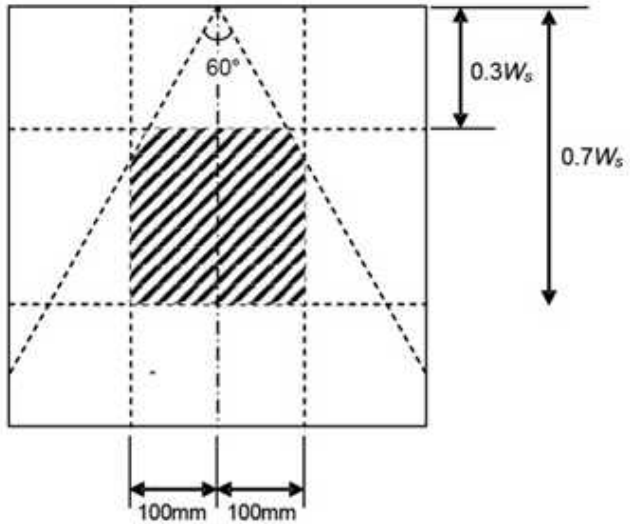
Present	Amendment	reason
<New>	(ii) Crack branching In the case where a crack deviates from the direction vertical to the loading direction, the length projected to the plane vertical to the loading line is defined as the arrest crack length. Similarly, in the case of crack branching, the length of the longest branch crack projected to the plane vertical to the loading line is defined as the branch crack length. More specifically, from the coordinates (x_a, y_a) of the arrest crack tip position and the coordinates (x_{br}, y_{br}) of the branch crack tip position shown in **Fig 2.1.8**, obtain the angle Θ from the x-axis and define xa as the arrest crack length, a. Here, x is the coordinate in the test specimen width direction, and the side face of the impact side is set as x=0; y is the coordinate in the test specimen length direction, and the notch position is set as y=0.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

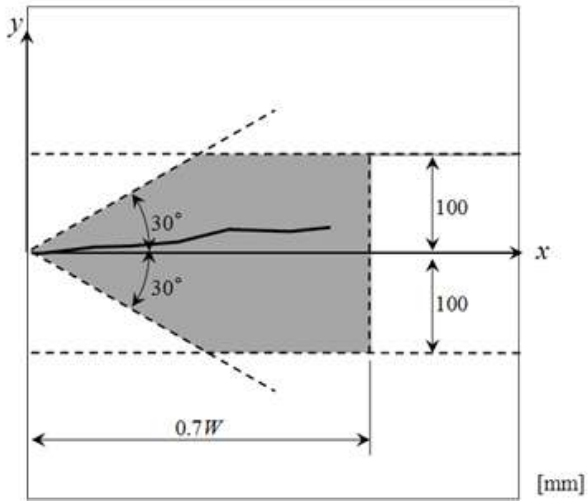


(a) Case of branching from notch **(b) Case of branching during brittle crack propagation**

Fig 2.1.8 Measurement methods of main crack and branch crack lengths

(c) Prepare a temperature distribution curve (line diagram showing the relation between the temperature and the distance from the test specimen top side) from the thermocouple measurement results, and obtain the arrest temperature T corresponding to the arrest crack length.

Present	Amendment	reason
<New>	(7) Determination of arrest toughness (A) Judgment of arrested crack When an arrested crack satisfies all of the conditions (a) through (d) below as shown in **Fig 2.1.9**, the length of the arrested crack determined by (6) (D) is valid. If any of the conditions is not met, the arrest toughness calculated from (7) (C) is invalid.  **Fig 2.1.9 Necessary conditions of arrest crack position**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
<New>	(a) Conditions for crack propagation path All of the crack path from crack initiation to arrest shall be within the range shown in **Fig 2.1.10**. However, in the case where a main crack tip lies within this range but a part of the main crack passes outside the range, the arrest toughness may be assessed as valid if the temperature at the most deviated position of the main crack in the y direction is lower than that at y=0, and also K for the main crack falls within ± 5 % of K for a straight crack of the same a. The calculation method of Ks for the main crack and a straight crack is obtained from equation below. $K = K_I \cos^3(\frac{\Phi}{2}) + 3K_{II}\cos^2(\frac{\Phi}{2})\sin(\frac{\Phi}{2})$  **Fig 2.1.10 Allowable range of main crack propagation path**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
<New>	(b) Conditions for arrest crack length Equation (3) ensures minimal influence of force drop at the centre of the specimen which might be caused by crack propagation and reflection of the stress wave at the two ends of the specimen. However, application of equation (3) is not necessarily required if the strain and the crack length have been dynamically measured and the value of the strain at the time of arrest is 90 % or more of the static strain immediately before crack initiation. $0.3 \le (\frac{a}{W}) \le 0.7$ ---------- (1) $(\frac{a}{W}) \ge 1.5$ ---------- (2) $(\frac{a}{L_p}) \le 0.15$ ---------- (3) (c) Conditions for crack straightness $\lvert y_a \rvert \le 50mm$ ----------(4) In the case where $50mm < \lvert y_a \rvert \le 100mm$ and $\lvert \theta \rvert \le 30^\circ$, the result is valid only when the temperature at x=0.5W and y=±100 mm falls within ± 2.5 °C of that at x=0.5W and y=0. (d) Conditions for crack branching $(\frac{x_{br}}{x_a}) \le 0.6$ ----------(5)	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
<New>	(B) Assessment of impact energy Impact energy shall satisfy equation below. If it does not satisfy the equation, the value of arrest toughness calculated from the equations in (C) is invalid. Conditions for impact energy: $\frac{E_i}{E_s+E_t} \le \frac{5a-1050+1.4W}{0.7W-150}$, $0.3 \le (\frac{a}{W}) \le 0.7$ --------(6) units: a [mm], and W [mm]. E_i [impact energy calculated from the equation (7), J] E_s [energy calculated from the equation (8), J] E_t [energy calculated from the equation (9), J] If equation (6) is not satisfied, the influence of impact energy on the stress intensity factor is too large to obtain an accurate arrest toughness. In the case where the tab plates are multistage as shown in **Fig 2.1.5** (b), calculate and total the strain energy of each tab plate using equation (8). In the case where tab plate widths are tapered as shown in **Fig 2.1.5** (d), calculate the strain energy based on elastostatics. $E_i = mgh$ ----------(7) $E_s = \frac{10^9 F^2}{2E}\frac{L}{W_t}$ ----------(8) $E_t = \frac{10^9 F^2}{E}(\frac{L_{tb}}{W_{tb}t_{tb}} + \frac{L_{pc}}{W_{pc}t_{pc}})$ ----------(9) Units: E_s[J], E_t[J], F[MN], E[N/mm^2], L[mm], W[mm], t[mm]	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

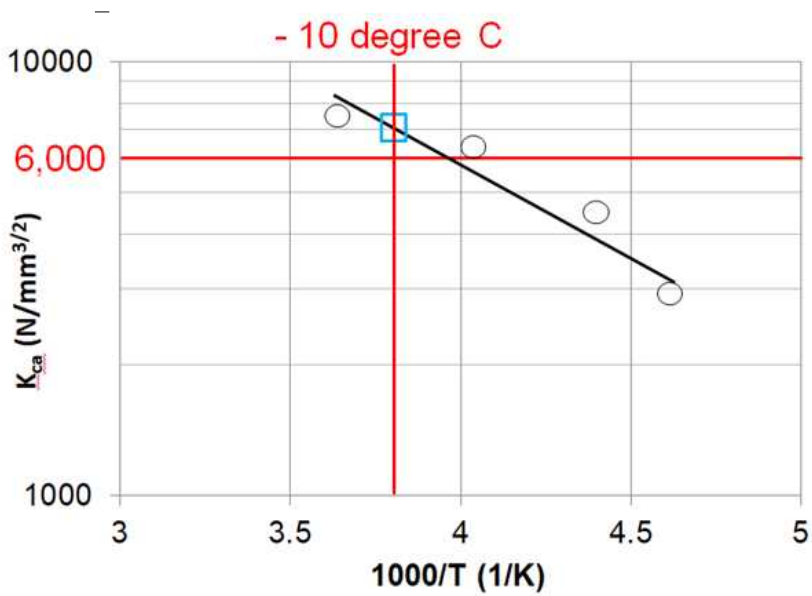
Present	Amendment	reason
<New>	(C) Calculation of arrest toughness The arrest toughness, K_{ca}, at the temperature, T, shall be calculated from equation (10) using the arrest crack length, a, and the applied stress, σ, judged by (A). Calculate σ from equation (11). $K_{ca} = \sigma\sqrt{\pi a}\left[\frac{2W}{\pi a}\tan\left(\frac{\pi a}{2W}\right)\right]^{1/2}$ ----------(10) $\sigma = \frac{10^6 F}{Wt}$ ----------(11) Units : F[MN], W[mm], t[mm] If the conditions specified in (A) and (B) are not satisfied, the K_{ca} calculated from equation (10) is invalid. (8) Reporting Using **Table 2.1.6**, the following items shall be reported. (A) Test material: Steel type and yield stress at room temperature (B) Testing machine: Capacity of the testing machine (C) Test specimen dimensions: Thickness, width, length, angular distortion, and linear misalignment (D) Integrated specimen dimensions: Tab plate thickness, tab plate width, integrated specimen length including the tab plates, and distance between the loading pins (E) Test conditions: Applied force, applied stress, temperature gradient, impact energy, and the ratio of impact energy to the strain energy stored in the integrated specimen (sum of test specimen strain energy and tab plate strain energy) (F) Test results (a) Judgment of arrest: Crack length, presence or absence of crack branching, main crack angle, presence or absence of crack re-initiation, and arrest temperature (b) Arrest toughness value (G) Temperature distribution at moment of impact: Thermocouple position, temperature value, and temperature distribution (H) Test specimen photographs: Crack propagation path (one side), and brittle crack fracture surface (both sides) (I) Dynamic measurement results(if necessary): History of crack propagation velocity, and strain change at pin chucks	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

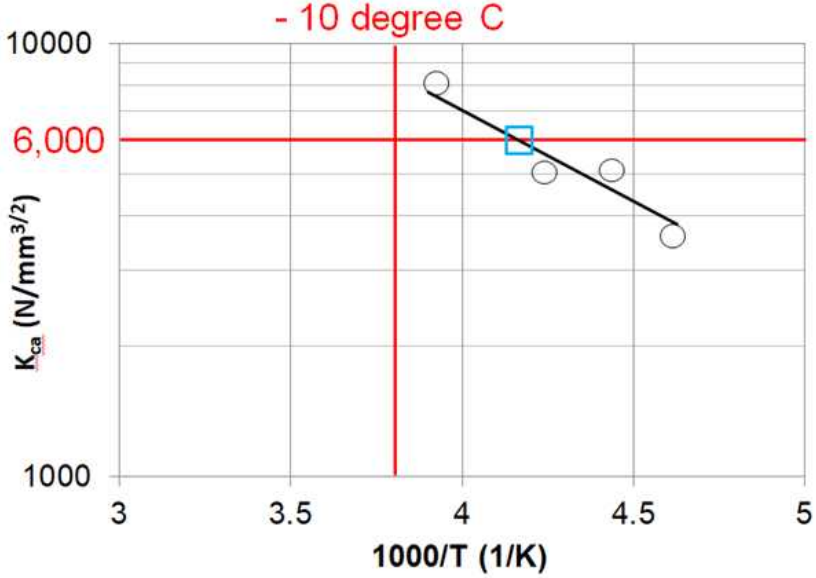
<New>

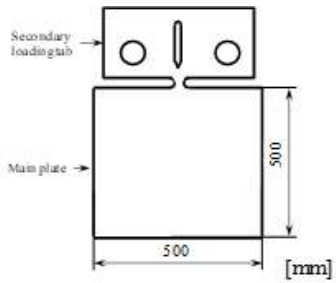
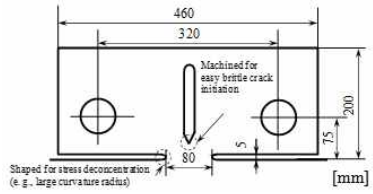
Table 2.1.6 Report sheet for brittle crack arrest test results

Item	Details		Symbol	Conditions/ Results	Unit	Valid/ Invalid
(1) Test material	Steel type		–		–	–
	Yield stress at room temperature		σ_{Y0}		N/mm^2	–
(2) Test equipment	Testing machine capacity		–		MN	–
(3) Test specimen dimensions	Thickness		t		mm	
	Width		W		mm	
	Length		L		mm	
	Angular distortion + linear misalignment		–		mm/m	
(4) Integrated specimen dimensions	Tab plate thickness		t_{tb}		mm	
	Tab plate width		W_{tb}		mm	
	Test specimen length including a tab plate		L + L_{tb}		mm	
	Distance between loading pins		L_p		mm	
(5) Test conditions	Applied force		F		MN	
	Applied stress		σ		N/mm^2	
	Temperature gradient		–		°C /mm	
	Impact energy		E_i		J	
	Ratio of impact energy to strain energy stored in integrated specimen		$E_i/(E_s+E_t)$		–	
(6) Test results	Judgment of crack propagation/arrest	Crack length	a		mm	
		Presence/absence of crack branching	–		–	–
		Ratio of branch crack length to main crack	x_{br}/x_a		–	
		Main crack angle	Θ		degree (°)	
		Presence/absence of crack re-initiation	–		–	
		Temperature at crack arrest position	T		°C	
	Arrest toughness value		K_{ca}	_	$N/mm^{3/2}$	
(7) Temperature distribution at moment of impact	Temperature measurement position		–	Attached	–	–
	Temperature at each temperature measurement position		–	Attached	°C	–
	Temperature distribution curve		–	Attached	–	
(8) Test specimen photographs	Crack propagation path		–	Attached	–	
	Brittle crack fracture surface (both sides)		–	Attached	–	
(9) Dynamic measurement results	History of crack propagation velocity		–	Attached	–	
	Strain change at pin chucks		–	Attached	–	

Present	Amendment	reason
<New>	**2. Method for Obtaining K_{ca} at a specific temperature and the evaluation** (1) Application This requirement specifies the method for conducting multiple tests specified in **1.** to obtain K_{ca} value at a specific temperature T_D. (2) Method A number of experimental data show dependency of K_{ca} on arrest temperature, as expressed by equation below, where T_K [K] (= T[°C] + 273), c and K_0 are constants. $$K_{ca} = K_0 \exp\left(\frac{c}{T_k}\right)$$ The arrest toughness at a required temperature T_D[K] can be obtained by following the procedures below. (A) Obtain at least four valid K_{ca} data. (B) Approximating $\log K_{ca}$ by a linear expression of $1/T_K$, determine the coefficients $\log K_0$ and c for the data described in (A) by using the least square method. $$\log K_{ca} = \log K_0 + c\frac{1}{T_K}$$ (C) Obtain the value of $(K_{ca}/K_0)\exp(c/T_K)$ for each data item. When the number of data outside the range of 0.85 through 1.15 does not exceed, the least square method used in paragraph (2) is considered valid. Here is an integer obtained by rounding down the value of (number of all data divided by 6). If this condition is not met, conduct additional tests to add at least two data and apply the procedure in paragraph (2) to the data. (D) The value of $K_0\exp(c/T_D)$ is defined as the estimated value of K_{ca} at T_D. The estimated value for the temperature corresponding to a specific value of K_{ca} can be obtained from $T_K = c/\log(K_{ca}/K_0)$. If the condition specified in (C) is not met, these estimated values are treated as reference values.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
<New>	(3) Evaluation The straight-line approximation of arrhenius plot for valid K_{ca} data by interpolation method are to comply with either the following (A) or (B). (A) The evaluation temperature of K_{ca}(i.e. -10 degree C) is located between the upper and lower limits of the arrest temperature, with the K_{ca} corresponding to the evaluation temperature not lower than the required K_{ca}(e.g. 6,000 $N/mm^{3/2}$ or 8,000 $N/mm^{3/2}$), as shown in **Fig 2.1.11**.  **Fig 2.1.11 Example for evaluation of K_{ca} at - 10 degree C** (B) The temperature corresponding to the required K_{ca} (e.g. 6,000 $N/mm^{3/2}$ or 8,000 $N/mm^{3/2}$) is located between the upper and lower limits of the arrest temperature, with the temperature corresponding to the required K_{ca} not higher than the evaluation temperature (i.e. -10 degree C), as shown in **Fig 2.1.12**. (C) If both of (1) and (2) above are not satisfied, conduct additional tests to satisfy this condition.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
<New>	 **Fig 2.1.12 Example for evaluation of temperature corresponding to the required K_{ca}**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

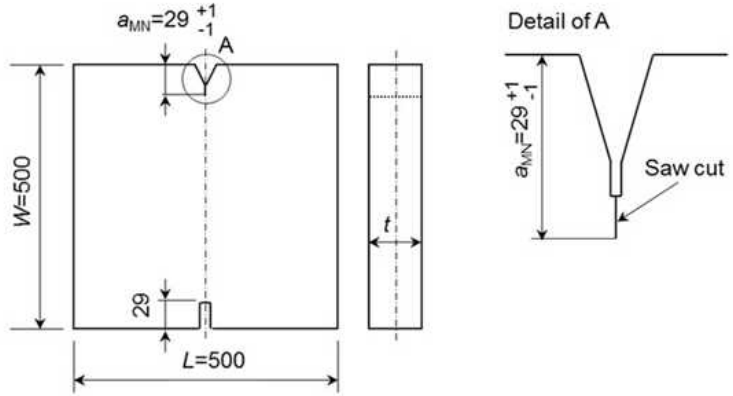
Present	Amendment	reason
<New>	**3. Double tension type arrest test** (1) Application (A) The values of arrest toughness obtained by this method can be considered the same as the results obtained by the brittle crack arrest toughness test specified in **1.**. (B) The specifications described in **1.** shall be applied to conditions not mentioned in these requirements. (2) Features of this test method A double tension type arrest test specimen consists of a main plate and a secondary loading tab. The main plate is a test plate for evaluating brittle crack arrest toughness. The secondary loading tab is a crack starter plate for assisting a brittle crack to run into the main plate. After applying a predetermined tension force and a temperature gradient to the main plate, a secondary force is applied to the secondary loading tab by a secondary loading device to cause a brittle crack to initiate and run into the main plate. The arrest toughness is evaluated from the arrest temperature and the crack length in the main plate. The narrow connection part of the main plate and the secondary loading tab in this test suppress the flow of the tension stresses of the secondary loading tab into the main plate. (3) Test specimen shapes The recommended shapes of the entire double tension type arrest test specimen and the secondary loading tab are shown in (a) and (b) of **Fig 2.1.13**, respectively. Clause (4) (B) of **1.** is applied to the shapes of the tab plates and pin chucks.   **(a) Example of shape of entire test specimen** **(b) Example of shape of secondary loading tab** **Fig 2.1.13 Test specimen shapes for double tension type arrest test**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
<New>	(4) Temperature conditions and temperature control methods Establish a temperature gradient in the main plate in order to evaluate its brittle crack arrest toughness. The specifications for temperature gradients and methods for establishing the temperature gradient are described in **1.** (5). In addition, in the double tension type arrest test, the secondary loading tab must be cooled. The secondary loading tab is cooled without affecting the temperature gradient of the main plate. As in the cooling method for test specimens described in **1.**, cooling may be applied using a cooling box and a coolant. The temperature of the secondary loading tab can be measured using thermocouples as described in **1.**. (5) Secondary loading method A secondary loading device is used to apply force to the secondary loading tab. The secondary loading device shall satisfy the conditions below. (A) Holding methods of secondary loading device To avoid applying unnecessary force to the integrated specimen, the secondary loading device must be held in an appropriate way. Suspension type or floor type holding methods can be used. In the suspension type method, the secondary loading device is suspended and held by using a crane or a similar device. In the floor type method, the secondary loading device is lifted and held by using a frame or a similar device. (B) Loading system A hydraulic type loading system is most suitable for applying a force to the secondary loading tab. However, other methods may be used. Clause (4) (B) of **1.** is applied to the shapes of the tab plates and pin chucks. (C) Loading method The method of loading the secondary loading tab shall be a pin type loading method. A loading method other than a pin type may be used by agreement among the parties concerned. The loading rate is not specifically specified because it does not have a direct influence on the crack arrest behavior of the main plate.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

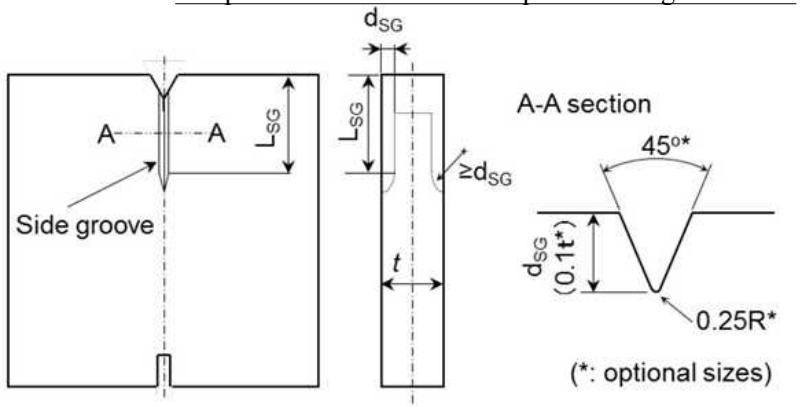
Present	Amendment	reason
<New>	**4. Outline of requirements for undertaking isothermal Crack Arrest Temperature** (1) Application (A) These requirements are to be applied according to the scope defined in **Pt 2**, **Ch 1**, **312.** of the Rules. (B) These are requirements for test procedures and test conditions when using the isothermal crack arrest test to determine a valid test result under isothermal conditions and in order to establish the crack arrest temperature(CAT). These requirements are applicable to steels with thickness over 50mm and not greater than 100mm. (C) This method uses an isothermal temperature in the test specimen being evaluated. Unless otherwise specified in these requirements, the other test parameters are to be in accordance with **1.**. (D) **Table 2.1.35** of **Pt 2**, **Ch 1**, **312.** of the Rules gives the relevant requirements for the brittle crack arrest property described by the crack arrest temperature(CAT). (E) The manufacturer is to submit the test procedure to the Society for review prior to testing. (F) Where required, the method can also be used for determining the lowest temperature at which a steel can arrest a running brittle crack (the determined CAT) as the material property characteristic in accordance with (8) (C). (2) Symbols and their significance **Table 2.1.7** supplements **Table 2.1.3** with specific symbols for the isothermal test.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

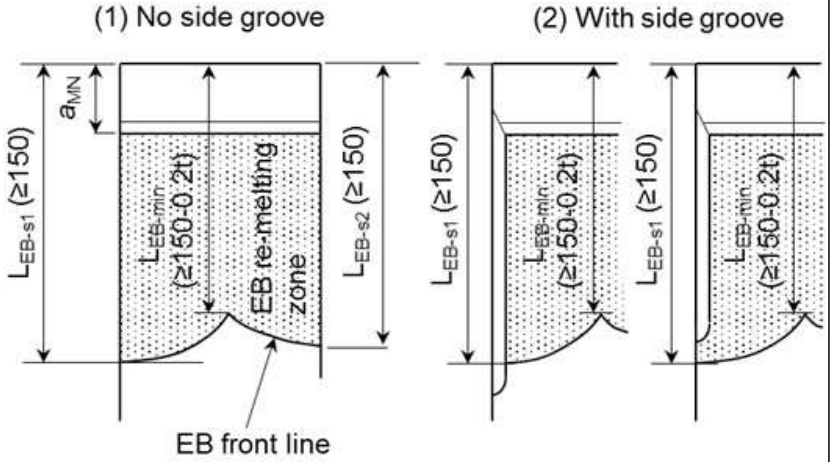
Present	Amendment	reason
<New>	**Table 2.1.7 Symbols and their significance**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

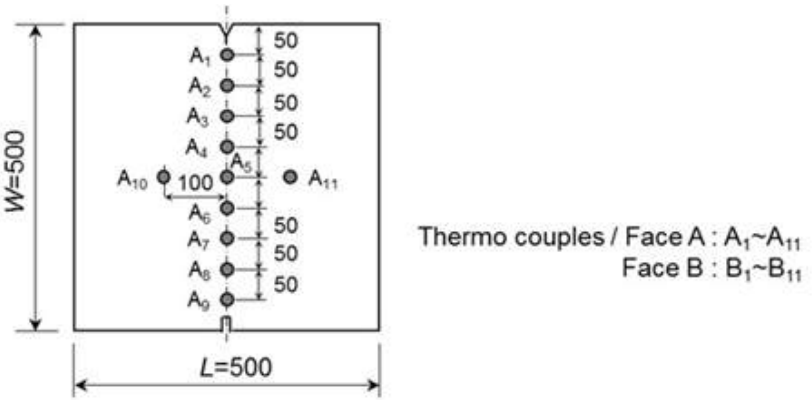
Symbol	Unit	Significance
t	mm	Test specimen thickness
L	mm	Test specimen length
W	mm	Test specimen width
a_{MN}	mm	Machined notch length on specimen edge
L_{SG}	mm	Side groove length on side surface from the specimen edge. L_{SG} is defined as a groove length with constant depth except a curved section in depth at side groove end.
d_{SG}	mm	Side groove depth in section with constant depth
$L_{EB-\min}$	mm	Minimum length between specimen edge and electron beam re-melting zone front
$L_{EB-s1,-s2}$	mm	Length between specimen edge and electron beam re-melting zone front appeared on both specimen side surfaces
L_{LTG}	mm	Local temperature gradient zone length for brittle crack runway
a_{arrest}	mm	Arrested crack length
T_{target}	℃	Target test temperature
T_{test}	℃	Defined test temperature
T_{arrest}	℃	Target test temperature at which valid brittle crack arrest behaviour is observed
σ	N/mm^2	Applied test stress at cross section of W x t
SMYS	N/mm^2	Specified minimum yield strength of the tested steel grade to be approved
CAT	℃	Crack arrest temperature, the lowest temperature, T_{arrest}, at which running brittle crack is arrested

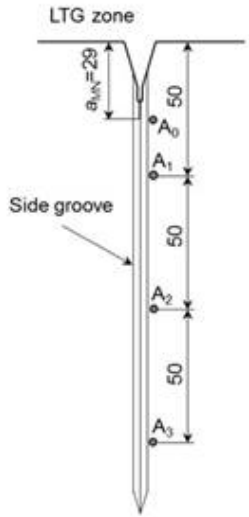
Present	Amendment	reason
<New>	(3) Testing equipment (A) The test equipment to be used is to be of the hydraulic type of sufficient capacity to provide a tensile load equivalent to ⅔ of SMYS of the steel grade to be approved. (B) The temperature control system is to be equipped to maintain the temperature in the specified region of the specimen within ±2 ℃ from T_{target}. (C) Methods for initiating the brittle crack may be of drop weight type, air gun type or double tension tab plate type. (D) The detailed requirements for testing equipment are specified in **1.** (3). (4) Test specimens (A) Impact type crack initiation (a) Test specimens are to be in accordance with **1.** (4), unless otherwise specified in these requirements. (b) Specimen dimensions are shown in **Fig 2.1.14**. The test specimen width, W shall be 500mm. The test specimen length, L shall be equal to or greater than 500mm.  **Fig 2.1.14 Test specimen dimensions for an impact type specimen**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
<New>	(c) V-shape notch for brittle crack initiation is machined on the specimen edge of the impact side. The whole machined notch length shall be equal to 29 mm with a tolerance range of ±1 mm. (d) Requirements for side grooves are described in (D). (B) Double tension type crack initiation (a) Reference shall be made to **3.** for the shape and sizes in secondary loading tab and secondary loading method for brittle crack initiation. (b) In a double tension type test, the secondary loading tab plate may be subject to further cooling to enhance an easy brittle crack initiation. (C) Embrittled zone setting (a) An embrittled zone shall be applied to ensure the initiation of a running brittle crack. Either Electron Beam Welding (EBW) or Local Temperature Gradient (LTG) may be adopted to facilitate the embrittled zone. (b) In EBW embrittlement, electron beam welding is applied along the expected initial crack propagation path, which is the centre line of the specimen in front of the machined V- notch. (c) The complete penetration through the specimen thickness is required along the embrittled zone. One side EBW penetration is preferable, but dual sides EB penetration may be also adopted when the EBW power is not enough to achieve the complete penetration by one side EBW. (d) The EBW embrittlement is recommended to be prepared before specimen contour machining. (e) In EBW embrittlement, zone shall be of an appropriate quality. (f) EBW occasionally behaves in an un-stable manner at start and end points. EBW line is recommended to start from the embrittled zone tip side to the specimen edge with an increasing power control or go/return manner at start point to keep the stable EBW. (g) In LTG system, the specified local temperature gradient between machined notch tip and isothermal test region is regulated after isothermal temperature control. LTG temperature control is to be achieved just before brittle crack initiation, nevertheless the steady temperature gradient through the thickness shall be ensured.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

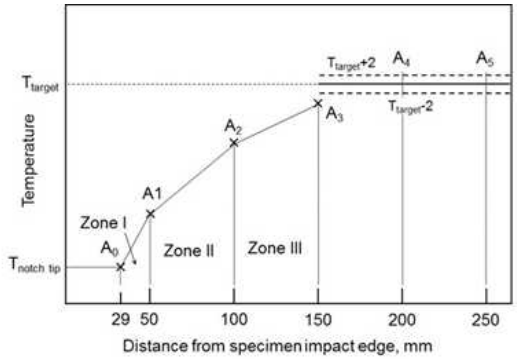
Present	Amendment	reason
<New>	(D) Side grooves (a) Side grooves on side surface can be machined along the embrittled zone to keep brittle crack propagation straight. Side grooves shall be machined in the specified cases as specified in this section. (b) In EBW embrittlement, side grooves are not necessarily mandatory. Use of EBW avoids the shear lips. However, when shear lips are evident on the fractured specimen, e.g. shear lips over 1 mm in thickness in either side then side grooves should be machined to suppress the shear lips. (c) In LTG embrittlement, side grooves are mandatory. Side grooves with the same shape and size shall be machined on both side surfaces. (d) The length of side groove, L_{SG} shall be no shorter than the sum of the required embrittled zone length of 150mm. (e) When side grooves would be introduced, the side groove depth, the tip radius and the open angle are not regulated, but are adequately selected in order to avoid any shear lips over 1 mm thickness in either side. An example of side groove dimensions are shown in **Fig 2.1.15**. (f) Side groove end shall be machined to make a groove depth gradually shallow with a curvature larger than or equal to groove depth, d_{SG}. Side groove length, L_{SG} is defined as a groove length with constant depth except a curved section in depth at side groove end.  **Fig 2.1.15 Side groove configuration and dimensions**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
<New>	(E) Nominal length of embrittled zone (a) The length of embrittled zone shall be nominally equal to 150 mm in both systems of EBW and LTG.  **(a) No side groove (b) With side groove** **Fig 2.1.16 Side groove configuration and dimension** (b) EBW zone length is regulated by three measurements on the fracture surface after test as shown in **Fig 2.1.16**, $L_{EB-\min}$ between specimen edge and EBW front line, and L_{EB-s1} and L_{EB-s2}. (c) The minimum length between specimen edge and EBW front line, $L_{EB-\min}$ should be no smaller than 150 mm. However, it can be acceptable even if $L_{EB-\min}$ is no smaller than 150mm-0.2t, where t is specimen thickness. When $L_{EB-\min}$ is smaller than 150 mm, a temperature safety margin shall be considered into T_{test} (See (8) (A) (b)). (d) Another two are the lengths between specimen edge and EBW front appeared on both side surfaces, as denoted with L_{EB-s1} and L_{EB-s2}. Both of L_{EB-s1} and L_{EB-s2} shall be no smaller than 150 mm. (e) In LTG system, L_{LTG} is set as 150 mm.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

