CCS Rule Change Notice For:

RULES FOR MATERIALS AND WELDING

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Effective date: 1 January, 2018

Beijing

PART ONE METALLIC MATERIALS

CHAPTER 3 STEEL PLATES,FLAT BARS AND SECTIONS

Section 3 HIGHER STRENGTH HULL STRUCTURAL STEELS

3.3.2.3 For steels supplied in TMCP condition, the following requirements are also to be complied with:

(1) The carbon equivalent Ceq is to be calculated from the chemical composition of ladle samples using the formula given in 3.3.2.2 of this Section, and is to comply with Table 3.3.2.3(1).

Carbon Equivalent Ceq of TMCP Higher Strength Steel up to ~~100~~ 150mm in Thickness

Table 3.3.2.3(1)

Garde	Carbon equivalent Ceq (%)		
	Thickness *t* (mm)		
	t	50< *t*≤100	100< *t*≤150
AH32, DH32, EH32, FH32	≤0.36	≤0.38	≤0.40
AH36, DH36, EH36, FH36	≤0.38	≤0.40	≤0.42
AH40, DH40, EH40, FH40	≤0.40	≤0.42	≤0.45

Note: It is a matter for the manufacturer and the shipbuilder to mutually agree in individual cases as to whether they wish to specify a more stringent carbon equivalent.

CHAPTER 5 STEEL FORGINGS

Section 3 FORGINGS FOR SHAFTING AND MACHINERY

5.3.6 Non-destructive examination

5.3.6.1 Non-destructive examination ~~Magnetic particle testing~~ is to be carried out on the ~~following forgings~~ forged components required to be subject to non-destructive examination in Section 2, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships in accordance with the requirements of 5.1.6 of this Chapter~~:~~

~~(1) all connecting rod forgings;~~

~~(2) the following components when intended for diesel engines having a bore diameter larger than 400 mm:~~

~~— cylinder covers;~~

~~— piston crowns;~~

~~— piston rods;~~

~~— tie rods;~~

~~— gear wheels for camshaft drives;~~

~~— bolts and studs for cylinder covers, crossheads, main bearings and connecting rod bearings~~.

5.3.6.2 Ultrasonic testing is to be carried out on shafts having a finished diameter of 250 mm or larger when intended for main propulsion such as tube shafts, screwshafts, thrust shafts, intermediate shafts and shafts for other essential services ~~the following forgings~~ in accordance with the requirements of 5.1.6 of this Chapter~~:~~

~~(1) shafts having a finished diameter of 250 mm or larger when intended for main propulsion such as tube shafts, screwshafts, thrust shafts, intermediate shafts and shafts for other essential services;~~

~~(2) all piston crowns and cylinder covers;~~

~~(3) piston and connecting rods for diesel engines having a bore diameter greater than 400 mm~~.

5.3.6.3 The non-destructive examination for other forgings may be carried out in accordance with the requirements given in the drawings approved by CCS.

Section 4 FORGINGS FOR CRANKSHAFTS

5.4.7 Non-destructive examination

5.4.7.1 Non-destructive examination ~~Magnetic particle testing~~ is to be carried out on ~~all machined surfaces of~~ the crankshaft forgings of diesel engines required to be subject to non-destructive examination in Section 2, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships in accordance with the requirements of 5.1.6 of this Chapter, and particular attention is to be given to the following positions during magnetic particle testing:

(1) pins, journals and associated fillet radii of solid forged crankshafts;

(2) pins and fillet radii of combined web and pin forgings.

5.4.7.2 The non-destructive examination for other forgings for crankshafts may be carried out in accordance with the requirements given in the drawings approved by CCS~~ All forgings for crankshafts with crankpin diameter not less than 150 mm are to be ultrasonically tested~~.

PART THREE WELDING

CHAPTER 4 QUALIFICATION TESTS OF WELDERS

Section 1 GENERAL PROVISIONS

4.1.1 **Application**

4.1.1.1 The requirements of this Chapter apply to the qualification tests of welders intended to be engaged in the fusion welding ~~involved in~~ ~~manual~~ (including shielded metal arc welding, semi-automatic welding and TIG welding) of ship structures, offshore structures, machinery, boilers and pressure vessels as well as piping with carbon steels, carbon-manganese steels, alloy steels or aluminum alloys as the base metal.[Notes]

4.1.1.2 The requirements of this Chapter do not apply to welders engaged in oxy-acetylene welding.

4.1.1.~~2~~3 For base metals, welding consumables and welding processes other than those specified in this Chapter, the requirements for the qualification tests of welders are to be submitted to CCS for approval.

4.1.1.~~3~~4 The method of qualification tests of welders engaged in special product welding is to be specially considered by CCS.

4.1.1.5 The welding operator responsible for setting up and/or adjustment of fully mechanized and automatic equipment, such as submerged arc welding, gravity welding, electro-gas welding and MAG welding with auto-carriage, etc., must be qualified whether he operates the equipment or not. However a welding operator, who solely operates the equipment without responsibility for setting up and/or adjustment, does not need qualification provided that he has experience of the specific welding work concerned and the production welds made by the operators are of the required quality.

For the qualification test and approval range of the welding operator, refer to ISO 14732.

4.1.2 General requirements

4.1.2.1 Those welders intended to be engaged in welding specified in 4.1.1.1 above in shipyards and manufacturers are to be tested and qualified in accordance with the requirements of this Chapter and issued with a qualification certificate endorsed by CCS.

4.1.2.~~3~~2 The requirements of this Chapter are applicable to welding of hull structures both during new construction and the repair of ships.

4.1.2.~~4~~3 The training of welders, control of their qualification and maintenance of their skills are

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Notes: ① The requirements of this Chapter apply to applications for welder or welding operator qualification (initial or renewal) dated on or after 1 January 2018.

