CHINA CLASSIFICATION SOCIETY

RULES FOR MATERIALS AND WELDING

AMENDMENTS

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CONTENTS

CCS

PART ONE METALLIC MATERIALS

CHAPTER 2 MATERIAL TESTS

Section 3 IMPACT TESTS

In paragraph 2.3.1.2, the sentence "The test specimen is generally to be close to the surface of the material. The notch is to be cut on a face of the specimen which was originally perpendicular to the rolled surface," is replaced by the sentence "The notch is generally to be perpendicular to the original surface of the piece,".

In paragraph 2.3.1.3, the words "with the notch cut on a face which is perpendicular to the rolled surface" are deleted.

Section 4 BEND TESTS

In paragraph 2.4.2.2, the words "original rolled surfaces" are replaced by the words "original surfaces".

A new Section 9 is added as follows:

"Section 9 PITTING CORROSION TEST FOR DUPLEX STAINLESS STEELS

2.9.1 General requirements

2.9.1.1 Pitting corrosion test for duplex stainless steels is mainly used to evaluate the corrosion resistance performance of austenitic-ferritic stainless steel products and weld joints.

2.9.2 Test specimen

2.9.2.1 An original surface of the specimen is to be kept as far as possible. For flat products, a specimen is recommended to be approximately 25 mm by 50 mm by (1.5 mm to 5.0 mm). Other product forms may be cut for test specimens convenient for testing. For weld joints, weld reinforcement is to be removed.

2.9.2.2 Specimens are generally taken by machining. After the specimens are cut, any material that may have been affected by high temperature or deformation associated with the cutting is to be removed by machining or grinding prior to testing.

2.9.2.3 All surfaces of the specimen are to be polished to a uniform finish. Polishing is to be performed slowly to prevent overheating.

2.9.2.4 The dimensions of the specimen are measured, and the total exposed surface area is calculated.

2.9.2.5 The specimen is to be cleaned, dipped in alcohol or acetone, and air dried.

2.9.2.6 The specimen is to be weighed to the nearest 1 mg or better.

2.9.3 Test procedures

2.9.3.1 The test solution is prepared by dissolving 100g of reagent-grade ferric chloride, $FeCl_3 \cdot 6H_2O$, in 900mL of distilled water (approximately 6% $FeCl_3$ by weight). The pH of the test solution is to be adjusted to approximately 1.3 prior to beginning the test by the addition of HCl or NaOH, as required.

2.9.3.2 Fill the test container with the required volume of at least 0.2 mL/mm^2 of the specimen surface area, submerge the specimen, transfer to the constant temperature bath, and allow to come to equilibrium at the desired test temperature. Test temperatures for different material are shown in Table 2.9.3.2.

Test temperature for different duplex stainless steel base material and weld Table 2.9.3.2

Grade	Uniform number	Condition	Test temperature (℃)
022Cr22Ni5Mo3N	S22253	Base metal	25
		Weld metal	22
022Cr23Ni5Mo3N	S22053	Base metal	25
		Weld metal	22
03Cr25Ni6Mo3Cu2N	S25554	Base metal / Weld metal	40
022Cr25Ni7Mo4N	S25073	Base metal / Weld metal	40

2.9.3.3 Place the specimen in the glass cradle and immerse in the test solution for 24 h once the temperature has been established. Cover the test container with a watchglass during the test period. Maintain the test temperature with an accuracy of ±1℃ throughout the test .

2.9.3.4 At the end of the test, remove the specimen from the solution, rinse with water, remove corrosion products, dry and weigh the specimen to 1 mg or better.

2.9.4 Test results

2.9.4.1 No pitting attack is to be visible on the test face(s).

2.9.4.2 The corrosion rate is calculated in accordance with the weight loss and total surface area. Unless otherwise specified, the calculated corrosion rate is not to exceed 10 mdd.

$$CR = \frac{W_1 - W_2}{S} \times 10^4$$

where: CR — corrosion rate, in mdd;

W_1 — specimen weight prior to test, in mg;

W_2 — specimen weight after test, in mg;

S — total surface area, in mm^2.”

CHAPTER 3 STEEL PLATES, FLAT BARS AND SECTIONS

Section 9 CLAD STEEL PLATES

In paragraph 3.9.5.2, “50 mm^2” is replaced by “4,000 mm^2”.

Section 10 PLATES WITH THROUGH THICKNESS PROPERTIES (Z-DIRECTION STEELS)

In the first line of Table 3.10.4.1, “$S \geq 0.005\%$” is replaced by “$S > 0.005\%$”, and “$S < 0.005\%$” is replaced by “$S \leqslant 0.005\%$”.