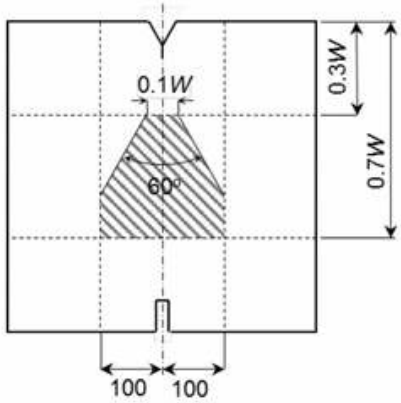
Present	Amendment	reason
<New>	(F) Tab plate / pin chuck details and welding of test specimen to tab plates The configuration and size of tab plates and pin chucks shall be referred to **1.** (4) (B). The welding distortion in the integrated specimen, which is welded with specimen, tab plates and pin chucks, shall be also within the requirement in **1.** (4) (C). (5) Test method (A) Preloading Preloading at room temperature can be applied to avoid unexpected brittle crack initiation at test. The applied load value shall be no greater than the test stress. Preloading can be applied at higher temperature than ambient temperature when brittle crack initiation is expected at preloading process. However, the specimen shall not be subjected to temperature higher than 100 ℃. (B) Temperature measurement and control (a) Temperature control plan showing the number and position of thermocouples is to be in accordance with this section. (b) Thermocouples are to be attached to both sides of the test specimen at a maximum interval of 50 mm in the whole width and in the longitudinal direction at the test specimen centre position (0.5 W) within the range of ±100 mm from the centreline in the longitudinal direction, refer to **Fig 2.1.7**.  **Fig 2.1.17 Locations of temperature measurement**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

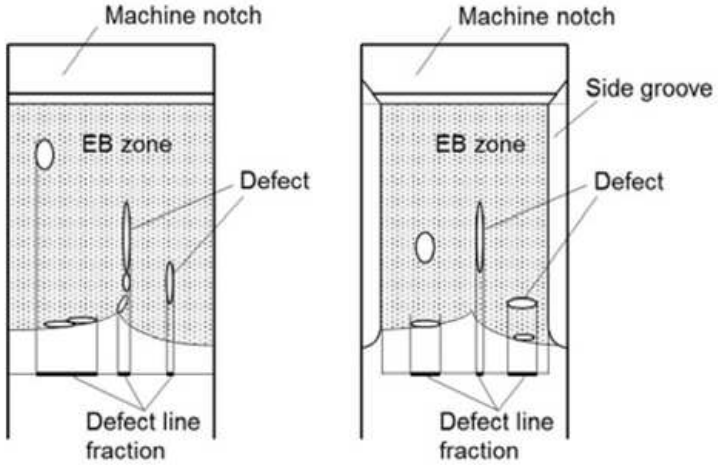
Present	Amendment	reason
<New>	(c) For EBW embrittlement (i) The temperatures of the thermocouples across the range of 0.3W~0.7W in both width and longitudinal directions are to be controlled within ± 2 °C of the target test temperature, T_{target}. (ii) When all measured temperatures across the range of 0.3W~0.7W have reached T_{target}, steady temperature control shall be kept at least for 10 + 0.1 x t[mm] minutes to ensure a uniform temperature distribution into mid-thickness prior to applying test load. (iii) The machined notch tip can be locally cooled to easily initiate brittle crack. Nevertheless, the local cooling shall not disturb the steady temperature control across the range of 0.3W~0.7W. (d) For LTG embrittlement (i) In LTG system, in addition to the temperature measurements shown in **Fig 2.1.17**, the additional temperature measurement at the machine notch tip, A_0 and B_0 is required. Thermocouples positions within LTG zone are shown in **Fig 2.1.18**.  **Fig 2.1.18 Detail of LTG zone and additional thermocouple A_0**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
<New>	(ii) The temperatures of the thermocouples across the range of 0.3W~0.7W in both width and longitudinal directions are to be controlled within ± 2 °C of the target test temperature, T_{target}. However, the temperature measurement at 0.3W (location of A_3 and B_3)shall be in accordance with (f) below. (iii) Once the all measured temperatures across the range of 0.3W~0.7W have reached T_{target}, steady temperature control shall be kept at least for 10 + 0.1 x t[mm] minutes to ensure a uniform temperature distribution into mid-thickness, then the test load is applied. (iv) LTG is controlled by local cooling around the machined notch tip. LTG profile shall be recorded by the temperature measurements from A_0 to A_3 shown in **Fig 2.1.19**. (v) LTG zone is established by temperature gradients in three zones, Zone I, Zone II and Zone III. The acceptable range for each temperature gradient is listed **Table 2.1.8**. (vi) Two temperature measurements at A_2, B_2 and A_3, B_3 shall be satisfied the following requirements. T at A_3, T at B_3 < T_{target} - 2 ℃ T at A_2 < T at A_3 - 5 ℃ T at B_2 < T at B_3 - 5 ℃ (vii) No requirements for T at A_0 and T at A_1 temperatures when T at A_3 and T at A_2 satisfy the requirements above. Face B is the same. (viii) The temperatures from A_0, B_0 to A_3, B_3 should be decided at test planning stage refer to **Table 2.1.8** which gives the recommended temperature gradients in three zones, Zone I, Zone II and Zone III in LTG zone.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
<New>	 **Fig 2.1.19 Schematic temperature gradient profile in LTG zone** **Table 2.1.8 Acceptable LTG range** | Zone | Location from edge | Acceptable range of temperature gradient | |---|---|---| | Zone Ⅰ | 29 mm~50 mm | 2.00 ℃/mm ~ 2.30 ℃/mm | | Zone Ⅱ | 50 mm~100 mm | 0.25 ℃/mm ~ 0.60 ℃/mm | | Zone Ⅲ(1) | 100 mm~150 mm | 0.10 ℃/mm ~ 0.20 ℃/mm | | NOTES: (1) The Zone Ⅲ arrangement is mandatory |	| (ix) The temperature profile in LTG zone mentioned above shall be ensured after holding time at least for 10 + 0.1 x t[mm] minutes to ensure a uniform temperature distribution into mid-thickness before brittle crack initiation. (x) The acceptance of LTG in the test shall be decided from **Table 2.1.8** based on the measured temperatures from A_0 to A_3. (e) For double tension type crack initiation specimen Temperature control and holding time at steady state shall be the same as the case of EBW embrittlement specified in (c) or the case of LTG embrittlement specified in Section (d).	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
<New>	(C) Loading and brittle crack initiation (a) Prior to testing, a target test temperature(T_{target}) shall be selected. (b) Test procedures are to be in accordance with **1.** (6) except that the applied stress is to be $\frac{2}{3}$ of SMYS of the steel grade tested. (c) The test load shall be held at the test target load or higher for a minimum of 30 seconds prior to crack initiation. (d) Brittle crack can be initiated by impact or secondary tab plate tension after all of the temperature measurements and the applied force are recorded. (6) Measurements after test and test validation judgement (A) Brittle crack initiation and validation (a) If brittle crack spontaneously initiates before the test force is achieved or the specified hold time at the test force is not achieved, the test shall be invalid. (b) If brittle crack spontaneously initiates without impact or secondary tab tension but after the specified time at the test force is achieved, the test is considered as a valid initiation. The following validation judgments of crack path and fracture appearance shall be examined. (B) Crack path examination and validation (a) When brittle crack path in embrittled zone deviates from EBW line or side groove in LTG system due to crack deflection and/or crack branching, the test shall be considered as invalid. (b) All of the crack path from embrittled zone end shall be within the range shown in **Fig 2.1.20**. If not, the test shall be considered as invalid.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
<New>	 **Fig 2.1.20 Allowable range of main crack propagation path** (C) Fracture surface examination, crack length measurement and their validation (a) Fracture surface shall be observed and examined. The crack “initiation” and “propagation” are to be checked for validity and judgements recorded. The crack “arrest” positions are to be measured and recorded. (b) When crack initiation trigger point is clearly detected at side groove root, other than the V-notch tip, the test shall be invalid. (c) In EBW embrittlement setting, EBW zone length is quantified by three measurements of L_{EB-s1}, L_{EB-s2} and $L_{EB-\min}$, which are defined in 4.5. When either or both of L_{EB-s1} and L_{EB-s2} are smaller than 150mm, the test shall be invalid. When $L_{EB-\min}$ is smaller than 150mm-0.2t, the test shall be invalid. (d) When the shear lip with thickness over 1 mm in either side near side surfaces of embrittled zone are visibly observed independent of the specimens with or without side grooves, the test shall be invalid. (e) In EBW embrittlement setting, the penetration of brittle crack beyond the EBW front line shall be visually examined. When any brittle fracture appearance area continued from the EB front line is not detected, the test shall be invalid.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
<New>	(f) The weld defects in EBW embrittled zone shall be visually examined. If detected, it shall be quantified. A projecting length of defect on the thickness line through EB weld region along brittle crack path shall be measured, and the total occupation ratio of the projected defect part to the total thickness is defined as defect line fraction (See **Fig 2.1.21**). When the defects line fraction is larger than 10 %, the test shall be invalid.  **Fig 2.1.21 Counting procedure of defect line fraction** (g) In EBW embrittlement by dual sides' penetration, a gap on embrittled zone fracture surface which is induced by miss meeting of dual fusion lines is visibly detected at an overlapped line of dual side penetration, the test shall be invalid.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
<New>	(7) Judgement of “arrest” or “propagate” The final test judgment of “arrest”, “propagate” or “invalid” is decided by the following requirements of (A) through (E). (A) If initiated brittle crack is arrested and the tested specimen is not broken into two pieces, the fracture surfaces should be exposed with the procedures specified in (C) and (D) of **1.**. (B) When the specimen was not broken into two pieces during testing, the arrested crack length, a_{arrest} shall be measured on the fractured surfaces. The length from the specimen edge of impact side to the arrested crack tip (the longest position) is defined as a_{arrest}. (C) For LTG and EBW, a_{arrest} shall be greater than L_{LTG} and L_{EB-s1}, L_{EB-s2} or $L_{EB-\min}$. If not, the test shall be considered as invalid. (D) Even when the specimen was broken into two pieces during testing, it can be considered as “arrest” when brittle crack re-initiation is clearly evident. Even in the fracture surface all occupied by brittle fracture, when a part of brittle crack surface from embrittled zone is continuously surrounded by thin ductile tear line, the test can be judged as re-initiation behaviour. If so, the maximum crack length of the part surrounded tear line can be measured as a_{arrest}. If re-initiation is not visibly evident, the test is judged as “propagate”. (E) The test is judged as “arrest” when the value of aarrest is no greater than 0.7W. If not, the test is judged as “propagate”. (8) T_{test}, T_{arrest} and CAT determination (A) T_{test} determination (a) It shall be ensured on the thermocouple measured record that all temperature measurements across the range of 0.3W ~ 0.7W in both width and longitudinal direction are in the range of $T_{target} \pm 2$ °C at brittle crack initiation. If not, the test shall be invalid. However, the temperature measurement at 0.3W (location of A_3 and B_3) in LTG system shall be exempted from this requirement.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
<New>	(b) If $L_{EB-\min}$ in EBW embrittlement is no smaller than 150mm, T_{test} can be defined to equal with T_{target}. If not, T_{test} shall be equaled with T_{target} + 5°C. (c) In LTG embrittlement, T_{test} can be equaled with T_{target}. (d) The final arrest judgment at T_{test} is concluded by at least two tests at the same test condition which are judged as “arrest”. (B) T_{arrest} determination When at least repeated two “arrest” tests appear at the same T_{target}, brittle crack arrest behaviour at T_{target} will be decided (T_{arrest} = T_{target}).When a “propagate” test result is included in the multiple test results at the same T_{target}, the T_{target} cannot to be decided as T_{arrest}. (C) CAT determination (a) When CAT is determined, one “propagate” test is needed in addition to two “arrest” tests. The target test temperature, T_{target} for “propagate” test is recommended to select 5 °C lower than T_{arrest}. The minimum temperature of T_{arrest} is determined as CAT. (b) With only the “arrest” tests, without “propagation” test, it is decided only that CAT is lower than T_{test} in the two “arrest” tests, i.e. not deterministic CAT. (9) Reporting The following items are to be reported. (A) Test material: grade and thickness (B) Test machine capacity (C) Test specimen dimensions: thickness t; width W and length L; notch details and length a_{MN}, side groove details if machined (D) Embrittled zone type: EBW or LTG embrittlement (E) Integrated specimen dimensions: Tab plate thickness, tab plate width, integrated specimen unit length including the tab plates, and distance between the loading pins, angular distortion and linear misalignment (F) Brittle crack trigger information: impact type or double tension. If impact type, drop weight type or air gun type, and applied impact energy.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
<New>	(G) Test conditions; Applied load; preload stress, test stress - Judgements for preload stress limit, hold time requirement under steady test stress. (H) Test temperature: complete temperature records with thermocouple positions for measured temperatures (figure and/or table) and target test temperature. - Judgements for temperature scatter limit in isothermal region. - Judgement for local temperature gradient requirements and holding time requirement after steady local temperature gradient before brittle crack trigger, if LTG system is used. (I) Crack path and fracture surface: tested specimen photos showing fracture surfaces on both sides and crack path side view; Mark at “embrittled zone tip” and“arrest” positions. - Judgment for crack path requirement. - Judgment for cleavage trigger location (whether side groove edge or V-notch edge). (J) Embrittled zone information: (a) When EBW is used: L_{EB-s1}, L_{EB-s2} and $L_{EB-\min}$ - Judgement for shear lip thickness requirement - Judgment whether brittle fracture appearance area continues from the EBW front line - Judgement for EBW defects requirement - Judgement for EBW lengths, L_{EB-s1}, L_{EB-s2} and $L_{EB-\min}$ requirements (b) When LTG is used: L_{LTG} - Judgment for shear lip thickness requirement (c) Test results: (ⅰ) When the specimen did not break into two pieces after brittle crack trigger, arrested crack length a_{arrest} (ⅱ) When the specimen broke into two pieces after brittle crack trigger, - judgement whether brittle crack re-initiation or not. (ⅲ) If so, arrested crack length a_{arrest}: - Judgement for a_{arrest} in the valid range ($0.3W < a_{arrest} \leq 0.7W$) - Final judgement either “arrest”, “propagate” or “invalid”	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)

Present	Amendment	reason
(K) <New>	(K) Dynamic measurement results: History of crack propagation velocity, and strain change at pin chucks, if needed	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020) - To reflect IACS UR W31(Rev.2 CR)
Section 3 Rolled Steels	**Section 3 Rolled Steels**	
301. ~ 310. <Omitted>	**301. ~ 310. <Same as the present Guidance>**	
~~311. YP47 Steel Plates~~	**311. <Deleted>**	
~~1. Application~~		
~~(1) The following (2) and (3) from "The requirements other than those specified in this instruction" in **311.** (4) of the Rules are to be in accordance with this Guidance.~~		
~~(2) In the case where YP47 steel is applied as brittle crack arrest steel required by **Pt 7, Annex 7-8** of the Guidance, the brittle crack arrest properties are to be in accordance with **2.**.~~		
~~(3) Brittle fracture toughness of welded joints is to comply with **Pt 2, Ch 2, Sec. 4** of the Rules and this Guidance.~~		
~~2. Brittle crack arrest properties~~		
~~Brittle crack arrest steel is defined as steel plate with measured crack arrest properties at manufacturing approval stage, $K_{ca} \geq 6{,}000\ N/mm^{3/2}$ at -10 ℃ or other methods based on the determination of Crack Arrest Temperature(CAT).~~		
~~(1) The Crack Arrest Fracture Toughness K_{ca} is to be determined by the ESSO Test shown in **203.** of this Guidance or other alternative method. Crack Arrest Temperature (CAT) may also be determined by the Double Tension Wide Plate Test or equivalent. The use of small scale test parameters such as the Nil Ductility Test Temperature (NDTT) may be considered provided that mathematical relationships of NDTT to K_{ca} or CAT can be shown to be valid.~~		
~~(2) Where the thickness of the steel exceeds 80 mm the required K_{ca} value or alternative crack arrest parameter for the brittle crack arrest steel plate is to be specifically agreed with the Society.~~		

Present	Amendment	reason
312. <New>	**312. Brittle crack arrest steels *(2021)***	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-71-2020)
	1. Brittle crack arrest properties	
	(1) The K_{ca} value in **Table 2.1.45** Note (3) of **312.** of the Rules are obtained by performing a brittle crack arrest test in accordance with **Pt 2**, **Ch 1**, **203. 1.** of the Guidance. **【See Rule】**	
	(2) The CAT in **Table 2.1.45** Note (4) of **312.** of the Rules are obtained by performing a test in accordance with **Pt 2**, **Ch 1**, **203. 4.** of the Guidance. **【See Rule】**	- To reflect IACS UR W31(Rev.2 CR)
Section 4 ~ Section 8 <Omitted>	**Section 4 ~ Section 8 <Same as the present Guidance>**	

Present	Amendment	reason
CHAPTER 2 WELDING **Section 1 <Omitted>** **Section 3 Welding Works and Inspection** **303. Application of welding consumables** Hydrogen cracking test specified in **303.** (4) of the Rules is to comply with *KS B ISO 17642-2* or equivalent. **[See Rule]** 2. <New> **304. ~ 309. <Omitted>** ~~**311. Welding works for YP47 Steel Plates [See Rule]**~~ ~~**1. Welder**~~ ~~Welders engaged in YP47 welding work are to possess welder's qualifications specified in **Pt 2, Ch 2, Sec 5** of the Rule.~~ ~~**2. Short bead**~~ ~~Short bead length for tack and repairs of welds by welding are not to be less than 50mm. In the case where P_{cm} is less than or equal to 0.19, 25mm of short bead length may be adopted with approval of the Society.~~ ~~**3. Preheating**~~ ~~Preheating is to be 50°C or over when air temperature is 5°C or below. In the case where P_{cm} is less than or equal to 0.19, air temperature of 0°C or below may be adopted with approval of the Society.~~	**CHAPTER 2 WELDING** **Section 1 <Same as the present Guidance>** **Section 3 Welding Works and Inspection** **303. Application of welding consumables** 1. Hydrogen cracking test specified in **303.** (4) of the Rules is to comply with *KS B ISO 17642-2* or equivalent. **[See Rule]** 2. In order to use 4Y46 and 5Y46 specified in **Table 2.2.3** Notes (6) of **303.** of the Rules, the manufacturer of the welding consumables is to be guaranteed that it can be used for EH47-H, and the welding procedure qualification test of the shipyard/manufacturer is to be carried out with satisfactory results in accordance with **Pt 2**, **Ch 2**, **Sec 4** of the Rules. *(2021)* **304. ~ 309. <Same as the present Guidance>** **311. <Deleted>**	Complimentary requirements for slight differences in strength

Present	Amendment	reason
4. Welding consumable (1) Specifications of welding consumables for YP47 steel plates are to be in accordance with **Table 2.2.5**. **Table 2.2.5 Mechanical properties for deposited metal tests for welding consumables** Mechanical Properties | Impact test Yield Strength (N/mm^2) min. | Tensile Strength (N/mm^2) | Elongation (%) min. | Test Temp. (°C) | Average Impact Energy (J) min. 460 | 570~720 | 19 | -20 | 53 (2) Consumable tests for butt weld assemblies are to be in accordance with **Table 2.2.6**. **Table 2.2.6 Mechanical properties for butt weld tests for welding consumables** Tensile strength (N/mm^2) | Bend test ratio: ($\frac{D}{t}$) | Charpy V-notch impact tests Test temp (°C) | Average energy (J) min. Downhand, horizontal-vertical, overhead | Vertical (upward and downward) 570~720 | 4 | - 20 | 53 | 53 **5. Others** (1) Special care is to be paid to the final welding so that harmful defects do not remain. (2) Jig mountings are to be completely removed with no defects in general, otherwise the treatment of the mounting is to be accepted by the Society. <hereafter, omitted>	<hereafter, same as the present Guidance>	

GUIDANCE RELATING TO THE RULES FOR THE CLASSIFICATION OF STEEL SHIPS

(Guidance Part 2 Materials and Welding)

- For external opinion inquiries -

2021. 01.

Machinery Rule Development Team

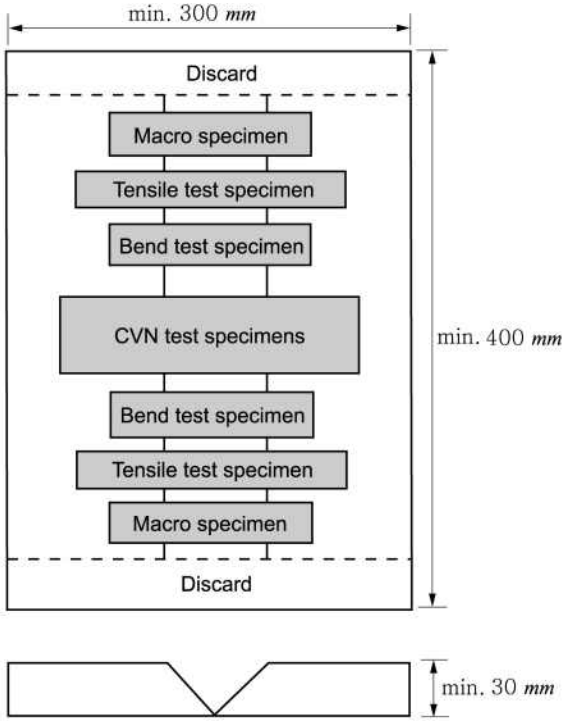
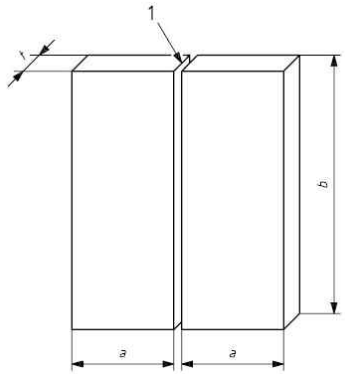
- Main Amendments -

(1) Enter into force on 1 July 2021 (the date of application for certification of material & welding or the contract date for ship construction)

◉ To reflect Request for Establishment/Revision of Classification Technical Rules
◉ To reflect IACS UR W24(Rev.4 July 2020)
◉ To reflect IACS UR W27(Rev.2 July 2020)
◉ To reflect IACS Rec.69(Rev.2 Oct 2020)

Present	Amendment	reason
CHAPTER 1 MATERIALS **Section 1 ~ Section 4 <Omitted>** **Section 5 Castings** **501. ~ 502. <Omitted>** **505. Stainless steel casting for propeller** **1. Application** "agreement with the Society" referred in **505. 1** (1) of the Rules includes the possible normal operation throughout the repair of propellers damaged in service. **【See Rule】** **2. Non-destructive inspection** (1) The liquid penetrant test of steel propeller casting specified in **505. 8** (1) of the Rules is to comply with **Annex 2-6.** **【See Rule】** (2) The division of severity zones of steel propeller casting specified in **505. 8** (2) is to comply with the **Figs. 1** and **2** of **Annex 2-6.** **【See Rule】**	**CHAPTER 1 MATERIALS** **Section 1 ~ Section 4 <Same as the present Guidance>** **Section 5 Castings** **501. ~ 502. <Same as the present Guidance>** **505. Stainless steel casting for propeller** **1. Application** "agreement with the Society" referred in **505. 1** (1) of the Rules includes the possible normal operation throughout the repair of propellers damaged in service. **【See Rule】** **2. Non-destructive inspection** (1) The liquid penetrant test of steel propeller casting specified in **505. 8** (1) of the Rules is to comply with **Annex 2-6**. Magnetic particle testing may be used in lieu of liquid penetrant testing for examination of martensitic stainless steels castings. Magnetic particle testing procedure is to be submitted to the Society and is to be in accordance with **ISO 9934-1:2016** or a recognized standard. The acceptance criteria is accordance with **Annex 2-6**. **【See Rule】** (2) The division of severity zones of steel propeller casting specified in **505. 8** (2) is to comply with the **Figs. 1** and **2** of **Annex 2-6.** **【See Rule】**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020) - To reflect IACS UR W27(Rev.2 July 2020)

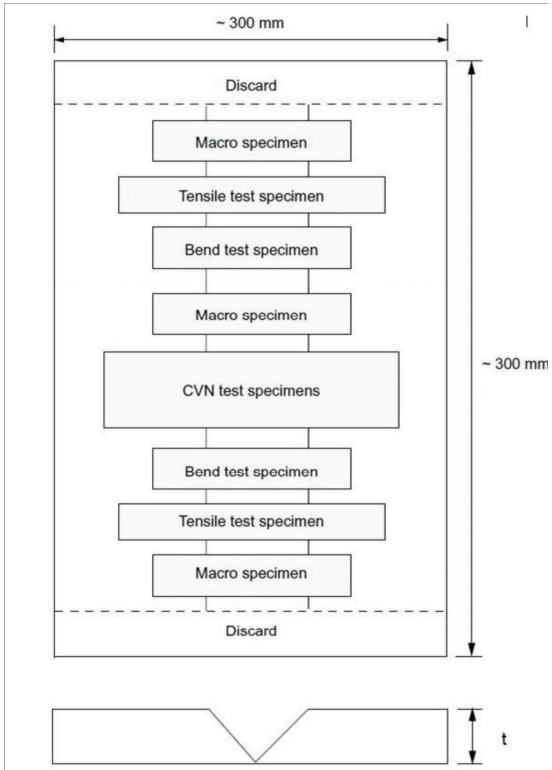
Present	Amendment	reason
3. Repair of defects In application to **505. 9** (4) of the Rules, the repair welding procedure is to comply with the followings **[See Rule]** (1) The limits of repair welding are to comply with **Annex 2-6, 3** (2) to (4). (2) **Repair welding procedure** When steel propeller casting is repaired by welding in accordance with the previous (1), the following requirements apply. (A) Before welding is started, a detailed welding procedure specification ~~is to be submitted~~ covering the weld preparation, welding positions, welding parameters, welding consumables, preheating, post weld heat treatment and inspection procedures to the Society. The welding procedure qualification tests are to carried out in accordance with following (3). (B) All weld repairs are to be made by welders qualified as deemed appropriate by the Society. (C) ~ (E) <New> (C) ~ (G) <Omitted>	**3. Repair of defects** In application to **505. 9** (4) of the Rules, the repair welding procedure is to comply with the followings **[See Rule]** (1) The limits of repair welding are to comply with **Annex 2-6, 3** (2) to (4). (2) **Repair welding procedure** When steel propeller casting is repaired by welding in accordance with the previous (1), the following requirements apply. (A) Before welding is started, manufacturer shall submit to the Society a detailed welding procedure specification covering the weld preparation, welding positions, welding parameters, welding consumables, preheating, post weld heat treatment and inspection procedures to the Society. The welding procedure qualification tests are to carried out in accordance with following (3). (B) All weld repairs are to be carried out in accordance with qualified procedures, and, by welders who are qualified to a recognized standard. Welding Procedure Qualification Tests are to be carried out in accordance with following (3) and witnessed by the Surveyor. (C) Defects to be repaired by welding are to be ground to sound material according to **505. 10.** of the Rules. (D) The welding grooves are to be prepared in such a manner which will allow a good fusion of the groove bottom. (E) The resulting ground areas are to be examined in the presence of the Surveyor by liquid penetrant testing in order to verify the complete elimination of defective material. (C) ~ (G) <Same as the present Guidance>	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020) - To reflect IACS UR W27(Rev.2 July 2020)

Present	Amendment	reason
(3) **Welding procedure qualification test** (A) *Preparation of test sample* The test sample is to be as shown **Fig 2.1.6** of the Guidance. The edge preparation, in principle, to be V-shape and bevel angle is to be not less than 60°. (B) *Non-destructive testing* The test sample is to be visually inspected and liquid penetrant tested. (C) *Macro-structure examination* Two macro-sections shall be prepared. No pores greater than 3 mm and cracks in welded sections is permitted.  **Fig 2.1.6 Test Sample for Butt Welding Test**	(3) **Welding procedure qualification tests for repair of cast steel propeller** (A) *General* (a) For the welding procedure approval the welding procedure qualification tests are to be carried out with satisfactory results. The qualification tests are to be carried out with the same welding process, filler metal, preheating and stress-relieving treatment as those intended applied by the actual repair work. Welding procedure specification is to refer to the test results achieved during welding procedure qualification testing. (b) Welding procedures qualified at a manufacturer are valid for welding in workshops under the same technical and quality management. (B) *Test piece and welding of sample* (a) The test assembly, consisting of cast samples, is to be of a size sufficient to ensure a reasonable heat distribution and according to **Fig 2.1.6** with the minimum dimensions.  Note) 1 : Joint preparation and fit-up as detailed in the preliminary Welding Procedure Specification a : minimum value 150mm b : minimum value 350mm t : material thickness **Fig 2.1.6 Test piece for welding repair procedure**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020) - To reflect IACS UR W27(Rev.2 July 2020)

<table>
<tr><th>Present</th><th>Amendment</th><th>reason</th></tr>
<tr>
<td>(D) Tensile testing
Two flat transverse tensile test specimens shall be prepared. The tensile strength shall meet the specified minimum value of the base material. The location of fracture is to be reported, i.e. weld metal, HAZ or base material.
(E) Bend testing
Two transverse side bend test specimens shall be prepared . The former diameter shall be 4 x thickness except for austenitic steels, in which case the former diameter shall be 3 x thickness.
The test specimen, when visually inspected after bending, shall show no surface imperfections greater than 2 mm in length.
(F) Impact testing
Impact test is not required, except where the base material is impact tested. Two sets shall be taken, one set with the notch positioned in the center of the weld and one set with the notch positioned in the fusion line, respectively. The test temperature, and impact energy shall comply with the requirement specified for the base material.
(G) Hardness testing
One of the macro-sections shall be used for Hv5 hardness testing. At least three individual indentations in the weld metal, the HAZ (both sides) and in the base material. The values are to be reported for information.</td>
<td>(b) Preparation and welding of test pieces are to be carried out in accordance with the general condition of repair welding work which it represents.
(c) Welding of the test assemblies and testing of test specimens are to be witnessed by the Surveyor.
(C) Examinations and tests
(a) Test assembly is are to be examined non-destructively and destructively in accordance with Table 2.1.17 and Fig 2.1.7.