② The requirements of this Chapter do not invalidate welder's qualifications issued and accepted by CCS before 1 January 2018. These qualifications are to be renewed in accordance with the requirements of this Chapter latest by 31 December 2020.

③ Certificates that expire after 1 January 2018 are to be renewed in accordance with the requirements of this Chapter.

④ The welder's or welding operator's qualifications which have not been required before 1 January 2018, are to be initially issued in accordance with the requirements of this Chapter by the 31 December 2020 at the latest.

the responsibility of shipyards and manufacturers. The Surveyor is to verify and be satisfied that the welders are appropriately qualified.

4.1.2.~~5~~4 Welders or welding operators qualified in accordance with national or international welder qualification standards may also be engaged in welding of hull structures and relevant products at the discretion of CCS provided that the qualification testing, range of approval and revalidation requirements are considered equivalent to the requirements of this Chapter.

~~4.1.2 **Qualification Test Committee**~~

4.1.2.~~1~~5 A Qualification Test Committee may be individually or jointly set up by manufacturers/training providers concerned to take the responsibilities for carrying out the qualification tests in compliance with the requirements of this Chapter.

~~4.1.2.2~~ The Qualification Test Committee, which is to be approved by CCS, is in general to consist of a technical manager, welding engineers or technicians, welding quality inspectors, and experienced welders of the manufacturer.

4.1.3 Requirements for test applicants

4.1.3.1 Applicants satisfying one of the following requirements may submit an application to the Qualification Test Committee and take part in the tests upon approval:

(1) holding a graduation certificate of welder training of a technical school and being engaged in welding work;

(2) being capable of welding independently with adequate skill and being engaged in welding work;

(3) having been trained in basic knowledge and operational skill;

(4) additionally for applicants for qualification tests of underwater welders: holding a valid diver's certificate or a graduation certificate of a diving school and possessing a certain skill in underwater welding~~, or being a diver trained in underwater welding and approved by the Qualification Test Committee~~.

~~4.1.3.2 The requirements for welders applying for upgrading are as follows:~~

~~(1) In general, the applicant is to take part in the tests grade by grade. In special cases, if agreed by the Qualification Test Committee and approved by the attending Surveyor, the applicant may apply for the test of an appropriate grade according to his/her actual working range and operational skill.~~

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

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

~~4.1.3.3 Applicants engaged in welding are to apply for the tests of an appropriate category according to the requirements specified in this Chapter. Corresponding qualification certificates will be issued by CCS to those who have passed the tests.~~

4.1.4 Categorization of ~~welder's qualification grades and~~ qualification test items

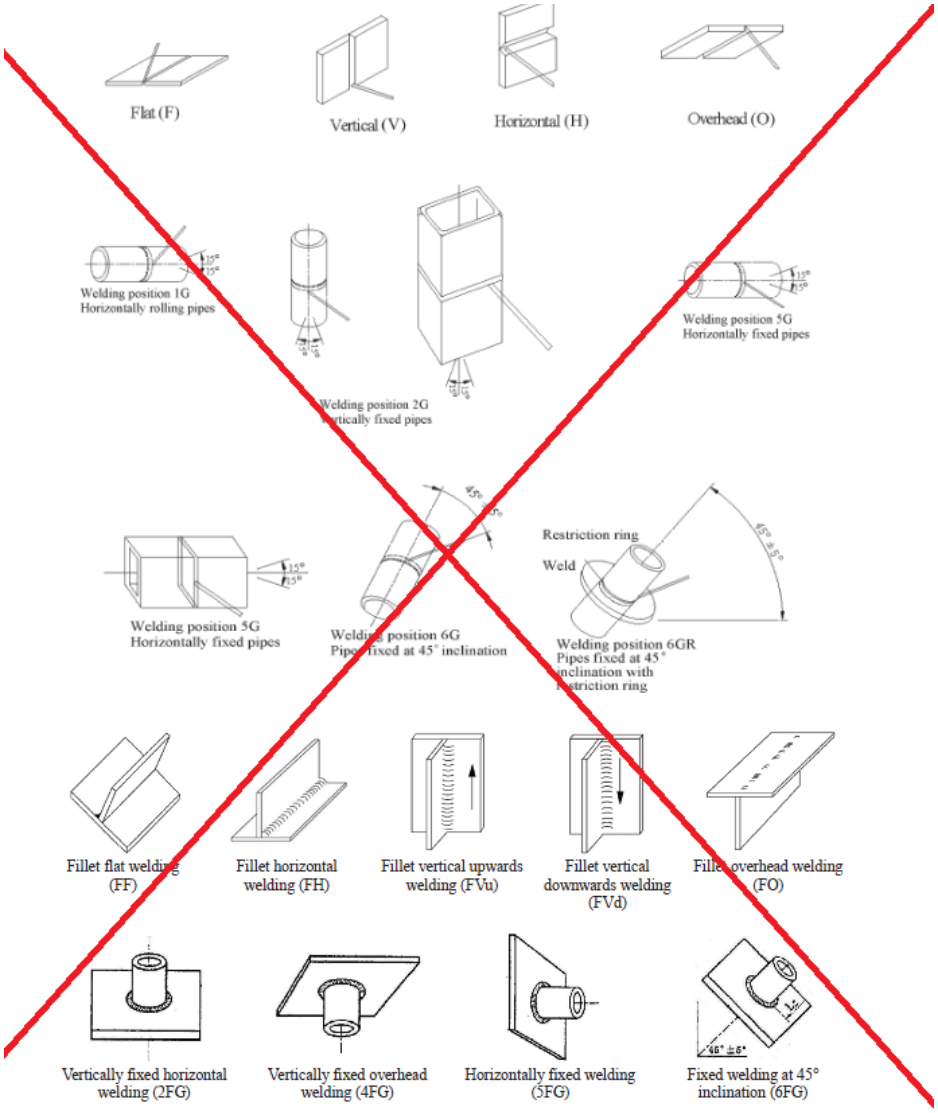
4.1.4.1 According to types of products, welders are categorized as those qualified for the welding of ships and offshore structures (S) and those qualified for the welding of marine boilers and pressure vessels (B). ~~And according to different welding positions, the qualification grades of welders are categorized as Grades I, II and III for the welding of plates and Grades I_P, II_P, III_P and III_{PR} for the welding of pipes. Grade T means underwater wet tack welding.~~

