CHINA CLASSIFICATION SOCIETY

RULES FOR MATERIALS AND WELDING

AMENDMENTS

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2.7.2.3 For butt weld joint, test piece is to be cut from a test specimen of the same base material, welding material and welding procedures as the weld joint under investigation. Longitudinal bending test piece with thickness not more than 6 mm is to be used, and base material, heat affected zone and weld metal are to be included as far as possible. Where the thickness of the test piece is more than 6 mm, the test piece is to be machined down to 6 mm from one side. The retained surface is in contact with corroding media and is to be stretched during bending test. The requirements for the sizes of test pieces of plate joint and tube joint are as follows:

CHAPTER 3 STEEL PLATES, FLAT BARS AND SECTIONS

Section 1 GENERAL PROVISIONS

3.1.1.3 Normal and higher strength corrosion resistant hull structural steels used as the alternative means of coating for crude oil tanks are to comply with, in addition to the relevant requirements of this Chapter, the relevant requirements of CCS Guidelines for Survey of Corrosion Resistant Steel of Cargo Oil Tanks in Crude Oil Tankers.

3.1.3.4 Unless otherwise agreed mutually in the contract, the thickness of steel plates, wide flats equal to or over 600 mm in width and sections mentioned in this Chapter is to comply with the following requirements:

(1) The tolerances on nominal thickness for steel plates and flat bars below 5 mm may be accepted in accordance with a recognized standard, the minus tolerance shall not exceed 0.3mm.

(2) For steel plates and wide flats intended for hull structures as detailed in Sections 2, 3 and 4 of this Chapter, except those intended for pressure vessels for the transportation of chemicals or liquefied gases in bulk as well as independent tank structures, thickness measurements are to be carried out for the mother plates produced (i.e. steel plates rolled directly from one slab or steel ingot and not cut) according to the provisions of 3.1.3.5, and the arithmetic mean of the measurements is not to be less than the nominal thickness, and the minus tolerance of individual measuring points is not to exceed 0.3 mm. If steel plates are rolled by such technological means that the thickness of any measuring point is not less than the nominal thickness, the arithmetic mean need not be calculated, but the steel mill is to demonstrate to the satisfaction of CCS that the number of measurements and measurement distribution is appropriate to establish that the mother plates produced are at or above the specified nominal thickness.

(3) For steels for boilers and pressure vessels as detailed in Section 5 of this Chapter as well as steels for independent tanks for the transportation of chemicals or liquefied gases in bulk, the minus tolerance on thickness of products is not to exceed 0.3 mm unless mutually agreed.

(4) For steel plates and wide flats intended for machinery as detailed in Section 6 of this Chapter, the under thickness tolerances are to comply with Table 3.1.3.4(4).

Under Thickness Tolerance of Steel Plates and Wide Flats for Machinery Table 3.1.3.4(4)

Nominal thickness t (mm)	Minus tolerance (mm)
$3 \le t < 5$	≤ 0.3
$5 \le t < 8$	< 0.4
$8 \le t < 15$	< 0.5
$15 \le t < 25$	< 0.6
$25 \le t < 40$	< 0.7
~~t~~ $40 \le t < 80$	~~< 1.0~~ < 0.9
$80 \le t < 150$	≤ 1.1
$150 \le t < 250$	≤ 1.2
$t \ge 250$	≤ 1.3

(5) For steel plates and wide flats detailed in Sections 7, 8 and 9 of this Chapter and where in the order specifications it is not specified that the nominal thickness is to be taken as the minimum thickness, the under thickness tolerance is not to exceed 0.3 mm for plate thickness not exceeding 10 mm, and 0.5 mm for plate thickness exceeding 10 mm.

(6) For steels as detailed in Sections 10 and 11 of this Chapter, the thickness tolerance is to comply with the requirements for parent steel.

(7) The plus tolerances on nominal thickness of all steels may be accepted in accordance with a recognized national or international standard.

(8) These requirements do not apply to products intended for the construction of lifting appliances

3.1.5.5 Unless otherwise specified in relevant Sections of this Chapter, the non-destructive testing of materials is not required for acceptance purposes. However, steelmakers are expected to employ suitable methods for the general maintenance of quality standards. The acceptance by CCS of material does not absolve the steelmaker of the responsibility of ensuring the internal quality of the material. If plates and wide flats are ordered with ultrasonic inspection, this is to be made in accordance with a recognized standard.

3.1.7.1 Every finished item (small items may be fastened in bundles) is to be clearly marked, at least at one position, by the manufacturer with the CCS stamp and the following particulars:

(1) the manufacturer's name or trade mark;

(2) the grade of steel;

(3) cast number and identification number or initials which will enable the full history of the item to be traced;

(4) delivery condition of steels for structures (if required by the purchaser, e.g. N, NR, TM, TM+AcC, TM+DQ or Q&T);

(5) if required by the purchaser, his order number or other identification mark.

The above stamps and marks are to be encircled with paint or otherwise marked so as to be easily recognisable. ~~for easy recognition.~~

Section 3 HIGHER STRENGTH HULL STRUCTURAL STEELS

3.3.1.2 Higher strength hull structural steels for large container ships: EH47 (with thicknesses of 50 mm to 100 mm and the specified minimum yield strength not less than 460 N/mm^2) and crack arrest steels are to comply with the requirements of CCS Guidelines for Inspection of Thick Higher Strength Steel Plates for Ships.