Table 2.1.17 Type of tests and extent of testing
<table>
<tr><th>Type of test</th><th>Extent of testing</th></tr>
<tr><td>Visual testing</td><td>100% as per article (b)</td></tr>
<tr><td>Liquid penetrant testing(1)</td><td>100% as per article (b)</td></tr>
<tr><td>Transverse tensile test</td><td>Two specimens as per article (c)</td></tr>
<tr><td>Bend test(2)</td><td>Two root and two face specimens as per article (d)</td></tr>
<tr><td>Macro examination</td><td>Three specimens as per article (e)</td></tr>
<tr><td>Impact test</td><td>Two sets of three specimens as per article (f)</td></tr>
<tr><td>Hardness test</td><td>As per article (g)</td></tr>
<tr><td colspan="2">Notes:
1. Magnetic particle testing may be used in lieu of liquid penetrant testing for martensitic stainless steels.
2. For t≥12mm, the face and root bend may be substituted by 4 side bend test specimens.</td></tr>
</table>
</td>
<td>* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020)

- To reflect IACS UR W27(Rev.2 July 2020)</td>
</tr>
</table>

Present	Amendment	reason
	 **Fig 2.1.7 Weld test assembly**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020) - To reflect IACS UR W27(Rev.2 July 2020)

Present	Amendment	reason
<New>	(b) Non-destructive testing (i) Test assembly is to be examined by visual and liquid penetrant testing, or magnetic particle testing if applicable, prior to the cutting of test specimen. In case, that any post-weld heat treatment is required or specified, non-destructive testing is to be performed after heat treatment. (ii) No cracks are permitted. Imperfections detected by liquid penetrant testing, or magnetic particle testing if applicable, are to be assessed in accordance with **Annex 2-6**. (c) Tensile test (i) Two flat transverse tensile test specimens shall be prepared. Testing procedures shall be in accordance with **Pt2**, **Ch1**, **203.** of the Rules. Alternatively tensile test specimens according to recognized standards acceptable to the Society may be used. (ii) The tensile strength shall meet the specified minimum value of the base material. The location of fracture is to be reported, i.e. weld metal, HAZ or base material. (d) Bend test (i) Transverse bend tests for butt joints are to be in accordance with **Pt2**, **Ch2**, **204.** of the Rules, or, according to a recognized standard. The mandrel diameter shall be 4 x thickness except for austenitic steels, in which case the mandrel diameter shall be 3 x thickness. (ii) The bending angle is to be 180°. After testing, the test specimens are not to reveal any open defects in any direction greater than 3 mm. Defects appearing at the corners of a test specimen during testing are to be investigated case by case. (iii) Two root and two face bend specimens are to be tested. For thickness 12 mm and over, four side bend specimens may alternatively be tested.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020) - To reflect IACS UR W27(Rev.2 July 2020)

Present	Amendment	reason
<New>	(e) Macro-examination Two macro-sections shall be prepared and etched on one side to clearly reveal the weld metal, the fusion line, and the heat affected zone. Cracks and lack of fusion are not permitted. Imperfections such as slag inclusions, and pores greater than 3 mm are not permitted. (f) Impact test (ⅰ) Impact test is required, where the base material is impact tested. Charpy V-notch test specimens shall be in accordance with **Pt2**, **Ch1**, **202. 3.** of the Rules. Two sets shall be taken, one set with the notch positioned in the center of the weld and one set with the notch positioned in the HAZ (i.e. the mid-point of the notch shall be at 1 mm to 2 mm from the fusion line), respectively. (ⅱ) The test temperature, and impact energy shall comply with the requirement specified for the base material. (e) Hardness test The macro-section representing the start of welding shall be used for HV 10 hardness testing. Indentations shall traverse 2 mm below the surface. At least three individual indentations are to be made in the weld metal, the HAZ(both sides) and in the base metal(both sides). The values are to be reported for information. (f) Re-testing If the test piece fails to comply with any of the requirements of this Appendix, reference is made to re-test procedures given in **Pt2**, **Ch2**, **406. 1.** of the Rules. (D) *Test record* (a) Welding conditions for test assemblies and test results are to be recorded in welding procedure qualification. Forms of welding procedure qualification records can be accordance with an accepted form at the discretion of the Society.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020) - To reflect IACS UR W27(Rev.2 July 2020)

Present	Amendment	reason
<New>	(b) A statement of the results of assessing each test piece, including repeat tests, is to be made for each welding procedure qualification records. The relevant items listed for the WPS are to be included. (c) The welding procedure qualification record is to be signed by the Surveyor witnessing the test and is to include the Society's identification. (E) *Range of approval* (a) General (ⅰ) All the conditions of validity stated below are to be met independently of each other. Changes outside of the ranges specified are to require a new welding procedure test. (ⅱ) A qualification of a WPS obtained by a manufacturer is valid for welding in workshops or sites under the same technical and quality control of that manufacturer. (b) Base metal Range of approval for steel cast propeller is limited to steel grade tested. (c) Thickness The qualification of a WPS carried out on a weld assembly of thickness t is valid for the thickness range given in **Table 2.1.8**. Table 2.1.18 Range of qualification for thickness Thickness of the test piece, t (mm) / Range of approval(mm) 15 < t ≤ 30 / 3 ≤ T ≤ 2t 30 < t / 0.5t ≤ T ≤ 2t or 200 mm(whichever is the greater)	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020) - To reflect IACS UR W27(Rev.2 July 2020)

Present	Amendment	reason
<New>	(d) Welding position Approval for a test made in any position is restricted to that position. (e) Welding process The approval is only valid for the welding process used in the welding procedure test. Single run is not qualified by multi-run butt weld test. (f) Filler metal The approval is only valid for the filler metal used in the welding procedure test. (g) Heat input The upper limit of heat input approved is 15 % greater than that used in welding the test piece. The lower limit of heat input approved is 15 % lower than that used in welding the test piece. (h) Preheating and interpass temperature The minimum preheating temperature is not to be less than that used in the qualification test. The maximum interpass temperature is not to be higher than that used in the qualification test. (i) Post-weld heat treatment The heat treatment used in the qualification test is to be specified in pWPS. Holding time may be adjusted as a function of thickness.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020) - To reflect IACS UR W27(Rev.2 July 2020)
506. ~ 507. <Omitted>	**506. ~ 507. <Same as the present Guidance>**	
Section 6 ~ Section 8 <Omitted>	**Section 6 ~ Section 8 <Same as the present Guidance>**	
CHAPTER 2 WELDING <Omitted>	**CHAPTER 2 WELDING <Same as the present Guidance>**	

Present	Amendment	reason
Annex 2-1 <Omitted>	**Annex 2-1** <Same as the present Guidance>	
Annex 2-2 Guidance for non-destructive examination of marine steel castings	**Annex 2-2 Guidance for non-destructive testing of marine steel castings**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020)
1. Application	**1. Application**	
(1) The requirements in this Guidance is intended to give general guidance on the extent, methods and recommended quality levels applicable to the non-destructive examinations (NDE), of marine steel castings(hereinafter referred to as "castings") specified in **Pt 2, Ch 1, 501. 8** and **10** of the Rules, except in those cases where alternative criteria have been otherwise approved or specified.	(1) The requirements in this Guidance is intended to give general guidance on the extent, methods and recommended quality levels applicable to the non-destructive testing (NDT), of marine steel castings(hereinafter referred to as "castings") specified in **Pt 2, Ch 1, 501. 8** and **10** of the Rules, except in those cases where alternative criteria have been otherwise approved or specified.	- To reflect IACS Rec69(Rev.2 Oct 2020)
(2) Although no detailed Guidance are given for machinery components, the requirements in this Guidance may apply correspondingly considering their materials, kinds, shapes and stress conditions being subjected.	(2) Although no detailed Guidance are given for machinery components, the requirements in this Guidance may apply correspondingly considering their materials, kinds, shapes and stress conditions being subjected.	
(3) ~ (6) <New>	(3) Castings should be examined in the final delivery condition	
	(4) Where intermediate inspections have been performed the manufacturer should provide reports of the results upon the request of the Surveyor.	
	(5) Where a casting is supplied in semi-finished condition, the manufacturer should take into account the quality level of final finished machined components.	
	(6) Where advanced ultrasonic testing methods are applied, e.g. PAUT or TOFD, reference is made to **Annex 2-12**, for general approach in adopting and application of these advanced methods. Acceptance levels regarding accept/reject criteria are specified in this Guidance.	

Present	Amendment	reason
2. Personnel Requirements (1) Personnel carrying out NDE are generally to be qualified and certified to Level II of a recognised certification scheme such as *KS B ISO* 9712, *SNT-TC-1A*, *EN* 473, *ASNT Central Certification Program* (*ACCP*) or equivalent. (2) Personnel responsible for the NDE activity including approval of procedures should be qualified and certified to Level III. (3) Personnel qualifications are to be verified by certification.	**2. Personnel Requirements** (1) Personnel engaged in visual examination are to have sufficient knowledge and experience, however, may be exempted from formal qualifications specified in this Recommendation. (2) Personnel carrying out NDT should be certified to a recognised national or international certification scheme, e.g. ISO 9712:2012, or an employer based scheme such as SNT-TC-1A:2016, or ANSI/ASNT CP-189:2016. Where employer based schemes are applied, personnel qualification to these schemes may be accepted if the written practice is reviewed and found acceptable by the Society. The written practice should align with the main requirements with those of ISO 9712 (apart from the impartiality requirements of a certification body). (3) Personnel responsible for the NDT activity including approval of procedures should be qualified and certified to Level III. (4) The NDT personnel's certificates and competence should comprise all industrial sectors and techniques being applied by the manufacturer or its subcontractors. Certificates should be made available to the Society for verification, when requested. (5) The operator carrying out the NDT and interpreting indications, should as a minimum, be qualified and certified to Level II in the NDT method(s) concerned. However, operators only undertaking the gathering of data using any NDT method and not performing data interpretation or data analysis may be qualified and certified as appropriate, at level I. The operator should have adequate knowledge of materials, weld, structures or components, NDT equipment and limitations that are sufficient to apply the relevant NDT method for each application appropriately.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS Rec69(Rev.2 Oct 2020)

Present	Amendment	reason
3. Casting Condition (1) Non-destructive examinations applied for acceptance purposes should be made after the final heat treatment of the casting. Where intermediate inspections have been performed the manufacturer shall furnish the documentation of the results upon request of the Surveyor. (2) Castings are to be examined in the final delivery condition free from any material such as scale, dirt, grease or paint that might affect the efficacy of the inspection. A thin coating of contrast paint is permissible when using magnetic particle techniques. (3) ~~Unless otherwise specified in the order, magnetic particle test shall be carried out within 0.3 mm of the final machined surface condition for *AC* techniques or within 0.8 mm for *DC* techniques.~~ (4) Ultrasonic testing is to be carried out after the castings have been ground, machined or shot blasted to a suitable condition. The surfaces of castings to be examined should be such that adequate coupling can be established between the probe and the casting and that excessive wear of the probe is avoided.	**3. Casting Condition** (1) Non-destructive testing applied for acceptance purposes to support final casting certification should be made after the final heat treatment of the casting. Where intermediate inspections have been performed the manufacturer should provide reports of the results upon request of the Surveyor. (2) Castings should be examined in the final delivery condition free from any material such as scale, dirt, grease or paint that might affect the effectiveness of the inspection. A thin coating of contrast paint is permissible when using magnetic particle techniques. For surface inspection NDT methods, the surface quality should be a minimum value of Ra≤6.3 μm. (3) <Deleted> (3) Ultrasonic testing should be carried out after the castings have been ground, machined or shot blasted to a suitable condition, with a minimum value surface quality of Ra≤12,5 μm. The surfaces of castings to be examined should be such that adequate coupling can be established between the probe and the casting and that excessive wear of the probe is avoided.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS Rec69(Rev.2 Oct 2020)

Present	Amendment	reason
4. Extent of Examinations (1) **Castings to be examined** Castings to be examined by NDE methods are identified in **Fig 1** to **Fig 3** of this Guidance. Criteria for the examination of other castings not identified in **Fig 1** to **Fig 3** of this Guidance will be subject to agreement. (2) **Zones to be examined** (A) Zones to be examined in nominated castings are identified in **Fig 1** to **Fig 3** of this Guidance. Examinations are to be made in accordance with an inspection plan approved by the Society. The plan should specify the extent of the examination, the examination procedure, the quality level or, if necessary, level for different locations of the castings. (B) In addition to the areas identified in **Fig 1** and **Fig 2** of this Guidance, surface inspections shall be carried out in the following locations: (a) at all accessible fillets and changes of section, (b) in way of fabrication weld preparation, for a band width of 30mm, (c) in way of chaplets, (d) in way of weld repairs, (e) at positions where surplus metal has been removed by flame cutting, scarifying or arc-air gouging. (C) Ultrasonic testing shall be carried out in the zones indicated in **Fig 1** and **Fig 3** of this Guidance and also at the following locations: (a) in way of all accessible fillets and at pronounced changes of section, (b) in way of fabrication weld preparations for a distance of 50 mm from the edge, (c) in way of weld repairs where the original defect was detected by ultrasonic testing. (d) in way of riser positions, (e) in way of machined areas particularly those subject to further machining such as bolt	**4. Extent of Inspections** (1) **Castings to be examined** Castings to be examined by NDT methods are identified in **Fig 1** to **Fig 3** of this Guidance. Criteria for the examination of other castings not identified in **Fig 1** to **Fig 3** of this Guidance will be subject to agreement. (2) **Zones to be examined** (A) Zones to be examined in nominated castings are identified in **Fig 1** to **Fig 3** of this Guidance. Testing should be made in accordance with an inspection plan approved by the Society. The plan should specify the extent of the testing, the testing procedure, the quality level or, if necessary, level for different locations of the castings. (B) In addition to the areas identified in **Fig 1** and **Fig 2** of this Guidance, surface inspections should be carried out in the following locations: (a) at all accessible fillets and changes of section, (b) in way of fabrication weld preparation, for a band width of 30mm, (c) in way of chaplets, (d) in way of weld repairs, (e) at positions where surplus metal has been removed by flame cutting, scarifying or arc-air gouging. (C) Ultrasonic testing shall be carried out in the zones indicated in **Fig 1** and **Fig 3** of this Guidance and also at the following locations: (a) in way of all accessible fillets and at pronounced changes of section, (b) in way of fabrication weld preparations for a distance of 50 mm from the edge, (c) in way of weld repairs where the original defect was detected by ultrasonic testing. (d) in way of riser positions, (e) in way of machined areas particularly those subject to further machining such as bolt	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS Rec69(Rev.2 Oct 2020)

Present	Amendment	reason
5. Examination Procedures	**5. Examination Procedures**	
(1) **Visual Inspection** Steel castings nominated for NDE shall be subjected to a 100% visual examination of all accessible surfaces by the Surveyor. Lighting conditions at the inspected surfaces shall be in accordance with a nationally or internationally recognised standard. Unless otherwise agreed, the visual and surface ~~crack detection~~ inspections are to be carried out in the presence of the Surveyor.	(1) **Visual Inspection** Steel castings nominated for NDT should be subjected to a 100% visual examination of all accessible surfaces by the manufacturer and made available to the Surveyor. Viewing conditions at the inspected surfaces should be in accordance with a nationally or internationally recognised standard. Unless otherwise agreed, the visual and surface inspections should be carried out in the presence of the Surveyor.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS Rec69(Rev.2 Oct 2020)
(2) **Surface Crack Detection** (a) Magnetic particle inspection will be carried out in preference to liquid penetrant testing except in the following cases; (i) austenitic stainless steels, (ii) interpretation of open visual or magnetic particle indications, (iii) at the instruction of the Surveyor. (b) The testing procedures, apparatus and conditions of magnetic particle testing and liquid penetrant testing other than those specified in this Guidance are to comply with recognised national or international standards. (c) <New>	(2) **Surface Inspection** (a) Magnetic particle testing is preferable to penetrant testing except in the following cases; (i) austenitic stainless steels, (ii) interpretation of open visual or magnetic particle indications, (iii) at the instruction of the Surveyor, where a paricular need for penetrant testing has been identified. (b) The testing procedures, apparatus and conditions of magnetic particle testing and liquid penetrant testing other than those specified in this Guidance are to comply with recognised national or international standards. (c) AC magnetisation method should normally be used, as it is more sensitive for detecting surface indications. Where DC magnetisation method is used, this should be in agreement with the Society, and the reason for use clearly stated.	
(c) Magnetic particle testing is to be carried out along two directions so that magnetic field can be directed at an right angle each other by means of the wet prod methods or the yoke method. In making magnetization by the prod method, the distance between prods is to be 200～300 mm. The magnetizing current is to be *DC* 800～1200 *A* for the prod method. For the yoke method, lifting power is to be 4.5 kg for *AC*, 18 kg over for *DC*.	(c) Magnetic particle testing is to be carried out along two directions so that magnetic field can be directed at an right angle each other by means of the wet prod methods or the yoke method. In making magnetization by the prod method, the distance between prods is to be 200～300 mm. The magnetizing current is to be *DC* 800～1200 *A* for the prod method. For the yoke method, lifting power is to be 4.5 kg for *AC*, 18 kg over for *DC*.	
(d) For magnetic particle testing attention is to be paid to the contact between the casting and the clamping devices of stationary magnetisation benches in order to avoid local overheating or burning damage in its surface. Prods shall not be permitted on finished machined items. Note that the use of solid copper at the prod tips must be avoided due to the risk of copper penetration.	(d) For magnetic particle testing attention is to be paid to the contact between the casting and the clamping devices of stationary magnetisation benches in order to avoid local overheating or burning damage in its surface. Prods should not be permitted on finished machined items. Note that the use of solid copper at the prod tips must be avoided due to the risk of copper contamination into the casting. The pole of the magnets should have close contact with the component.	

Present	Amendment	reason
(e) When indications have been detected as a result of the surface inspection, acceptance or rejection is to be decided in accordance with **Art 6**.	(e) When indications have been detected as a result of the surface inspection, acceptance or rejection should be decided in accordance with **Art 6**.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS Rec69(Rev.2 Oct 2020)
(3) **Ultrasonic testing**	(3) **Volumetric Inspection**	
(a) Volumetric inspection in accordance with these guidance is to be carried out by ultrasonic testing using the contact method with straight beam and/or angle beam technique. The testing procedures, apparatus and conditions of ultrasonic testing are to comply with the recognised national or international standards. ~~Radiographic testing may be carried out on the basis of prior agreement with the Society.~~	(a) Volumetric inspection in accordance with these guidance is normally to be carried out by ultrasonic testing using the contact method with normal(0°) beam and/or angle beam technique. The testing procedures, apparatus and conditions of ultrasonic testing should comply with the recognised national or international standards.	
(b) <New>	(b) In some cases, due to the shape, nature, complexity of casting, or defect type or orientation, there may be a need for radiographic testing. In such cases, radiographic testing may be carried out on the basis of prior agreement with the Society. Where radiographic testing is to be applied, national or international standards for both the testing method, and the quality or severity level to be applied, should be agreed with the Society. These following examples are suitable national or international standards as appropriate to the radiographic testing of castings, and casting thickness. - ASTM E446–15 - ASTM E186–15(2019) e1 - ASTM E280–15(2019) e1 - ISO 4993:2015 A suitable quality level for marine castings would normally be severity level 2 or 3 (of the above standards), depending on the location zone and type of casting. Other severity levels may be applied, and should be agreed with the Society.	
(b) Only those areas shown in the agreed inspection plan need to be tested. The plan should include those locations nominated in **4.** (2), (c) together with the scanning zones identified for the relevant casting in **Fig 1** to **Fig 3**.	(c) Only those areas shown in the agreed inspection plan need to be tested, however, the inspections may reveal indications that require further evaluation, or an extension of testing. In such cases, this should be agreed with the Society. The plan should include those locations nominated in **4.** (2), (c) together with the scanning zones identified for the relevant casting in **Fig 1** to **Fig 3**.	

Present	Amendment	reason
(c) Ultrasonic scans are to be made using a normal probe of 1~4 MHz (usually 2 MHz) frequency. Whenever possible scanning is to be performed from both surfaces of the casting and from surfaces perpendicular to each other. (d) The back-wall echo obtained on parallel sections should be used to monitor variations in probe coupling and material attenuation. Any reduction in the amplitude of the back-wall echo without evidence of intervening defects should be corrected. Attenuation in excess of 30dB could be indicative of an unsatisfactory annealing heat treatment. (e) Machined surfaces, especially those in the vicinity of riser locations and in the bores of stern boss castings, should also be subject to a near surface (25 mm) scan using a twin crystal 0o probe. Additional scans on machined surfaces are of particular importance in cases where bolt holes are to be drilled or where surplus material such as 'padding' has been removed by machining thus moving the scanning surface closer to possible areas of shrinkage. Also, it is advisable to examine the machined bores of castings using circumferential scans with 70° probes in order that axial radial planar flaws such as hot tears can be detected. Fillet radii should be examined using 45°, 60°, or 70° probes scanning from the surfaces/direction likely to give the best reflection.	(d) Ultrasonic scans should be made using a normal probe of 1~4 MHz (usually 2 MHz) frequency, and angle probes, where required. Whenever possible scanning is to be performed from both surfaces of the casting and from surfaces perpendicular to each other. (e) The back-wall echo obtained on parallel sections should be used to monitor variations in probe coupling and material attenuation. Any reduction in the amplitude of the back-wall echo due to material properties should be corrected. Attenuation in excess of 30dB/m could be indicative of an unsatisfactory annealing heat treatment, and may render the effectiveness of the testing as unsuitable. In such cases of excessive attenuation, this should be investigated, and suitable mitigation measures carried out for effective ultrasonic testing to continue, where possible. (f) Machined surfaces, especially those in the vicinity of riser locations and in the bores of stern boss castings, should also be subject to a near surface (approximately 25 mm) scan using a twin crystal 0° probe. Additional scans on machined surfaces are of particular importance in cases where bolt holes are to be drilled or where surplus material such as 'padding' has been removed by machining thus moving the scanning surface closer to possible areas of shrinkage. Additionally it is good practice to examine the machined bores of castings using circumferential scans with 70° probes in order that axial radial planar flaws such as hot tears can be detected. Fillet radii should be examined using 45°, 60°, or 70° probes scanning from the surfaces/direction likely to give the best reflection, primarily to determine the presence of any cracks within the radiused areas, and as an additional scan to confirm any indications that may have been detected with 0° probe(s) within this area.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS Rec69(Rev.2 Oct 2020)

Present	Amendment	reason
(f) In the examinations of those zones nominated for ultrasonic examination the reference sensitivity is to be established against a 6mm diameter disk reflector. Sensitivity can be calibrated either against 6mm diameter flat bottomed hole(s) in a reference block (or series of blocks) corresponding to the thickness of the casting provided that a transfer correction is made, or, as a preferred alternative, by using the *DGS* (distance-gain-size) method.	(g) In the examinations of those zones nominated for ultrasonic examination the reference sensitivity for the 0° probe should be established against a 6mm diameter disk reflector. Sensitivity can be calibrated either against 6mm diameter flat bottomed hole(s) in a reference block (or series of blocks) corresponding to the thickness of the casting provided that a transfer correction is made, using the DAC(distance-amplitude-correction) method, or, by using the *DGS* (distance-gain-size) method.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS Rec69(Rev.2 Oct 2020)
(h) <New>	(h) The reference sensitivity of angle probes (where required for testing) should be established against an appropriate 6mm reflector (e.g. reference reflectors angled perpendicular to the sound beam) for the DAC method, or equivalent using the DGS method.	
The DGS diagrams issued by a probe manufacturer identify the difference in dB between the amplitude of a back wall echo and that expected from a 6mm diameter disk reflector. By adding this difference to the sensitivity level initially set by adjusting a back wall echo to a reference height eg 80 %, the amended reference level will be representative of a 6mm diameter disk reflector. Similar calculations can be used for evaluation purposes to establish the difference in dB between a back wall reflector and disk reflectors of other diameters such as 12 or 15 mm.	(i) The DGS diagrams issued by a probe manufacturer identify the difference in dB between the amplitude of a back wall echo and that expected from a 6mm diameter disk reflector. By adding this difference to the sensitivity level initially set by adjusting a back wall echo to a reference height e.g. 80 %, the amended reference level will be representative of a 6mm diameter disk reflector. Similar calculations can be used for evaluation purposes to establish the difference in dB between a back wall reflector and disk reflectors of other diameters such as 12 or 15 mm.	
(g) Having made any necessary corrections for differences in attenuation or surface condition between the reference block and the casting any indications received from the nominated zones in the casting that exceed the 6mm reference level should be marked for evaluation against the criteria given in **6.** (3) below. Evaluation should include additional scans with angle probes in order that the full extent of the discontinuity can be plotted.	(j) Having made any necessary corrections for differences in attenuation or surface condition between the reference block and the casting any indications received from the nominated zones in the casting that exceed the 6mm reference level should be marked for evaluation against the criteria given in **6.** (3) below. Evaluation should include additional scans with angle probes in order that the full extent of the discontinuity can be plotted.	

Present	Amendment	reason
6. Acceptance Criteria (1) **Visual Testing** (a) All castings shall be free of cracks, crack-like indications, hot tears, cold shuts or other injurious indications. Thickness of the remains of sprues or risers is to be within the casting dimensional tolerance. (b) Additional magnetic particle, ~~dye~~ penetrant or ultrasonic testing may be required for a more detailed evaluation of surface irregularities at the request of the Surveyor. (2) **Surface Crack Detection** (A) The following definitions relevant to indications apply: (a) Linear indication : an indication in which the length is at least three times the width. (b) Non-linear indication : an indication of circular or elliptical shape with a length less than three times the width. (c) Aligned indication : three or more indications in a line, separated by 2 mm or less edge-to-edge. (d) Open indication : an indication visible after removal of the magnetic particles or that canbe detected by the use of ~~contrast dye~~ penetrant. (e) Non-open indication : an indication that is not visually detectable after removal of the magnetic particles or that cannot be detected by the use of ~~contrast dye~~ penetrant. (f) Relevant indication : an indication that is caused by a condition or type of discontinuity that requires evaluation. Only the indications which have any dimension greater than 1.5 mm shall be considered relevant.	**6. Acceptance Criteria** (1) **Visual Inspection** (a) All castings should be free of cracks, crack-like indications, hot tears, cold shuts or other detrimental indications. Thickness of the remains of sprues or risers should be within the casting dimensional tolerance. (b) Additional magnetic particle, penetrant or ultrasonic testing may be required for a more detailed evaluation of surface irregularities at the request of the Surveyor. (2) **Surface Crack Detection** (A) The following definitions relevant to indications apply: (a) Linear indication : an indication with a largest dimension three or more times its smallest dimension (i.e. l ≥ 3 w). (b) Non-linear indication : an indication with a largest dimension less than three times its smallest dimension (i.e. l < 3w). (c) Aligned indication : three or more indications in a line, separated by 2 mm or less edge-to-edge, which results in a unique indication, defined as follows: (i) Non-linear indications form an alignment when the distance between indications is less than 2mm and at least three indications are aligned. An alignment of indications is considered to be a unique indication and its length is equal to the overall length of the alignment. (ii) Linear indications form an alignment when the distance between two indications is smaller than the length of the longest indication. (d) Open indication : an indication visible after removal of the magnetic particles or that canbe detected by the use of penetrant testing. (e) Non-open indication : an indication that is not visually detectable after removal of the magnetic particles or that cannot be detected by the use of contrast dye penetrant testing. (f) Relevant indication : an indication that is caused by a condition or type of discontinuity that requires evaluation. Only the indications which have any dimension greater than 1.5 mm should be considered relevant for the categorization of indications.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS Rec69(Rev.2 Oct 2020)

Present

(B) For the purpose of evaluating indications, the surface is to be divided into reference band length of 150 mm for level MT1/PT1 and into reference areas of 225 cm^2 for level MT2/PT2. The band length and/or area shall be taken in the most unfavourable location relative to the indications being evaluated.

(C) The following quality levels recommended for magnetic particle testing (MT) and/or ~~liquid~~ penetrant testing (PT) are;

Level MT1/PT1 - fabrication weld preparation and weld repairs.
Level MT2/PT2 - other locations nominated for surface crack detection in **Fig 1** and **Fig 2**

The allowable numbers and sizes of indications in the reference band length and/or area are given in **Table 1.** The required quality level should be shown on the manufacturer's inspection plan. Cracks and hot tears are not acceptable.

Table 1 Allowable number and size of indications in a reference band length/area

Quality Level	Max. number of indications	Type of indication	Max. number for each type	Max. dimension of single indication, (mm)(2)
MT1/PT 1	4 in 150 mm length	Non-linear Linear Aligned	4(1) 4(1) 4(1)	5 3 3
MT2/PT 2	20 in 22500 ㎟ area	Non-linear Linear Aligned	10 6 8	7 5 5

Notes:
(1) 30 mm min. between relevant indications.
(2) In weld repairs, the maximum dimension is 2 mm.

Amendment

(B) For the purpose of evaluating indications, the surface should be divided into reference band length of 150 mm for level MT1/PT1 and into reference areas of 225 cm^2 for level MT2/PT2. The band length and/or area should be taken in the most unfavourable location relative to the indications being evaluated.

(C) The following quality levels recommended for magnetic particle testing (MT) and/or penetrant testing (PT) are;

Level MT1/PT1 - fabrication weld preparation and weld repairs.
Level MT2/PT2 - other locations nominated for surface inspection in **Fig 1** and **Fig 2**

The allowable numbers and sizes of indications in the reference band length and/or area are given in **Table 1.** The required quality level should be shown on the manufacturer's inspection plan. Cracks and hot tears should not be accepted.