CHAPTER 4 STEEL PIPES AND TUBES

Section 1 GENERAL PROVISIONS

In paragraph 4.1.2.2, the words “hot finished” are replaced by the words “hot formed”.

Section 2 SEAMLESS PRESSURE PIPES

In paragraph 4.2.2.1, the words “hot or cold finished” are replaced by the words “hot formed or cold finished”.

CHAPTER 5 STEEL FORGINGS

Section 4 FORGINGS FOR CRANKSHAFTS

The existing paragraph 5.4.7.2 is replaced by the following:

“5.4.7.2 All forgings for crankshafts with crankpin diameter not less than 150 mm are to be ultrasonic tested.”

Section 5 FORGINGS FOR GEARING

The last sentence of the existing paragraph 5.5.7.1 is replaced by the following:

“The results of all impact tests are to comply with the requirements for forgings in the quenched and tempered condition as given in Table 5.4.6.2.”

CHAPTER 8 ALUMINIUM ALLOYS

A new Section 5 is added as follows:

“Section 5 ALUMINIUM/STEEL TRANSITION JOINTS

8.5.1 Scope

8.5.1.1 Provision is made in this Section for transition joints used for connecting aluminium structures to steel plating.

8.5.2 General requirements

8.5.2.1 Aluminium/steel transition joints are to be made by the manufacturer approved by CCS.

8.5.2.2 The manufacturer is to submit a specification which is to include the maximum temperature allowable at the interface during welding.

8.5.2.3 Aluminium/steel transition joints are composed of two or three layers of metal with steel plate as base layer and aluminium alloys as cover layer. For three-layer transition joints, intermediate layer may be titanium or aluminium.

8.5.2.4 The base material is generally to be normal strength hull structural steels which comply with the relevant requirements of Section 2, Chapter 3 of this PART.

8.5.2.5 The cover material is generally to be marine aluminium alloys which comply with the relevant requirements of Section 2 of this Chapter.

8.5.2.6 Industrially pure titanium or aluminium for intermediate layer is to comply with the recognized standards.

8.5.3 Manufacture

8.5.3.1 Composite plates are to be manufactured by explosion welding.

8.5.3.2 Composite plates are processed to transition joints of strip, block or other shape by machining.

8.5.4 Visual and ultrasonic examination

8.5.4.1 Each composite plate is to be subjected to 100 percent visual and ultrasonic examination to determine the extent of any unbonded areas. Unbonded areas are unacceptable and any such area plus 25 mm of surrounding sound material is to be discarded.

8.5.4.2 Ultrasonic examination is to comply with the recognized standards.

8.5.5 Mechanical tests

8.5.5.1 One composite plate from each lot is to be sampled for mechanical testing. A test lot consists of three or less composite plates produced at one time and with same material, dimension and explosion-bonding technology. The selected plate is to be sampled at diagonally opposite corners.

8.5.5.2 Following specimens are included in each sample:

(1) Two tensile test specimens: Tensile tests may be made across the interface by welding extension pieces to each surface or by the ram method shown in Figure 8.5.5.2. One specimen is to be tested at ambient temperature after heating to the maximum allowable interface temperature for 15 min.