~~4.1.4.2 The welding positions expressed by the codes of test items for different types of test assemblies are shown in Table 4.1.4.2 and Figure 4.1.4.2.~~

~~4.1.4.3 The test items corresponding to different welder grades are shown in Table 4.1.4.3.~~

4.1.4.~~4~~2 ~~For special needs, fillet weld tests may be carried out according to the actual welding position of the product.~~ Welders may choose to have butt weld and/or fillet weld tests according to their actual needs.

4.1.4.~~5~~3 For welders engaged in the welding of marine boilers and pressure vessels, special tests of tube-to-plate fillet welding are to be carried out when necessary.



~~Figure 4.1.4.2 Welding Positions~~

Test Items for Different Qualification Grades of Welders **Table 4.1.4.3**

Type of assembly	Grade of welder①	General test items for qualification of welders	Test items for qualification of underwater welders
Butt welding of plates	I	F	F
	II	H, V	H, V
	III	H, V, O	O
Butt welding of pipes	I_p	1G	2G
	II_p	2G or 5G	5G
	III_p	2G + 5G or 6G	6G
	III_{pR}	6GR	–
Underwater wet tack welding	T	–	F, H, V

Note: ①Qualification grades of welders for different product types are distinguished by letters: "S" for welders engaged in welding of ships and offshore structures, "B" for welders engaged in welding of marine boilers and pressure vessels.

4.1.5 Re-tests and new tests

4.1.5.1 Where the result of any bend or macro specimen is unacceptable in one test item, duplicate specimens for the unsatisfactory item are to be prepared for re-tests. If the results of re-tests are all satisfactory, the test item is considered passed.

4.1.5.2 Where any of the following occurs in one test item, the test item is considered failed and re-tests are not allowed:

(1) visual examination is not satisfactory;

(2) radiographic inspection or 2 bend specimens of any butt weld are not satisfactory;

(3) fracture test or 2 macro specimens of any fillet weld are not satisfactory.

4.1.5.3 Supplementary tests for the failed test item are allowed within a month. The test item is considered passed if the results of all supplementary tests are satisfactory.

4.1.5.4 New tests are allowed only a month later for welders who have failed in all test items. The Qualification Certificate of Welder is to be issued only when all test items are passed. If a welder fails again in the new tests, further tests are not allowed unless the welder is retrained.

4.1.5.5 If the test failure is caused by a poor-machined specimen or any defect resulted not from welding, the specimen is to be discarded and a replacement assembly is to be prepared for testing.

4.1.5.1 When a welder fails a qualification test, the following is to apply.

(1) In cases where the welder fails to meet the requirements in part of the tests, a retest may be welded immediately, consisting of another test assembly of each type of welded joint and position that the welder failed. In this case, the test is to be done for duplicate test specimens of each failed test. All retest specimens are to meet all of the specified requirements.

(2) In cases where the welder fails to meet the requirements in all parts of the required tests or in the retest prescribed in 4.1.5.1(1), the welder is to undertake further training and practice.

4.1.5.2 When there is specific reason to question the welder's ability or the period of effectiveness has lapsed, the welder is to be re-qualified in accordance with the tests specified in Section 2 of this Chapter.

4.1.5.3 Where any test specimen does not comply with dimensional specifications due to poor machining, a replacement test assembly is to be welded and tested.

4.1.6 Certificates

4.1.6.1 ~~For welders who have satisfactorily passed a qualification test, a Qualification Certificate of Welder is to be issued by CCS. The welders are to strictly observe the certified range of work as specified in the Certificate.~~ Qualification certificates are normally issued when the welder has passed the qualification test by CCS. Each Shipyard and Manufacturer are to be responsible for the control of the validity of the certificate and the range of the approval.

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

~~(1) personal information (name, ID number and photograph) of the welder;~~

~~(2) name of the work unit where the welder serves;~~

~~(3) range of qualification for welding processes, joint types, material and size of base metals, and welding positions as well as water depth for underwater welding;~~

~~(4) expiry date of the certificate;~~

~~(5) record of six months' supervision by the manufacturer;~~

~~(6) record of extension approved by CCS of the period of validity of the certificate.~~

(1) Range of qualification for base metal, welding processes, filler metal type, types of welded joint, plate thicknesses (wall thickness and pipe diameter for pipes) and welding positions as well as water depth (for underwater welding only).

(2) Expiry date of the validity of the qualification.

(3) Name, date of birth, identification and the photograph of the welder.

(4) Name of shipbuilder / manufacturer.

4.1.6.3 ~~The Surveyor has the right to check the Qualification Certificate of Welder whenever the welders are engaged in welding.~~ When a certificate is issued, the relative documents such as test reports and/or revalidation records are to be archived as annexes to the copy of certificate.

4.1.6.4 ~~Each manufacturer is to control the application and validity of the certificate.~~ The status of approvals of each individual qualification is to be demonstrated to CCS when requested.

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.~~ Normally the validity of the welder's approval begins from the issue date of qualification certificate when all the required tests are satisfactorily completed.

4.1.7.2 ~~Except that the Qualification Certificate of Welder for tack welding is valid for an unlimited period, the Qualification Certificate of Welder for various grades 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:~~The certificate is to be signed at six-month intervals by the shipyards/manufacturers personnel who is responsible for production weld quality (e.g. personnel in charge of the quality inspection department) provided that all the following conditions are 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/or knowledge.