Section 4 HIGH STRENGTH ~~QUENCHED AND TEMPERED~~ STEELS FOR WELDED STRUCTURES

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3.12.5.2 A tensile specimen is to be taken from the test sample. Except for grade 1 chain steels, a set of three Charpy V-notch impact specimens are to be taken from the same test sample. The tensile and impact specimens are to be taken from the sample in the longitudinal direction at a position of 1/6 diameter from the surface or as close as possible to this position, as shown in Figure 3.12.5.2 (a) or (b). The preparation and dimensions of specimens are to comply with the relevant requirements of Chapter 2 of this PART. The cross-sectional area of the tensile specimen is in general not to be less than 150 mm^2. Where the cross-sectional area of the sample is not sufficient for taking these specimens, the tensile specimen in full cross section may also be taken.

CHAPTER 4 STEEL PIPES AND TUBES

Section 1 GENERAL PROVISIONS

4.1.5.1 If required by CCS, All pipes and tubes are to be heat treated and supplied in the appropriate conditions detailed in the relevant Sections of this Chapter.

4.1.7.1 For ~~A~~all pipes for Class I and II pressure systems, boiler and super heater tubes, the manufacturers are responsible for ensuring that the quality of the internal and external surfaces and dimensions comply with relevant requirements. ~~are to be presented for visual examination of the internal and external surfaces and verification of dimensions.~~

Section 3 WELDED PRESSURE PIPES

4.3.3.1 Steel pipes are to be heat treated as follows:

(1) If required by CCS, pipes in carbon and carbon-manganese steels are to be normalized, or normalized and tempered ~~at the option of the manufacturer~~;

Section 6 AUSTENITIC AND AUSTENITIC/FERRITIC DUPLEX STAINLESS STEEL PRESSURE PIPES

Chemical composition of Austenitic Stainless Steel Pressure Pipes Table 4.6.2.2(1)

Grade	Uniform number code	Chemical composition (%)									
		C	Si	Mn	P	S	Cr	Ni	Mo	N	Other elements
06Cr19Ni10	S30408	≤0.08	≤1.00	≤2.00	≤0.045	≤0.030	18.0~20.0	8.0~11.0	—	—	—
022Cr19Ni10	S30403	≤0.03	≤1.00	≤2.00	≤0.045	≤0.030	18.0~20.0	8.0~12.0	—	—	—
06Cr17Ni12Mo2	S31608	≤0.08	≤1.00	≤2.00	≤0.045	≤0.030	16.0~18.0	10.0~14.0	2.0~3.0	—	—
022Cr17Ni12Mo2	S31603	≤0.03	≤1.00	≤2.00	≤0.045	≤0.030	16.0~18.0	10.0~14.0	2.0~3.0	—	—
06Cr19Ni13Mo3	S31708	≤0.08	≤1.00	≤2.00	≤0.045	≤0.030	18.0~20.0	11.0~15.0	3.0~4.0	—	—
022Cr19Ni13Mo3	S31703	≤0.03	≤1.00	≤2.00	≤0.045	≤0.030	18.0~20.0	11.0~15.0	3.0~4.0	—	—
06Cr18Ni10Ti	S32168	≤0.08	≤1.00	≤2.00	≤0.045	≤0.030	17.0~19.0	9.0~12.0	—	—	5C≤Ti≤0.80
06Cr18Ni11Nb	S34778	≤0.08	≤1.00	≤2.00	≤0.045	≤0.030	17.0~19.0	9.0~12.0	—	—	10C≤Nb≤1.10

Mechanical and Technical Properties of Austenitic Stainless Steel Pressure Pipes Table 4.6.4.1(1)

Grade	Uniform number code	Proof strength $R_{p0.2}$ min. (N/mm^2)	Proof strength $R_{p1.0}$ min. (N/mm^2)	Tensile strength R_m (N/mm^2)	Elongation A_5 min. (%)	Flattening test constant C	Bend test diameter of former (mm)
06Cr19Ni10	S30408	205	245	520 ~ 720	35	0.09	3t (t being thickness)
022Cr19Ni10	S30403	175	205	480 ~ 680	35	0.09	3 t
06Cr17Ni12Mo2	S31608	205	245	520 ~ 720	35	0.09	3 t
022Cr17Ni12Mo2	S31603	175	205	480 ~ 680	35	0.09	3 t
06Cr19Ni13Mo3	S31708	205	245	520 ~ 720	35	0.09	3 t
022Cr19Ni13Mo3	S31703	175	205	480 ~ 680	35	0.09	3 t
06Cr18Ni10Ti	S32168	205	245	520 ~ 720	35	0.09	3 t
06Cr18Ni11Nb	S34778	205	245	520 ~ 720	35	0.09	3 t

Notes: ① The tensile strength range for all grades in the Table is 200 N/mm^2.

② The proof strength values $R_{p1.0}$ are given for information purposes only and unless otherwise agreed, are not required to be verified by testing.