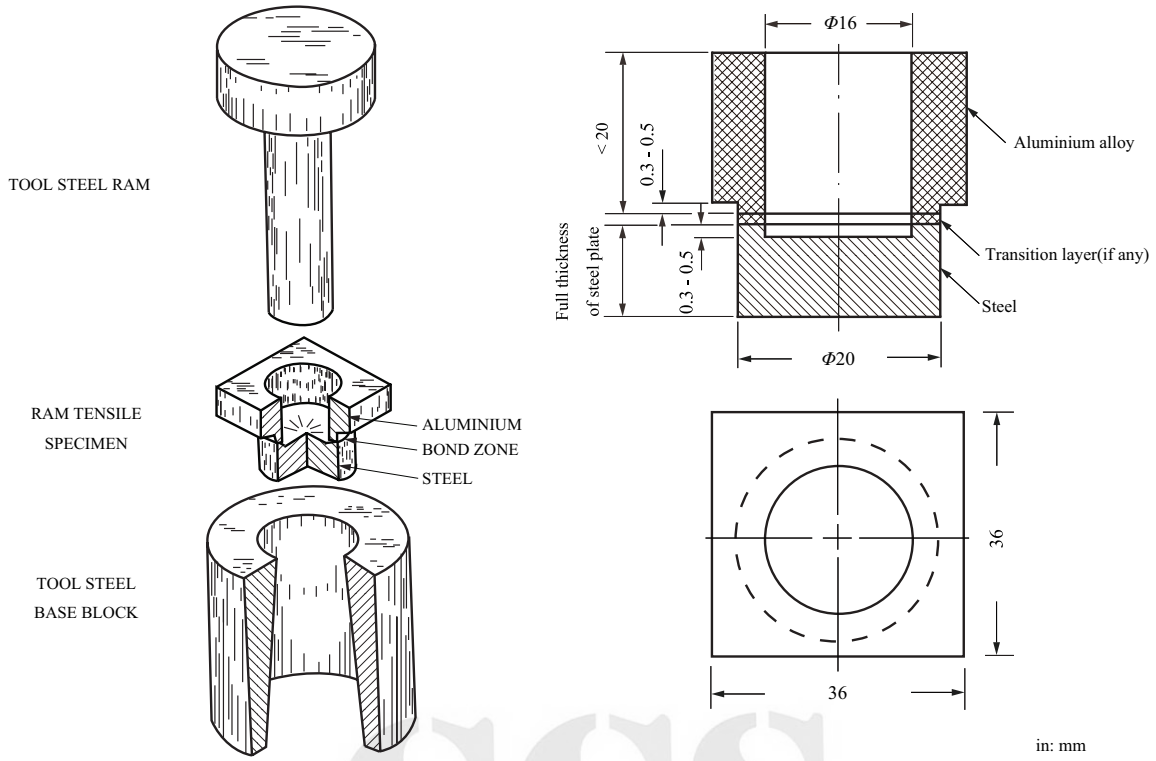
(2) Two shear test specimens: to measure shear strength of the interface. One specimen is to be tested at ambient temperature after heating to the maximum allowable interface temperature for 15 min. If the intermediate transition layer is titanium, two specimens are to be added to measure the shear strength at interface.

(3) One bend test specimen: The specimen is to be bent over 90° to a head diameter of six times the thickness of the specimen.

8.5.5.3 Methods for above tests are to comply with the recognized standards.

8.5.5.4 Test results are to comply with the manufacturer's specifications.

8.5.5.5 Where the result of any mechanical test does not comply with the requirements, two times additional specimens are to be taken from the same plate for re-tests. If additional tests comply with the requirements, the said batch of products may be accepted. If additional tests fail, the products are to be examined one by one."



(a) Ram tensile test setup **(b) Recommended dimension for ram test specimen**

Figure 8.5.5.2 Ram test

CHAPTER 9 OTHER NON-FERROUS MATERIALS

Section 3 COPPER TUBES

In paragraph 9.3.8.1, the sentence “and the test pressure is to be 1.5 times the design pressure or 7.0 N/mm^2, whichever is greater.” is replaced by “and the test pressure is to be 1.5 times the design pressure, but need not exceed 7.0 MPa in maximum.”

PART TWO NON-METALLIC MATERIALS

CHAPTER 2 PLASTIC MATERIALS

Section 2 RAW MATERIALS

A new paragraph 2.2.8 is added as follows:

"**2.2.8 Synthetic bearing material for rudder stock, rudder pintle, rudder axle and stuntube shaft**

2.2.8.1 Synthetic bearing material for rudder stock, rudder pintle, rudder axle and stuntube shaftis to be approved by CCS before use.

2.2.8.2 Synthetic bearing material for rudder stock, rudder pintle, rudder axle and stuntube shaft may generally be prepared as circumferential shape or strip shape.

2.2.8.3 The following physical properties of bearing material are to be inspected:

(1) compressive stress and elastic modulus (25% straining);

(2) temperature resistance (compressive stress and modulus at 50℃ and 25% compressive strain);

(3) volumetric swelling in corresponding lubricating medium (ocean water or oil) for 4 weeks/672 h;

(4) water resistance (compressive stress and modulus at 25% compressive strain after 4 weeks in ocean water);

(5) thermal expansion coefficient (vertical to the compression side);

(6) wear rate (volume);

(7) hardness;

(8) Izod impact strength (notched);

(9) friction coefficient (dynamic and static friction coefficients at both 20℃ and 80℃ under dry and wet conditions of material).

2.2.8.4 The physical properties of synthetic bearing material for rudder stock, rudder pintle, rudder axle and stuntube shaft are to comply with the requirements of Table 2.2.8.4, and the data of wear rate and hardness are to be submitted to CCS for information.

Requirements for physical properties of macromolecular bearing Table 2.2.8.4

Compressive stress① (MPa)	Impact strength of cantilever beam (KJ/m²)	Compressive modulus① (MPa)	Friction coefficient	Temperature resistance and water resistance	Volumetric swelling in lubricating medium (%)
⩾ 120② ⩾ 85③	⩾ 90②	⩾ 1500②	⩽ 0.25	Not less than 80% of normal test value	⩽ 3

Notes: ① Under the condition of 25% compressive straining.
② Vertical to the compression side.
③ Parallel to the compression side, only for bearings of strip shape.