4.1.7.3 If any of these conditions are not fulfilled, CCS is to be informed and the certificate is to be cancelled.

The validity of the certificate may be maintained in agreement with CCS if the maintenance scheme of qualification is in accordance with either one of 4.1.7.4.

4.1.7.4 Except that the Qualification Certificate of Welder for tact welding is valid for an unlimited period, revalidation is to be carried out by CCS for the Qualification Certificate of all welders. The skill of the welder is to be periodically verified by one of the following:

(1) The welder is to be tested every 3 years.

(2) Every 2 years, two welds made during the last 6 months of the 2 years validity period are to be tested by radiographic or ultrasonic testing or destructive testing and are to be recorded. The weld tested are to reproduce the initial test conditions except for the thickness. These tests revalidate the welder's qualifications for an additional 2 years.

4.1.7.5 CCS has to verify compliance with the above conditions and sign the maintenance of the welder’s qualification certificate.

~~4.1.7.3 If a welder (or tack welder) has not been engaged in welding for 6 consecutive months, he is, prior to being re-engaged in welding, 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 upon satisfactory results of the test.~~

~~4.1.7.4 Prior to the expiry date of the Certificate, welders are to take new tests especially for operational skill. With satisfactory results of the new tests, the period of validity of the Certificate may be extended for another 3 years.~~

~~4.1.7.5 If a welder has been proved to be consistently good in welding quality (i.e. more than 90% of his welding products have been found satisfactory by non-destructive testing) within the period of validity of the Certificate and possesses a record of such welding quality which has been checked by the Surveyor, the period of validity of the Certificate may be extended for one year without new tests, subject to his nomination by the Qualification Test Committee and the approval by CCS.~~

Section 2 QUALIFICATION TESTS AND EVALUATION OF WELDERS

4.2.1 General requirements

4.2.1.1 Welding of the test assemblies and testing of test specimens are to be witnessed by the Surveyor. ~~The qualification tests of welders consist of a basic knowledge test and an operational skill test. An applicant is qualified to take the operational skill test only after he has successfully passed the basic knowledge test. Both the test of basic knowledge and that of operational skill are to be carried out under the supervision of the Surveyor.~~

~~4.2.1.2 The basic knowledge test is to correspond to the welding processes to be applied for the operational skill test and may include the basic knowledge of normal base metals, welding consumables, welding equipment, welding procedures, common types of welding defects, prevention and repair of defects as well as safety of welding. Test questions are to be determined by CCS.~~

4.2.1.~~3~~2 Prior to the ~~operational skill~~ welder qualification test, the Qualification Test Committee is to submit the intended ~~qualification grades of welders~~ welding positions, material groups, thicknesses of test assemblies (pipe diameters), joint types and edge preparation dimensions to

CCS for confirmation.

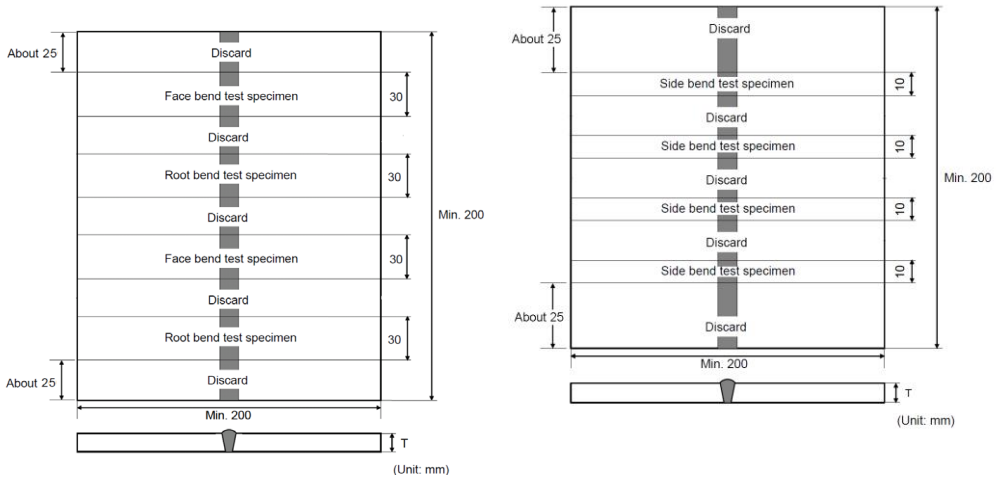
4.2.1.43 For the test of ~~operational skill~~ welder qualification, on-site record of the test is to be made by the person in charge of the test and confirmed by the Surveyor. The Test Committee is to complete a summary table of test evaluation and submit it to CCS.

4.2.1.54 The plates, pipes and welding consumables for the tests are to comply with the relevant requirements specified in ~~PART ONE and Chapter 2 of this PART~~ 4.2.3 of this Chapter. ~~Typical materials are to be selected for the tests.~~

~~4.2.1.6 For tack welding, one pair of test plates is to be welded for each position on which the welder will be engaged.~~

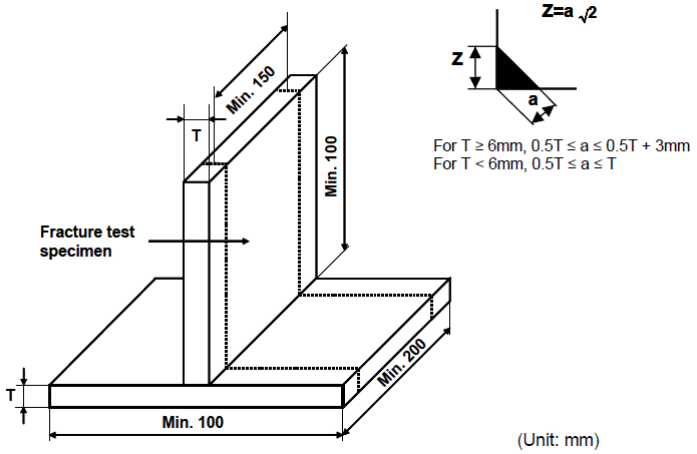
4.2.2 Type and dimensions of test assemblies

4.2.2.1 Dimensions for butt and fillet welds in plates, butt welds in pipes and pipe-to-plate fillet welds are shown in Figures 4.32.2.1(a), (b), (c) and (d) respectively.