CHAPTER 5 STEEL FORGINGS

Section 1 GENERAL PROVISIONS

5.1.1 Application

5.1.1.5 Stainless steel forgings are to comply with the relevant provisions in Section 9 of this Chapter.

Section 4 FORGINGS FOR CRANKSHAFTS

5.4.1.2 Where it is proposed to use alloy steel forgings, particulars of the chemical composition, heat treatment and mechanical properties are to be submitted to CCS for approval. The ~~minimum~~ tensile strength of the alloy steel crankshaft forging is normally not to be greater than ~~exceed~~ 1,000 N/mm^2. If the tensile strength is greater than 1,000 N/mm^2, this is to be subject to special consideration by CCS.

Section 9 AUSTENITIC AND DUPLEX STAINLESS STEEL FORGINGS

5.9.1 General requirements

5.9.1.1 This Section applies to austenitic and duplex stainless steel forgings for cargo tanks and piping systems used at low temperature service in liquefied gas carriers and for cargo tanks and piping systems used at corrosion-resisting service in bulk chemical tankers and for rudder stock and shafting.

5.9.1.4 For all austenitic and duplex stainless steel forgings, details of the chemical composition, heat treatment and mechanical properties are to be submitted to CCS for approval.

5.9.2 Chemical composition

Chemical Composition of Austenitic Stainless Steel Forgings Table 5.9.2.1

Grade	Uniform number code	Chemical composition (%)									
		C	Si	Mn	P	S	Cr	Ni	Mo	Other elements	Note
06Cr19Ni10	S30408	0.08	1.00	2.00	0.045	0.030	18.0~20.0	8.0~11.0	–	–	1
022Cr19Ni10	S30403	0.03	1.00	2.00	0.045	0.030	18.0~20.0	8.0~12.0	–	–	
06Cr17Ni12Mo2	S31608	0.08	1.00	2.00	0.045	0.030	16.0~18.0	10.0~14.0	2.0~3.0	–	1
022Cr17Ni12Mo2	S31603	0.03	1.00	2.00	0.045	0.030	16.0~18.0	10.0~14.0	2.0~3.0	–	
06Cr19Ni13Mo3	S31708	0.08	1.00	2.00	0.045	0.030	18.0~20.0	11.0~15.0	3.0~4.0	–	1
022Cr19Ni13Mo3	S31703	0.03	1.00	2.00	0.045	0.030	18.0~20.0	11.0~15.0	3.0~4.0	–	
06Cr23Ni13	S30908	0.08	1.00	2.00	0.045	0.030	22.0~24.0	12.0~15.0	–	–	2
06Cr25Ni20	S31008	0.08	1.00	2.00	0.045	0.030	24.0~26.0	19.0~22.0	–	–	2
06Cr18Ni10Ti	S32168	0.08	1.00	2.00	0.045	0.030	17.0~19.0	9.0~12.0	–	5C≤Ti≤0.80	
06Cr18Ni11Nb	S34778	0.08	1.00	2.00	0.045	0.030	17.0~19.0	9.0~12.0	–	10C≤Nb≤1.10	

Notes: ① Not recommended for structural components in cargo tanks of liquefied natural gas carriers.

② Recommended for service at elevated temperatures in severe corrosive environment.

③ Data in the Table, except for those with indication of limits, are maximum limits.

5.9.2.2 Chemical composition of ladle samples for duplex stainless steel forgings is generally to comply with the provisions in Table 3.8.3.2 of this PART.

5.9.3 Heat treatment

5.9.3.1 All austenitic and duplex stainless steel forgings are to receive a solid solution treatment.

5.9.4.3 Unless otherwise agreed, impact test is generally not required for austenitic stainless steel forgings. When austenitic stainless steel is used at temperatures equal to or lower than -100℃, Charpy V-notch impact test at -196℃ may be required. The average value of test results is not to be lower than 41 J (axes of specimens parallel to the final direction of rolling).

5.9.4.4 Mechanical properties of duplex stainless steel forgings are to comply with the provisions in Table 3.8.5.4 of this PART.

5.9.5 Non-destructive testing

5.9.5.1 Austenitic and duplex stainless steel forgings used for propeller shafts with diameters greater than 250 mm are generally to be subjected to ultrasonic testing.

5.9.5.2 Austenitic and duplex stainless steel forgings other than shaft forgings are to be subjected to non-destructive testing according to the requirements of approved plans, standards, contracts or agreements.

5.9.5.4 Operators engaged in the ultrasonic test are to have sufficient technique and experience for the testing of austenitic and duplex stainless steel forgings.

5.9.6 Intergranular corrosion tests

5.9.6.1 When austenitic and duplex stainless steels are intended for use in a corrosive environment, specimens are to be taken after heat treatment and subjected to the intergranular corrosion test in accordance with Section 7, Chapter 2 of this PART.

5.9.7 Pitting corrosion test

5.9.7.1 When the material is used in occasions of corrosion, duplex stainless steels after heat treatment are to be sampled for pitting corrosion test according to Section 9 of Chapter 2 of this PART.

CHAPTER 6 STEEL CASTINGS

Section 1 GENERAL PROVISIONS

6.1.10.10 For small defects found during finish machining or assembly, heat treatment may be waived or local heat treatment may be carried out after repair subject to agreement by CCS.