Table 1 Allowable number and size of indications in a reference band length/area

Quality Level	Total maximum number of all indications	Type of indication	Maximum number of each type of indication	Maximum dimension of single indication, (mm)(2)
MT1/PT 1	4 in 150 mm length	Non-linear Linear Aligned	4(1) 4(1) 4(1)	5 3 3
MT2/PT 2	20 in 22500 ㎟ area	Non-linear Linear Aligned	10 6 8	7 5 5

Notes:
(1) 30 mm minimum(measured in any direction) between relevant indications.
(2) In weld repairs, the maximum dimension is 2 mm.

reason

* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020)

- To reflect IACS Rec69(Rev.2 Oct 2020)

Present

(3) **Ultrasonic testing**

(A) Acceptance criteria for ultrasonic testing are identified in **Table 2** as UT1 and UT2. As stated in **4** (2), (a), the quality levels applicable to the zones to be examined are to be identified on an inspection plan. The following quality levels are nominated for the castings identified in **Fig 1** and **Fig 3.**

Table 2 Ultrasonic Acceptance Criteria for steel castings

Quality Level	Allowable disc shape according to *DGS*(1) (mm)	Max. number of indications to be registered(2)	Allowable length of linear indications (mm)(3)
UT1	> 6	0	0
UT2	12-15 > 15	5 0	50 0

Notes:
(1) *DGS*: distance-gain size.
(2) grouped in an area measuring 300 x 300 mm
(3) measured on the scanning surface

Amendment

(3) **Volumetric Inspection**

(A) Acceptance criteria for ultrasonic testing are identified in **Table 2** as UT1 and UT2. As stated in **4** (2), (a), the quality levels applicable to the zones to be examined should be identified on an inspection plan. The following quality levels are nominated for the castings identified in **Fig 1** and **Fig 3.**

Table 2 Ultrasonic Acceptance Criteria for steel castings

Quality Level	Allowable disc shape according to *DGS*(1) (mm) or diameter of FBH according to DAC(2)(3) Curve(mm)	Maximum number of indications to be registered(4)	Allowable size of all relevant indications (mm)(5)(6)
UT1	> 6	0	0
UT2	12-15 > 15	5 0	50 0

Notes:
(1) DGS: distance-gain size.
(2) DAC: Distance Amplitude Correction
(3) The corresponding DAC level to each of the FBH reflectors is at 100% DAC
(4) grouped in an area measuring 300 x 300 mm
(5) measured on the scanning surface
(6) the measured indication is regarded as the longest dimension, as measured in the scanning process

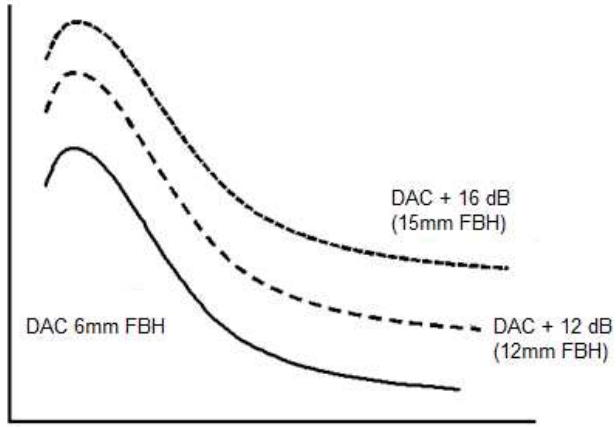
reason

* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020)

- To reflect IACS Rec69(Rev.2 Oct 2020)

Present	Amendment	reason
(B) Level UT1 is applicable to: (a) fabrication weld preparations for a distance of 50 mm, (b) 50 mm depth from the final machined surface including bolt holes and fillet radii to a depth of 50 mm and within distance of 50 mm from the radius end, (c) castings subject to cyclic bending stresses e.g. rudder horn, rudder castings and rudder stocks - the outer one third of thickness in the zones nominated for volumetric examination by **Fig 1** and **Fig 3.** (d) discontinuities within the examined zones interpreted to be cracks or hot tears. (C) Level UT2 is applicable to: (a) other locations nominated for ultrasonic testing in **Fig 1** and **Fig 3** or on the inspection plan. (b) positions outside locations nominated for level UT1 examination where feeders and gates have been removed (c) castings subject to cyclic bending stresses - at the central one third of thickness in the zones of nominated for volumetric inspection by **Fig 1** and **Fig 3**. (D) <New> (D) Ultrasonic acceptance criteria for other casting areas not nominated in **Fig 1** and **Fig 3** will be subject to special consideration based on the anticipated stress levels and the type, size and position of the discontinuity.	(B) Level UT1 is applicable to: (a) fabrication weld preparations for a distance of 50 mm, (b) 50 mm depth from the final machined surface including bolt holes and fillet radii to a depth of 50 mm and within distance of 50 mm from the radius end, (c) castings subject to cyclic bending stresses e.g. rudder horn, rudder castings and rudder stocks - the outer one third of thickness in the zones nominated for volumetric inspection by **Fig 1** and **Fig 3.** (d) discontinuities within the examined zones interpreted to be cracks or hot tears. (C) Level UT2 is applicable to: (a) other locations nominated for ultrasonic testing in **Fig 1** and **Fig 3** or on the inspection plan. (b) positions outside locations nominated for level UT1 examination where feeders and gates have been removed (c) castings subject to cyclic bending stresses - at the central one third of thickness in the zones of nominated for volumetric inspection by **Fig 1** and **Fig 3**. (D) For near surface testing (to an approximate depth of 25 mm) twin crystal 0° (normal beam) probe should be used, plus a 0° probe (usually single crystal beyond a depth of 25 mm) for the remaining volume. (E) Ultrasonic acceptance criteria for other casting areas not nominated in **Fig 1** and **Fig 3** should be subject to special consideration based on the anticipated stress levels and the type, size and position of the discontinuity.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS Rec69(Rev.2 Oct 2020)

Present	Amendment	reason
(F) ~ (L) <New>	(F) DGS and DAC methods may be used for determining sensitivity. The DAC method for normal beam probes may be based on a 6.0 mm diameter reflector or flat bottomed hole (FBH). A DAC curve should be produced using reference blocks containing 6.0 mm FBH reflectors over a range representative of the inspection thickness, after adjustment for transfer and attenuation losses, (G) For quality level UT 1, any discontinuity producing a signal amplitude in excess of the 6.0 mm DAC curve is unacceptable. (H) For quality level UT2, the sensitivity may be based on actual size FBH (of 12 mm and 15 mm) or based on equivalent 6 mm FBH, and the sensitivity adjusted to obtain equivalent amplitudes, as described in (I). (I) For use of FBH of 6 mm for setting sensitivity, adjustment of signal amplitudes (measured in dB above 6 mm DAC) can be determined for 12 mm and 15 mm FBH reflectors: to be DAC + 12dB and DAC + 16dB (plus any compensation for transfer and attenuation losses). This is illustrated in Figure 1. The increase in dB to the indicated levels represent the equivalent FBH sizes (for 12 mm and 15 mm), and their respective corresponding ultrasonic response amplitudes. (J) The maximum number of indications to be registered and the maximum length of indications permissible for quality level 2 (as stated in **Table 2**) apply to normal probes. (K) For quality level UT 2, any discontinuity producing a signal amplitude in excess of the 15.0 mm DAC curve should be regarded as unacceptable. (L) Any signal between 12 + 15 curve should be evaluated for length of defect, and referred to **Table 2** for acceptance	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS Rec69(Rev.2 Oct 2020)

Present	Amendment	reason
Fig 4 <New>	 (Notes) (1) The bottom curve (DAC) represents a sensitivity based on 6mm FBH, and the two additional curves (DAC + 12 and DAC + 16dB) above this represent the equivalent sensitivities converted for larger FBH's (12mm and 15mm). (2) When scanning using these curves, and applying **Table 2** acceptance criteria, for UT2, any indication below DAC +12mm should be disregarded, and any indication above DAC +16mm should be rejected. (3) Any indication between these two curves should be evaluated according to its size, as per **Table 2**. **Fig 4 DAC curve produced from 6.0 mm FBH reflector and DAC curves adjusted to represent equivalent 12.0 mm and 15.0 mm FBH reflectors**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS Rec69(Rev.2 Oct 2020)

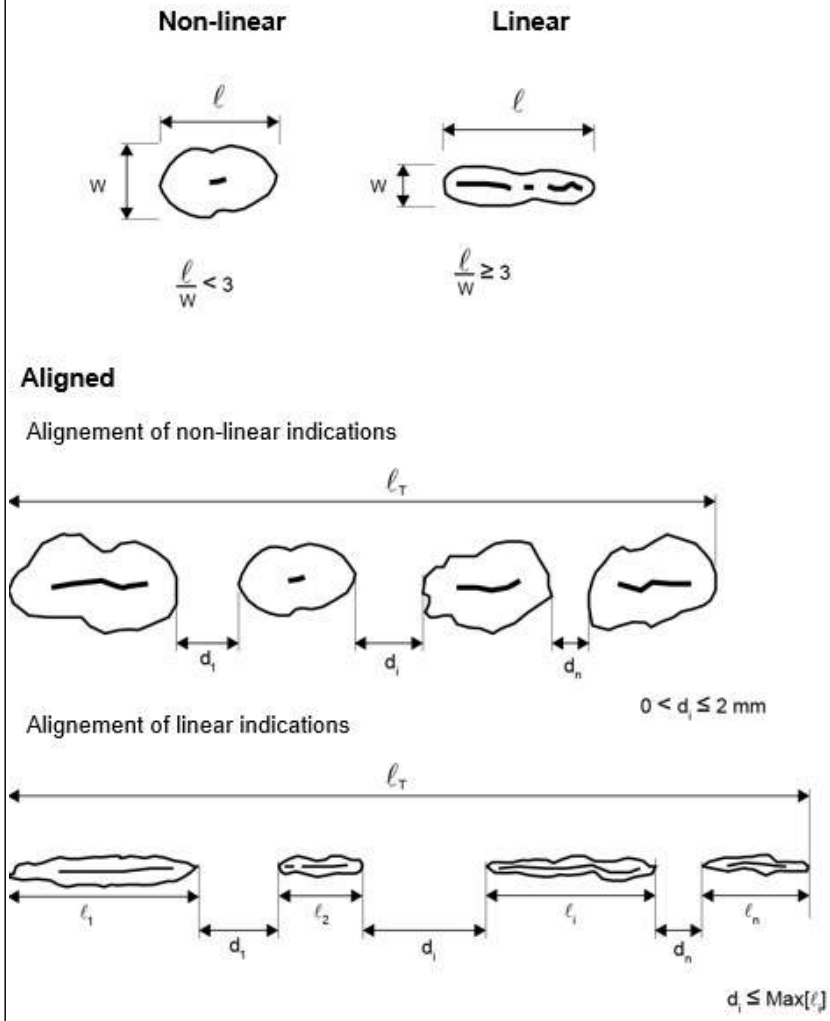
Present	Amendment	reason
7. Reporting (1) All reports of non-destructive examinations should include the following items; (a) Date of testing. (b) Names and qualification level of inspection personnel. (c) Type of casting. (d) Product number for identification. (e) Grade of steel. (f) Heat treatment. (g) Stage of testing. (h) Locations for testing. (i) Surface condition. (j) Test standards used. (k) Results. (l) Statement of acceptance / non-acceptance. (m) Locations of reportable indications. (n) Details of weld repairs including sketches. (2) In addition to the items listed in **7** (1), reports of surface ~~crack detection~~ inspections are to include at least the following items: (a) for liquid penetrant testing; the consumables used, (b) for magnetic particle testing: method of magnetising, test media and magnetic field strength. (c) ~ (e) <New> (3) In addition to the items listed in **7** (1), reports of ultrasonic inspection should include at least the following items: (a) flaw detector, probes, calibration blocks and couplant used.	**7. Reporting** (1) All reports of non-destructive examinations should include the following items; (a) Date of testing. (b) Name(s), signature(s) and qualification level of inspection personnel. (c) Type of casting. (d) Product number and unique identification. (e) Grade of steel. (f) Heat treatment. (g) Stage of testing. (h) Locations for testing. (i) Surface condition. (j) Test standards used including reference to the appropriate tables for acceptance purposes (k) Results including documentation regarding the repair and testing history(as appropriate); (l) Statement of acceptance / non-acceptance. (m) Locations of reportable indications. (n) Details of weld repairs including sketches(where applicable). (2) In addition to the items listed in **7** (1), reports of surface inspections should include at least the following items: (a) for liquid penetrant testing; the penetrant system used, (b) for magnetic particle testing: method of magnetising, test media and magnetic field strength and magnetic flux indicators(where appropriate). (c) viewing conditions (as appropriate to the penetrant or magnetic technique and media used) (d) testing details and procedure number (e) details of any test restrictions (3) In addition to the items listed in **7** (1), reports of ultrasonic inspection should include at least the following items: (a) flaw detector probe type, size, angle and frequency (and any adaptions to probes for curved surfaces), calibration and reference blocks, sensitivity method (including reflector size, transfer correction), maximum scanning rate (mm/s), and couplant.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS Rec69(Rev.2 Oct 2020)

Present	Amendment	reason
8. Rectification of Defects (1) **General** (a) Defects and unacceptable indications must be repaired as indicated below. (b) In either case where, after removing defects, the steel castings are used as they are or repair welding are carried out approval of the surveyor is to be obtained. In case where the depth of the recess after removing the defects is not larger than 15 mm (or 10 % of the thickness of the steel castings, whichever is smaller) and the length is not more than 100 mm, the steel castings may be used without repair welding. (c) <New> (2) **Rectification of Defects** Defective parts of material are to be completely removed either by grinding, or by chipping and grinding, or by arc air-gouging and grinding and to be repaired by either of the following methods. Thermal methods of metal removal should only be allowed before the final heat treatment. (A) **In case of no repair welding being carried out** The portions required no repair welding after removing defects, are to be finished with a grinder etc. in accordance with the following: (a) All grooves shall have a bottom radius of approximately three times the groove depth. (b) Grooves and their vicinity are to be finished smoothly avoiding abrupt changes in configuration. (c) The portions where defects have been removed are to be verified that they are free from harmful defects by liquid penetrant test or magnetic particle test after finishing of the surface configuration.	**8. Rectification of Defects** (1) **General** (a) Indications that exceed the requirements of **Table 1** and **Table 2**, should be classed as defects, and should be repaired or rejected as appropriate. (b) In either case where, after removing defects, the steel castings are used as they are or repair welding are carried out approval of the surveyor is to be obtained. In case where the depth of the recess after removing the defects is not larger than 15 mm (or 10 % of the thickness of the steel castings, whichever is smaller) and the length is not more than 100 mm, the steel castings may be used without repair welding. (c) Castings which are repaired should be examined by the same method as at initial inspection, as well as by any additional methods as requested by the Surveyor. (2) **Rectification of Defects** Defective parts of material are to be completely removed either by grinding, or by chipping and grinding, or by arc air-gouging and grinding and to be repaired by either of the following methods. Thermal methods of metal removal should only be allowed before the final heat treatment. However, if there is a track record used on the ship by repairing in a different way, or if the Surveyor satisfies the repair method according to national or international standards, the other repair method may be acceptable. (A) **In case of no repair welding being carried out** The portions required no repair welding after removing defects, are to be finished with a grinder etc. in accordance with the following: (a) All grooves shall have a bottom radius of approximately three times the groove depth. (b) Grooves and their vicinity are to be finished smoothly avoiding abrupt changes in configuration. (c) The portions where defects have been removed are to be verified that they are free from harmful defects by liquid penetrant test or magnetic particle test after finishing of the surface configuration.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS Rec69(Rev.2 Oct 2020)

Present	Amendment	reason
(B) The portions required repair welding are to be suitably shaped and verified that they are free from harmful defects by nondestructive tests specified in (2) (A) (c) above and also repaired in accordance with the requirements in **3.** of this Appendix. Weld repairs should be suitably classified as follows.; (a) *Major repairs* (i) where the depth is greater than 25 % of the wall thickness or 25 mm whichever is less, (ii) where the total weld area on a casting exceeds 2 % of the casting surface noting that where a distance between two welds is less than their average width, they are to be considered as one weld. (iii) Major repairs require the approval of the Society before the repair is carried out. The repair should be carried out before final furnace heat treatment. (b) *Minor repairs* (i) where the total weld area (length x width) exceeds 500 mm^2 (ii) Minor repairs do not usually require the approval of the Society but should be recorded on a weld repair sketch as a part of the manufacturing procedure documents. These repairs should be carried out before final furnace heat treatment. (c) *Cosmetic repairs* (i) all other welds. (ii) Cosmetic repairs do not require the approval of the Society but should be recorded on a weld repair sketch. These repairs may be carried out after final furnace heat treatment but are subject to a local stress relief heat treatment. (3) <Omitted>	(B) The portions required repair welding are to be suitably shaped and verified that they are free from harmful defects by nondestructive tests specified in (2) (A) (c) above and also repaired in accordance with the requirements in **3.** of this Appendix. Weld repairs should be suitably classified as follows.; (a) *Major repairs* (i) where the depth is greater than 25 % of the wall thickness or 25 mm whichever is less, (ii) where the total weld area on a casting exceeds 2 % of the casting surface noting that where a distance between two welds is less than their average width, they are to be considered as one weld. (iii) Major repairs require the approval of the Society before the repair is carried out. The repair should be carried out before final furnace heat treatment. (b) *Minor repairs* (i) where the total weld area (length x width) exceeds 500 mm^2 (ii) Minor repairs do not usually require the approval of the Society but should be recorded on a weld repair sketch as a part of the manufacturing procedure documents. These repairs should be carried out before final furnace heat treatment. (c) *Cosmetic repairs* (i) all other welds. (ii) Cosmetic repairs do not require the approval of the Society but should be recorded on a weld repair sketch. These repairs may be carried out after final furnace heat treatment but are subject to a local stress relief heat treatment. (3) <Same as the present Guidance>	

Present	Amendment	reason
Annex 2-2 ~ Annex 2-5 <Omitted>	**Annex 2-2 ~ Annex 2-5 <Same as the present Guidance>**	
Annex 2-6 Guidance for liquid penetrant inspection and repair of defects of copper alloy propeller castings	**Annex 2-6 Guidance for liquid penetrant inspection and repair of defects of copper alloy propeller castings**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020)
1. <Omitted>	**1. <Same as the present Guidance>**	- To reflect IACS UR W24(Rev.4 July 2020)
2. The liquid penetrant inspection	**2. The liquid penetrant inspection**	
(1) **Area of test (Severity zones)**	(1) **Area of test (Severity zones)**	
(a) In order to relate the degree of inspection to the criticality of defects in propeller blades and to help reduce the risk of failure by fatigue cracking after repair, propeller blades are divided into the three zones designated A, B and C as shown in **Fig 1** and **Fig 2**	(a) In order to relate the degree of inspection to the criticality of defects in propeller blades and to help reduce the risk of failure by fatigue cracking after repair, propeller blades are divided into the three severity zones designated A, B and C as shown in **Fig 1** and **Fig 2**	
(b) The severity zones "A" are to be subjected to a dye penetrant inspection in the presence of the Surveyor. In zones "B" and "C" the dye penetrant inspection is to be performed by the manufacturer and may be witnessed by the Surveyor upon his request.	(b) The severity zones "A" are to be subjected to a dye penetrant inspection in the presence of the Surveyor. In zones "B" and "C" the dye penetrant inspection is to be performed by the manufacturer and may be witnessed by the Surveyor upon his request.	
(c) If repairs have been made either by grinding or by welding the repaired areas are additionally to be subjected to the dye penetrant inspection independent of their location and/or severity zone.	(c) If repairs have been made either by grinding, straightening or by welding the repaired areas are additionally to be subjected to the dye penetrant inspection independent of their location and/or severity zone.	
(2) **Methods of testing**	(2) **Methods of testing**	
(a) The methods of testing are to conform to the standard of *KS B* 0816 or equivalent.	(a) Liquid penetrant testing procedure is to be submitted to the Society and is to be in accordance with **ISO 3452-1:2013** or a recognized standard. The acceptance criteria are specified in (4).	
~~(b) In the dye penetrant inspection an indication is the presence of detectable bleed-out of the penetrant liquid from the material discontinuities appearing at least 10 minutes after the developer has been applied.~~	(b) <Deleted>	
(c) Where indications of defects appear, the type of defects and the size of the indications are to be recorded in detail. These records are to be presented to the Surveyor. For reference, the true size of the defects are also to be confirmed.	(b) Where indications of defects appear, the type of defects and the size of the indications are to be recorded in detail. These records are to be presented to the Surveyor. For reference, the true size of the defects are also to be confirmed.	

Present	Amendment	reason
(3) **Types of defects** ~~The defects detected by the liquid penetrant test are divided into following types of (A) to (D).~~ (A) Cracks : the defects regarded as a crack. (B) Circular defects : the defects other than crack, in which the length is less than 3 times the width. (C) Linear defects : the defects other than crack, in which the length is equal to or greater than 3 times the width. (D) Aligned defects : Aligned defects consisting of two or more linear or circular defects which are almost aligned and the spacings between them do not exceed 2 mm. The length of an aligned defect is to be equal to the sum of the lengths of a11 individual defects and all spacings between them.	(3) **Definitions of liquid penetrant indications(refer to Fig 3)** (A) Indication : In the liquid penetrant testing an indication is the presence of detectable bleed-out of the penetrant liquid from the material discontinuities appearing at least 10 minutes after the developer has been applied. (B) Relevant indication: Only indications which have any dimension greater than 1.5mm shall be considered relevant for the categorization of indications. (C) Non-linear indication: an indication with a largest dimension less than three times its smallest dimension (i.e. $l<3w$). (D) Linear indication: an indication with a largest dimension three or more times its smallest dimension (i.e. $l \geq 3w$). (E) Aligned indications (a) Non-linear indications form an alignment when the distance between indications is less than 2 mm and at least three indications are aligned. An alignment of indications is considered to be a unique indication and its length is equal to the overall length of the alignment. (b) Linear indications form an alignment when the distance between two indications is smaller than the length of the longest indication.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020) - To reflect IACS UR W24(Rev.4 July 2020)

Present	Amendment	reason
Fig 3 <New>	 **Fig 3 Shape of indications**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020) - To reflect IACS UR W24(Rev.4 July 2020)

Present

(4) **Acceptance criteria**

(A) Where cracks or other defects which do not meet the acceptance criteria given in **Table 1** are detected by the penetrant test, the defects are to be repaired in accordance with the requirements in **3.**.

Table 1 Acceptance Criteria

Are of test	Type of Defect (excluding crack)	Acceptance Criteria		
		Max. total number of all defects(I)	defects of same type	
			Max. number of each type(II)	Max. size for each indication(III) (mm)
Zone A	Circular	7	5	4
	Linear		2	3
	Aligned		2	3
Zone B	Circular	14	10	6
	Linear		4	6
	Aligned		4	6
Zone C	Circular	20	14	8
	Linear		6	6
	Aligned		6	6

(Notes)

(1) The defects are to be repaired when they do not meet one or more criteria of (I) through (III) in this table.

(2) The counting of the number of defects is to be conducted at the most unfavourable location relative to the indication being evaluated. The area of a reference zone is to be 100 cm^2

(3) Singular circular indications less than 2 mm for zone A and less than 3 mm for other zones may be disregarded.

(4) Where only circular defects were detected, all defects(I) are to be repaired for the judgement.

Amendment

(4) **Acceptance criteria**

(A) Where cracks or other defects which do not meet the acceptance criteria given in **Table 1** are detected by the penetrant test, the defects are to be repaired in accordance with the requirements in **3.**.

Table 1 Acceptance Criteria

Are of test	Type of Indication (excluding crack)	Acceptance Criteria		
		Max. total number of indications(I)	Indications of same type	
			Max. number of each type(II)	Max. size for each indication(III) (mm)
Zone A	Non-linear	7	5	4
	Linear		2	3
	Aligned		2	3
Zone B	Non-linear	14	10	6
	Linear		4	6
	Aligned		4	6
Zone C	Non-linear	20	14	8
	Linear		6	6
	Aligned		6	6

(Notes)

(1) The indications are to be repaired when they do not meet one or more criteria of (I) through (III) in this table.

(2) The counting of the number of indications is to be conducted at the most unfavourable location relative to the indication being evaluated. The area of a reference zone is to be 100cm^2. Each reference area may be square or rectangular with the major dimension not exceeding 250 mm.

(3) Singular non-linear indications less than 2 mm for zone A and less than 3 mm for other zones are not considered relevant.

(4) Where only non-linear indications were detected, all indications(I) are to be repaired for the judgement.

reason

* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020)

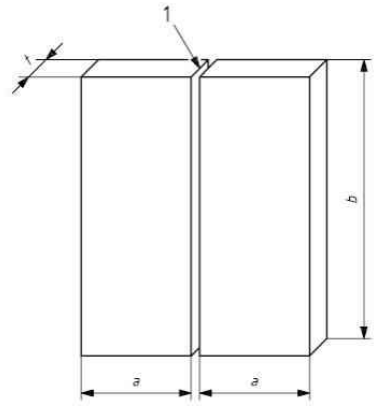
- To reflect IACS UR W24(Rev.4 July 2020)

Present	Amendment	reason
(B) ~ (C) <Omitted>	(B) ~ (C) <Same as the present Guidance>	
3. Repair of defects	**3. Repair of defects**	
(1) **Repair procedures**	(1) **Repair procedures**	
(A) In general, the repairs are to be carried out by mechanical means, e. g. by grinding, chipping or milling. After milling or chipping, grinding is to be applied for such defects.	(A) In general, the repairs are to be carried out by mechanical means, e. g. by grinding, chipping or milling. After milling or chipping, grinding is to be applied for such defects.	
(B) The contour of the ground depression is as smooth as possible in order to avoid stress concentrations or to minimize cavitation corrosion.	(B) The contour of the ground depression is as smooth as possible in order to avoid stress concentrations or to minimize cavitation corrosion.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020)
(C) <New>	(C) Complete elimination of the defective material is to be verified by liquid penetrant testing.	
(2) **Repair of defects in zone A**	(2) **Repair of defects in zone A**	- To reflect IACS UR W24(Rev.4 July 2020)
(a) In zone A of **Fig 1** and **Fig 2**, repair welding will generally not be allowed unless specially approved by the Society.	(a) In zone A of **Fig 1** and **Fig 2**, repair welding will generally not be allowed unless specially approved by the Society.	
(b) Grinding may be carried out to an extent which maintains the blade thickness of the approved drawing.	(b) Grinding may be carried out to an extent which maintains the blade thickness of the approved drawing.	
(c) The possible repair of defects which are deeper than those referred to above is to be considered by the Society.	(c) The possible repair of defects which are deeper than those referred to above is to be considered by the Society.	- typo
(d) <New>	(d) In some cases the propeller designer may submit technical documentation to propose a modified zone A based on detailed hydrodynamic load and stress analysis for consideration by the Society.	
(3) **Repair of defects in zone B**	(3) **Repair of defects in zone B**	
(a) In zone B of **Fig 1** and **Fig 2**, defects that are not deeper than dB = (t/40) mm (t = min. local thickness in mm according to the Rules) or 2 mm (whichever is greatest) below min. local thickness according to the Rules should be removed by grinding.	(a) In case the depth of defects in zone B of **Fig 1** and **Fig 2**, is not deeper than dB(dB=t/40 mm, t=Min. local thickness in mm according to the Rules) or 2 mm, whichever is greater, those defects may be removed by grinding in accordance with the previous **3.** (1).	
(b) Those defects that are deeper than allowable for removal by grinding may be repaired by welding.	(b) For defects that are deeper than those allowable in previous **3.** (2) (b), upon the approval of the Society, repair welding is possible in accordance with Para 4.	
(c) Where the propellers in zone B in accordance with the requirements specified in previous (b) are repaired by welding, the limits of the repair welding are to be as shown in **Table 2.**	(c) Where the propellers in zone B in accordance with the requirements specified in previous (b) are repaired by welding, the limits of the repair welding are to be as shown in **Table 2**.	
(4) **Repair of defects in zone C**	(4) **Repair of defects in zone C**	
In zone C of **Fig 1** and **Fig 2**, repair welds are generally permitted.	In zone C of **Fig 1** and **Fig 2**, repair welds are generally permitted.	

Present	Amendment	reason
4. Repair Welding Repair welding which permitted in accordance with the requirements in **3** (3) and (4) above is to comply with the following; (1) **General** (a) Companies wishing to carry out welding work on propellers must have at their disposal the necessary workshops, lifting gear, welding equipment, preheating and, where necessary, annealing facilities, testing devices. (b) <New> (b) All welding work is to be carried out preferably in the shop free from draughts and influence of the weather. (2) **Welder** The welders are to have qualifications deemed appropriate by the Society. (3) **Edge preparation** (a) Defects to be repaired by welding are to be ground to sound material according to the requirements as given under para **3** (1). To ensure complete removal of the defects the ground areas are to be examined by dye penetrant methods in the presence of the Surveyor. (b) <New> (b) The edge preparation for repair welding after removing the defects is to be as shown in **Fig 3** and **4**.	**4. Repair Welding** Repair welding which permitted in accordance with the requirements in **3** (3) and (4) above is to comply with the following; (1) **General** (a) Before welding is started, manufacturer shall submit to the Society a detailed welding procedure specification covering the weld preparation, welding parameters, filler metals, preheating and post weld heat treatment and inspection procedures. (b) All weld repairs are to be carried out in accordance with qualified procedures, and, by welders who are qualified to a recognized standard. Welding Procedure Qualification Tests are to be carried out in accordance with (5) and witnessed by the Surveyor. (c) All welding work is to be carried out preferably in the shop free from draughts and influence of the weather. (2) **Welder** The welders are to have qualifications deemed appropriate by the Society. (3) **Edge preparation** (a) Defects to be repaired by welding are to be ground to sound material according to the requirements as given under para **3** (1). The resulting ground areas are to be examined in the presence of the Surveyor by liquid penetrant testing in order to verify the complete elimination of defective material. (b) The welding grooves are to be prepared in such a manner which will allow a good fusion of the groove bottom. (c) The edge preparation for repair welding after removing the defects is to be as shown in **Fig 3** and **4**.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020) - To reflect IACS UR W24(Rev.4 July 2020)

Present	Amendment	reason
(4) **Welding repair procedure** (a) <New> (a) Arc welding with coated electrodes and gas-shielded metal arc process (*GMAW*) are generally to be applied. Argon-shielded tungsten welding (*GTAW*) should be used with care due to the higher specific heat input of this process. ~~(b) For material thickness less than 30 mm, gas welding may give a satisfactory weldment for *CU* 1 and *CU* 2 materials.~~ (c) Recommended filler metals, pre-heating and stress relieving temperatures are listed in **Table 3.** However, the welding consumables are to be approved by the approval tests for welding procedure specified in (5). (d) All propeller alloys are generally to be welded in down-hand (flat) position. Where this cannot be done, gas-shielded metal arc welding should be carried out. (e) The section to be welded is to be clean and dry. Flux-coated electrodes are to be dried before welding according to the maker's instructions. ~~(f) Adequate pre-heating is to be carried out with care to avoid local overheating, c.f. **Table 3.**~~ (g) ~ (j) <Omitted>	(4) **Welding repair procedure** (a) Metal arc welding is to be used for all types of welding repair on cast copper alloy propellers. (b) Arc welding with coated electrodes and gas-shielded metal arc process (*GMAW*) are generally to be applied. Argon-shielded tungsten welding (*GTAW*) should be used with care due to the higher specific heat input of this process. (b) <Deleted> (c) Recommended filler metals, pre-heating and stress relieving temperatures are listed in **Table 3.** However, the welding consumables are to be approved by the approval tests for welding procedure specified in (5). (d) All propeller alloys are generally to be welded in down-hand (flat) position. Where this cannot be done, gas-shielded metal arc welding should be carried out. (e) The section to be welded is to be clean and dry. Flux-coated electrodes are to be dried before welding according to the maker's instructions. (f) <Deleted> (f) ~ (i) <Same as the present Guidance>	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020) - To reflect IACS UR W24(Rev.4 July 2020)

Present	Amendment	reason
(5) **Welding procedure qualification test** The manufacturer of propellers intending to carry out repair welding in zone B and zone C is to pass the welding procedure qualification test as shown below. The qualification test is also to be in accordance with the requirements specified in **Pt 2, Ch 2, Sec 4** of the Rules, in addition to the following requirements: (A) <New>	(5) **Welding procedure qualification test** The manufacturer of propellers intending to carry out repair welding in zone B and zone C is to pass the welding procedure qualification test as shown below. The qualification test is also to be in accordance with the requirements specified in **Pt 2, Ch 2, Sec 4** of the Rules, in addition to the following requirements: (A) *General* (a) For the welding procedure approval the welding procedure qualification tests are to be carried out with satisfactory results. The qualification tests are to be carried out with the same welding process, filler metal, preheating and stress-relieving treatment as those intended applied by the actual repair work. Welding procedure specification (WPS) is to refer to the test results achieved during welding procedure qualification testing. (b) Welding procedures qualified at a manufacturer are valid for welding in workshops under the same technical and quality management.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020) - To reflect IACS UR W24(Rev.4 July 2020)
(a) *Tests for butt welding* (i) Test assembly The test assembly as specified in **Fig 5** is to be prepared by means of butt welding. The edge preparation is, in principle, to be either the V shape or an appropriate shape and the bevel angle is to be not less than 60°.	(B) *Tests for butt welding* (a) Test assembly (i) The test assembly, consisting of cast samples, is to be of a size sufficient to ensure a reasonable heat distribution and according to **Fig 5** with the minimum dimensions. (ii) A test sample of minimum 30 mm thickness is to be used. (iii) Preparation and welding of test pieces are to be carried out in accordance with the general condition of repair welding work which it represents. (iv) Welding of the test assemblies and testing of test specimens are to be witnessed by the Surveyor.	