2.2.8.5 The maximum permissible surface pressure of synthetic bearing material for rudder stock, rudder pintle, rudder axle and stuntube shaft is generally not greater than 5.5 N/mm^2. If permissible surface pressure greater than 5.5 N/mm^2 need to be approved, in addition to complying with the requirements of 2.2.8.3 and 2.2.8.4, expansion data of the material under dry and wet alternate conditions of seawater are to be submitted. ”

CHAPTER 3 FIBER-REINFORCED PLASTIC HULL MATERIALS

Section 1 GENERAL PROVISIONS

Subparagraph 3.1.3.3(1) is replaced by the following:

“(1) Prior to the construction of fiber reinforced plastic ship by new construction technology or new laminating method or new resin or reinforced material, the manufacture is to provide a test specimen laid up by operators in accordance with the procedure 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.”

Section 2 RAW MATERIALS

Paragraph 3.2.3.5 is replaced by the following:

“3.2.3.5 For lifeboats and rescue boats for which fire resistance is required, fire-retardant resins are to be used for construction.”

A new sentence is added at the end of paragraph 3.2.5.1 as follows:

“The medium alkali glass fibers and fabrics of such fibers are not to be used as the reinforcing materials used for the construction of fiber reinforced plastic ships.”

The existing paragraph 3.2.5.2 is deleted, and the subsequent paragraphs of 3.2.5 are renumbered accordingly.

A new paragraph 3.2.8 is added as follows:

“**3.2.8 Adhesives for structural application**

3.2.8.1 Adhesives for structural application of construction of fiber reinforced plastic ship are to be approved by CCS.

3.2.8.2 The type and amount of adhesives for structural application are to be in accordance with the manufacturer’s recommendations and compatible with the lamination resins.

3.2.8.3 Adhesives for structural application may not be used for connection of shell jointing.

3.2.8.4 Prior to the application of structural adhesives, particular attention is to be given to the cleanliness of the surfaces to be bonded and removal of dust, grease, resin or reinforced fiber residue.

3.2.8.5 The process for the application of the adhesive is to be submitted to CCS for information and is to include the maximum bondline thickness, maximum creep and water resistance.

3.2.8.6 Adhesives for structural application are to ensure that minimum shear strength is not less than 7 N/mm^2 in temperatures ranging from ambient to 60℃.”

Section 3 LAMINATING PROCEDURE

A new sentence is added at the end of paragraph 3.3.2.2 as follows:

"For small craft produced in batches according to the same plan type, same procedure and same production conditions, one specimen is permitted for 10 craft."

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PART THREE WELDING

CHAPTER 2 WELDING CONSUMABLES

Section 2 MECHANICAL PROPERTIES OF WELDING CONSUMABLES

In notes ③ and ④ of Table 2.2.2.3, "automatic welding" is replaced by "submerged arc automatic welding".

Section 3 ELECTRODES FOR MANUAL ARC WELDING

In paragraph 2.3.4.5, the words "(axes of specimen are located at the center of plate thickness)" are added after "be subjected to tensile, face and root bend and impact tests respectively".

In paragraph 2.3.7.3, the words "(axes of specimen are located at the center of plate thickness)" are added after "be subjected to tensile, bend and impact tests respectively".

Section 4 WIRE-FLUX COMBINATIONS FOR SUBMERGED ARC AUTOMATIC WELDING

In paragraph 2.4.4.3, the words "(axes of specimen are located at the center of plate thickness)" are added after "be subjected to tensile, face and root bend and impact tests respectively".

Section 5 WIRES AND WIRE-GAS COMBINATIONS FOR SEMI-AUTOMATIC AND AUTOMATIC WELDING

A new paragraph 2.5.2.4 is added as follows:

"2.5.2.4 Wires or wire-gas combinations approved for semi-automatic and automatic multirun welding may be tested according to the requirements of 2.5.2.1, without additional tests, for automatic multirun welding."

In paragraph 2.5.8.2(1), "one deposited metal test assembly is to be prepared in accordance with the requirements of 2.5.3 of this Section" is to be replaced by "one deposited metal test assembly is to be prepared in accordance with the requirements of 2.5.3 of this Section using a wire of diameter within the range approved for the semi-automatic multirun welding of ship structures".

Section 7 CONSUMABLES FOR USE IN ONE-SIDE WELDING WITH TEMPORARY BACKING MATERIALS

In paragraph 2.7.2.1, "and the other with plates 35 mm to 40 mm in thickness" is replaced by "and the other with plates 30 mm to 35 mm in thickness".