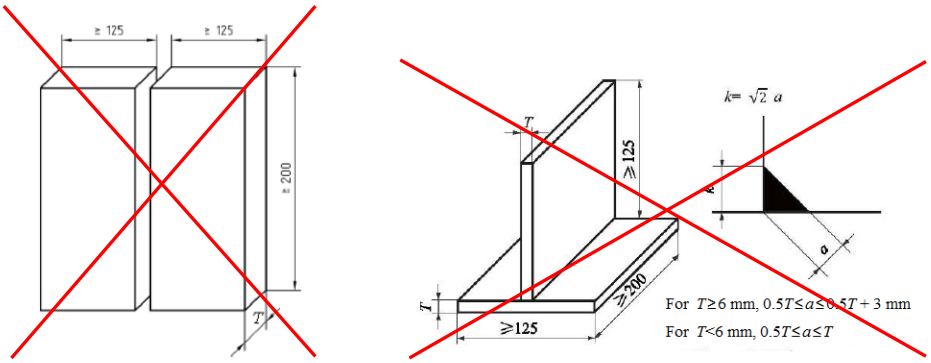


T<12 mm T≥12 mm

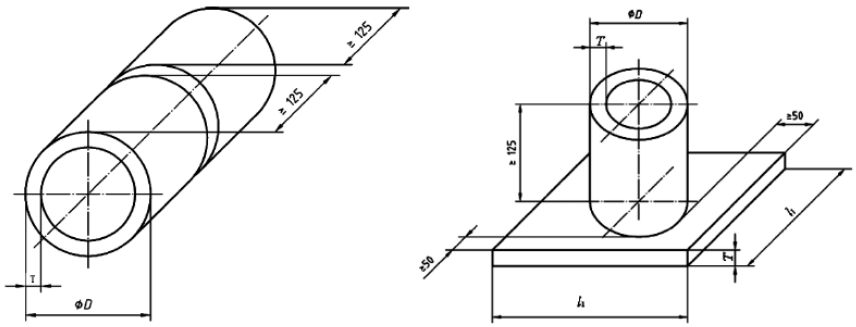
(a) Butt welds



(b) Fillet welds



(a) Butt welds in plates (b) Fillet welds in plates



(c) Butt welds in pipes (d) Pipe-to-plate fillet welds (insertion)

Figure 4.2.2.1 Dimensions of Test Assemblies

4.2.2.2 For butt welds in pipes, a minimum examination length of 150 mm is required. If the circumference of pipes is less than 150 mm, additional test assemblies are to be required.

4.2.2.3 Specific types of butt welded joints (both sides, one side, with or without backing) and dimensions of edge preparation (included angle, root face, gap) may be determined by the manufacturer according to the actual production.

4.2.2.4 Special requirements for dimensions of the butt welded pipe assembly in the 6GR position are shown in Figure 4.2.2.4.

4.2.2.5 Insertion is to be adopted for pipe-to-plate fillet welds, and the type of joint is shown in Figure 4.2.2.5.

4.2.2.6 Fillet welding is to be adopted for plates, and the throat thickness is shown in Figure 4.2.2.1(b).

4.2.2.7 ~~Dimensions and tacking requirements of tack welding are shown in Figure 4.2.2.7.~~ Dimensions of test assemblies for tack butt welds and tack fillet welds are shown in Figures 4.2.2.7(a) and (b) respectively.

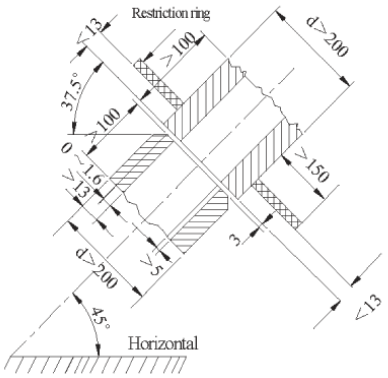


Figure 4.2.2.4
Dimensions of butt welded pipe assembly in the 6GR position

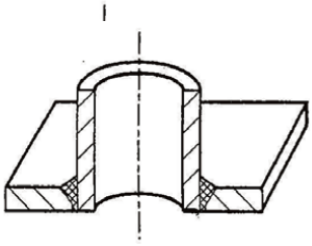
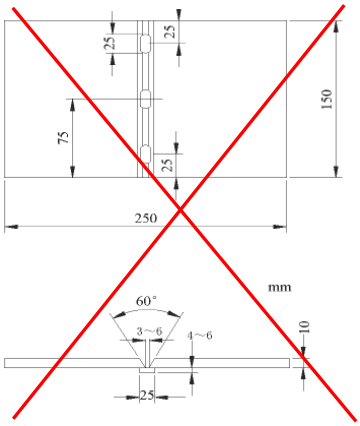
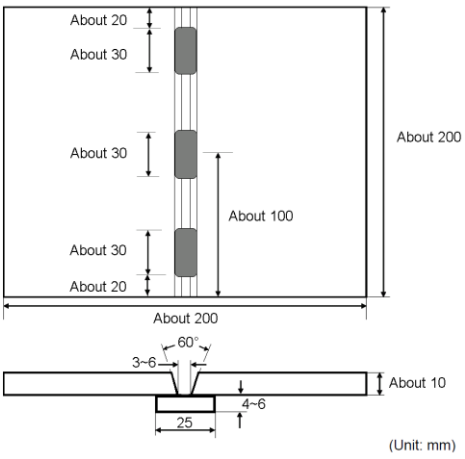
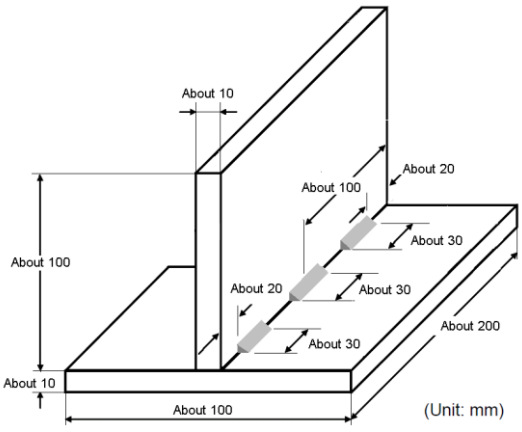