6.1.10.13 The manufacturer is to maintain full records detailing the extent and location of repairs made to each casting and details of weld procedures and heat treatments applied for repairs as well as subsequent survey reports. Results of treatment of various defects repaired by welding are to be confirmed by the surveyor and reports and/or records of non-decorative repairs are to be submitted to the surveyor. ~~These documents are to be available to the Surveyor and copies provided on request.~~

CHAPTER 8 ALUMINIUM ALLOYS

Section 2 ALUMINIUM ALLOY PLATES AND SECTIONS

8.2.3.3 The Manufacturer's declared analysis will be accepted subject to occasional checks if required by the Surveyor; in particular, product analysis may be required where the final product chemistry is not well represented by the analysis from the cast.

CHAPTER 9 OTHER NON-FERROUS MATERIALS

Section 1 COPPER ALLOY PROPELLERS

9.1.5.1 For cast copper alloy propellers, separately cast keel block type test samples as given in Figure 9.1.5.1 are generally used. Where possible, test bars attached on blades are to be located in an area between 0.5*R* and 0.6*R*(*R* being the radius of the propeller). Separately cast test samples in accordance with other recognized standards may be used.

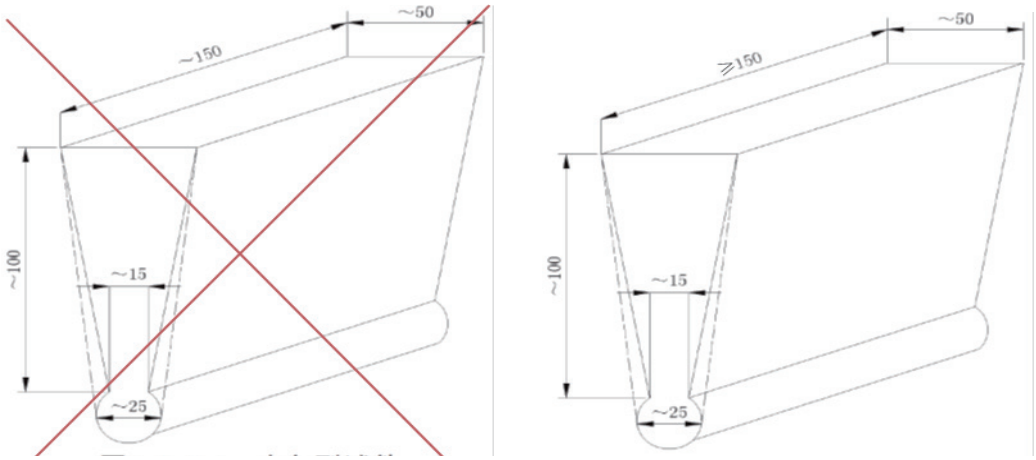


Figure 9.1.5.1 Keel Type Test Sample

CHAPTER 10 EQUIPMENT

Section 1 ANCHORS

10.1.5.1 Anchors ~~of all sizes~~ are to be proof load tested according to the requirements in Table 10.1.5.3 of this Chapter. Prior to the proof load test, examination and confirmation is to be made that no harmful surface defects are found on anchors. The testing machines are to be calibrated.

Section 3 OFFSHORE MOORING CHAINS AND ACCESSORIES

10.3.3.2 Forged steels used for the manufacture of accessories are to comply with the relevant requirements of Section 1, Chapter 5 of this PART, unless otherwise specified as follows:

(1) Forged steels are to comply with the approved specifications and the submitted test reports approved by CCS. Steel is to be manufactured by basic oxygen, electric furnace or such other process as may be specially approved. All steel is to be killed and fine grain treated. Steel for forgings intended for MR4S and MR5 chain is to be vacuum degassed.

PART TWO NON-METALLIC MATERIALS

CHAPTER 2 PLASTICS MATERIALS

Section 2 RAW MATERIALS

2.2.2.5 The following are to be determined using these samples, the results of which are to comply with the requirements of Table 2.2.2.5. For items not mentioned in the table, the results are to comply with limit values specified in the standards or by the manufacturer:

(1) density or relative density;

(2) volume shrinkage after cure;

(3) Barcol hardness;

(4) tensile strength;

(5) elongation at break;

(6) water absorption (~~if required~~ if in long-term exposure to water or for construction of fiber-reinforced-plastic craft);

(7) temperature of deflection.

Properties for Resin Castings Used for Lay-up **Table 2.2.2.5**

~~Items~~	~~Standard~~	~~Unsaturated polyester/vinyl ester resin~~	~~Gel coat/topcoat resin/ epoxy resins~~
~~Tensile strength (N/mm^2)~~	~~ISO527-2~~	~~≥45~~	~~≥55~~
~~Elongation at break (%)~~	~~ISO527-2~~	~~≥1.5~~	~~≥2.5~~
~~Flexural modulus of elasticity (N/mm^2)~~	~~ISO178~~	~~≥2700~~	~~≥2700~~
~~Flexural strength (N/mm^2)~~	~~ISO178~~	~~≥80~~	~~≥100~~
~~Heat deflection temperature (℃)~~	~~ISO75-2~~	~~≥75~~	~~≥75~~
~~Barcol hardness~~	~~ASTM D2583~~	~~≥35~~	~~≥35~~
~~Water absorption (mg)~~	~~ISO62~~	~~≤80 (hull)~~ ~~≤100 (non hull)~~	~~≤70~~
~~Note 1: Test samples are to be solidified for 24 h under 50℃.~~ ~~Note 2: The size of test sample for water absorption is 50 mm × 50 mm × 4 mm, exposure time 672 h at 23℃±2℃.~~			