CHAPTER 4 QUALIFICATION TESTS OF WELDERS

Section 1 GENERAL PROVISIONS

The existing subparagraph 4.1.3.2(2) is replaced by the following:

"(2) Except for underwater welders, only those who have more than 6 months' actual working experience of one grade can apply for upgrading test of next grade. Personnel applying for Grade III need to hold Grade II certificate and have continuous working experience of more than 1 year."

A new subparagraph 4.1.3.2(3) is added as follows:

"(3) For underwater welders, only those who hold certificate of one grade and have continuous working experience of more than 1 year can apply for upgrading test of next grade."

The existing paragraph 4.1.6 is replaced by the following new 4.1.6 and 4.1.7:

"**4.1.6 Certificates**

4.1.6.1 After a satisfactory qualification test, a Qualification Certificate of Welder is to be issued by CCS. The welders are to observe the certified range of work as specified in the Certificate.

4.1.6.2 The following items are to be specified in the Certificate:

(1) Name, ID number and photograph of the welder;

(2) Name of shipbuilder / manufacturer;

(3) Range of qualification for materials, welding processes, types of welded joint, plate thicknesses and welding positions as well as underwater working depth for underwater welders;

(4) Expiry date of the validity of the qualification;

(5) Six months' supervision record by the manufacturer;

(6) Extension record approved by CCS.

4.1.6.3 The Surveyor has the right to check the Qualification Certificate of Welder whenever the welders are engaged in welding.

4.1.6.4 Each manufacturer is to be responsible for the control of the validity of the certificate and the range of the approval.

4.1.7 Validity of the qualification

4.1.7.1 The Qualification Certificate of Welder is to be valid from the date of issue.

4.1.7.2 Except that the Qualification Certificate for tack welders is valid for unlimited period, the Qualification Certificate of Welder is valid for three years from the date of issue (including Grade T wet tack welding), and all the following conditions are to be fulfilled:

(1) The welder is to be engaged with reasonable continuity on welding work within the current range of approval. An interruption for a period no longer than six months is permitted.

(2) The welder's work is in general to be in accordance with the technical conditions under which the approval test is carried out.

(3) There is to be no specific reason to question the welder's skill and knowledge.

4.1.7.3 Within the period of validity, if the bearer of a Qualification Certificate of Welder has not been engaged in welding for a consecutive period of 6 months, prior to the actual welding, the bearer is to weld a test assembly in the most difficult position specified in his Qualification Certificate. The welder may be permitted to continue to be engaged in the welding work only with satisfactory results of the test.

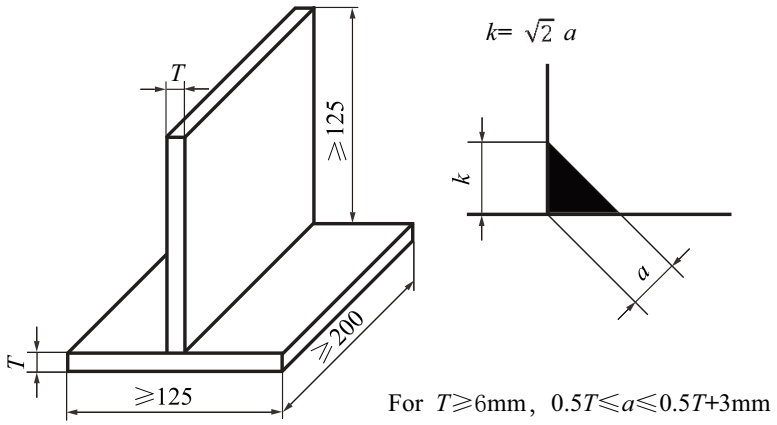
4.1.7.4 Prior to the expiration date of the Certificate, welders are to take renewal tests especially for operational skill. With satisfactory results of the renewal tests, the validity of the Certificate is to be extended for another 3 years.

4.1.7.5 Within the period of validity, if the bearer of a qualification certificate has been proved to be consistently good in welding quality (i.e. more than 90% of his welding products have been proved to be satisfactory by non-destructive testing) and possesses a record of welding quality on products checked by the Surveyor, the validity of the Certificate may be extended for one year without renewal tests, subject to the nomination of the Qualification Test Committee and the confirmation of CCS."