Present	Amendment	reason
Fig 4 <New>	 (Notes) 1 : Joint preparation and fit-up as detailed in the preliminary welding procedure specification a : minimum value 150 mm b : minimum value 300 mm t : material thickness **Fig 4 Test piece for welding repair procedure**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020) - To reflect IACS UR W24(Rev.4 July 2020)
(ii) Welding procedure The welding procedures are to comply with the requirements in (5) above. (c) <New>	(b) Welding procedure The welding procedures are to comply with the requirements in (4) above. (c) Examinations and tests Test assembly is to be examined non-destructively and destructively in accordance with the **Table 5** and **Fig 6**.	

Present	Amendment	reason
Table 5 <New>	**Table 5 Type of tests and extent of testing**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020) - To reflect IACS UR W24(Rev.4 July 2020)

Type of test(1)	Extent of testing
Visual inspection	100% as per (d)
Liquid penetrant testing	100% as per (f)
Transverse tensile test	Two specimens as per (e)
Macro examination	Three specimens as per (g)

(Notes)
(1) Bend or fracture test are at the discretion of the Society.

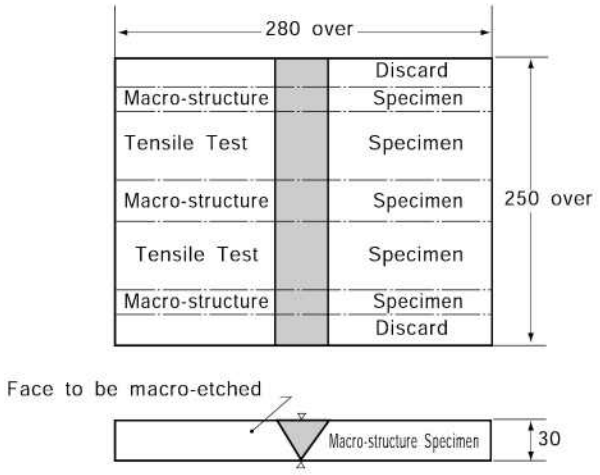


Fig 5 Test Assembly (Unit: mm)

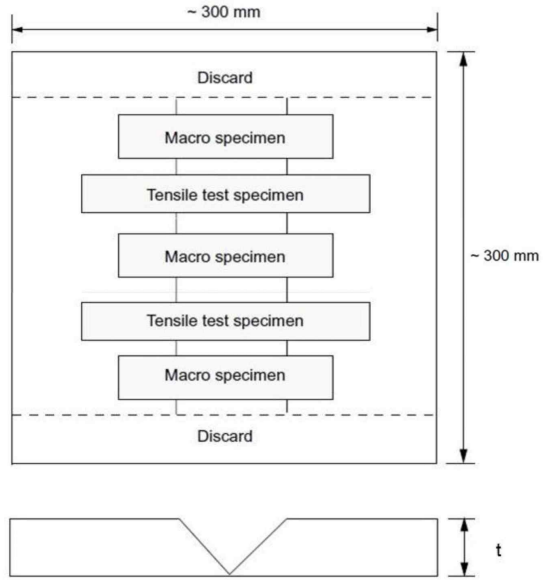
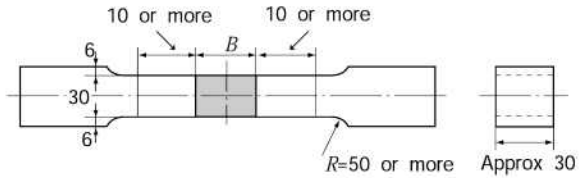


Fig 5 Test Specimen

Present	Amendment	reason
(iii) Visual inspection The welded surface is to be regular and uniform and free from harmful defects such as cracks and undercuts.	(d) Visual inspection The welded surface is to be regular and uniform and free from harmful defects such as cracks and undercuts. Test assembly is to be examined by visual inspection prior to the cutting of test specimen. In case, that any post-weld heat treatment is required or specified, visual inspection is to be performed after heat treatment.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020) - To reflect IACS UR W24(Rev.4 July 2020)
(iv) Tensile test Tensile tests are to be carried out using the two test specimens taken in accordance with **Fig 5**, and the values obtained are to be less than those given in **Table 5**. The form of the test specimens are to comply with **Fig 6**.	(e) Tensile test Tensile tests are to be carried out using the two test specimens taken in accordance with **Fig 6**, and the values obtained are to be less than those given in **Table 6**. The form of the test specimens are to comply with **Fig 7**. Alternatively tensile test specimens according to recognized standards acceptable to the Society may be used.	

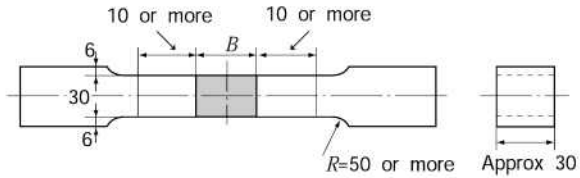


* The welded surface is to be ground or machined flush with base metal.

Fig 6 Size of Tensile Test Specimen (Unit : mm)

Table 5 Tensile Test Requirements for Approval Test

Material	Tensile Strength (N/mm^2)
CU 1	370 min.
CU 2	410 min.
CU 3	500 min.
CU 4	550 min.



* The welded surface is to be ground or machined flush with base metal.

Fig 7 Size of Tensile Test Specimen (Unit : mm)

Table 6 Tensile Test Requirements for Approval Test

Material	Tensile Strength (N/mm^2)
CU 1	370 min.
CU 2	410 min.
CU 3	500 min.
CU 4	550 min.

Present	Amendment	reason
(v) Non-destructive inspection Welded joint is to be tested for the whole length by liquid penetrant test, and is to show that there are no crack and other injurious defects.	(f) Non-destructive inspection Test assembly is to be examined by liquid penetrant testing prior to the cutting of test specimen. In case, that any post-weld heat treatment is required or specified, nondestructive testing is to be performed after heat treatment. Imperfections detected by liquid penetrant testing are to be assessed in accordance with **2.** (4). No cracks are permitted.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020) - To reflect IACS UR W24(Rev.4 July 2020)
(vi) Macro-structure inspection *(2017)* Macro etched test specimen is to be prepared as shown in **Fig 5.** Pores greater than 3 mm and cracks not permitted. A suitable etchant for this purpose is : - 5 g iron(Ⅲ) chloride - 30 ml hydrochloric acid (cone) - 100 ml water	(g) Macro-structure examination *(2017)* Three test specimens are to be prepared and etched on one side to clearly reveal the weld metal, the fusion line and the heat affected zone (see **Fig 6**). - 5 g iron(Ⅲ) chloride - 30 ml hydrochloric acid (cone) - 100 ml water The test specimens are to be examined for imperfections present in the weld metal and the heat affected zone. Cracks and lack of fusion are not permitted. Imperfections such as pores, or slag inclusions, greater than 3 mm are not permitted.	
(b) ~ (c) <Omitted>	(C) ~ (D) <Same as the present Guidance>	
(E) <New>	(E) *Range of approval* (a) General (i) All the conditions of validity stated below are to be met independently of each other. Changes outside of the ranges specified are to require a new welding procedure test. (ii) A qualification of a WPS obtained by a manufacturer is valid for welding in workshops or sites under the same technical and quality control of that manufacturer. (b) Base metal The range of qualification related to base metal is given in **Table 7**.	

Present	Amendment	reason
	Table 7 Range of qualification for base metal | Copper alloy material grade used for qualification | Range of approval | |---|---| | CU 1 | CU 1 | | CU 2 | CU 1, CU 2 | | CU 3 | CU 3 | | CU 4 | CU 4 | (c) Thickness The qualification of a WPS carried out on a weld assembly of thickness t is valid for the thickness range given in **Table 8**. **Table 8 Range of qualification for thickness** | Thickness of the test piece, t(mm) | Range of approval, T(mm) | |---|---| | 30≤ t | 3 ≤ T | (d) Welding position Approval for a test made in any position is restricted to that position. (e) Welding process The approval is only valid for the welding process used in the welding procedure test. Single run is not qualified by multi-run butt weld test used. (f) Filler metal The approval is only valid for the filler metal used in the welding procedure test. (g) Heat input The upper limit of heat input approved is 25% greater than that used in welding the test piece. The lower limit of heat input approved is 25% lower than that used in welding the test piece.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020) - To reflect IACS UR W24(Rev.4 July 2020)

Present	Amendment	reason
5. Straightening (1) **Hot straightening** (a) <New> (a) ~ (d) <Omitted> (2) ~ (3) <Omitted>	(h) Preheating and interpass temperature The minimum preheating temperature is not to be less than that used in the qualification test. The maximum interpass temperature is not to be higher than that used in the qualification test. (i) Post-weld heat treatment The heat treatment used in the qualification test is to be specified in pWPS. Soaking time may be adjusted as a function of thickness. **5. Straightening** (1) **Hot straightening** (a) Weld repaired areas may be subject to hot straightening, provided it can be demonstrated that weld properties are not impaired by the hot straightening operations. (b) ~ (e) <Same as the present Guidance> (2) ~ (3) <Same as the present Guidance>	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-110-2020) - To reflect IACS UR W24(Rev.4 July 2020)

Present

Annex 2-7 ~ Annex 2-10 <Omitted>

Annex 2-11 High manganese austenitic steels

1. ~ 2. <Omitted>

3. Manufacturing process

(1) Where the high manganese austenitic steel plates are manufactured from the continuous casting slabs, the maximum thickness for approval is to be determined, as a rule, with the roll ratio of 6 as standard. However, upon consideration of the manufacturing process, the roll ratio may be reduced to 4.

(2) The grade, thickness, deoxidation practice and chemical composition are to comply with the requirements given in **Table 1**.

Table 1 Grade, Thickness, Deoxidation Practice and Chemical Composition

Grade	Thickness, t(mm)	Deoxidation Practice	Chemical Composition (%)								
			C	*Si*[1)]	*Mn*	*P*	*S*	*Cu*	*Cr*	*N*	*B*
HMN 40	$6 \leq t \leq$ 30	Killed and Fine grain treated	0.35 ~ 0.55	0.10 ~ 0.50	22.50 ~ 25.50	0.030 max.	0.010 max.	0.30 ~ 0.70	3.00 ~ 4.00	0.050 max.	0.005 max.

NOTES:

(1) Silicon(Si) may be less than 0.10 %, provided total aluminum is 0.03 % or higher, or provided acid soluble aluminum is 0.025 % or higher.

4. ~ 7. <Omitted>

Amendment

Annex 2-7 ~ Annex 2-10 <Same as the present Guidance>

Annex 2-11 High manganese austenitic steels

1. ~ 2. <Same as the present Guidance>

3. Manufacturing process

(1) Where the high manganese austenitic steel plates are manufactured from the continuous casting slabs, the maximum thickness for approval is to be determined, as a rule, with the roll ratio of 6 as standard. However, upon consideration of the manufacturing process, the roll ratio may be reduced to 4.

(2) The grade, thickness, deoxidation practice and chemical composition are to comply with the requirements given in **Table 1**.

Table 1 Grade, Thickness, Deoxidation Practice and Chemical Composition

Grade	Thickness, t(mm)	Deoxidation Practice	Chemical Composition (%)								
			C	*Si*[1)]	*Mn*	*P*	*S*	*Cu*	*Cr*	*N*	*B*
HMN 40	$6 \leq t \leq$ 40	Killed and Fine grain treated	0.35 ~ 0.55	0.10 ~ 0.50	22.50 ~ 25.50	0.030 max.	0.010 max.	0.30 ~ 0.70	3.00 ~ 4.00	0.050 max.	0.005 max.

NOTES:

(1) Silicon(Si) may be less than 0.10 %, provided total aluminum is 0.03 % or higher, or provided acid soluble aluminum is 0.025 % or higher.

4. ~ 7. <Same as the present Guidance>

reason

- To reflect IMO interim guideline

Present	Amendment	reason
8. Welding consumables for high manganese austenitic steel (1) ~ (3) <Omitted> (4) Deposited metal test (A) Chemical composition ~~(a) Deposited metals of welding consumables for flux cored wire welding and submerged arc welding are to have the chemical composition given in **Table 5** and **Table 6** respectively.~~ ~~(b) TIG welding consumables are to have the chemical composition of ladle analysis value complied with the requirements as given in **Table 7**.~~	**8. Welding consumables for high manganese austenitic steel** (1) ~ (3) <Omitted> (4) Deposited metal test (a) ~ (b) <Deleted>	* Request for Establishment/Revision of Classification Technical Rules (MET4800-732-2020) - To reflect Technical Committee's opinion : The requirement for Chemical Composition is not necessary.
~~Table 5 Chemical Composition of Deposited Metal for Flux Cored Wire Welding~~	Table 5 <Deleted>	

~~Grade~~	~~Chemical composition (%)~~									
	~~*C*~~	~~*Si*~~	~~*Mn*~~	~~*P*~~	~~*S*~~	~~*Ni*~~	~~*Cr*~~	~~*Mo*~~	~~*N*~~	~~Others~~
~~*RW-HMN*~~	~~0.2~0.5~~	~~0.2~1.0~~	~~18.0~26.0~~	~~0.02max.~~	~~0.015max.~~	~~5.0max.~~	~~5.0max.~~	~~2.5max.~~	~~0.1max.~~	~~—~~

~~Table 6 Chemical Composition of Deposited Metal for Submerged Arc Welding~~

Table 6 <Deleted>

~~Grade~~	~~Chemical composition (%)~~									
	~~*C*~~	~~*Si*~~	~~*Mn*~~	~~*P*~~	~~*S*~~	~~*Ni*~~	~~*Cr*~~	~~*Mo*~~	~~*N*~~	~~Others~~
~~*RU-HMN*~~	~~0.2~0.6~~	~~1.5max.~~	~~18.0~26.0~~	~~0.020max.~~	~~0.015max.~~	~~3.0max.~~	~~5.0max.~~	~~2.5max.~~	~~0.10max.~~	~~—~~

Present	Amendment	reason
Table 7 Chemical Composition of Deposited Metal for TIG Electrodes ~~Grade~~ / ~~Chemical composition (%)~~ / ~~*C*~~ ~~*Si*~~ ~~*Mn*~~ ~~*P*~~ ~~*S*~~ ~~*Ni*~~ ~~*Cr*~~ ~~*Mo*~~ ~~*N*~~ ~~Others~~ ~~*RY-HMN*~~ ~~0.2~0.5~~ ~~0.1~1.0~~ ~~18.0~26.0~~ ~~0.020max.~~ ~~0.015max.~~ ~~5.0max.~~ ~~5.0max.~~ ~~2.5max.~~ ~~0.10max.~~ ~~—~~ <hereafter, omitted>	Table 7 <Deleted> <hereafter, same as the present Guidance>	

GUIDANCE RELATING TO THE RULES FOR THE CLASSIFICATION OF STEEL SHIPS

(Guidance Part 2 Materials and Welding)

- For external opinion inquiries -

2021. 01.

Machinery Rule Development Team

- Main Amendments -

(1) Enter into force on 1 July 2021 (the contract date for ship construction)

◉ To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

◉ To reflect IACS UR W34(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
Annex 2-7 Guidance for non-destructive testing of ship hull steel welds	**Annex 2-7 Guidance for non-destructive testing of ship hull steel welds**	
1. General	**1. General**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)
(1) **Application**	(1) **Application**	
(A) This Guidance applies to the Non-destructive inspection for all hull welds of ships whose, in general, length exceeds 30 m to confirm the quality of the hull welds. Effective date of this Guidance is the date of contract for construction.	(A) This Guidance applies to the Non-destructive inspection for all hull welds of ships whose, in general, length exceeds 30 m to confirm the quality of the hull welds. Effective date of this Guidance is the date of contract for construction.	
(B) In ships of less than 30m in length, the range of the inspection, the members to be inspected and the number of checkpoints are to be determined by the Surveyor based on consultation with the manufacturer.	(B) In ships of less than 30m in length, the range of the inspection, the members to be inspected and the number of checkpoints are to be determined by the Surveyor based on consultation with the manufacturer.	
(C) The quality levels given in this Guidance refer to production quality and not to fitness for-purpose of the welds examined.	(C) The quality levels given in this Guidance refer to production quality and not to fitness for-purpose of the welds examined.	
(D) The non-destructive testing is normally to be performed by the Shipbuilder or its subcontractors in accordance with this Guidance. Surveyor may require to witness some testing.	(D) The non-destructive testing is normally to be performed by the Shipbuilder or its subcontractors in accordance with this Guidance. Surveyor may require to witness some testing.	
(E) It should be the Shipbuilder's responsibility to assure that testing specifications and procedures are adhered to during the construction and the report is made available to the Society on the findings made by the NDT.	(E) It should be the Shipbuilder's responsibility to assure that testing specifications and procedures are adhered to during the construction and the report is made available to the Society on the findings made by the NDT.	
(F) <New>	(F) The extent of testing and the number of checkpoints are to be agreed between the Shipbuilder and the Society. For criticality of structure reference is to be made to **Pt3 Ch1 Sec4** of the Rules of Structural Member Categories and **Pt13** of the Rules.	
(F) This Guidance is intented to apply to welds of irons and nonferrous metals. Other marine structures may be applied subject to the approval by the Society. However, in case of ultrasonic inspection, the transducer design and calibration block material used are appropriate to the material under inspection.	(G) This Guidance is intented to apply to welds of irons and nonferrous metals. Other marine structures may be applied subject to the approval by the Society. However, in case of ultrasonic inspection, the transducer design and calibration block material used are appropriate to the material under inspection.	

Present	Amendment	reason
(F) <New>	(H) These requirements cover conventional NDT methods. Advanced non-destructive testing (ANDT) methods such as phased array ultrasonic testing (PAUT), time of flight diffraction (TOFD), digital radiography (RT-D), radioscopic testing (RT-S), and computed radiography (RT-CR) are covered by **Annex 2-12**.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020)
(2) ~ (4) <New>	(2) **Terms and definitions** The following terms and definitions apply for these requirements. (A) NDT(Non-Destructive Testing) - the development and application of technical methods to examine materials or components in ways that do not impair their future usefulness and serviceability, in order to measure geometrical characteristics and to detect, locate, measure and evaluate flaws. NDT is also known as non-destructive examination (NDE), non-destructive inspection (NDI) and non-destructive evaluation(NDE). (B) RT - Radiographic Testing (C) UT - Ultrasonic Testing (D) MT - Magnetic Particle Testing (E) PT - Dye or Liquid Penetrant Testing (F) PWHT - Post Weld Heat Treatment (G) VT - Visual Testing (3) **Welding processes** These requirements apply to fusion welds made using manual metal arc welding (shielded metal arc welding, 111), gas-shielded metal arc welding (gas metal arc welding, including flux cored arc welding, 13x), gas-shielded arc welding with non-consumable tungsten electrode (gas tungsten arc welding, 14x), submerged arc welding (12x), electro-slag welding (72x) and electro-gas welding processes (73). Terms and numbers according to *ISO 4063:2009* ("x" indicates that relevant subgroups are included). These requirements may also be applied to welding processes other than the above at the discretion of the Society. (4) **Weld joints** These requirements apply to butt welds with full penetration, tee, corner and cruciform joints with or without full penetration, and fillet welds.	- To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present

(2) **Means of Non-destructive Inspection**

(A) Applicable methods for testing of the different types of weld joints are given in **Table 1.**

Table 1 Applicable methods for testing of weld joints

Weld Joint	Parent material thickness(mm)	Applicable testing methods
Butt welds with full penetration	t ≤ 8	VT, PT, MT, RT
	t > 8	VT, PT, MT, UT, RT
Tee joints, corner joints and cruciform joints with full penetration	t ≤ 10	VT, PT, MT
	t > 10	VT, PT, MT, UT
Tee joints, corner joints and cruciform joints without full penetration and fillet welds	All	VT, PT, MT, UT(1)

Note:
(1) <New>
(1) UT can be used to monitor the extent of penetration in tee, corner and cruciform joints.
(3) <New>

(B) All welds should be subject to visual testing by personnel designated by the Shipyard.

(C) Non-destructive inspection for detection of surface imperfections of weld joints of hull construction is, in principle, to be magnetic particle testing specified in **2** (2) However liquid penetrant testing can be applied under consideration of this Society.

Amendment

(5) **Means of Non-destructive Inspection**

(A) Applicable methods for testing of the different types of weld joints are given in **Table 1.**

Table 1 Applicable methods for testing of weld joints

Weld Joint	Parent material thickness(mm)	Applicable testing methods
Butt welds with full penetration	t < 8(1)	VT, PT, MT, RT
	t ≥ 8	VT, PT, MT, UT, RT
Tee joints, corner joints and cruciform joints with full penetration	t < 8(1)	VT, PT, MT, RT(3)
	t ≥ 8	VT, PT, MT, UT, RT(3)
Tee joints, corner joints and cruciform joints without full penetration and fillet welds	All	VT, PT, MT, UT(2), RT(3)

Note:
(1) In cases of thickness below 8mm, the Society may consider application of an appropriate advanced UT method.
(2) UT can be used to monitor the extent of penetration in tee, corner and cruciform joints. This requirement is to be agreed with the Society.
(3) RT may be applied however there will be limitations

(B) All welds over their full length are to be subject to VT by personnel designated by the Shipbuilder, who may be exempted from the qualification requirements defined in (7).

(C) As far as practicable, PT or MT shall be used when investigating the outer surface of welds, checking the intermediate weld passes and back-gouged joints prior to subsequent passes deposition. MT shall be performed in ferromagnetic materials welds unless otherwise agreed with the Society. Surface inspection of important tee or corner joints, using an approved MT or PT method, shall be conducted to the satisfaction of the surveyor.

reason

* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020)

- To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
(D) Non-destructive inspection for detection of internal imperfections is, in principle, to be radiographic inspection specified in **3.** However, for larger thickness over 30 mm, ultrasonic inspection specified in **4** is to be used as the primary inspection method.	(D) Non-destructive inspection for detection of internal imperfections is, in principle, to be radiographic inspection specified in **3.** However, if the following (E) is satisfied, methods to be used shall be agreed with the Society. The method used shall be suited for the detection of particular types and orientations of discontinuities. RT and UT are used for detection of internal discontinuities, and in essence they supplement and complement each other. RT is generally most effective in detecting volumetric discontinuities (e.g. porosity and slag) whilst UT is more effective for detecting planar discontinuities (e.g. laminations, lack of fusion and cracks). Although one method may not be directly relatable to the other, either one would indicate conditions of inadequate control of the welding process.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)
(E) For welded joints of hull construction in thickness of 8 mm and above, a part or all of radiographic inspection may be replaced by the ultrasonic inspection based on the requirements given in **4**, in case that the shipyard submitting ultrasonic testing specifications containing information on the items mentioned below (a) Approval of inspection manual Prior to carrying out the inspection, the shipyard has to submit the inspection manual containing the items mentioned below, and have the manual approved by the Society. (i) Type of ultrasonic detector and kind of probe (nominal frequency and material, dimension, type and nominal angle of refraction of transducer), and the applicable range of the testing (thickness, welding process, etc.) (ii) Calibration block and reference block for calibration (iii) Kind of ultrasonic test process (Angle beam technique is to be of standard one), and extent of the measurements and method for sensitivity adjustment for the process (iv) Judgement criteria for ultrasonic test (The criteria for angle beam technique test is to be in accordance with **Table 11**. For the other kind of ultrasonic test process, judgement criteria are to be described in detail.) (v) Record of the results of ultrasonic test (vi) List of operators and judges	(E) For welded joints of hull construction in thickness of 8 mm and above, a part or all of radiographic inspection may be replaced by the ultrasonic inspection based on the requirements given in **4**, in case that the shipyard submitting ultrasonic testing specifications containing information on the items mentioned below (a) Approval of inspection manual Prior to carrying out the inspection, the shipyard has to submit the inspection manual containing the items mentioned below, and have the manual approved by the Society. (i) Type of ultrasonic detector and kind of probe (nominal frequency and material, dimension, type and nominal angle of refraction of transducer), and the applicable range of the testing (thickness, welding process, etc.) (ii) Calibration block and reference block for calibration (iii) Kind of ultrasonic test process (Angle beam technique is to be of standard one), and extent of the measurements and method for sensitivity adjustment for the process (iv) Judgement criteria for ultrasonic test (The criteria for angle beam technique test is to be in accordance with **Table 11**. For the other kind of ultrasonic test process, judgement criteria are to be described in detail.) (v) Record of the results of ultrasonic test (vi) List of operators and judges	

Present	Amendment	reason
(b) The capability of shipyard The capability of shipyard about the reliability of the test methods is to judged by the items mentioned below. (i) Qualification of engineers (ii) Quality control conditions (iii) Reliability (iv) Keeping the Standards and their application ability (v) Documents for type, extent and repair of defects (c) Confirmation by radiographic inspection (i) When the initial ultrasonic inspection is carried out according to this Guidance, ultrasonic testing for 1/10 of welds to be subject, based on the instructions of the Surveyor, to radiographic testing of at least three ships to confirm that the results match those of (a) (iv) and is approved by the Society for the consistence. However the confirmation by radiographic inspection can be waived for the shipyard which has the records to carry out confirmation inspection more than 3 ships. (F) Where a yard desires to use ultrasonic inspection as the primary inspection method according to (E), following requirements to be complied. (a) a reasonable amount of checkpoints are to be examined by the radiography or alternative means approved by the Society. The amount examined together with the area covered are to be agreed and marked on the NDE plan specified in (5). (b) Radiographic inspection may be required at random in important locations at the discretion of the Surveyor.	(b) The capability of shipyard The capability of shipyard about the reliability of the test methods is to judged by the items mentioned below. (i) Qualification of engineers (ii) Quality control conditions (iii) Reliability (iv) Keeping the Standards and their application ability (v) Documents for type, extent and repair of defects (c) Confirmation by radiographic inspection (i) When the initial ultrasonic inspection is carried out according to this Guidance, ultrasonic testing for 1/10 of welds to be subject, based on the instructions of the Surveyor, to radiographic testing of at least three ships to confirm that the results match those of (a) (iv) and is approved by the Society for the consistence. However the confirmation by radiographic inspection can be waived for the shipyard which has the records to carry out confirmation inspection more than 3 ships. (F) Where a yard desires to use ultrasonic inspection as the primary inspection method according to (E), following requirements to be complied. (a) a reasonable amount of checkpoints are to be examined by the radiography or alternative means approved by the Society. The amount examined together with the area covered are to be agreed and marked on the NDE plan specified in (5). (b) Radiographic inspection may be required at random in important locations at the discretion of the Surveyor.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

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(G) Alternative means to the radiographic inspection (a) In case where shipyard intend to apply the new advanced NDT technologies such as Phased array UT (PAUT) or Time of Flight Diffraction (TOFD) in lieu of radiographic inspection, the shipyard has to submit the inspection manual as specified above (E), (a) and have the manual approved by the Society. (b) Additional test and/or data for comparison of alternative means with radiographic inspection may be required when deemed necessary by the Society.	(G) In case where shipyard intend to apply the new advanced NDT technologies such as Phased array UT (PAUT) or Time of Flight Diffraction (TOFD) in lieu of radiographic inspection, it is to be accordance with **Annex 2-12**.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)
(H) ~ (M) <New>	(H) Where the surveyor becomes aware that an NDT location has been repaired without a record of the original defect, the shipyard is to carry out additional examinations on adjacent areas to the repaired area to the satisfaction of the attending surveyor. Reference is to be made to **Pt 1**, **Annex 1-12** of the Guidance. (I) Welds in thick steels (>50 mm) used in container carrier, deck and hatch coaming areas are to be inspected in accordance with the additional requirements in **Pt 7**, **Annex 7-8** of the Guidance. (J) The testing method, equipment and conditions shall comply with recognized National or International standards, or other documents to the satisfaction of the Society. (K) Sufficient details shall be given in a written procedure for each NDT technique submitted to the Society for acceptance. (L) The testing volume shall be the zone which include the weld and parent material for at least 10 mm each side of the weld, or the width of the heat affected zone(HAZ), whichever is greater. In all cases inspection shall cover the whole testing volume. (M) Provision is to be made for the surveyor to verify the inspection, reports and records(e.g. radiographs) on request.	
(H) The additional non-destructive inspection required for workmanship control of welded joints of hull is to be in accordance with the requirements specified in **3** (2), (C).	(N) The additional non-destructive inspection required for workmanship control of welded joints of hull is to be in accordance with the requirements specified in **3** (2), (C).	