Figure 4.2.2.5
Pipe-to-plate fillet welds



~~**Figure 4.2.2.7**~~
~~**Dimensions and tacking requirements for tack welding**~~





(a) Tack butt welds **(b) Tack fillet welds**

Figure 4.2.2.7 Dimensions of test assemblies for tack butt welds and tack fillet welds

4.2.3 Preparation of test assemblies

4.2.3.1 Testing materials are to comply with the relevant provisions of PART ONE of the Rules. Hull structural steels are to conform to one of the following requirements or to be of equivalent grade approved by CCS:

(1) Hull structural steels specified in Sections 2 and 3, Chapter 3, PART ONE of the Rules;

(2) Hull structural forged steels specified in Section 2, Chapter 5, PART ONE of the Rules;

(3) Hull structural cast steels specified in Section 2, Chapter 6, PART ONE of the Rules;

(4) Hull structural steels with specified minimum yield point 460 N/mm^2 specified in CCS Guidelines for Inspection of Thick Higher Strength Steel Plates for Ships.

4.2.3.2 Welding consumables are to match testing materials in performance. Welding consumables for hull structural steels are to conform to one of the following requirements:

(1) Consumables for hull structural steels specified in Sections 1 to 7, Chapter 2 of this PART;

(2) Consumables for H47 steels specified in CCS Guidelines for Inspection of Thick Higher Strength Steel Plates for Ships.

4.2.3.~~1~~3 The welder qualification test assembly is to be edge prepared, joined, cleaned prior to

welding and welded according to a welding procedure specification (WPS or pWPS) simulating the conditions in production, as far as practicable. ~~The test assembly is to be welded according to the welding procedure used for products. Welding parameters are to comply with the requirements of WPS.~~

~~4.2.3.2 Edge preparation, joining and cleaning prior to welding are to be carried out as required.~~

4.2.3.~~3~~4 Each test assembly is to be stamped with the identification number of the welder and the mark of the welding position, and the stamps are to be kept throughout the test. Welding positions for pipes fixed horizontally or at 45° inclination to the horizon are to be expressed by clock hours.

~~4.2.3.4 Run-on and run-off tabs are not to be fitted on the ends of the groove.~~

4.2.3.5 Once welding is started, the welding position of the test assembly is not to be changed or altered. The welding direction is to be kept consistent throughout the operation.

4.2.3.6 Root run and capping run need each to have a minimum of one stop and restart. The welders are allowed to remove minor imperfections only in the stop by grinding before restart welding. ~~The test assemblies are to have at least one stop and one re-start in the capping run. For the test of one-side welding with back formation, one stop and one re-start are to be additionally available in the root run.~~

~~4.2.3.7 For materials or procedures requiring preheating, postheating or heat input control, the welding conditions are to be the same as those required for products (post-weld heat treatment or ageing may be omitted unless bend tests are required).~~

4.2.3.~~8~~7 On completion of welding, there is to be no grinding or repairs on the surface of the weld.

4.2.4 Test or inspection

4.2.4.1 Test or inspection items ~~and required specimens~~ for different types of test assemblies are shown in Table 4.2.4.1.

Test and Inspection Items Table 4.2.4.1

Type of assembly	Test or inspection items④
Butt welding of plates	1. Visual inspection 2. Bend test①②
Butt welding of pipes	1. Visual inspection 2. Bend test①②
Fillet welding of plates	1. Visual inspection 2. Fracture test or macro examination③
Pipe-to-plate fillet welds	1. Visual inspection 2. Macro examination
Tack welding	1. Visual inspection 2. Fracture test

Notes: ① Radiographic test or fracture test may be carried out in lieu of bend test except the gas-shielded welding processes with solid wire or metal cored wire and aluminum alloy welding.

② Radiographic inspection + bend test for welders engaged in welding of marine boilers and pressure vessels.

③ Two macro sections may be taken in lieu of the fracture test.

④ Additional tests may be required, at the discretion of CCS.

~~Test or Inspection Items and Required Specimens~~ **~~Table 4.2.4.1~~**

~~Type of assembly~~	~~Test or inspection items~~	~~Required specimens~~
~~Butt welding of plates~~	~~1. Visual inspection~~ ~~2. Bend test and/or radiographic inspection①②~~	~~Visual inspection: weld length~~ ~~Radiographic inspection: examination length of weld③~~ ~~Bend: one for face bend test and one for root bend test④~~
~~Butt welding of pipes~~	~~1. Visual inspection~~ ~~2. Bend test and/or radiographic inspection①②~~	~~Visual inspection and radiographic inspection: weld length~~ ~~Bend: one for face bend test and one for root bend test④ at 1G and 2G;~~ ~~two for face bend test and two for root bend test④ at 5G, 6G and 6GR~~
~~Fillet welding of plates~~	~~1. Visual inspection~~ ~~2. Fracture test or macro examination~~	~~Visual inspection: weld length~~ ~~Fracture: examination length of weld③~~ ~~Macro: two~~
~~Pipe-to-plate fillet welds~~	~~1. Visual inspection~~ ~~2. Macro examination~~	~~Visual inspection: weld length~~ ~~Macro: two~~
~~Tack welding~~	~~1. Visual inspection~~ ~~2. Bend test~~	~~Visual inspection: all welding points~~ ~~Bend: the specimen is bent with backing strap in place and with face of the welds in tension~~