Section 2 QUALIFICATION TESTS OF WELDERS AND EVALUATION

The existing Figure 4.2.2.1(b) is replaced by the following:

"



For $T \geq 6$mm, $0.5T \leq a \leq 0.5T+3$mm

For $T < 6$mm, $0.5T \leq a \leq T$

"

Section 3 APPLICATION OF QUALIFICATION OF WELDERS

The existing paragraph 4.3.2.1 is replaced by the following:

"4.3.2.1 The welding processes applicable to welder's qualifications are divided into 3 categories in Table 4.3.2.1. The individual qualifications for welding process of different category cannot cover each other.

Categories of Welding Processes **Table 4.3.2.1**

Category		Welding process
Metal arc welding		Metal arc welding
Gas metal arc welding①	First group	Self-shielded arc welding with flux-cored wires Metal active gas (MAG) welding with flux-cored wires Metal inert gas (MIG) welding with flux-cored wires
	Second group	Metal active gas (MAG) welding with solid wires Metal inert gas (MIG) welding with solid wires
Non-consumable electrode gas shielded arc welding		Tungsten inert gas (TIG) welding

Note: ① In gas metal arc welding, welding process of group 2 can cover welding process of group 1."

The existing Table 4.3.4.2 is replaced by the following:

"**Range of welder's qualification for parent metal** **Table 4.3.4.2**

Material group of test piece①	Range of qualification					
	W01	W02	W03	W04	W05	W11
W01	*	×	×	×	×②	—
W02	×	*	×	×	×②	—
W03	×	×	*	×	×②	—
W04	×	×	×	*	×②	—
W05	×	×	×	×	*	—
W11	×③	×③	×③	×③	×③	*

Notes: ① When parent metal indicated by * and filler metal are in the same group.
② This Table applies only when parent metal indicated by * and filler metal are in the same group. When other filler metal is used, further test is required.
③ When using filler metal from group W11.

Key: * indicates the material group for which the welder is approved in the qualification test.
× indicates those material groups for which the welder is also qualified.
— indicates those material groups for which the welder is not qualified."

A new paragraph 4.3.4.4 is added as follows:

"4.3.4.4 When welding with filler materials outside the grouping system in 4.3.4.1 and 4.3.4.3, a separate test is required."

The existing Section 4 is replaced by the following:

"Section 4 UNDERWATER WELDER QUALIFICATION TESTS AND EVALUATION

4.4.1 Test requirements

4.4.1.1 Qualification tests of underwater welders consist of basic knowledge test and operational skill test. An applicant is qualified to take the test for operational skill only after he has successfully passed the basic knowledge test.

4.4.1.2 The contents of the basic knowledge test is to include the basic knowledge of base metals, welding consumables, welding equipment, technical procedures, normal underwater welding defects and underwater inspection technology, offshore engineering installations as well as safety knowledge of underwater welding. The scope of test is subject to approval by CCS.

4.4.1.3 Prior to operational skill test, the Qualification Test Committee is to report grades of qualification tests of welders, material group, thickness of test assembly (pipe diameter), joint type and edge preparation dimensions to CCS for confirmation.

4.4.1.4 The applicants are to take the qualification test as specified in this Section. The test is to be carried out under the supervision of the Surveyor.

4.4.1.5 The operational skill test consists of wet welding and local dry welding.

Wet welding means welding directly carried out by underwater welders in water without any drainage of water. Local dry welding means the welding carried out by underwater welders with drainage of water in the local area to be welded by gas-shielded means.

4.4.1.6 Welders passing the test of wet welding can only be engaged in wet welding. Welders passing the test of local dry welding can only be engaged in local dry welding.

4.4.1.7 Welding consumables for the tests are to be suitable for the parent material.

4.4.1.8 Applicants may take the test at a selected depth of water according to the actual working positions.

4.4.2 Test assemblies

4.4.2.1 The form and dimensions of test assemblies are as follows (see Figure 4.4.2.1):

(1) Butt welds in plates: Length $L \geqslant 300$ mm, Breadth $B \geqslant 125$ mm;

(2) Butt welds in pipes: Length $L \geqslant 125$ mm × 2;

(3) Grade T (wet tack welding): Length $L \geqslant 400$ mm, Breadth $B \geqslant 100$ mm.

The plate thickness of test assemblies of Grade T is 6 mm, and the plate thickness of other butt welded assemblies may be determined by the manufacturer according to actual production.