Present	Amendment	reason
(3) **Testing apparatus** The testing apparatus of radiographic and ultrasonic Inspection are to be calibrated and/or corrected in accordance with the recognised national or international standards. (4) **Personnel requirements** (a) Personnel carrying out non-destructive inspection are generally to be qualified and certified to Level II or above in (*KS B*) *ISO* 9712, *SNT-TC-1A*, *ASNT Central Certification Program* (ACCP) or equivalent. However, the personnel qualified to Level I can engage in the testing under supervision of those qualified for Level II or above. (b) Personnel responsible for the radiographic and/or ultrasonic Inspection activity including approval of procedures should be qualified and certified to Level III. (c) Periodic re-evaluations of test personnel are to be conducted in accordance with (*KS B*) *ISO* 9712 or equivalent to verify that such capability is maintained. (d) ~ (g) <New>	(6) **Testing apparatus** The testing apparatus of radiographic and ultrasonic Inspection are to be calibrated and/or corrected in accordance with the recognised national or international standards. (7) **Personnel requirements** (a) The Shipbuilder or its subcontractors is responsible for the qualification and preferably 3rd party certification of its supervisors and operators to a recognised certification scheme based on *ISO 9712:2012*. (b) Personnel qualification to an employer based qualification scheme as e.g. *SNT-TC-1A,2016* or *ANSI/ASNT CP-189,2016* may be accepted if the Shipbuilder or its subcontractors written practice is reviewed and found acceptable by the Society. The Shipbuilder or its subcontractors written practice shall as a minimum, except for the impartiality requirements of a certification body and/or authorised body, comply with *ISO 9712:2012*. (c) The supervisors' and operators' certificates and competence shall comprise all industrial sectors and techniques being applied by the Shipbuilder or its subcontractors. Level 3 personnel shall be certified by an accredited certification body. (d) The Shipbuilder or its subcontractors shall have a supervisor or supervisors, responsible for the appropriate execution of NDT operations and for the professional standard of the operators and their equipment, including the professional administration of the working procedures. The Shipbuilder or its subcontractors shall employ, on a full-time basis, at least one supervisor independently certified to Level 3 in the method(s) concerned as per the requirements of (a) ~ (c) above. It is not permissible to appoint Level 3 personnel; they must be certified by an accredited certification body. It is recognised that a Shipbuilder or its subcontractors may not directly employ a Level 3 in all the stated methods practiced. In such cases, it is permissible to employ an external, independently certified, Level 3 in those methods not held by the full-time Level 3(s) of the Shipbuilder or its subcontractors.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
	(e) The supervisor shall be directly involved in review and acceptance of NDT Procedures, NDT reports, calibration of NDT equipment and tools. The supervisor shall on behalf of the Shipbuilder or its subcontractors re-evaluate the qualification of the operators annually. (f) The operator carrying out the NDT and interpreting indications, shall as a minimum, be qualified and certified to Level 2 in the NDT method(s) concerned and as described in (a) ~ (c) above. However, operators only undertaking the gathering of data using any NDT method and not performing data interpretation or data analysis may be qualified and certified as appropriate, at level 1. (g) The operator shall have adequate knowledge of materials, welding, structures or components, NDT equipment and limitations that are sufficient to apply the relevant NDT method for each application appropriately.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
(5) **NDE plan** (a) The Shipbuilder should submit a plan for approval by the Society, specifying the areas to be examined and the extent of testing with reference to the NDT procedures to be used according to the ship design, ship type and welding processes used. Particular attention should be paid to highly stressed areas. (b) The plan should only be released to the personnel in charge of the NDT and its supervision. (c) The identification system should identify the exact locations of the lengths of weld examined.	(8) **NDT plan** (A) The extent of testing and the associated quality levels are to be planned by the Shipbuilder according to the ship design, ship type and welding processes used. For new construction survey reference is to be made to the NDT requirements of **Pt 1**, **Annex 1-12** of the Guidance and the applicable parts of the Table 1 of **Pt 1**, **Annex 1-12** of the Guidance and Appendices. (B) For each construction, the Shipbuilder shall submit a plan for approval by the Society, specifying the areas to be examined and the extent of testing and the quality levels, with reference to the NDT procedures to be used. Particular attention is to be paid to inspecting welds in highly stressed areas and welds in primary and special structure indicated in **Pt 3**, **Ch 1**, **Sec 4** of the Rules. The NDT procedure(s) shall meet the requirement stated in this **Annex** and the specific requirements of the Society. The plan shall only be released to the personnel in charge of the NDT and its supervision. (a) In selecting checkpoints, emphasis shall be given to the following inspection locations: - Welds in high stressed areas - Fatigue sensitive areas - Other important structural elements - Welds which are inaccessible or very difficult to inspect in service - Field erected welds - Suspected problem areas (b) Block construction welds performed in the yards, or at subcontracted yards/facilities, are to be considered in selecting checkpoints. (c) For other marine and offshore structures the extent is to be agreed by the Society. (d) If an unacceptable level of indications are found the NDT extent is to be increased. (C) The identification system should identify the exact locations of the lengths of weld examined.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
(d) Welded connections of large cast or forged components (stern frame, stern boss, rudder parts, shaft brackets...) should be tested over their full length using MT or PT and at agreed locations using RT or UT.	(D) Welded connections of large cast or forged components (e.g. stern frame, stern boss, rudder parts, shaft brackets...) are to be tested over their full length using MT (MT is the preferred method) or PT, (PT is to be applied for non-ferrous metals) and at agreed locations using RT or UT.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)
(e) All start/stop points in welds made using automatic (mechanised) welding processes should be examined using RT or UT except for internal members where the extent of testing should be agreed.	(E) In general start/stop points in welds made using automatic (mechanized) welding processes are to be examined using RT or UT, except for internal members where the extent of testing is to be agreed with the attending surveyor.	
(f) Tee joints with full penetration between corrugated bulkheads and inner bottom without lower stools should be tested minimum 10 % for the number of corner part of corrugation. The 200 mm of corner part from side to side is to be examined by MT or PT and at agreed locations are to be examined by RT or UT. The surveyor may request the additional non-destructive testing according to the quality of workmanship of the shipyard. *(2017)*	(F) Tee joints with full penetration between corrugated bulkheads and inner bottom without lower stools should be tested minimum 10 % for the number of corner part of corrugation. The 200 mm of corner part from side to side is to be examined by MT or PT and at agreed locations are to be examined by RT or UT. The surveyor may request the additional non-destructive testing according to the quality of workmanship of the shipyard. *(2017)*	
(6) **Timing of NDT**	(9) **Timing of NDT**	
(a) NDT should be conducted after welds have cooled to ambient temperature and after post weld heat treatment where applicable.	(a) NDT shall be conducted after welds have cooled to ambient temperature and after post weld heat treatment where applicable.	
(b) For steels with specified minimum yield stress of 420 N/mm^2 and above, NDT should not be carried out before 48 hours after completion of welding. Where post weld heat treatment (PWHT) is carried out or consistent low failure rate of delayed cracking has been documented for the materials and welding consumables in question, the requirement for testing after 48 hours may upon agreement be reduced.	(b) For high strength steels for welded structure with specified minimum yield stress in the range of 420 N/mm^2 to 690 N/mm^2, NDT shall not be carried out before 48 hours after completion of welding. For steel with specified minimum yield greater than 690 N/mm^2, NDT shall not be carried out before 72 hours after completion of welding. Regardless of yield strength consideration is to be given to requiring a delayed inspection where evidence of delayed cracking has been observed in production welds.	
(c) ~ (e) <New>	(c) At the discretion of the surveyor, a longer interval and/or additional random inspection at a later period may be required, (for example in case of high thickness welds).	

Present	Amendment	reason
	(d) At the discretion of the surveyor, the 72 hour interval may be reduced to 48 hours for RT or UT inspection, provided there is no indication of delayed cracking, and a complete visual and random MT or PT inspection to the satisfaction of the surveyor is conducted 72 hours after welds have been completed and cooled to ambient temperature. (e) Where PWHT is carried out the requirement for testing after a delay period may be relaxed, at the discretion of the surveyor.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)
(7) **Performance and responsibility** (a) The non-destructive testing is normally to be performed by the Shipbuilder or its subcontractors in accordance with inspection manual and NDE plan approved by the Society. The Surveyor may require to witness some testing. (b) It should be the Shipbuilder's responsibility to assure that testing specifications and procedures are adhered to during the construction and the report is made available to the Society on the findings made by the NDT.	(10) **Performance and responsibility** (a) The non-destructive testing is normally to be performed by the Shipbuilder or its subcontractors in accordance with inspection manual and NDE plan approved by the Society. The Surveyor may require to witness some testing. (b) It should be the Shipbuilder's responsibility to assure that testing specifications and procedures are adhered to during the construction and the report is made available to the Society on the findings made by the NDT.	
(8) **Surface inspections** (a) <New> (a) Surface inspections shall be carried out as bellows; (b) The surface of welds to be radiographed are to be sufficiently free from irregularities that may mask or interfere with interpretation (c) The test surface (within I skip distance from welds edge) to be ultrasonic tested are free from spatter, floating scales, painting film, remarkable rust which prevent transmission of ultrasonic wave and the likes. They are removed if existed.	(11) **Surface inspections** (a) Areas to be examined shall be free from scale, slag, loose rust, weld spatter, oil, grease, dirt or paint that might affect the sensitivity of the testing method. (b) Preparation and cleaning of welds for subsequent NDT are to be in accordance with the accepted NDT procedures, and are to be to the satisfaction of the surveyor. Surface conditions that prevent proper interpretation may be cause for rejection of the weld area of interest. (c) The surface of welds to be radiographed are to be sufficiently free from irregularities that may mask or interfere with interpretation (d) The test surface (within I skip distance from welds edge) to be ultrasonic tested are free from spatter, floating scales, painting film, remarkable rust which prevent transmission of ultrasonic wave and the likes. They are removed if existed.	

Present	Amendment	reason
2. NDT for detection of surface imperfections (1) **Visual testing** (a) The welds examined should be clean and free from paint. (b) Acceptance criteria are given in **Table 2**. **~~Table 2 Acceptance criteria for visual testing, magnetic particle and liquid penetrant testing~~** ~~Surface discontinuity~~ / ~~Acceptance criteria for visual testing~~ ~~Crack~~ / ~~not accepted~~ ~~Lack of fusion~~ / ~~not accepted~~ ~~Incomplete root penetration in butt joints welded from one side~~ / ~~not accepted~~ ~~Surface pore~~ / ~~Single pore diameter d ≤ 0.25t(1) for butt welds (d ≤0.25a(1) for fillet welds) with maximum diameter 3mm; 2.5d as minimum distance to adjacent pore.~~ ~~Undercut in butt welds~~ / ~~depth ≤ 0.5mm whatever is the length depth ≤ 0.8mm with a maximum continuous(2) length of 90mm~~ ~~Undercut in fillet welds~~ / ~~depth ≤ 0.8mm whatever is the length~~ ~~Note: (1) "t" is the plate thickness of the thinnest plate and "a" is the throat of the fillet weld. (2) Adjacent undercuts separated by a distance shorter than the shortest undercut should be regarded as a single continuous undercut.~~	**2. Visual testing** The personnel in charge of VT is to confirm that the surface condition is acceptable prior to carrying out the inspection. VT shall be carried out in accordance with standards agreed between the Shipbuilder and the Society. Table 2 <Deleted>	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
(2) **Magnetic particle testing** (a) Methods of inspection not specified in this Guidance are to comply with the *KS B ISO* 9934-1 or other recognized standard subject to the approval by the Society. (b) The Shipbuilder should submit a procedure for approval by the Surveyor, specifying the surface preparation, magnetizing equipment, calibration methods, detection media and application, viewing conditions and post demagnetization. (c) The surface to be examined should be free from scale, weld spatter, oil, grease, dirt or paint and should be clean and dry. (d) ~~When using current flow equipment with prods, care shall be taken to avoid local damage to the material. Copper prod tips must not be used. The prod tips should be lead, steel, aluminium or aluminium-copper braid.~~ (e) To ensure detection of discontinuities of any orientation, the welds are magnetized in two directions approximately perpendicular to each other with a maximum deviation of 30°. Adequate overlapping shall ensure testing of the whole zone. (f) ~~Continuous wet particle method should be used as far as practicable.~~ (g) magnetic particle testing should cover a minimum weld length of 500 mm. (h) ~~Acceptance criteria are given in **Table 2**. Only the indications which have any dimension greater than 2 mm should require evaluation.~~	**3. Magnetic particle testing(MT)** (1) MT shall be carried out in accordance to *ISO 17638:2016* or a recognized accepted standard by the Society. (2) The Shipbuilder shall submit a procedure for approval by the Surveyor, specifying the surface preparation, magnetizing equipment, calibration methods, detection media and application, viewing conditions and post demagnetization. (3) The surface to be examined shall be free from scale, weld spatter, oil, grease, dirt or paint and shall be clean and dry. In general, the inside and outside of the welds to be inspected need to be sufficiently free from irregularities that may mask or interfere with interpretation. (4) The extent of MT shall be in accordance to the plans agreed with the attending surveyor and to the satisfaction of the surveyor. (5) To ensure detection of discontinuities of any orientation, the welds are magnetized in two directions approximately perpendicular to each other with a maximum deviation of 30°. Adequate overlapping shall ensure testing of the whole zone. (6) Magnetic particle testing should cover a minimum weld length of 500 mm.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
(3) **Liquid penetrant testing** (a) Methods of inspection not specified in this Guidance are to comply with the *KS B ISO* 3452 or other recognized standard subject to the approval by the Society. (b) The Shipbuilder should submit a procedure for approval by the Surveyor, specifying the calibration equipment, surface preparation, cleaning and drying prior to testing, temperature range, type of penetrant, cleaner and developer used, penetrant application and removal, penetration time, developer application and development time and lighting conditions during testing. (c) The surface to be examined should be clean and free from scale, oil, grease, dirt or paint and should include the weld bead and base metal for at least 10 mm on each side of the weld, or the width of the heat affected zone, whichever is greater. (d) The temperature of parts examined should be typically between 5°C and 50°C, outside this temperature range special low/high temperature penetrant and reference comparator blocks should be used. (e) The penetration time should not be less than 10 minutes and in accordance with the manufacturer's specification. The development time should not be less than 10 minutes and in accordance with the manufacturer's specification, normally between 10～30 minutes. (f) magnetic particle testing should cover a minimum weld length of 500 mm. (g) ~~Acceptance criteria are given in **Table 2**. Only the indications which have any dimension greater than 2 mm should require evaluation.~~	**4. Liquid penetrant testing(PT)** (1) PT shall be carried out in accordance to *ISO 3452-1:2013* or a recognized accepted standard by the Society. (2) The Shipbuilder should submit a procedure for approval by the Surveyor, specifying the calibration equipment, surface preparation, cleaning and drying prior to testing, temperature range, type of penetrant, cleaner and developer used, penetrant application and removal, penetration time, developer application and development time and lighting conditions during testing. (3) The surface to be examined shall be clean and free from scale, oil, grease, dirt or paint so there are not contaminants and entrapped material that may impede penetration of the inspection media. (4) The temperature of parts examined should be typically between 5°C and 50°C, outside this temperature range special low/high temperature penetrant and reference comparator blocks should be used. (5) The extent of PT shall be in accordance to the plans agreed with the attending surveyor and to the satisfaction of the surveyor. (6) PT should cover a minimum weld length of 500 mm.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
~~(4) **Survey records**~~ ~~(A) In addition to generic items, reports of magnetic particle testing should include the following specific items and their records are to be filed to compare the inspection locations with their results.~~ ~~(a) type of magnetization~~ ~~(b) magnetic field strength~~ ~~(c) detection media~~ ~~(d) viewing conditions~~ ~~(e) demagnetization, if required~~ ~~(B) In addition to generic items, reports of liquid penetrant testing should include the following specific items and their records are to be filed to compare the inspection locations with their results.~~ ~~(a) type of penetrant, cleaner and developer used~~ ~~(b) penetration time and development time~~	(4) <Deleted>	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)
3. Radiographic Inspection (1) **Methods of radiography** (A) Methods of inspection not specified in this Guidance are to comply with the *KS B* 0845(Methods of radiographic examination for welded joints in steel) or other recognized standard subject to the approval by the Society. (B) Test range of **radiographic inspection** is to be not less than 250 mm or overall length of the welds inspected, whichever is smaller. (C) <New> (C) Processed films should display hull no., frame no., weld boundary indicators, Port/Starboard, location (or film serial number) and date as radiographic image.	**5. Radiographic Testing(RT)** (1) **Methods of radiography** (A) RT shall be carried out in accordance to *ISO 17636-1:2013* or an accepted recognized standard by the Society (B) Test range of RT is to be not less than 250 mm or overall length of the welds inspected, whichever is smaller. However, For hull welds the minimum length inspected by RT is typically 300 mm. The minimum inspected weld length for each checkpoint is to be specified in the approved NDT plan. (C) The extent of RT shall be in accordance to the approved plans in accordance with (2) and to the satisfaction of the surveyor. (D) Processed films should display hull no., frame no., weld boundary indicators, Port/Starboard, location (or film serial number) and date as radiographic image.	

Present	Amendment	reason
(E) <New>	(E) Consideration may be given for reduction of inspection frequency for automated welds where quality assurance techniques indicate consistent satisfactory quality. The number of checkpoints is to be increased if the proportion of non-conforming indications is abnormally high.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)
(F) <New>	(F) The inside and outside surfaces of the welds to be radiographed are to be sufficiently free from irregularities that may mask or interfere with interpretation. Surface conditions that prevent proper interpretation of radiographs may be cause for rejection of the weld area of interest.	
~~(D) **Film density** Film density through the area of interest shall be within 1.8 to 4.0 except for the defect images.~~	(D) <Deleted>	

Present	Amendment	reason
(E) **Penetrameter** (a) The penetrameter is to be a wire type image quality indicator specified in the *KS B ISO* 19232, *ISO* 1027 or equivalent. (b) The penetrameters including wire having minimum perceptible diameter are to be placed across a weld and near the both edge (end) of the weld, facing the radiation source. However, if the length under examination is less than three times the width of penetrameter, only one penetrameter may be laid on the center of the weld length. (c) Minimum perceptible wire diameter of penetrameter on the radiographic films are to be less than the value specified in **Table 3.** (d) When using IQI's of wire type, the image of a wire is considered visible on the film if a continuous length of at least 10 mm is clearly visible in a section of uniform optical density. **Table 3 Minimum perceptible wire diameter of penetrameter** (Unit : mm) Thickness of base metal / Minimum perceptible wire diameter of penetrameter (mm) / Thickness of base metal / Minimum perceptible wire diameter of penetrameter (mm) t ≤ 4.0 / 0.10 / 32.0 < t ≤ 40.0 / 0.63 4.0 < t ≤ 6.3 / 0.16 / 40.0 < t ≤ 63.0 / 0.80 6.3 < t ≤ 10.0 / 0.20 / 63.0 < t ≤ 80.0 / 1.00 10.0 < t ≤ 12.5 / 0.25 / 80.0 < t ≤ 125 / 1.25 12.5 < t ≤ 16.0 / 0.32 / 125 < t ≤ 200 / 1.60 16.0 < t ≤ 20.0 / 0.40 / 200 < t ≤ 320 / 2.00 20.0 < t ≤ 32.0 / 0.50 / 320 < t / 2.50	(E) <Deleted>	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
(2) **Extent of survey** (A) *Survey of welded joints of the shell and deck plating in ships* (a) The number of checkpoints The minimum number of radiographic check points for the welded joints of the shell and deck plating in ships is to be governed by the following equation or the same as the length of the ship(m), (round off), whichever is the greater. $N = \frac{L(B+D)}{46.5}$ where, N = minimum number of checkpoints L = length specified in **Pt 3, Ch 1, 102.** of the Rules (m) B = breadth specified in **Pt 3, Ch 1, 104.** of the Rules (m) D = depth specified in **Pt 3, Ch 1, 106.** of the Rules (m) (b) Survey location and distribution of checkpoints (i) Survey location and distribution of checkpoints are to comply with the requirements in **Table 4.** These inspection spots are not to adjoin each other. (ii) In the distribution of checkpoints, the selection of inspection locations is to be considered the followings and carried out by the field Surveyor. ① Welds in high stressed areas ② Welds which are inaccessible or very difficult to inspection in service ③ Intersections of field erected welds (iii) If the welds to be inspected can not be inspected because of the structure, other possible welds in the vicinity of that weld are to be subjected to radiographic inspection.	(2) **Extent of survey** (A) *Survey of welded joints of the shell and deck plating in ships* (a) The number of checkpoints The minimum number of radiographic check points for the welded joints of the shell and deck plating in ships is to be governed by the following equation or the same as the length of the ship(m), (round off), whichever is the greater. $N = \frac{L(B+D)}{46.5}$ where, N = minimum number of checkpoints L = length specified in **Pt 3, Ch 1, 102.** of the Rules (m) B = breadth specified in **Pt 3, Ch 1, 104.** of the Rules (m) D = depth specified in **Pt 3, Ch 1, 106.** of the Rules (m) (b) Survey location and distribution of checkpoints (i) Survey location and distribution of checkpoints are to comply with the requirements in **Table 2.** These inspection spots are not to adjoin each other. (ii) In the distribution of checkpoints, the selection of inspection locations is to be considered the followings and carried out by the field Surveyor. ① Welds in high stressed areas ② Welds which are inaccessible or very difficult to inspection in service ③ Intersections of field erected welds (iii) If the welds to be inspected can not be inspected because of the structure, other possible welds in the vicinity of that weld are to be subjected to radiographic inspection.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present

Table 4 Survey location and distribution of checkpoints for the welded joints of the shell and deck plating in ships

Survey location	distribution of checkpoints	
	Butt welds within 0.6 L midship	Butt welds outside 0.6 L midship
(1) Strength deck(excluding the area within hatch side lines) (2) Sheer strake, (3) Side shell plating, (4) bilge strake (5) Bottom shell plating, (including flat plate keel.) (6) Hatch side coaming(including the top plate)(1)	$N^{(2)}$	$\frac{1}{10}N$

Note
(1) Butt joints of the hatch side coaming exceeding 0.15L in length.
(2) one-third of the number of checkpoints is to be the inter-sections of weld lines.

Amendment

Table 2 Survey location and distribution of checkpoints for the welded joints of the shell and deck plating in ships

Survey location	distribution of checkpoints	
	Butt welds within 0.6 L midship	Butt welds outside 0.6 L midship
(1) Strength deck(excluding the area within hatch side lines) (2) Sheer strake, (3) Side shell plating, (4) bilge strake (5) Bottom shell plating, (including flat plate keel.) (6) Hatch side coaming(including the top plate)(1)	$N^{(2)}$	$\frac{1}{10}N$

Note
(1) Butt joints of the hatch side coaming exceeding 0.15L in length.
(2) one-third of the number of checkpoints is to be the inter-sections of weld lines.

reason

* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020)

- To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present

(B) *Survey of welded joints of internal structural members of ships*

(a) Survey location and distribution of checkpoints are to comply with **Table 5.** These inspection spots are not to adjoin each other.

(b) Distribution of checkpoints is to be as specified in (2), (A), (b), (ii)

Table 5 Survey location and distribution of checkpoints for the welded joints of internal structural members of ships

Survey location	distribution of checkpoints(1)(2)	
	within 0.6L midship	outside 0.6L midship
	Butt welds	
(1) Web and face plates of longitudinal members on the strength deck (deck longitudinal, girders under deck and above deck).(longitudinal on the deck within the side lines of a cargo hatch opening are excluded.)	$\frac{1}{8}L$	$\frac{1}{40}L$
(2) Uppermost steel plate of longitudinal bulkheads.	$\frac{1}{8}L$	
(3) Lowermost plate of the longitudinal bulkhead.	$\frac{1}{16}L$	
(4) Web and face plates of longitudinal members (longitudinal frames, center-line girder plate, etc.) on sheer strake, shell plating, turn of bilge strake and keel plate.	$\frac{1}{16}L$	
(5) Web and face plates of transverse and horizontal girders.	$\frac{1}{16}L$	

Note

(1) Number of inspections is to round up decimal places per joints of each members subject to inspections.

(2) Distribution of number of inspections may change in consideration of the type of ship, structural arrangement, welding process, arrangement of joints, etc.

Amendment

(B) *Survey of welded joints of internal structural members of ships*

(a) Survey location and distribution of checkpoints are to comply with **Table 3**. These inspection spots are not to adjoin each other.

(b) Distribution of checkpoints is to be as specified in (2), (A), (b), (ii)

Table 3 Survey location and distribution of checkpoints for the welded joints of internal structural members of ships

Survey location	distribution of checkpoints(1)(2)	
	within 0.6L midship	outside 0.6L midship
	Butt welds	
(1) Web and face plates of longitudinal members on the strength deck (deck longitudinal, girders under deck and above deck).(longitudinal on the deck within the side lines of a cargo hatch opening are excluded.)	$\frac{1}{8}L$	$\frac{1}{40}L$
(2) Uppermost steel plate of longitudinal bulkheads.	$\frac{1}{8}L$	$\frac{1}{40}L$
(3) Lowermost plate of the longitudinal bulkhead.	$\frac{1}{16}L$	$\frac{1}{40}L$
(4) Web and face plates of longitudinal members (longitudinal frames, center-line girder plate, etc.) on sheer strake, shell plating, turn of bilge strake and keel plate.	$\frac{1}{16}L$	$\frac{1}{40}L$
(5) Web and face plates of transverse and horizontal girders.	$\frac{1}{16}L$	$\frac{1}{40}L$

Note

(1) Number of inspections is to round up decimal places per joints of each members subject to inspections.

(2) Distribution of number of inspections may change in consideration of the type of ship, structural arrangement, welding process, arrangement of joints, etc.

reason

* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020)

- To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
(C) *Workmanship control of welded joints of hull* (a) In addition to preceding (A) and (B), non-destructive testing may be required additionally for parts of start, interrupted and end points of automatic welded joints, welded joints of hatch corner, connections of stern frame or rudder horn made of casting steel to rolled steels for hull, welded joints of insert plate for working holes and welded joints in the vicinity of parts where stress is concentrated. (b) In addition to (a) above, non-destructive testing may be required additionally for the areas where welding workmanship is suspect, the areas where new welding methods have been adopted, the areas where defects are liable to occur easily, the welds which are inaccessible or very difficult to inspect in service and other appropriate areas deemed necessary by the Surveyor to encourage good welding work. (c) The locations of and the number of joints to be inspected additionally according to (a) and (b) above are to be appropriately decided by the Surveyor according to the actual status of workmanship of the shipyard. (D) *Addition/Reduction in the number of checkpoints* (a) If it is deemed necessary in considering the results of visual inspection for welds of the members, the Surveyor may require, additional non-destructive inspections for welds other than those subject to non-destructive inspection, or alteration of non-destructive inspection procedure. (b) If the survey results (before repair) of a previously constructed ship show that the number of welds that need to be repaired exceeds 20 % of the total number of locations, then the number of checkpoints is to be a minimum of twice the number required. (c) If automatic welding has been carried out at joints to be surveyed and the results of the survey verify that the quality of the welding procedure is consistent satisfactory quality, the number of checkpoints may appropriately be reduced.	(C) *Workmanship control of welded joints of hull* (a) In addition to preceding (A) and (B), non-destructive testing may be required additionally for parts of start, interrupted and end points of automatic welded joints, welded joints of hatch corner, connections of stern frame or rudder horn made of casting steel to rolled steels for hull, welded joints of insert plate for working holes and welded joints in the vicinity of parts where stress is concentrated. (b) In addition to (a) above, non-destructive testing may be required additionally for the areas where welding workmanship is suspect, the areas where new welding methods have been adopted, the areas where defects are liable to occur easily, the welds which are inaccessible or very difficult to inspect in service and other appropriate areas deemed necessary by the Surveyor to encourage good welding work. (c) The locations of and the number of joints to be inspected additionally according to (a) and (b) above are to be appropriately decided by the Surveyor according to the actual status of workmanship of the shipyard. (D) *Addition/Reduction in the number of checkpoints* (a) If it is deemed necessary in considering the results of visual inspection for welds of the members, the Surveyor may require, additional non-destructive inspections for welds other than those subject to non-destructive inspection, or alteration of non-destructive inspection procedure. (b) If the survey results (before repair) of a previously constructed ship show that the number of welds that need to be repaired exceeds 20 % of the total number of locations, then the number of checkpoints is to be a minimum of twice the number required. (c) If automatic welding has been carried out at joints to be surveyed and the results of the survey verify that the quality of the welding procedure is consistent satisfactory quality, the number of checkpoints may appropriately be reduced.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
(d) If a weld that needs to be repaired is found from automatically welded joints whose number has been reduced in accordance with (c), additional radiographs amounting to the number of checkpoints as prescribed in (c), are to be taken immediately. The number of checkpoints is not to be reduced until an appropriate period has elapsed and the quality is verified to be stable and satisfactory. (e) For ships whose length 120 m or under, the survey locations and the number of checkpoints can be reduced. ~~(3) **Acceptable Criteria of Radiographic Inspections**~~ ~~In radiographic testing, the Surveyor is to decide whether or not the results are acceptable when the test records specified in **3.** (5) The judgement may be required to the engineers of the shipbuilder (personnel with qualifications) but the results of its judgement frequently are to be verified. Where deemed necessary by the society, all radiographic films related with the ship are to be submitted.~~ ~~(A) *Classification of Defects*~~ ~~(a) Classification of defects is to be as given in **Table 6.**~~ ~~**Table 6 Classification of defects**~~ ~~Types of defects | Kind of defects~~ ~~Type 1 | Porosity(blow hole) and similar defects~~ ~~Type 2 | Elongated slag inclusion, pipe, incomplete penetration, incomplete fusion, and similar defects~~ ~~Type 3 | Crack and similar defects~~	(d) If a weld that needs to be repaired is found from automatically welded joints whose number has been reduced in accordance with (c), additional radiographs amounting to the number of checkpoints as prescribed in (c), are to be taken immediately. The number of checkpoints is not to be reduced until an appropriate period has elapsed and the quality is verified to be stable and satisfactory. (e) For ships whose length 120 m or under, the survey locations and the number of checkpoints can be reduced.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
(b) Where it is difficult to classify the defects into type 1 or type 2, classify respective defects into type 1 or type 2, and then decide whether or not the results are acceptable. (c) In case of butt welded joints between plates with different thickness, thickness of the thinner plate is taken. (B) *Defect of Type 1* (a) Size of defect of type 1 is to be represented by score and maximum length of the defect. The test field vision specified in **Table 8** is to be selected from radiographic so that the defects of maximum size exists and the sum of size of defects is maximum. Where the flaw falls on the boundary of the test field of vision, the part outside the test field of vision shall be included for measurement. (b) The score of defect in the case of single defect of type 1 shall be determined by using the value in **Table 7** according to the dimension of the major diameter of the defect. The score of defect for two or more defect of type 1 shall be the grand total of the score for each defect in the test field of vision.		* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Table 7 Score of defect Units : mm

Major diameter of flaw (mm)	Up to and incl. 1.0	Over 1.0, up to and incl. 2.0	Over 2.0, up to and incl. 3.0	Over 3.0, up to and incl. 4.0	Over 4.0, up to and incl. 6.0	Over 6.0, up to and incl. 8.0	Over 8.0
Score	1	2	3	6	10	15	25

Present	Amendment	reason
(c) The defects of type 1 are to be judged unacceptable, if the size of the defects exceeds the value of acceptable criteria specified in **Table 8.** **Table 8 Acceptance criteria for type 1 defect** Thickness of base metal t(mm) | t ≤ 10 | 10 < t ≤25 | 25 < t ≤50 | 50 < t ≤ 100 Test field of vision | 10 mm × 10 mm | | 10 mm × 20 mm | Acceptance criteria: Maximum size of single defect (mm) | 4 | 5 | t/5 | 10 Acceptance criteria: Total score of defect | 6 | 12 | 24 | 30 Note (1) Where the thickness of base metal is not more than 25 mm, the defects of not more than 0.5 mm may be ignored. Where the thickness of base metal is more than 25 mm, the defects of not more than 0.7 mm may be ignored.		* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
(C) *Defect of Type 2* (a) Size of defect of type 2 is to be represented by length of the defect. Where defects are present in a row and the distance between the mutual defects does not exceed the length of larger defect, the sizes of all defects including the spaces between the mutual defects is to be considered as the length of the defect. (b) The defects of type 2 are to be judged unacceptable, if the length of a defect exceeds the value of acceptable criteria specified in **Table 9.** (c) Incomplete root penetration is not accepted in butt joint welded from one side		* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Table 9 Acceptance criteria for type 2 defect

	Thickness of base metal t (mm)	$t \leq 12$	$12 < t \leq 50$	$50 < t$
Acceptance criteria	Sum of size of defect (mm)	6 or under	t/2 or under	24 or under

(D) *Defect of Type 3*

Any defect of type 3 is to be judged unacceptable.

(E) *In Case of Coexistence of Defects of Type 1 and Type 2*

Where two or more types of defects are coexistent, the defects are to be judged unacceptable, provided the size of defects of each type are more than half of the size specified in **Table 8** and **Table 9** respectively.