Items	Standard	Unsaturated polyester/vinyl ester resin		epoxy resins
		Grade 1	Grade 2	
Tensile strength (N/mm^2)	ISO527-2	≥55	≥45	≥55
Elongation at break (%)	ISO527-2	≥2.5	≥1.5	≥2.5
Flexural modulus of elasticity (N/mm^2)	ISO178	≥2700	≥2700	≥2700
Flexural strength (N/mm^2)	ISO178	≥100	≥80	≥100
Heat deflection temperature (℃)	ISO75-2	≥70	≥60	≥75
Barcol hardness	ASTM D2583	≥35	≥35	≥35
Water absorption (mg)	ISO62	≤80	≤100	≤70
Note 1: Test samples are to be solidified for 24 h under 50℃. Note 2: The size of test sample for water absorption is 50 mm × 50 mm × 4 mm, exposure time 672 h at 23±2℃. Note 3: Gel coat resin and surface resin made of unsaturated polyester resin or vinyl resin are to meet the requirements for Grade 1.				

CHAPTER 3 FIBER-REINFORCED PLASTIC HULL MATERIALS

Section 1 GENERAL PROVISIONS

3.1.3.3 Approval test of molding procedures for fiber-reinforced plastic craft:

(1) Prior to the commencement of construction of fiber reinforced plastic craft where a new construction technology or a new laminating method or new resins and reinforced materials will be used, the manufacturer is to provide a test specimen laid up by operators in accordance with the procedure specification submitted for approval under the same condition as that of the molding workshop, for verification of fiber reinforced plastic hull design. The thickness of the specimen is to be the smallest thickness of the hull.

(2) The surface of the specimen is to be smooth, even and free from defects such as porosity, lamination, naked fiber, etc.

(3) Laminated plate specimens are to be prepared in accordance with the relevant accepted standards for mechanical tests such as tensile test, compression test, bending test, etc. The density (complying with limit values specified by the manufacturer), Barcol hardness, fiber content of the specimen are also to be measured.

(4) Shearing test is to be carried out for sandwich panel specimen in accordance with ~~the relevant accepted standards~~ the standard ISO 1922, and the shear strength is not to be less than ~~1.33 times~~ that of core material, and the damaged surface is not to be the bonding surface of the core material and the face plate. In addition, a laminate specimen of sandwich panel plate is to be prepared for other tests. The test requirements, methods and results are to be the same as those for the laminated plate specimen.

(5) For hull using glass fiber as reinforcing material, the results of the above-mentioned tests are not to be lower than the requirements given in Table 3.1.3.3(5); for hull using Aramid fiber or carbon fiber as reinforcing material, the performance tests mentioned above are to be carried out and the test results are not to be lower than the requirements of the strength calculation, with interlaminar shear strength not to be less than 17MPa, and are to be submitted to the Surveyor for confirmation.

(6) The laminated plate moulded by laying up chopped strand mat (CSM) and BIAXIAL woven rovings alternately is recommended.

Section 2 RAW MATERIALS

3.2.3.5 Gel coat resins are to be of waterproof polyester resin or vinyl ester resin for marine use. There is to be a good adhesiveness between gel coat resins and fiber-reinforced plastics. The elongation at break for gel coat resins is to be greater than that of the laminating resin, and the difference is in general not to be greater than 1%.

3.2.3.6 When unsaturated polyester resins are used to build ships/boats, for high speed crafts and cruise ships, Grade 1 resins as shown in Table 2.2.2.5 are to be used to build the single-plate hull and the hull outer face plates of the sandwich structure, while Grade 2 resins can only be used to build superstructures and hull internal structures. Grade 2 resins may be used to build life boats and rescue boats.

Section 3 LAMINATING PROCEDURE

3.3.2.2 Test panels are to be laid up while laminating is proceeding. Test panels may be taken from hull openings or hull extensions. Where this is impracticable, test panels are to be simulated by ordinary operators using a plate mould placed at an angle of about 45°, with the same environmental conditions, raw materials, mixing ratio and process techniques (except for gel coat) as in actual production. Specimens are to be taken in the as-cured condition and their properties tested in accordance with the requirements in 3.4.3.5 with the results in compliance with the requirements in 3.4.3.6. For epoxy resin test panel for which post cure is needed, the test panel and the hull are to be put into one same cure oven and specimens are to be taken after cure is performed. For small craft produced in batches according to the same type as shown in drawings, the same procedure specification and the same production conditions, one specimen is permitted for 10 craft.