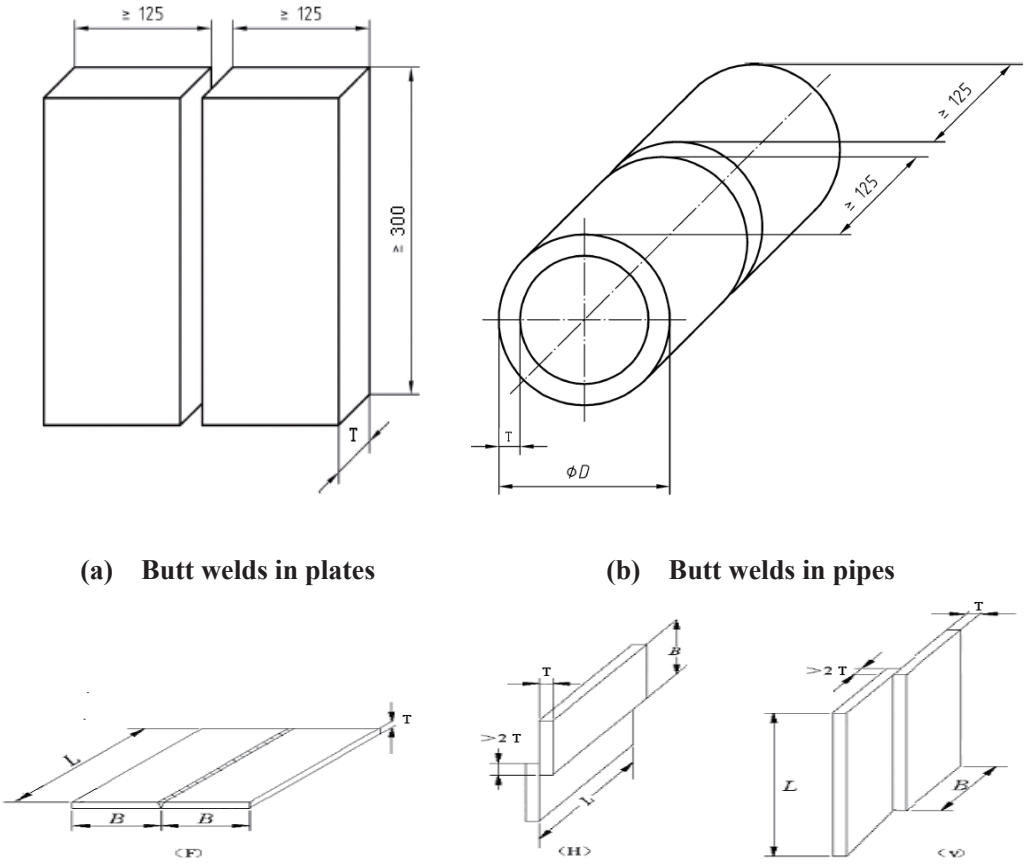
4.4.2.2 One-side welding is generally used for butt joints, which may be carried out with or without backings. Type and edge size of butt joints may be determined by the manufacturer according to actual production.

4.4.3 Preparation of test assembly

4.4.3.1 Underwater welders are to take the qualification test at a designated depth of water or in an equivalently simulated condition.

4.4.3.2 For Grade T, for each specimen only one run of weld in accordance with the requirements of 4.4.2.1(c) is to be made.

4.4.3.3 In addition to the above requirements, 4.2.3.1 to 4.2.3.8 of this Chapter are to be complied with.



(a) Butt welds in plates **(b) Butt welds in pipes**

(c) Test assemblies of Grade T

(in mm)

Figure 4.4.2.1 Dimensions of Test Assemblies

4.4.4 Test or inspection

4.4.4.1 Test or inspection items and required specimens for different types of test assemblies are shown in Table 4.4.4.1.

Test or inspection items and required specimens for underwater welder qualification tests

Table 4.4.4.1

Type of assembly	Test or inspection items	Required specimens
Butt welding of plates	1. Visual inspection 2. Radiographic inspection 3. Bend test 4. Macro examination	Weld length Examination length of weld① Two for face bend test and two for root bend test② One
Butt welding of pipes	1. Visual inspection 2. Radiographic inspection 3. Bend test 4. Macro examination	Weld length Weld length Two for face bend test and two for root bend test② One
Grade T	Visual inspection	Weld length

Notes: ① The examination length of weld is the length deducted by 25 mm from both ends of the test assembly respectively.

② If the thickness of the test assembly is not less than 12 mm, two side bend specimens may be used instead.

4.4.4.2 Before the visual inspection, the surface of welds is to be in the as-welded state and no machining is to be made.

4.4.4.3 Specimens are generally taken by machining. If flame-cutting is applied, surplus metal not less than 5 mm from the line of cut is to be kept on both sides for machining.

4.4.4.4 For preparation of bend test specimens, reinforcement of weld and backing (if any) are to be machined flush with the rolled surface of the base metal. Undercut is not to be removed. Bend test specimens are to be taken as shown in Figure 4.2.4.5(a) and (b). Specimen dimensions and requirements are shown in Figure 1.2.3.3 and Figure 1.2.3.4 of Chapter 1 of this PART.