Present	Amendment	reason
(4) **Repair and Treatment after the Repair** (A) Unacceptable indications should be eliminated and repaired where necessary. The repair welds should be examined on their full length using ultrasonic or radiographic testing method. (B) When unacceptable indications are found, additional areas of the same weld length should be examined unless the indication is judged isolated without any doubt. In case of automatic welded joints, additional NDT should be extended to all areas of the same weld length. Same weld length mean the locations where, for manual and semi-automatic welding, identical person, identical postures and identical time and, for automatic welding, identical welding method, and identical time. (C) The extent of testing can be extended at the surveyor's discretion when repeated nonacceptable discontinuities are found. (D) The Shipbuilder should take appropriate actions to monitor and improve the quality of welds to the required level. The repair rate at which corrective action is to be instigated should be identified in the builder''s QA system. (5) **Survey records** (A) The survey results are to be recorded to the survey records such as followings and their records are to be filed to compare the inspection locations with their results. (a) Radiation source, type and focal spot size (b) Geometry of radiographic setup (c) Film type (d) Intensifying screens (e) Film coverage (f) Image quality indicators (g) Film identification marking (h) Exposure conditions (i) Film processing (j) Film density (k) Film viewing conditions (l) The result of judgement for acceptance (m) Name of personnel performed the radiographic inspection (n) Name of personnel performed the radiographic review		* Request for Establishment/Revision of Classification Technical Rules () - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
(B) The Society may require to duplicate some radiographs in order that some processed films are handed over to the Society together with testing reports. Alternative method to duplicate the processed film can be agreed with the Society.	**(movement)**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020)
4. Ultrasonic Inspection	**6. Ultrasonic Testing(UT)**	- To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)
(1) **Methods of ultrasonic inspection**	(1) **Methods of ultrasonic testing**	
(A) General	(A) UT shall be carried out according to procedure based on *ISO 17640:2018*(testing procedure), *ISO 23279:2017* (characterization) and *ISO 11666:2018*(acceptance levels) or accepted standards by the Society.	
(a) The inspection methods other than those specified in this Guidance are to comply with *KS B* 0896 (Method for ultrasonic examination for welds of ferritic steel) except in those cases where alternative criteria have been otherwise approved or specified.	(B) The minimum inspected weld length for each checkpoint is to be specified in the approved NDT plan in accordance with (2).	
(B) <New>	(C) The extent of UT shall be in accordance to the approved plans in accordance with (2) and to the satisfaction of the surveyor.	
(C) <New>	(D) In general, the scanning of weld is performed by using angle beam technique. However, normal beam technique is appled to the place where the application of angle beam technique is difficult or the place specially specified as that where the other technique are more suitable than angle beam technique for detecting a discontinuity.	
(b) In general, the scanning of weld is performed by using angle beam technique. However, normal beam technique is appled to the place where the application of angle beam technique is difficult or the place specially specified as that where the other technique are more suitable than angle beam technique for detecting a discontinuity.		
(c) The stage of the test is the time when the final heat treatment is completed, in the case where heat treatment or the like after completion of weld has been specified in the document.	(E) The stage of the test is the time when the final heat treatment is completed, in the case where heat treatment or the like after completion of weld has been specified in the document.	
(d) The test of parent materials of the part through which ultrasonic waves pass when angle beam technique is performed, are previously tested normal technique to detect a discontinuity such as lamination etc.	(F) The test of parent materials of the part through which ultrasonic waves pass when angle beam technique is performed, are previously tested normal technique to detect a discontinuity such as lamination etc.	

Present	Amendment	reason
(e) The probes may be affixed to suitable wedges designed to induce beam waves in the material under test at the selected angles. (f) The couplant, in general, is to be used the glycerine-water solution of 75 % or more. The kinds and temperature of the couplant used for test are to be equivalent to those used for calibration of ultrasonic test instrument. (g) The weld reinforcement is adequately finished in case where its form affects the results of the test. ~~(B) Checking the overall performance characteristics of ultrasonic equipment~~ ~~(a) The vertical linearity is to be checked in accordance with the 4.1 of the *KS B* 0534 (Method for Assessing the Overall Performance Characteristics of Ultrasonic pulse echo instrument) and the result is to be within ±3% of full scale.~~ ~~(b) The linearity of the time base is to be measured in accordance with the 4.2 of the *KS B* 0534 and the result is to be within ±1% of full scale.~~ ~~(c) A margin of gain control is to be measured in accordance with the 4.3 of the *KS B* 0534 and the result is to be not less than 40dB.~~ ~~(d) Periodical checks of ultrasonic test instrument are to be performed not less once every year. However, The check of the test instrument immediately is to be performed in the case that the repair relating to the performance characteristics of the ultrasonic test instrument was performed within this period.~~	(G) The probes may be affixed to suitable wedges designed to induce beam waves in the material under test at the selected angles. (H) The couplant, in general, is to be used the glycerine-water solution of 75 % or more. The kinds and temperature of the couplant used for test are to be equivalent to those used for calibration of ultrasonic test instrument. (I) The weld reinforcement is adequately finished in case where its form affects the results of the test.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
(C) Probes (a) In general, the scanning of weld is performed by using probes of angle beam technique. In case where normal probe is used, the standard is to comply with the *KS B* 0896. (b) The frequency to be used for angle beam technique is in accordance with **Table 10.** However, the frequency lower than the value specified in **Table 10** may be used for the test of test object with remarkable ultrasonic attenuation and the frequency higher than the value specified in **Table 10** may be used for improving the resolution.		* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Table 10 Nominal Frequency to be used for Angle Beam Technique

Plate thickness of parent materials (mm)	Nominal frequency (MHz)
75 or less	5 or 2
over 75	2

(c) The refraction angle of probe to be used is to comply with **Table 11** according to the thickness of parent materials. Where deemed appropriate by the Society, the different refraction angle of probe may be used.

Table 11 Nominal Refraction Angle of Probe used

Plate thickness of parent materials (mm)	Nominal refraction angle
40 or less	70°
Over 40 to 60 incl.	70° or 60°
Over 60	70° and 45° or 60° and 45°

Present	Amendment	reason
(D) Adjustment of ultrasonic test instrument (a) Measurement of probe index The probe index is measured by using A1 calibration block or A3 calibration block specified in *KS B* 0831. The probe index is measured in precision of ±1% and to be indicated on the both sides of probe. (b) Measurement of refraction angle Refraction angle is measured in unit of 0.5° by using A1 calibration block or A3 calibration block (c) Adjustment of time base range and correction of the starting point The adjustment of time base range is performed in precision of ±1% by using A1 calibration block or A3 calibration block and the starting point is corrected. (d) The equipment (instrument and probes) should be verified by the use of appropriate standard calibration blocks at suitable time intervals. (E) Making of curve for dividing echo height (a) Curve for dividing echo height The height for evaluation of the depth is made for four regions specified in **Fig 2.** The positions of probe for making the curves for dividing echo height using the distance amplitude characteristic curve are to comply with **Fig 1.** (b) Determination of H line, M line and L line The curve for dividing echo height by working sensitivity of (d) is selected to take it as H line, and the curve for dividing echo height lower than H line by 6 dB is taken as M line and the curve lower than H line by 12 dB is taken as L line. H line is of over 40 %.		* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

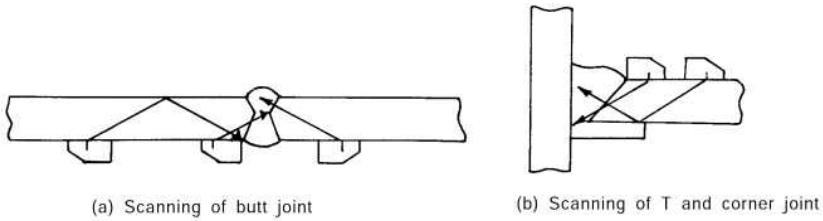
Present	Amendment	reason
(c) Regions The regions divided by H, M and L line are designated as given in **Table 12** and the examples of regional division are indicated as given in **Fig 2.** **Fig 1 Position of Probe for making the Curves for Dividing Echo Height** **Fig 2 Examples for Drawing Curves for Dividing Echo Height**		* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
~~Table 12 Designation of Regional Division of Echo Height~~ ~~Range of echo height~~ | ~~Region of echo height~~ ~~L line or less~~ | ~~I~~ ~~Over L to M line incl.~~ | ~~II~~ ~~Over M to H line incl.~~ | ~~III~~ ~~Over H line~~ | ~~IV~~ ~~(F) Working sensitivity~~ ~~(a) Using the A2 calibration block~~ ~~In the case of using nominal refraction angle of 60° or 70°, the gain of instrument is adjusted so that the echo height of the standard hole of ϕ 4 x 4 mm agrees with H line. In the case of using nominal refraction angle of 45°, the gain of instrument is increased by 6 dB after it is adjusted so that the echo height of the standard hole of ϕ 4 x 4 mm agrees with H line. In both case, where deemed appropriate by Society, sensitivity compensation calculated according to Annex of *KS B* 0896 to be added.~~ ~~(b) Using the RB-4 reference block~~ ~~The gain of instrument is adjusted so that the echo height of the standard hole agrees with H line.~~ ~~(c) Where deemed appropriate by the Society, other blocks considered as equivalent for block specified in (a) and (b) may be used.~~ ~~(d) The range and sensitivity should be set prior to each testing and checked at regular intervals as per the procedure and whenever needed.~~		* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
(G) Position and direction of scanning (a) In general, the scanning of weld is performed by using angle beam technique and scanning method is comply with the **Table 13 and Fig 3** depending on the type of joints and plate thickness. However, for welds in which the surfaces have been ground, the probe is placed on the weld surface and moved along the weld axis with the sound beam directed parallel to the weld.		* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Table 13 Position and direction of scanning

Type of Joints	Plate thickness (mm)	Position and direction of scanning	Scanning methods
butt joints	t ≤ 100	both side of single face	Directed and 1 skip reflected.
	t > 100	both side of both face	Directed
T joints, corner joints	t ≤ 60	single side of single face	Directed and 1 skip reflected.
	t > 60	single side of both face	Directed



(a) Scanning of butt joint

(b) Scanning of T and corner joint

Fig 3 Position and Direction of Scanning

Present	Amendment	reason
(b) The scanning technique should be determined to allow the testing of the entire volume of the weld bead and base metal for at least 10 mm on each side of the weld, or the width of the heat affected zone, whichever is greater. (H) Ultrasonic discontinuity length and presentation of location of discontinuity (a) Ultrasonic discontinuity length (i) The position indicating the maximum echo height is taken as center of scanning, the transference distance of the probe in the range where the echo height exceeds L line is measured by scanning its circumference is taken as the ultrasonic discontinuity length. The measurement is performed by unit of 1 mm. (ii) In the case where the plate thickness of part where the probe is contacted is not less than 75 mm, nominal frequency is 2 MHz and the probe with transducer size of 20 x 20 mm is used, the transference distance of the probe in the range where the echo height exceeds one half of the height of the maximum echo is taken as the ultrasonic discontinuity length. (b) Presentation of location of discontinuity The discontinuity location in the transverse section [depth(*d*) and distance(*k*) from weld centerline] is presented by the probe location(*Xp*) where the maximum echo can obtain. The discontinuity location in the plane is presented by both ends((*Xs* and *Xe*) of ultrasonic discontinuity length(*l*)		* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
 Fig 4 Presentation of location of discontinuity (2) **Extent of survey** (A) Survey of welded joints of the shell and deck plating in ships (a) The survey location and distribution of checkpoints of ultrasonic inspection are to comply with the requirements given in (A) of **3** (2). (b) Test range of ultrasonic inspection is entire length of the joint or 750 mm, whichever is smaller. (B) Survey of welded joints of internal structural members of ships (a) The survey location and distribution of checkpoints of ultrasonic inspection are to comply with the requirements given in (B) of **3** (2). (b) Test range of ultrasonic inspection is entire length of the joint or 300 mm, whichever is smaller. (C) Workmanship control of welded joints of hull (a) The survey location and distribution of checkpoints of ultrasonic inspection for workmanship control of welded joints of hull are to comply with the requirements given in (C) of **3** (2). (b) Test range of ultrasonic inspection is to comply with the requirements given in (B) above. (D) Addition/Reduction in the number of checkpoints Addition/reduction in the number of checkpoints is to comply with the requirements given in (D) of **3** (2).	(2) **Extent of survey** (A) Survey of welded joints of the shell and deck plating in ships (a) The survey location and distribution of checkpoints of ultrasonic inspection are to comply with the requirements given in (A) of **3** (2). (b) Test range of ultrasonic inspection is entire length of the joint or 750 mm, whichever is smaller. (B) Survey of welded joints of internal structural members of ships (a) The survey location and distribution of checkpoints of ultrasonic inspection are to comply with the requirements given in (B) of **3** (2). (b) Test range of ultrasonic inspection is entire length of the joint or 300 mm, whichever is smaller. (C) Workmanship control of welded joints of hull (a) The survey location and distribution of checkpoints of ultrasonic inspection for workmanship control of welded joints of hull are to comply with the requirements given in (C) of **3** (2). (b) Test range of ultrasonic inspection is to comply with the requirements given in (B) above. (D) Addition/Reduction in the number of checkpoints Addition/reduction in the number of checkpoints is to comply with the requirements given in (D) of **3** (2).	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
(3) **Acceptance Criteria of ultrasonic inspections** (A) Defects detected by ultrasonic inspection are to be judged in accordance with **Table 14** **Table 14 Acceptance criteria for defects detected by ultrasonic inspection**		* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

	Thickness of base metal t (mm)	t ≤ 50	50 < t	t ≤ 50	50 < t
	Region of maximum echo heights	II and III		IV	
Acceptance Criteria	length of defect (mm)	t or less	50 or less	t/2 or less	25 or less

Note:

1. (1) The symbol t is plate thickness (mm) of the parents materials of the groove side. However, in the case of butt joint weld with different plate thickness of the parents materials, the thinner plate thickness is adopted.
2. In applying this table, in the case where the distance between discontinuities is smaller or equal to the length of the discontinuity with longer ultrasonic discontinuity length that the depth considered to be same, these discontinuities are regarded as same discontinuity group and treated as a continuous discontinuity including such distance. In the case where the distance between discontinuities is longer than the larger one out of the both ultrasonic discontinuity lengths, these discontinuities are regarded as independent from each other. The examination results of straddle scanning, parallel scanning by slanted probe and longitudinal scanning on the weld line are classified in accordance with the agreement between the parties concerned.

Present	Amendment	reason
~~(B) Where kind of defect is considered as cracks from welding process, location of defects, etc., the defects are to be judged unacceptable.~~ ~~(4) **Repair and Treatment after the Repair**~~ ~~Repair and treatment after the repair is to comply with the requirements given in **3** (4).~~ ~~(5) **Records**~~ ~~(A) Making the records~~ ~~The records after test are to be made.~~ ~~(B) Items of Records~~ ~~The records are to be included the followings.~~ ~~(a) Name of the work and manufacturer~~ ~~(b) Number and name of ship~~ ~~(c) Name and qualification of personnel engaged in the test~~ ~~(d) Date of the test~~ ~~(e) Calibration and reference blocks used~~ ~~(f) Performance of test instrument (identity, probe type, size, frequency, angle etc)~~ ~~(g) Unusual condition of weld bead~~ ~~(h) Method of welding and form of groove~~ ~~(i) Materials and dimension~~ ~~(j) Location and length of the welds inspected~~ ~~(k) Length and location of discontinuity~~ ~~(l) Classification~~ ~~(m) Kind of couplant~~ ~~(n) Working sensitivity~~ ~~(o) Other items(designated items, subject of discussion, witness, sampling method etc.)~~ ~~(C) Evaluation of records~~ ~~The ultrasonic test reports is to be made under condition of rigid quality control and is to be to the satisfaction of the Surveyor.~~		* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)
5. Improvement of qualification Where the faulty welds are more than 10 % of the number of inspection specified in **Table 4** or **5**, the results of investigation on the substantial cause and the measures to improve the quality are to be submitted to the Surveyor. ⚓	**(movement)**	

Present	Amendment	reason
<New>	**7. Acceptance Levels(criteria)** (1) **General** (A) This requirement details the acceptance levels (criteria) followed for the assessment of the NDT results. Techniques include but are not limited to: VT, MT, PT, RT and UT. (B) As far as necessary, testing techniques shall be combined to facilitate the assessment of indications against the acceptance criteria. (C) The assessment of indications not covered by this document shall be made in accordance with a standard agreed with the Society. Alternative acceptance criteria can be agreed with the Society, provided equivalency is established. (D) The general accepted methods for testing of welds are provided in **Table 4** and **Table 5** for surface and embedded discontinuities respectively. Refer to *ISO 17635:2016*.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Table 4 Method for detection of surface discontinuities(All type of welds including fillet welds)

Materials	Testing Methods
Ferritic Steel	VT
	VT, MT
	VT, PT

Table 5 NDT for detection of embedded discontinuities (for butt and T joints with full penetration)

Materials and type of joint	Nominal thickness (t) of the parent material to be welded (mm)		
	t < 8	8≤t≤40	t > 40
Ferritic butt-joints	RT or UT(1)	RT or UT	UT or RT(2)
Ferritic T-joints	UT(1) or RT(2)	UT or RT(2)	UT or RT(2)

Note:
(1) Below 8mm the Society may consider application of an appropriate advanced UT method.
(2) RT may be applied however there will be limitations.

Present	Amendment	reason
<New>	(2) **Quality Levels** (A) Testing requirements follows the designation of a particular quality level of imperfections in fusion-welded joints in accordance with *ISO 5817:2014*. Three quality levels (B, C and D) are specified. (B) In general Quality level C is to be applied for hull structure. (C) Quality level B corresponds to the highest requirement on the finished weld, and may be applied on critical welds. (D) This standard applies to steel materials with thickness above 0.5 mm. *ISO 5817:2014* **Table 1** provides the requirements on the limits of imperfections for each quality level. *ISO 5817:2014* Annex A also provides examples for the determination of percentage of imperfections(number of pores in surface percent). (E) All levels (B,C and D) refer to production quality and not to the fitness for purpose (ability of product, process or service to serve a defined purpose under specific conditions). The correlation between the quality levels defined in *ISO 5817:2014*, testing levels/techniques and acceptance levels (for each NDT technique) will serve to define the purpose under specific conditions. The acceptance level required for examination shall be agreed with the Society. This will determine the quality level required in accordance with the non-destructive technique selected. Refer to **Tables 6** to **11**. (3) **Testing Levels** (A) The testing coverage and thus the probability of detection increases from testing level A to testing level C. The testing level shall be agreed with the Society. Testing level D is intended for special applications, this can only be used when defined by specification. *ISO 17640:2018* Annex A tables A.1 to A.7 provide guidance on the selection of testing levels for all type of joints in relation to the thickness of parent material and inspection requirements. (B) The testing technique used for the assessment of indications shall also be specified. (4) **Acceptance Levels** (A) The acceptance levels are specified for each testing technique used for performing the inspection. The criteria applied is to comply with each standard identified in **Tables 6** to **11** (or any recognized acceptable standard agreed with the Society). (B) Probability of detection (POD) indicates the probability that a testing technique will detect a given flaw.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

<table>
<tr><th>Present</th><th>Amendment</th><th>reason</th></tr>
<tr>
<td><New></td>
<td>
(C) Visual testing(VT)
The acceptance levels and required quality levels for VT are provided in IACS Rec 47 and Table 6 below.

Table 6 Visual testing
<table>
<tr><th>Quality Levels
(ISO 5817:2014 applies)(1)</th><th>Testing Techniques/ levels
(ISO 17637:2016 applies)(1)</th><th>Acceptance levels(2)</th></tr>
<tr><td>B</td><td rowspan="3">Level not specified</td><td>B</td></tr>
<tr><td>C</td><td>C</td></tr>
<tr><td>D</td><td>D</td></tr>
<tr><td colspan="3">Note:
(1) Or any recognized standard agreed with the Society and demonstrated to be acceptable
(2) The acceptance levels for VT are the same to the quality levels requirements of ISO 5817:2014</td></tr>
</table>

(D) Liquid Penetrant testing(PT)
The acceptance levels and required quality levels for PT are provided in Table 7 below.

Table 7 Liquid Penetrant Testing
<table>
<tr><th>Quality Levels
(ISO 5817:2014 applies)(1)</th><th>Testing Techniques/ levels
(ISO 3452-1:2013 applies)(1)</th><th>Acceptance levels
(ISO 23277:2015 applies)(1)</th></tr>
<tr><td>B</td><td rowspan="3">Level not specified</td><td>2X</td></tr>
<tr><td>C</td><td>2X</td></tr>
<tr><td>D</td><td>3X</td></tr>
<tr><td colspan="3">Note:
(1) Or any recognized standard agreed with the Society and demonstrated to be acceptable</td></tr>
</table>
</td>
<td>* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020)

- To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)</td>
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</table>

<table>
<tr><th>Present</th><th>Amendment</th><th>reason</th></tr>
<tr>
<td><New></td>
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(E) Magnetic Particle testing(MT)
The acceptance levels and required quality levels for MT is provided in Table 8 below.

Table 8 Magnetic Particle Testing
<table>
<tr><th>Quality Levels
(ISO 5817:2014 applies)(1)</th><th>Testing Techniques/ levels
(ISO 17638:2016 applies)(1)</th><th>Acceptance levels
(ISO 23278:2015 applies)(1)</th></tr>
<tr><td>B</td><td rowspan="3">Level not specified</td><td>2X</td></tr>
<tr><td>C</td><td>2X</td></tr>
<tr><td>D</td><td>3X</td></tr>
<tr><td colspan="3">Note:
(1) Or any recognized standard agreed with the Society and demonstrated to be acceptable</td></tr>
</table>

(F) Radiographic testing(RT)
The acceptance levels and required quality levels for RT are provided in Table 9 below. Reference radiographs for the assessment of weld imperfections shall be provided in accordance to ISO 5817:2014 or acceptable recognized standard agreed with the Society.

Table 9 Radiographic Testing
<table>
<tr><th>Quality Levels
(ISO 5817:2014 applies)(1)</th><th>Testing Techniques/ levels
(ISO 17636-1:2013 applies)(1)</th><th>Acceptance levels
(ISO 10675-1:2016 applies)(1)</th></tr>
<tr><td>B</td><td>B(class)</td><td>1</td></tr>
<tr><td>C</td><td>B(2)(class)</td><td>2</td></tr>
<tr><td>D</td><td>At least A (class)</td><td>3</td></tr>
<tr><td colspan="3">Note:
(1) Or any recognized standard agreed with the Society and demonstrated to be acceptable
(2) For circumferential weld testing, the minimum number of exposures may correspond to the requirements of ISO 17636-1:2013, class A</td></tr>
</table>
</td>
<td>* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020)

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</tr>
</table>

<table>
<tr><th>Present</th><th>Amendment</th><th>reason</th></tr>
<tr>
<td><New></td>
<td>
(G) Ultrasonic testing(UT)
(a) The acceptance levels and required quality levels for UT are provided in Tables 10 and 11 below.

Table 10 Ultrasonic Testing
<table>
<tr><th>Quality Levels (ISO 5817:2014 applies)(1)(2)</th><th>Testing Techniques/Levels (ISO 17640:2018 applies)(1)(2)</th><th>Acceptance Levels (ISO 11666:2018 applies)(1)</th></tr>
<tr><td>B</td><td>at least B</td><td>2</td></tr>
<tr><td>C</td><td>at least A</td><td>3</td></tr>
<tr><td>D</td><td>at least A</td><td>3(3)</td></tr>
<tr><td colspan="3">Note:
(1) Or any recognized standard agreed with the Society and demonstrated to be acceptable
(2) When characterization of indications is required, ISO 23279:2017 is to be applied
(3) UT is not recommended but can be defined in a specification with same requirement as Quality Level C</td></tr>
</table>
</td>
<td>* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020)

- To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)</td>
</tr>
</table>

Present	Amendment	reason
<New>	**Table 11 Recommended Testing and Quality Levels (ISO 17640)** Testing Level(1)(2)(3) (ISO 17640:2018 applies) / Quality Level (ISO 5817:2014 applies) A / C, D B / B C / By agreement D / Special application Note: (1) POD increases from testing level A to C as testing coverage increases (2) Testing Level D for special application shall be agreed with the Society (3) Specific requirements for testing levels A to C, are provided for various types of joints in ISO 17460:2018 Annex A (b) UT Acceptance Levels apply to the examination of full penetration ferritic steel welds, with thickness from 8 mm to 100 mm. The nominal frequency of probes used shall be between 2 MHz and 5 MHz. Examination procedures for other type of welds, material, thicknesses above 100 mm and examination conditions shall be submitted to the consideration of the Society. (c) The acceptance levels for UT of welds are to be defined in accordance to ISO 11666:2018 requirements or any recognized acceptable standard agreed with the Society. The standard specifies acceptance level 2 and 3 for full penetration welded joints in ferritic steels, corresponding to quality levels B and C (Refer to **Table 10**). (d) **Sensitivity settings and levels.** The sensitivity levels are set by the following techniques. (i) Technique 1: based on 3mm diameter side- drilled holes (ii) Technique 2: based on distance gain size (DGS) curves for flat bottom holes (diskshaped reflectors) (iii) Technique 3: using a distance-amplitude-corrected (DAC) curve of a rectangular notch of 1mm depth and 1mm width (iv) Technique 4: using the tandem technique with reference to a 6mm diameter flatbottom hole (disk shaped reflector)	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
<New> <This is from present Guidance>	(e) The evaluation levels (reference, evaluative, recording and acceptance) are specified in *ISO 11666:2018* Annex A. (5) **Acceptance criteria when no quality level is specified** (A) If the acceptance level cannot be determined pursuant to (4) above because the quality level is not specified, these requirements can be followed. (B) Acceptance criteria for visual testing, magnetic particle and liquid penetrant testing are given in **Table 12**. Only the indications which have any dimension greater than 2 mm should require evaluation for MT&PT.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Table 12 Acceptance criteria for visual testing, magnetic particle and liquid penetrant testing

Surface discontinuity	Acceptance criteria for visual testing
Crack	not accepted
Lack of fusion	not accepted
Incomplete root penetration in butt joints welded from one side	not accepted
Surface pore	Single pore diameter d ≤ 0.25t(1) for butt welds (d ≤0.25a(1) for fillet welds) with maximum diameter 3mm; 2.5d as minimum distance to adjacent pore.
Undercut in butt welds	depth ≤ 0.5mm whatever is the length depth ≤ 0.8mm with a maximum continuous(2) length of 90mm
Undercut in fillet welds	depth ≤ 0.8mm whatever is the length
Note: (1) “t” is the plate thickness of the thinnest plate and “a” is the throat of the fillet weld. (2) Adjacent undercuts separated by a distance shorter than the shortest undercut should be regarded as a single continuous undercut.	

Present	Amendment	reason
<This is from present Guidance>	(C) Acceptance criteria for RT (a) *Classification of Defects* (i) Classification of defects is to be as given in **Table 13**.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Table 13 Classification of defects

Types of defects	Kind of defects
Type 1	Porosity(blow hole) and similar defects
Type 2	Elongated slag inclusion, pipe, incomplete penetration, incomplete fusion, and similar defects
Type 3	Crack and similar defects

(ii) Where it is difficult to classify the defects into type 1 or type 2, classify respective defects into type 1 or type 2, and then decide whether or not the results are acceptable.

(iii) In case of butt welded joints between plates with different thickness, thickness of the thinner plate is taken.

(b) *Defect of Type 1*

(i) Size of defect of type 1 is to be represented by score and maximum length of the defect. The test field vision specified in **Table 15** is to be selected from radiographic so that the defects of maximum size exists and the sum of size of defects is maximum. Where the flaw falls on the boundary of the test field of vision, the part outside the test field of vision shall be included for measurement.

(ii) The score of defect in the case of single defect of type 1 shall be determined by using the value in **Table 14** according to the dimension of the major diameter of the defect. The score of defect for two or more defect of type 1 shall be the grand total of the score for each defect in the test field of vision.

Table 14 Score of defect Units : mm

Major diameter of flaw (mm)	Up to and incl. 1.0	Over 1.0, up to and incl. 2.0	Over 2.0, up to and incl. 3.0	Over 3.0, up to and incl. 4.0	Over 4.0, up to and incl. 6.0	Over 6.0, up to and incl. 8.0	Over 8.0
Score	1	2	3	6	10	15	25

Present	Amendment	reason
<This is from present Guidance>	(iii) The defects of type 1 are to be judged unacceptable, if the size of the defects exceeds the value of acceptable criteria specified in **Table 15**.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Table 15 Acceptance criteria for type 1 defect

	Thickness of base metal t(mm)	t ≤ 10	10 < t ≤25	25 < t ≤50	50 < t ≤ 100
	Test field of vision	10 mm × 10 mm		10 mm × 20 mm	
Acceptance criteria	Maximum size of single defect (mm)	4	5	t/5	10
	Total score of defect	6	12	24	30

Note
(1) Where the thickness of base metal is not more than 25 mm, the defects of not more than 0.5 mm may be ignored. Where the thickness of base metal is more than 25 mm, the defects of not more than 0.7 mm may be ignored.

(c) Defect of Type 2
(i) Size of defect of type 2 is to be represented by length of the defect. Where defects are present in a row and the distance between the mutual defects does not exceed the length of larger defect, the sizes of all defects including the spaces between the mutual defects is to be considered as the length of the defect.
(ii) The defects of type 2 are to be judged unacceptable, if the length of a defect exceeds the value of acceptable criteria specified in **Table 16**.
(iii) Incomplete root penetration is not accepted in butt joint welded from one side.

Table 16 Acceptance criteria for type 2 defect

	Thickness of base metal t (mm)	t ≤ 12	12 < t ≤ 50	50 < t
Acceptance criteria	Sum of size of defect (mm)	6 or under	t/2 or under	24 or under

(d) Defect of Type 3
Any defect of type 3 is to be judged unacceptable.
(e) In Case of Coexistence of Defects of Type 1 and Type 2
Where two or more types of defects are coexistent, the defects are to be judged unacceptable, provided the size of defects of each type are more than half of the size specified in **Table 15** and **Table 16** respectively.

Present	Amendment	reason
<This is from present Guidance>	(D) Acceptance criteria for UT (a) The inspection methods are to comply with *KS B* 0896 (Method for ultrasonic examination for welds of ferritic steel) (b) Making of curve for dividing echo height (i) Curve for dividing echo height The height for evaluation of the depth is made for four regions specified in **Fig 2.** The positions of probe for making the curves for dividing echo height using the distance amplitude characteristic curve are to comply with **Fig 1.** (ii) Determination of H line, M line and L line The curve for dividing echo height by working sensitivity of (d) is selected to take it as H line, and the curve for dividing echo height lower than H line by 6 dB is taken as M line and the curve lower than H line by 12 dB is taken as L line. H line is of over 40 %. (iii) Regions The regions divided by H, M and L line are designated as given in **Table 17** and the examples of regional division are indicated as given in **Fig 2.** **Fig 1 Position of Probe for making the Curves for Dividing Echo Height**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
<This is from present Guidance>		* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Fig 2 Examples for Drawing Curves for Dividing Echo Height

Table 17 Designation of Regional Division of Echo Height

Range of echo height	Region of echo height
L line or less	I
Over L to M line incl.	II
Over M to H line incl.	III
Over H line	IV

Present	Amendment	reason
<This is from present Guidance>	(c) Acceptance Criteria (i) Defects detected by ultrasonic inspection are to be judged in accordance with **Table 18**. (ii) Where kind of defect is considered as cracks from welding process, location of defects, etc., the defects are to be judged unacceptable.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Table 18 Acceptance criteria for defects detected by ultrasonic inspection

	Thickness of base metal t (mm)	t ≤ 50	50 < t	t ≤ 50	50 < t
	Region of maximum echo heights	II and III		IV	
Acceptance Criteria	length of defect (mm)	t or less	50 or less	t/2 or less	25 or less

Note:
1. (1) The symbol t is plate thickness (mm) of the parents materials of the groove side. However, in the case of butt joint weld with different plate thickness of the parents materials, the thinner plate thickness is adopted.
2. In applying this table, in the case where the distance between discontinuities is smaller or equal to the length of the discontinuity with longer ultrasonic discontinuity length that the depth considered to be same, these discontinuities are regarded as same discontinuity group and treated as a continuous discontinuity including such distance. In the case where the distance between discontinuities is longer than the larger one out of the both ultrasonic discontinuity lengths, these discontinuities are regarded as independent from each other. The examination results of straddle scanning, parallel scanning by slanted probe and longitudinal scanning on the weld line are classified in accordance with the agreement between the parties concerned.