PART THREE WELDING

CHAPTER 2 WELDING CONSUMABLES

Section 1 GENERAL PROVISIONS

2.1.3.5 For all grades of welding consumables, the grade of steels used for the preparation of test assemblies may be selected from those listed in Table 2.1.3.5, and a toughness grade lower than that required in the Table may also be selected. For testing the deposited weld metal, any steel grade may be selected for welding consumables of grade Y40 and below; steels compatible with the properties of the weld metal may be selected for grade Y42 and above, or prepared edges of the base metal is to be built up with welding consumables which are to be approved; and for low-alloy steel containing nickel and stainless steel, the side walls of the weld are in general to be buttered with a weld metal of the same composition. When the building-up method is to be used, it is recommended that one or two layers be built up using appropriate welding consumables before the test assembly is fitted.

Grade of Steel for Approval Test **Table2.1.3.5**

Grade of welding consumables	Grade of steel for test	Grade of welding consumables	Grade of steel for test	Grade of welding consumables	Grade of steel for test
1	A	5Y42	FH420	3Y69	DH690
2	B、D	3Y46	DH460	4Y69	EH690
3	E	4Y46	EH460	5Y69	FH690
1Y	AH32、AH36	5Y46	FH460	3Y89	DH890
2Y	DH32、DH36	3Y50	DH500	4Y89	EH890
3Y	EH32、EH36	4Y50	EH500	5Y89	①
4Y	FH32、FH36	5Y50	FH500	3Y96	DH960
2Y40	DH40	3Y55	DH550	4Y96	EH960
3Y40	EH40	4Y55	EH550	5Y96	①
4Y40	FH40	5Y55	FH550	1.5Ni	1.5Ni
5Y40	FH40	3Y62	DH620	3.5Ni	3.5Ni
3Y42	DH420	4Y62	EH620	5Ni	5Ni
4Y42	EH420	5Y62	FH620	9Ni	9Ni

Note①: Choose the suitable steel grade

Section 2 MECHANICAL PROPERTIES OF WELDING CONSUMABLES

2.2.2.1 Consumables for welding structural steels are graded into ~~nine~~11 levels of yield stress, and each of which is further subdivided into several levels in respect of notch toughness. Designations of different grades are shown in Table 2.1.3.5. The notch toughness is indicated by the numerals 1 to 5, and the letter Y stands for high-strength welding consumables. Where the yield stress of welding consumables is greater than 400 N/mm2, Y is to be followed by a numeral from 40 to ~~69~~96. Consumables for the nickle alloy steel are divided into four levels of 1.5Ni, 3.5Ni, 5Ni and 9Ni in respect of the content of nickel in the base metal.

2.2.2.3 The mechanical properties of consumables for welding structural steels are to comply with the requirements given in Table 2.2.2.3.

Mechanical Properties of Consumables for Welding Structural Steels Table2.2.2.3

Grade of welding consumables			1、2、3	1Y、2Y 3Y、4Y①	2Y40 3Y40 4Y40 5Y40	3Y42 4Y42 5Y42	3Y46 4Y46 5Y46	3Y50 4Y50 5Y50	3Y55 4Y55 5Y55	3Y62 4Y62 5Y62	3Y69 4Y69 5Y69	3Y89 4Y89 5Y89	3Y96 4Y96 5Y96	1.5Ni	3.5Ni	5Ni	9Ni
Deposited metal test	Yield strength⑦ R_{eH}(N/mm^2)		≥305	≥375	≥400	≥420	≥460	≥500	≥550	≥620	≥690	≥890	≥960	≥375			
	Tensile strength⑧ R_m(N/mm^2)		400-560	490-660	510-690	~~530~~520-680	~~570~~540-720	~~610~~590-770	~~670-830~~640-820	~~720~~700-890	770-940	940-1100	980-1150	≥460	≥420	≥500	≥600
	Elongation A(%)		≥22			≥20		≥18			≥17	≥14	≥13	≥22	≥25		
	Charpy V-notch impact test	Test temp. (℃)	②											-80	-100	-120	-196
		Average impact energy⑥(J)	≥47③			≥47		≥50	≥55	≥62	≥69	≥69	≥69	≥69			
Butt Butt weld test test	Transverse tensile strength (N/mm^2)		≥400	≥490	≥510	≥~~530~~520	≥~~570~~540	≥~~610~~590	≥~~670~~640	≥~~720~~700	≥770	940	980	≥490	≥450	≥540	≥640
	Charpy V-notch impact test	Test temp. (℃)	②											-80	-100	-120	-196
		Average impact energy⑥(J)	≥47④			≥47		≥50	≥55	≥62	≥69	≥69	≥69	≥69			
	Bend test		After testing, the test specimens are not to reveal any open defects in any direction greater than 3 mm⑤														

Notes: ① Manual arc welding electrodes are to comply with Grade 2Y and above.

② The temperature of impact test for welding consumables of Grade 1 and Grade 1Y is to be 20℃;
for those of Grades 2, 2Y, 2Y40 to be 0℃;
for those of Grades 3, 3Y, 3Y40, 3Y42, 3Y46, 3Y50, 3Y55, 3Y62, 3Y69, 3Y89, 3Y96 to be -20℃;
for those of Grades 4Y, 4Y40, 4Y42, 4Y46, 4Y50, 4Y55, 4Y62, 4Y69, 4Y89, 4Y96 to be -40℃;
for those of Grades 5Y40, 5Y42, 5Y46, 5Y50, 5Y55, 5Y62, 5Y69, 5Y89, 5Y96 to be -60℃.
for those of impact grade F is not applicable for 890 N/mm^2 and 960 N/mm^2 yield strength levels, and especially considered by CCS

③ The average impact energy of deposited metal test of submerged arc automatic welding is not to be less than 34 J for welding consumables with R_{eH} < 400 N/mm^2; not to be less than 39 J for those with R_{eH} ≥ 400 N/ mm^2.