4.4.4.5 Preparation of macro specimens is to comply with the requrements of 1.2.3.7 of Chapter 1 of this PART.

4.4.5 Specimen evaluation

4.4.5.1 The requirements for visual inspection of test specimens are as follows:

(1) The surface of welds is to be well formed, the edges of welds are to be transmitted to the base metal smoothly and the width of welds is to be uniform.

(2) The surface of the welds is to be free from cracks, incomplete fusion, slag-inclusions, porosities and overlaps.

(3) The depth of depression on the surface of welds is not to be less than 0.8 mm from the surface of the base metal.

(4) The depth of undercuts is not to exceed 0.8 mm and the aggregate length of undercuts on both sides of the weld is not to exceed 10% the weld length for plate assemblies or 20% for pipe assemblies.

(5) On completion of welding of assemblies without backing, incomplete fusion is not acceptable. However, local depression may be acceptable provided that it has a depth neither exceeding 0.1 t (t being the thickness of specimens), nor greater than 1.5 mm and the aggregate length does not exceed 10% the weld length.

(6) The height of reinforcement is not to exceed 3 mm for flat welding position, and 4 mm for other welding positions. The weld width is not to exceed 2.5 mm beyond the groove edge on each side.

(7) Overlaps at the root of welds without backing are not to exceed 3 mm.

4.4.5.2 Radiographic examination is to comply with the requirements for class B in ISO 5817 or other equivalent standards.

4.4.5.3 The bend test is to comply with the following requirements:

(1) The diameter of the former is to be 4t and the bending angle of 120°.

(2) After testing, the test specimens are not to reveal any crack or other open defect in any direction greater than 3 mm on the surface in tension.

4.4.5.4 The macro examination is to reveal a regular weld profile and the absence of defects such as cracks, lack of fusion, etc.

4.4.6 Application

4.4.6.1 The application of base metal is only limited to the same material group (For steel grouping, refer to Table 4.3.4.1, Section 3 of this Chapter).

4.4.6.2 The application of butt weld joint material is shown in Table 4.4.6.2(a) and Table 4.4.6.2(b).

Test piece thickness and range of approval **Table 4.4.6.2(a)**

Test piece thickness T (mm)	Range of approval t (mm)
$T \leqslant 6$	$T \leqslant t \leqslant 6$
$T > 6$	$0.5\ T < t \leqslant 2\ T$ （minimum 6 mm）

Test piece diameter and range of approval **Table 4.4.6.2(b)**

Test piece diameter D（mm）	Range of approval d（mm）
$D \leqslant 100$	$0.7\ D \leqslant d \leqslant 2\ D$
$100 < D \leqslant 300$	$0.5\ D \leqslant d \leqslant 2\ D$（minimum 75）
$D > 300$	$d > 0.5\ D$

4.4.6.3 Where any of the following changes of welding consumables occurs, a new qualification test is required:

(1) change of the standard or commercial designation of the electrodes and waterprotective coating;

(2) change of the nominal electrode diameter;

(3) change of the nominal composition of the shielding gas.

4.4.6.4 The covering principle for welding position is that higher grade of qualification tests of welders can cover lower grade of qualification tests of welders. The applicable welding positions for fillet welds after passing qualification tests of different grade are shown in Table 4.4.6.4.

Welding positions applicable to various joint type test items **Table 4.4.6.4**

Grades of qualification tests of welders	Applicable plate fillet weld range	Applicable pipe and plate fillet weld range
I	FF, FH	-
II	FF, FH, FVd	-
III	FF, FH, FVd, FO	-
I_P	FF, FH	2FG
II_P	FF, FH、FVd, FO	2FG, 4FG, 5FG
III_P	FF, FH, FVd, FO	2FG, 4FG, 5FG, 6FG

4.4.6.5 Butt welding of pipes can cover butt welding of plates at the corresponding position.

4.4.6.6 Butt welding of plates can cover butt welding of pipes at the corresponding position with outside diameter not less than 600 mm.

4.4.6.7 Underwater welders who have passed the qualification tests with no backing in welding are deemed as qualified for welding with backings in the corresponding grade.

4.4.6.8 The range of approval for water depth is given in table 4.4.6.8.

Range of approval according to water depth **Table 4.4.6.8**

Welding consumables	Applicable maximum water depth① (m)
Carbon and low alloy steels	*X*+10
Austenitic stainless steel	*X*+3

Note: ① *X* is water depth during the qualification test.

4.4.6.9 Grade T wet welding qualification only applies to tack welding and emergency repair welding."

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