Present	Amendment	reason
<New>	**8. Reporting** (1) Reports of NDT required shall be prepared by the Shipbuilder and shall be made available to the Society. (2) Reports of NDT shall include the following generic items: (A) Date of testing (B) Hull number, location and length of weld inspected (C) Names, qualification level and signature of personnel that have performed the testing (D) Identification of the component examined (E) Identification of the welds examined (F) Steel grade, type of joint, thickness of parent material, welding process (G) Acceptance criteria (H) Testing standards used (I) Testing equipment and arrangement used (J) Any test limitations, viewing conditions and temperature (K) Results of testing with reference to acceptance criteria, location and size of reportable indications (L) Statement of acceptance/non-acceptance, evaluation date, name and signature of evaluator (M) Number of repairs if specific area repaired more than twice (3) In addition to generic items of (2) above, reports of **PT** shall include the following specific items: (A) Type of penetrant, cleaner and developer used (B) Penetration time and development time (4) In addition to generic items, reports of **MT** shall include the following specific items: (A) Type of magnetization (B) Magnetic field strength (C) Detection media (D) Viewing conditions (E) Demagnetization, if required	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
<New>	(5) In addition to generic items, reports of RT shall include the following specific items: (A) Type and size of radiation source (width of radiation source), X-ray voltage (B) Type of film/designation and number of film in each film holder/cassette (C) Number of radiographs (exposures) (D) Type of intensifying screens (E) Exposure technique, time of exposure and source-to-film distance as per below: (F) Distance from radiation source to weld (G) Distance from source side of the weld to radiographic film (H) Angle of radiation beam through the weld (from normal) (I) Sensitivity, type and position of IQI (source side or film side) (J) Density (K) Geometric un-sharpness (L) Specific acceptance class criteria for RT Examinations used for acceptance or rejection of welds shall be recorded in an acceptable medium. A written record providing following information: identification and description of welds, procedures and equipment used, location within recorded medium and results shall be included. The control of documentation unprocessed original images and digitally processes images is to be to the satisfaction of the surveyor. The Society may require to duplicate some radiographs in order that some processed films are handed over to the Society together with testing reports. Alternative method to duplicate the processed film can be agreed with the Society. (6) In addition to generic items, reports of UT shall include the following specific items: (A) Type and identification of ultrasonic equipment used (instrument maker, model, series number), probes (instrument maker, serial number), transducer type (angle, serial number and frequency) and type of couplant (brand) (B) Sensitivity levels calibrated and applied for each probe (C) Transfer loss correction applied Type of reference blocks (D) Signal response used for defect detection (E) Reflections interpreted as failing to meet acceptance criteria The method for review and evaluation of UT reports is required for adequate quality control and is to be to the satisfaction of the surveyor. (7) The shipyard is to keep the inspection records specified in (2) to (6) of this document for at least for 5 years.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)

Present	Amendment	reason
<New>	**9. Unacceptable indications and repairs** (1) Unacceptable indications shall be eliminated and repaired where necessary. The repair welds are to be examined on their full length using appropriate NDT method at the discretion of the Surveyor. (2) When unacceptable indications are found, additional areas of the same weld length shall be examined unless it is agreed with the surveyor and fabricator that the indication is isolated without any doubt. In case of automatic welded joints, additional NDT shall be extended to all areas of the same weld length. (3) All radiographs exhibiting non-conforming indications are to be brought to the attention of the surveyor. Such welds are to be repaired and inspected as required by the surveyor. When non-conforming indications are observed at the end of a radiograph, additional RT is generally required to determine their extent. As an alternative, the extent of non-conforming welds may be ascertained by excavation, when approved by the surveyor. (4) The extent of testing can be extended at the surveyor's discretion when repeated nonacceptable discontinuities are found. (5) The inspection records specified in **8.** are to include the records of repaired welds. (6) The Shipbuilder shall take appropriate actions to monitor and improve the quality of welds to the required level. The repair rate is to be recorded by the shipyard and any necessary corrective actions are to be identified in the builder's QA system.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W33(New Dec 2019 & Rev.1 May 2020)
5. Improvement of qualification Where the faulty welds are more than 10 % of the number of inspection specified in **Table 4** or **5**, the results of investigation on the substantial cause and the measures to improve the quality are to be submitted to the Surveyor. ⚓	**10. Improvement of qualification** Where the faulty welds are more than 10 % of the number of inspection specified in **Table 2** or **3**, the results of investigation on the substantial cause and the measures to improve the quality are to be submitted to the Surveyor. ⚓	

Present	Amendment	reason
Annex 2-8 ~ Annex 2-11 <Omitted> **Annex 2-12** <New>	**Annex 2-8 ~ Annex 2-11** <Same as the present Guidance> **Annex 2-12 Guidance for advanced non-destructive testing of materials and welds** **1. General** (1) **Application** (A) This requirements gives minimum requirements on the methods and quality levels that are to be adopted for the advanced non-destructive testing (ANDT) of materials and welds during new building of ships. The ANDT is to be performed by the shipbuilder, manufacturer or its subcontractors in accordance with these requirements. The Society's surveyor may require witnessing testing. (B) It is the shipbuilder's or manufacturer's responsibility to ensure that testing specifications and procedures are adhered to during the construction, and the report is to be made available to the Society on the findings made by the ANDT. (C) The extent and method of testing, and the number of checkpoints are normally agreed between the shipyard and the Society. (2) **Terms and definitions** The following terms and definitions apply for this document. (A) ANDT : Advanced non-destructive testing (B) RT-D : Digital Radiography (C) RT-S : Radioscopic testing with digital image acquisition(dynamic≥12bit) (D) RT-CR : Testing with computed radiography using storage phosphor imaging plates (E) PAUT : Phased Array Ultrasonic Testing (F) TOFD : Time of Flight Diffraction (G) AUT : Automated Ultrasonic Examinations. A technique of ultrasonic examination performed with equipment and search units that are mechanically mounted and guided, remotely operated, and motor-controlled (driven) without adjustments by the technician. The equipment used to perform the examinations is capable of recording the ultrasonic response data, including the scanning positions, by means of integral encoding devices such that imaging of the acquired data can be performed.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W34(New Dec 2019)

Present	Amendment	reason
<New>	(H) SAUT : Semi-Automated Ultrasonic Examinations. A technique of ultrasonic examination performed with equipment and search units that are mechanically mounted and guided, manually assisted (driven), and which may be manually adjusted by the technician. The equipment used to perform the examinations is capable of recording the ultrasonic response data, including the scanning positions, by means of integral encoding devices such that imaging of the acquired data can be performed. (3) **Materials** ANT should be applied to the materials in **Pt 2**, **Ch 1** of the Rules. For other materials, the application is as recognized by the Society. (4) **Welding processes** These requirements apply to welding processes specified in **Table 1**. ANDT of welding process unspecified in **Table 1** is to be to the satisfaction of the Society. **Table 1 Applicable welding process** <table><tr><th colspan="2">Welding process</th><th>ISO 4063:2009</th></tr><tr><td>Manual welding</td><td>Shield Metal Arc Welding(SMAW)</td><td>111</td></tr><tr><td>Resistance welding</td><td>Flash welding(FW)</td><td>24</td></tr><tr><td>Semi-automatic welding</td><td>(1) Metal Inert Gas welding(MIG) (2) Metal Active Gas welding(MAG) (3) Flux Cored Arc Welding(FCAW)</td><td>131 135, 138 136</td></tr><tr><td>TIG welding</td><td>Gas Tungsten Arc Welding(GTAW)</td><td>141</td></tr><tr><td>Automatic welding</td><td>(1) Submerged Arc Welding(SAW) (2) Electro-gas Welding(EGW) (3) Electro-slag Welding(ESW)</td><td>12 73 72</td></tr></table>	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W34(New Dec 2019)

Present	Amendment	reason
<New>	(5) **Welding joints** These requirements apply to butt welds with full penetration. Variations of joint design, for example, tee, corner and cruciform joints (with or without full penetration) can be tested using PAUT. The constraints of joint design with respect to testing are to be recognized, documented, and agreed with the Society before application. (6) **Timing of ANDT** (A) ANDT are to be conducted after welds have cooled to ambient temperature and after post weld heat treatment where applicable. (B) Timing of ANDT on ship hull welds on steels with specified minimum yield stress in the range of 420 N/mm^2 to 690 N/mm^2 shall be in accordance with **1.** (9) of **Annex 2-7**. (7) **Testing methods** (A) The methods mentioned in this **Annex** for detection of imperfections are PAUT(only automated / semi-automated PAUT), TOFD, RT-D. (B) Applicable methods for testing of the different types of materials and weld joints are given in **Table 2**.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W34(New Dec 2019)

Present	Amendment	reason
<New>	**Table 2 Applicable methods for testing of materials and weld joints**	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W34(New Dec 2019)

MATERIALS AND WELD JOINTS	PARENT MATERIAL THICKNESS(t)	APPLICABLE METHODS
Ferritic butt welds with full penetration	t < 6 mm	RT-D
	6 mm ≤ t ≤ 40 mm	PAUT, TOFD, RT-D
	t > 40 mm	PAUT, TOFD, RT-D(1)
Ferritic tee joints and corner joints with full penetration	t ≥ 6 mm	PAUT, RT-D(1)
Ferritic cruciform joints with full penetration	t ≥ 6 mm	PAUT(1)
Austenitic stainless steel butt welds with full penetration(2)	t < 6 mm	RT-D
	6 mm ≤ t ≤ 40 mm	RT-D, PAUT(1)
	t > 40 mm	PAUT(1), RT-D(1)
Austenitic stainless steel tee joints, corner joints with full penetration(2)	t ≥ 6 mm	PAUT(1), RT-D(1)
Aluminum tee joints and corner joints with full penetration	t ≥ 6 mm	PAUT(1), RT-D(1)
Aluminum cruciform joints with full penetration	t ≥ 6 mm	PAUT(1)
Aluminum butt welds with full penetration	t < 6 mm	RT-D
	6 mm ≤ t ≤ 40 mm	RT-D, TOFD, PAUT
	t > 40 mm	TOFD, PAUT, RT-D(1)
Cast Copper Alloy	All	PAUT, RT-D(1)
Steel forgings	All	PAUT, RT-D(1)
Steel castings	All	PAUT, RT-D(1)
Base materials/Rolled steels, Wrought Aluminum Alloys	t < 6 mm	RT-D
	6 mm ≤ t ≤ 40 mm	PAUT, TOFD, RT-D
	t > 40 mm	PAUT, TOFD, RT-D(1)

Note:

(1) Only applicable with limitations, need special qualification subject to acceptance by the Society.

(2) The ultrasonic testing of anisotropic material using advanced methods will require specific procedures and techniques. Additionally, the use of complementary techniques and equipment may also be required, e.g. using angle compression waves, and/or creep wave probes for detecting defects close to the surface.

Present	Amendment	reason
<New>	**2. Qualification of personnel involved in ANDT** Qualification of personnel is to be accordance with **1.** (7) of **Annex 2-7**. **3. Technique and procedure qualification** (1) **General** The shipbuilder or manufacturer has to submit to the Society the following documentation for review. (A) The technical documentation of the ANDT (B) The operating methodology and procedure of the ANDT according to **8.** (C) Result of software simulation, when applicable (2) **Software simulation** Software simulation may be required by the Society, when applicable for PAUT or TOFD techniques. The simulation may include initial test set-up, scan plan, volume coverage, result image of artificial flaw etc.. In some circumstances, artificial defect modeling/simulation may be needed or required by the project. (3) **Procedure qualification test** The procedure qualification for ANDT system shall include the following steps. (A) Review of available performance data for the inspection system (detection abilities and defect sizing accuracy) (B) Identification and evaluation of significant parameters and their variability (C) Planning and execution of a repeatability and reliability test programme which including onsite demonstration (D) Documentation of results from the repeatability and reliability test programs (4) The data from the repeatability and reliability test program specified in (3) (C) above is to be analyzed with respect to comparative qualification block test report and onsite demonstration. The qualification block shall be in accordance with **ASME V Article 14 MANDATORY APPENDIX II UT PERFORMANCE DEMONSTRATION CRITERIA** or agreed by the Society, and at least the intermediate level qualification blocks shall be used. The high level qualification blocks shall be used when sizing error distributions and an accurate POD need to be evaluated. The demonstration process onsite shall be witnessed by the Society's surveyor. **4. Procedure approval** The testing procedure is to be evaluated based upon the qualification results, if satisfactory the procedure can be considered approved.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W34(New Dec 2019)

Present	Amendment	reason
<New>	**5. Onsite review** (1) For the test welds, supplementary NDT shall be performed on an agreed proportion of welds to be cross checked with other methods. Alternatively, other documented reference techniques may be applied to compare with ANDT results. (2) Data analyses shall be performed in accordance with the above activities. Probability of Detection (PoD) and sizing accuracy shall be established when applicable. (3) When the result of inspection review does not conform to the approved procedure, the inspection shall be suspended immediately. Additional procedure review qualification and demonstration shall be undertaken to account for any nonconformity. (4) When a significant nonconformity is found, the Society has the right to reject the results of such activities. **6. Surface condition** (1) Area to be examined shall be free from scale, loose rust, weld spatter, oil, grease, dirt or paint that might affect the sensitivity of the testing method. (2) Where there is a requirement to carry out PAUT or TOFD through paint, the suitability and sensitivity of the test shall be confirmed through an appropriate transfer correction method defined in the procedure. In all cases, if transfer losses exceed 12 dB, the reason shall be considered and further preparation of the scanning surfaces shall be carried out, if applicable. If testing is done through paint, then the procedure shall be qualified on a painted surface. (3) The requirement for acceptable test surface finish is to ensure accurate and reliable detection of defects. For the testing of welds, where the test surface is irregular or has other features likely to interfere with the interpretation of NDT results, the weld is to be ground or machined. **7. General plan of testing: NDT method selection** The extent of testing shall be planned by the shipbuilder or manufacturer according to the ship design, ship or equipment type and welding processes used. Particular attention shall be paid to highly stressed areas.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W34(New Dec 2019)

Present	Amendment	reason
<New>	**8. Testing requirements** (1) **General** (A) The shipyard or manufacturer is to ensure that personnel carrying out NDT or interpreting the results of NDT are qualified to the appropriate level as detailed in **2.**. (B) Procedures (a) All NDT are to be carried out to a procedure that is representative of the item under inspection. (b) Procedures are to identify the component to be examined, the NDT method, equipment to be used and the full extent of the examinations including any test restrictions. (c) Procedures are to include the requirement for components to be positively identified and for a datum system or marking system to be applied to ensure repeatability of inspections. (d) Procedures are to include the method and requirements for equipment calibrations and functional checks, together with specific technique sheets/scan plans, for the component under test. (e) Procedures are to be approved by personnel qualified to Level III in the appropriate technique in accordance with a recognised standard. (f) Procedures are to be reviewed by the Society's Surveyor. (C) The methods considered within the application defined in **1.** (7). (D) PAUT techniques shall conform as a minimum to (2). Depending on the complexity of the item under test and the access to surfaces, there may be a requirement for additional scans and/or complementary NDT techniques to ensure that full coverage of the item is achieved. (a) PAUT of welds shall include a linear scan of the fusion face, together with other scans as defined in the specific test technique. Refer to linear scan requirements in (2) (B) (d). (E) TOFD techniques shall conform as a minimum to (3). Depending on the complexity of the item under test and the access to surfaces, there may be a requirement for additional scans and/or complementary NDT techniques to ensure that full coverage of the item is achieved. (F) RT-D techniques shall conform as a minimum to (4). RT-D comprises of two main RT methods; RT-S and RT-CR. Other methods may be included (e.g. radioscopy systems), however, then must conform to this **Annex** as applicable, and any specific requirements shall demonstrate equivalence to these requirements. (a) In all RT-D methods, in addition to specific requirements, detector output quality control methods shall be described within the procedure. (b) The procedure shall define the level of magnification, post-processing tools, image/data security and storage, for final evaluation and reporting.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W34(New Dec 2019)

Present	Amendment	reason
<New>	(2) **PAUT** PAUT shall be carried out according to procedures based on *ISO 13588:2019*, *ISO 18563-1:2015*, *ISO 18563-2:2017*, *ISO 18563-3:2015* and *ISO 19285:2017* or recognized standards and the specific requirements of the Society. (A) Information required prior to testing A procedure shall be written and include the following information as in minimum shown in **Table 3**. When an essential variable in **Table 3** is to change from the specified value, or range of values, the written procedure shall require requalification. When a nonessential variable is to change from the specified value, or range of values, requalification of the written procedure is not required. All changes of essential or nonessential variables from the value, or range of values, specified by the written procedure shall require revision of, or an addendum to, the written procedure.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W34(New Dec 2019)

<New>

Table 3 Requirements of a PAUT Procedure

Requirement	Essential Variable	Nonessential Variable
Material types or weld configurations to be examined, including thickness dimensions and material product form (castings, forgings, pipe, plate, etc.)	√	
The surfaces from which the examination shall be performed	√	
Technique(s) (straight beam, angle beam, contact, and/or immersion)	√	
Angle(s) and mode(s) of wave propagation in the material	√	
Search unit type, frequency, element size and number, pitch and gap dimensions, and shape	√	
Focal range(identify plane, depth, or sound path)	√	
Virtual aperture size(i.e., number of elements, effective height(1), and element width)	√	
Focal laws for E-scan and S-scan (i.e., range of element numbers used, angular range used, element or angle increment change)	√	
Special search units, wedges, shoes, or saddles, when used	√	
Ultrasonic instrument(s)	√	
Calibration [calibration block(s) and technique(s)]	√	
Directions and extent of scanning	√	
Scanning(manual vs. automatic)	√	
Method for sizing indications and discriminating geometric from flaw indications	√	
Computer enhanced data acquisition, when used	√	
Scan overlap(decrease only)	√	
Personnel performance requirements, when required	√	
Testing levels, acceptance levels and/or recording levels	√	
Personnel qualification requirements		√
Surface condition(examination surface, calibration block)		√
Couplant(brand name or type)		√
Post-examination cleaning technique		√
Automatic alarm and/or recording equipment, when applicable		√
Records, including minimum calibration data to be recorded (e.g., instrument settings)		√
Environmental and safety issues		√

Note:
(1) Effective height is the distance from the outside edge of the first to last element used in the focal law.

Present	Amendment	reason
<New>	(B) Testing (a) Testing levels The testing levels specified in the testing procedure shall be in accordance with recognized standards accepted by the Society. Four testing levels are specified in *ISO 13588:2019*, each corresponding to a different probability of detection of imperfections. (b) Weld Examinations The weld examinations shall in accordance with ISO 13588:2019 and the additional special requirements of this **Annex**. (c) Material Examinations Material examinations shall conform to **1.** (3) as a minimum. (d) Volume to be inspected (i) The purpose of the testing shall be defined by the testing procedure. Based on this, the volume to be inspected shall be determined. (ii) A scan plan shall be provided. The scan plan shall show the beam coverage, the weld thickness and the weld geometry. (iii) If the evaluation of the indications is based on amplitude only, it is a requirement that an 'E' scan (or linear scan) shall be utilized to scan the fusion faces of welds, so that the sound beam is perpendicular to the fusion face ± 5º. This requirement may be omitted if an 'S' (or sectorial) scan can be demonstrated to verify that discontinuities at the fusion face can be detected and sized, using the stated procedure (note, this demonstration shall utilize reference blocks containing suitable reflectors in location of fusion zone). (e) Reference blocks Depending on the testing level, a reference block shall be used to determine the adequacy of the testing (e.g. coverage, sensitivity setting). The design and manufacture of reference blocks shall be in accordance with *ISO 13588:2019* or recognized quivalent standards and the specific requirements of the Society. (f) Indication assessment Indications detected when applying testing procedure shall be evaluated either by length and height or by length and maximum amplitude. Indication assessment shall be in accordance with *ISO 19285:2017* or recognized standards and the specific requirements of the Society. The sizing techniques include reference levels, Time Corrected Gain(TCG), Distance Gain Size(DGS) and 6 dB drop. 6 dB drop method shall only be used for measuring the indications larger than the beam width.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W34(New Dec 2019)

Present	Amendment	reason
<New>	(3) **TOFD** TOFD shall be carried out according to procedure based on *ISO 10863:2011*, and *ISO 15626:2018* or recognized standards and the specific requirements of the Society. (A) Information required prior to testing A procedure shall be written and include the following information as shown in **Table 4**. When an essential variable in **Table 4** is to change from the specified value, or range of values, the written procedure shall require requalification. When a nonessential variable is to change from the specified value, or range of values, requalification of the written procedure is not required. All changes of essential or nonessential variables from the value, or range of values, specified by the written procedure shall require revision of, or an addendum to, the written procedure.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W34(New Dec 2019)

<New>

Table 4 Requirements of a TOFD Procedure

Requirement	Essential Variable	Nonessential Variable
Weld configurations to be examined, including thickness dimensions and material product form (castings, forgings, pipe, plate, etc.)	√	
The surfaces from which the examination shall be performed	√	
Angle(s) of wave propagation in the material	√	
Search unit type(s), frequency(ies), and element size(s)/shape(s)	√	
Special search units, wedges, shoes, or saddles, when used	√	
Ultrasonic instrument(s) and software(s)	√	
Calibration [calibration block(s) and technique(s)]	√	
Directions and extent of scanning	√	
Scanning (manual vs. automatic)	√	
Data sampling spacing (increase only)	√	
Method for sizing indications and discriminating geometric from flaw indications	√	
Computer enhanced data acquisition, when used	√	
Scan overlap (decrease only)	√	
Personnel performance requirements, when required	√	
Testing levels, acceptance levels and/or recording levels	√	
Personnel qualification requirements		√
Surface condition (examination surface, calibration block)		√
Couplant (brand name or type)		√
Post-examination cleaning technique		√
Automatic alarm and/or recording equipment, when applicable		√
Records, including minimum calibration data to be recorded (e.g., instrument settings)		√
Environmental and safety issues		√

Present	Amendment	reason
<New>	(B) Testing (a) Testing levels The testing levels specified in the testing procedure shall be in accordance with recognized standards accepted by the Society. Four testing levels are specified in *ISO 10863:2011*, each corresponding to a different probability of detection of imperfections. (b) Volume to be inspected (ⅰ) The purpose of the testing shall be defined by the testing procedure. Based on this, the volume to be inspected shall be determined. (ⅱ) A scan plan shall be provided. The scan plan shall show the locations of the probes, beam coverage, the weld thickness and the weld geometry. (c) Due to the nature of the TOFD method, there is a possibility that the scan plan may reveal weld volume zones that will not receive full TOFD coverage (commonly known as dead zones, either in the lateral wave, back wall, or both). If the scan plan reveals that these dead zones are not adequately inspected, then further TOFD scans and/or complementary NDT methods shall be applied to ensure full inspection coverage. (4) **RT-D** Digital radiography shall be performed per procedure(s) based on *ISO 17636-2:2013* and standards referenced therein, or recognized standards and additional specific requirements of the Society. Any variation to applying the standard (e.g. IQI placement) shall be agreed with Society. (A) A procedure shall be written and include the following information as shown in **Table 5**. (B) Testing levels Regarding choice of testing level per *ISO 17636-2:2013* this is referred to in **9.** (4).	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W34(New Dec 2019)

<New>

Table 5 Requirements of a Digital radiography Procedure

Requirement
Material types or weld configurations to be examined, including thickness dimensions and material product form (castings, forgings, pipe, plate, etc.)
Digitizing System Description:
Manufacturer and model no. of digitizing system
Physical size of the usable area of the image monitor
Film size capacity of the scanning device
Spot size(s) of the film scanning system
Image display pixel size as defined by the vertical/horizontal resolution limit of the monitor
Illuminance of the video display
Data storage medium
Digitizing Technique:
Digitizer spot size (in microns) to be used
Loss-less data compression technique, if used
Method of image capture verification
Image processing operations
Time period for system verification
Spatial resolution used:
Contrast sensitivity (density range obtained)
Dynamic range used
Spatial linearity of the system
Material type and thickness range
Source type or maximum X-ray voltage used
Detector type
Detector calibration
Minimum source-to-object distance
Distance between the test object and the detector
Source size
Test object scan plan (if applicable)
Image Quality Measurement Tools
Image Quality Indicator (IQI)
Wire Image Quality Indicator
Duplex Image Quality Indicator
Image Identification Indicator
Testing levels, acceptance levels and/or recording levels
Personnel qualification requirements
Surface condition
Records, including minimum calibration data to be recorded
Environmental and Safety issues

Present	Amendment	reason
<New>	**9. Acceptance Levels** (1) **General** (A) This section details the acceptance levels followed for the assessment of the NDT results. Methods include but are not limited to: Phased array ultrasonic testing(PAUT), Time of flight diffraction(TOFD), Digital radiography(RT-D). (B) It may be necessary to combine testing methods to facilitate the assessment of indications against the acceptance criteria. (2) **PAUT** (A) The relationship between acceptance levels, testing levels and quality levels is given in **Table 6**. Quality levels and acceptance levels for PAUT of welds shall be in accordance with *ISO 19285:2017* or recognized standard agreed with the Society.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W34(New Dec 2019)

Table 6 Acceptance levels for PAUT

Quality levels according to ISO 5817:2014	Testing level according to ISO 13588:2019	Acceptance levels according to ISO 19285:2017
C, D	A	3
B	B	2
By agreement	C	1
Special application	D	By agreement

(B) Material Examinations

Quality levels and acceptance levels for PAUT of material testing shall be in accordance to recognized standard agreed with the Society. The acceptance levels for material examinations shall conform as a minimum to the appropriate Technical Rules.

Present	Amendment	reason
<New>	(3) **TOFD** The relationship between acceptance levels, testing levels and quality levels is given in **Table 7**. Quality levels and acceptance levels for TOFD of welds shall be in accordance to *ISO 15626:2018* or recognized standard agreed with the Society. **Table 7 Acceptance levels for TOFD** **Quality levels according to ISO 5817:2014** / **Testing level according to ISO 10863:2011** / **Acceptance level according to ISO 15626:2018** B(Stringent) / C / 1 C(Intermediate) / At least B / 2 D(Moderate) / At least A / 3 (4) **RT-D** The relationship between acceptance levels, testing levels and quality levels is given in **Table 8**. Quality levels and acceptance levels for Digital Radiography of welds shall be in accordance with *ISO 10675* or standard agreed with the Society. **Table 8 Acceptance levels for RT-D** **Quality levels according to ISO 5817:2014 or ISO 10042:2018** / **Testing techniques/level(class) according to ISO 17636-2:2013** / **Acceptance level according to ISO 10675-1:2016 & ISO 10675-2:2017** B(Stringent) / B (class) / 1 C(Intermediate) / B(1) (class) / 2 D(Moderate) / A (class) / 3 Notes (1) For circumferential weld testing, the minimum number of exposures may correspond to the requirements of ISO 17636-2:2013, class A	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W34(New Dec 2019)

Present	Amendment	reason
<New>	**10. Reporting** (1) The test report shall include at least the information of **Table 9**. (2) Results of NDT are to be recorded and evaluated by the shipbuilder or manufacturer on a continual basis. These records are to be available to the Surveyor. (3) The shipbuilder or manufacturer is to be responsible for the review, interpretation, evaluation and acceptance of the results of NDT. Reports stating compliance or otherwise with the criteria established in the inspection procedure are to be issued. (4) In addition to the above general reporting requirements, all specified NDT methods will have particular requirements and details that shall be listed in the report. Refer to the applicable method standards for specific requirements. (5) The shipbuilder or manufacturer is to keep the inspection records for the appropriate period deemed by Society. **11. Unacceptable indications and repairs** All indications (discontinuities) exceeding the applicable acceptance criteria shall be classed as defects, and shall be eliminated and repaired as per applicable the Technical Rules.	* Request for Establishment/Revision of Classification Technical Rules (MRD4800-181-2020) - To reflect IACS UR W34(New Dec 2019)

Table 9 Information for the test report

NDT method	Related parts	Information
All	Standards	a reference to standards of compliance
	The object under test	1) identification of the object under test 2) dimensions including wall thickness 3) material type and product form 4) geometrical configuration 5) location of welded joint(s) examined 6) reference to welding process and heat treatment 7) surface condition and temperature 8) stage of manufacture
	Equipment	manufacturer and type of instrument, including with identification numbers if required.
	Test technology	1) testing level and reference to a written test procedure 2) purpose and extent of test 3) details of datum and coordinate systems 4) method and values used for range and sensitivity settings 5) details of signal processing and scan increment setting 6) access limitations and deviations from standards, if any
	Test results	1) acceptance criteria applied 2) tabulated data recording the classification, location and size of relevant indications and results of evaluation 3) results of examination including data on software used 4) date of test 5) reference to the raw data file(s) 6) date(s) of scan or exposure and test report 7) names, signatures and certification of personnel
PAUT	Equipment	1) manufacturer, type, frequency of phased array probes including number and size of elements, material and angle(s) of wedges with identification numbers if required 2) details of reference block(s) with identification numbers if required 3) type of couplant used
	Test technology	1) increment (E-scans) or angular increment (S-scans) 2) element pitch and gap dimensions 3) focus (calibration should be the same as scanning) 4) virtual aperture size, i.e. number of elements and element width 5) element numbers used for focal laws 6) documentation on permitted wedge angular range from manufacturer 7) documented calibration, TCG and angle gain compensation 8) scan plan
	Test results	1) phased array images of at least those locations where relevant indications have been detected on hard copy, all images or data available in soft format 2) reference points and details of the coordinate system
TOFD	Equipment	1) manufacturer, type, frequency, element size and beam angle(s) of probes with identification numbers if required 2) details of reference block(s) with identification numbers if required 3) type of couplant used
	Test technology	1) details of TOFD setups 2) details of offset scans, if required
	Test results	1) TOFD images of at least those locations where relevant TOFD indications have been detected

Table 9 Information for the test report(Cont'd)

NDT method	Related parts	Information
RT-D	Equipment	1) system of marking used 2) radiation source, type and size of focal spot and identification of equipment used 3) detector, screens and filters and detector basic spatial resolution
	Test technology	1) detector position plan 2) tube voltage used and current or source type and activity 3) time of exposure and source-to-detector distance 4) type and position of image quality indicators 5) achieved and required SNR_N for RT-S or achieved and required grey values and/or SNR_N for RT-CR 6) for RT-S: type and parameters such as gain, frame time, frame number, pixel size, calibration procedure 7) for RT-CR: scanner type and parameters such as pixel size, scan speed, gain, laser intensity, laser spot size 8) image-processing parameters used, e.g. of the digital filters