~~Notes: ① Bend test cannot be omitted for solid wire gas-shielded welding (including aluminum alloy).~~

~~② Radiographic inspection + bend test for welders engaged in welding of marine boilers and pressure vessels.~~

~~③ The examination length of weld is the length deducted by 25 mm from both ends of the test assembly respectively.~~

~~④ If the thickness of the test assembly is not less than 12 mm, side bends may be used instead.~~

~~4.2.4.2 For visual inspection, the surface of welds is to be in the as-welded state and no machining is to be made.~~

~~4.2.4.3 For radiographic inspection, the reinforcement of welds and backing may not be removed.~~

~~4.2.4.4 Specimens are generally taken by machining in order not to affect the properties of the material. 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.~~

~~4.2.4.5 For bend test, the reinforcement of welds 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 Figures 4.2.4.5(a) and (b). The dimensions of and requirements for specimens are shown in Figures 1.2.3.3 and 1.2.3.4 of Chapter 1 of this PART.~~

~~4.2.4.6 For pipe-to-plate fillet welds, the test assembly is to be cut by mechanical means into four equal parts as shown in Figure 4.2.4.6, from which two parts are to be selected for macro-examination of sections A and B (B being the stop/start location).~~

~~4.2.4.7 For the fracture test of fillet welds in plates, the test method is given in 1.2.4.4 of Chapter 1 of this PART.~~

~~4.2.4.8 For the macro examination of fillet welds in plates, one of the macro sections is to be taken at the stop/start location.~~

~~4.2.5 Evaluation of test assemblies~~

4.2.4.2 The welds are to be visually examined prior to the cutting of the test specimen for the bend test and fracture test. Visual examination is to comply with the following requirements:

(1) The surface of welds is to be in the as-welded state and no machining is to be made. The result of the examination is to show the absence of cracks or other serious imperfections.

(2) Imperfections detected for steel and aluminum alloy welds are to be assessed respectively in accordance with the requirements for level B of ISO 5817 and ISO 10042 (excess weld metal, excess penetration, excessive convexity and excessive throat thickness for which level C applies), and the acceptance standards for main items are given in Table 4.2.4.2.

~~4.2.5.1 The visual inspection of steel and aluminum alloy welds is to be respectively in accordance with the requirements for level B of ISO 5817 and ISO 10042 (excess weld metal, excessive convexity and excess penetration for which level C applies), and the acceptance standards for main items are given in Table 4.2.5.1.~~

Acceptance Standards for Visual Inspection of Welds Table 4.2.5~~4~~.12

Name of defect	Acceptance standards	
	Steel	Aluminum alloy
Crack	Not allowed	Not allowed
Lack of fusion	Not allowed	Not allowed
Root with incomplete penetration	Not allowed	Not allowed
Surface overlap	Not allowed	Not allowed
Surface pore	Not allowed	Concentrated pore and chain pore are not allowed; uniformly distributed porosity rate ≤0.5%, single pore diameter ≤0.2t①, maximum 1 mm
Local root depression	Depth ≤0.05t①, maximum 0.5 mm	Depth ≤0.05t①, maximum 0.5 mm
Undercut	Depth ≤0.05t①, maximum 0.5 mm	Depth≤0.1t①, maximum 0.5 mm (continuous undercuts are not allowed)
Excess weld metal (butt weld)	Height ≤1+0.15b②, maximum 7.0 mm	Height ≤1+0.15b②, maximum 8.0 mm
Excessive convexity (fillet weld)	Height ≤1+0.15b②, maximum 4.0 mm	Height ≤1.5+0.15b②, maximum 4.0 mm
Excess penetration	Height ≤1+0.6b②, maximum 4.0 mm	Height ≤4.0 mm
Excessive throat thickness	Height ≤1+0.2a③, maximum 4.0 mm	--
Insufficient throat thickness	Not allowed	Height ≤0.1a③
Unsymmetrical fillet weld leg	Difference of weld leg length ≤1.5+0.15a③	Difference of weld leg length≤1.5+0.2a③

Notes: ① t—plate thickness for butt weld and throat thickness for fillet weld, in mm;

② b—corresponding weld breadth (root weld breadth for excess penetration), in mm;

③ a—throat thickness, in mm.

4.2.5~~4~~.2~~3~~ The bend test for butt welding is to comply with the following requirements:

(1) See Figures 1.2.3.3 and 1.2.3.4, Chapter 1 of this PART for the dimensions of and requirements for transverse bend test specimens.

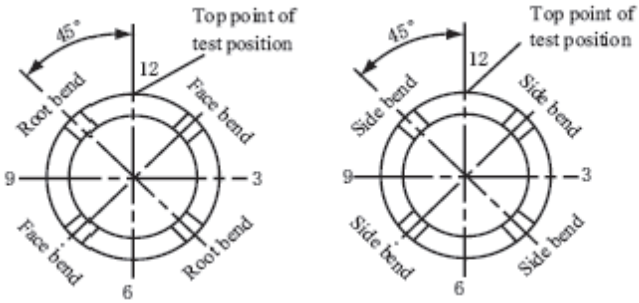
(~~1~~2) The diameter of the former ~~and the angle of bend are~~ is to comply with the requirements for welding procedure approval tests in 1.2.4.2 of Chapter 1 of this PART.

(3) For butt weld joints of plates，two face bend test and two root bend test specimens are to be tested for initial qualification test, and one face and one root bend test specimens for extension of approval. For thickness 12 mm and over, four side specimens (two side specimens for extension of approval) with 10 mm in thickness may be tested as an alternative. See Figure 4.2.2.1(a) of this Section for the sampling location of the bend specimen for initial qualification test.