④ The average impact energy of butt joints of vertical welding and submerged arc automatic welding is not to be less than 34 J for welding consumables with R_{eH} < 400 N/mm^2; not to be less than 39 J for those with R_{eH} ≥ 400 N/mm^2.

⑤ Except for 5Ni and 9Ni steel specimens to be bend tested with a former of diameter four times the plate thickness, the diameter of former is to comply with the requirements of 1.2.4.2 of this PART.

⑥ Energy values from individual impact test specimens are not to be less than 70% of the specified values.

⑦ In case of no marked yield stress, the proof stress $R_{P0.2}$ is to be reported.

⑧ Where the tensile strength exceeds the specified maximum value, special consideration is to be given by CCS.

2.2.2.4 Welding consumables with grade Y89 are considered suitable for welding steels in the same strength level only. Welding consumables with grade Y96 are also considered suitable for welding steels in the one strength level below that for which they have been approved.

2.2.2.~~4~~5 Where the bend test results of welding consumables with the yield stress of 420 N/mm^2 or above do not comply with Table 2.2.2.3, except that the elongation within the gauge length L_0 of bend specimens complies with that required for the deposited metal test, the test may be considered satisfactory. The gauge length L_0 of the bend specimen is shown in Figure 2.2.2.4.

Section 3 ELECTRODES FOR MANUAL ARC WELDING

Required Hydrogen Content for Welding Consumables Table 2.3.1.1

Grade of welding consumables	Diffusible hydrogen content
1, 2, 3, 1Y, 2Y, 3Y	Not mandatory
4Y, 2Y40, 3Y40, 4Y40	H15
3Y42, 4Y42, 5Y42, 3Y46, 4Y46, 5Y46, 3Y50, 4Y50, 5Y50	H10
3Y55, 4Y55, 5Y55, 3Y62, 4Y62, 5Y62, 3Y69, 4Y69, 5Y69	H5
3Y89、4Y89、5Y89、3Y96、4Y96、5Y96	H5

Note: For grades Y69 to Y96 annual hydrogen test is required.

Section 4 WIRE-FLUX COMBINATIONS FOR SUBMERGED ARC AUTOMATIC WELDING

2.4.5.1 Each test plate is not to be less than 150 mm in width and of sufficient length to allow the cutting out of test specimens of the prescribed number and size.

Butt Weld Test Plate Thicknesses Required for Different Grades of Welding Consumables in Respect to Two-Run Technique Table 2.4.5.1

Grade of welding consumables	Thickness of thinner test plate (mm)	Thickness of thicker test plate (mm)
1, 1Y	12 ~ 15	20 ~ 25
2, 2Y, 3, 3Y, 4Y, 2Y40, 3Y40, 4Y40, 5Y40	20 ~ 25①	30 ~ 35①

Note: ① A limitation of the approval to the medium range (up to the maximum welded plate thickness) may be agreed to by CCS. Test assemblies are then to be welded using plates of 12 to 15 mm and 20 to 25 mm irrespective of the grade for which the approval is requested. This is applicable to thicknesses up to 25 mm only.

Section 6 CONSUMABLES FOR USE IN ELECTRO-SLAG OR ELECTRO-GAS VERTICAL WELDING

2.6.1.2 For welding consumables of Grades 1Y, 2Y, 3Y, 4Y, 2Y40, 3Y40 ~~and,~~ 4Y40 and 5Y40 used for electro-slag or electro-gas vertical welding, the approval may be restricted for use only with specific types of higher strength steel. 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 approval tests.

CHAPTER 3 APPROVAL OF WELDING PROCEDURES

Section 1 GENERAL PROVISIONS

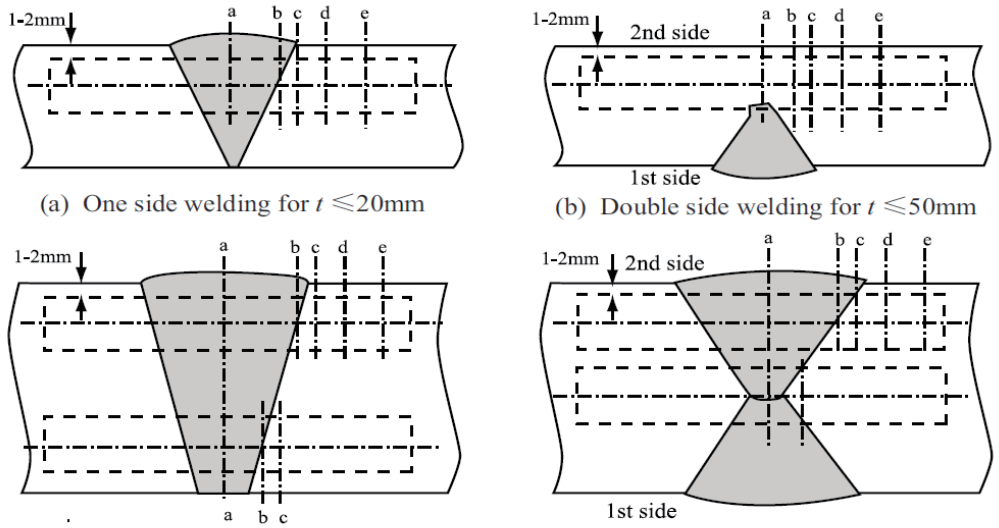
3.1.4.3 The application of a welding procedure specification to steel is specified as follows:

(2) For each toughness grade where the minimum value of the specified yield strength of steel is not more than 390 N/mm^2, welding procedures are considered applicable to the same and two lower strength levels as that tested. For high strength ~~quenched and tempered~~ steel for welded structures, welding procedures are considered applicable to the same and one lower strength level as that tested.

(3) For high heat input processes above 50 kJ/cm, the welding procedure is only applicable to that toughness grade tested and one strength level below.

Section 2 WELDING PROCEDURE APPROVAL TESTS FOR BUTT WELDS

3.2.3.1 Test assemblies are to be examined by 100% visual testing and by 100% non-destructive surface and internal testing prior to the cutting of test specimens. In case any post-weld heat treatment or aging is required or specified, the non-destructive testing is to be performed after the heat treatment or aging. For high strength ~~quenched and tempered~~ steels for welded structures with specified minimum yield strength of 420 N/mm^2 and above, the non-destructive testing is to be delayed for a minimum of 48 h, unless the heat treatment has been carried out. NDT procedures are to be agreed with CCS.



In the Figure, a, b, c, d and e are notch locations of impact specimens where: a – center of weld, b – fusion line, c – heat affected zone, 2 mm from fusion line, d – heat affected zone, 5 mm from fusion line, e – heat affected zone, ~~7 ~ 10 mm~~ 10 mm from fusion line ~~(to be determined according to heat input)~~.

Figure 3.2.4.1(3) Sampling Positions of Impact Specimens

CHAPTER 4 QUALIFICATION TESTS OF WELDERS

Section 3 SCOPE OF APPLICATION OF WELDER'S QUALIFICATION

Code of Welding Positions **Table4.3.7.1d**

Type of assembly	Code of welding position	Welding positions	ISO6947 corresponding code
Butt welding of plates	F	Flat (downhand) welding	PA
	Vu	Vertical upwards welding	PF
	Vd	Vertical downwards welding	PG
	H	Horizontal welding	PC
	O	Overhead welding	PE
Butt welding of pipes	1G	Welding of horizontally rolling pipes	PA
	2G	Welding of vertically fixed pipes	PC
	5G	Welding of horizontally fixed pipes	PH
	6G	Welding of pipes fixed at 45° inclination	H-L045
	6GR	Welding of pipes fixed at 45° inclination with restriction ring	-
Fillet welding of plates	FF	~~Fillet flat welding~~ Fillet welding in the flat position	PA
	FH	~~Fillet horizontal welding~~ Fillet flat welding	PB
	FHa	Fillet horizontal welding	PC
	FVu	Fillet vertical upwards welding	PF
	FVd	Fillet vertical downwards welding	PG
	FO	Fillet overhead welding	PD
	FOa	Fillet overhead welding	PE
Pipe-to-plate fillet welding	2FG	Fillet horizontal welding of vertically fixed pipe	PB
	4FG	Fillet overhead welding of vertically fixed pipe	PD
	5FG	Fillet welding of horizontally fixed pipe	PH
	6FG	Fillet welding of pipe fixed at 45° inclination	H-L045

5.3.2.4 The number (n) of non-destructive testing points in the strength deck and shell within 0.6L amidships (except where enhanced testing is required in 5.3.2.6) may be calculated by the following formula:

$$n = 0.16k\,(i + 0.1W_T) + 0.04W_L$$

where: n — the number of non-destructive testing points within 0.6L amidships;
k — average breadth of plates within 0.6L amidships, in m, which may be obtained from the following formula:

$$k = \frac{\text{circumference at transverse midship section (excluding opening)}}{\text{number of strakes seen at transverse section}};$$

i — amount of intersections of butt welds within 0.6L amidships;
W_T — whole length of transverse welds within 0.6L amidships, in m;
W_L — whole length of longitudinal welds joining the blocks within 0.6L amidships, in m.

L is the distance on the summer load waterline from the forward side of the stem to the after side of the rudder post, or to the center of the rudder stock if there is no rudder post. L is not to be less than 96%, and need not be greater than 97%, of the extreme length on the summer load waterline. For pontoon hulls, L is the distance on the summer load waterline from the forward side of the fore end plate to the after side of the after end plate. For ships without rudder stocks, L is 97% of the extreme length on the summer load waterline.

The density of non-destructive testing points is to be decreased in number with the decrease of structure importance and stress.

Where non-destructive testing is carried out at an intersection, the direction of testing is to be paralleled to the direction of the transverse welds.

Testing points are generally to be tested by radiographic method.