(4) For butt weld joints of pipes, the requirements of test positions at 1G and 2G are the same as those specified in (3) above, however, regardless of initial qualification test or retest, four bend tests are to be carried out for the welders at 5G, 6G and 6GR. The sampling positions for bend specimen are shown in Fig. 4.2.4.3(a) and (b).

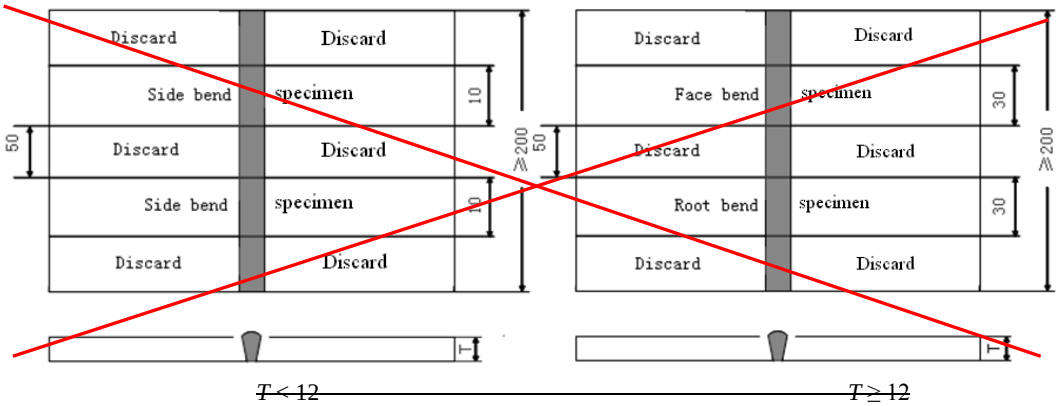
(5) At least one bend test specimen is to include one stop and restart in the bending part, for root run or for cap run.

(~~2~~6) The test specimens are to be bent through 180 degrees. After the test, 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. ~~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.~~



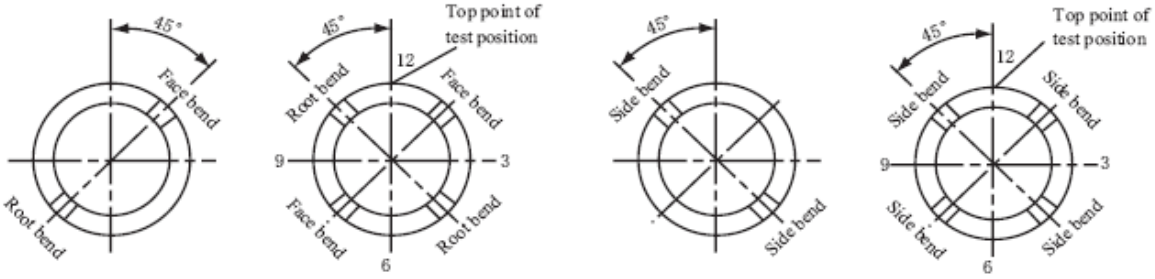
$T < 12$ $T \geq 12$

Figure 4.2.4.3(a) Sampling Position of Bend Test Specimen for Butt Weld Joints of Pipes (Initial Qualification Test)



~~$T < 12$~~ ~~$T \geq 12$~~

~~(a) Test assembly of plates~~



1G, 2G (T < 12) 5G, 6G, 6GR (T < 12) 1G, 2G ($T \geq 12$) 5G, 6G, 6GR ($T \geq 12$)

~~(b) Test assembly of pipes~~

Figure 4.2.4.~~5~~3(b) Sampling Positions of Bend Test Specimens for Butt Weld Joints of Pipes (Re-qualification Test)

4.2.~~5~~4.~~3~~4 For steels and aluminum alloys, when radiographic testing is used for butt welds, imperfections detected are to be assessed in accordance with ~~the results of the radiographic examination of butt welds are to comply with the requirements for~~ level B of ISO 5817 and ISO 10042 respectively ~~or other equivalent standards~~.

4.2.4.5 When fracture test is used for butt welds, full test specimen in length is to be tested in accordance with ISO 9017. Imperfections detected for steel and aluminum alloy welds are to be assessed in accordance with level B of ISO 5817 and ISO10042 respectively.

4.2.~~5~~4.~~4~~6 When fracture test is used for butt welds, the test method is to be in accordance with 1.2.4.4, Chapter 1 of this PART. Evaluation is to concentrate on cracks, porosity and pores, inclusions, lack of fusion and incomplete penetration. Imperfections detected are to be assessed in accordance with ~~The fractured surfaces of fracture test specimens (for fillet welds in plates) are to show welds without cracks and lack of fusion, with slag inclusions and pores complying with the requirements for~~ level B of ISO 5817 ~~or~~ and ISO 10042 respectively ~~or other equivalent standards~~.

4.2.~~5~~4.~~5~~7 When macro examination is used for fillet welds, two test specimens are to be prepared from different cutting positions; at least one macro examination specimen is to be cut at the position of one stop and restart in either root run or cap run. Prepare the specimens according to 1.2.3.7, Chapter 1 of this PART. These specimens are to be etched on one side to clearly reveal the weld metal, fusion line, root penetration and the heat affected zone. Macro sections are to include at least 10mm of unaffected base metal. The examination is to reveal a regular weld profile, through fusion between adjacent layers of weld and base metal, sufficient root penetration and the absence of defects such as cracks, lack of fusion etc. ~~The macro examination for fillet welds in plates and pipe-to-plate fillet welds is to reveal a regular weld profile, sufficient root penetration (full root penetration of pipe-to-plate fillet welds) and the absence of defects such as cracks, lack of fusion, etc.~~

4.2.4.~~6~~8 For pipe-to-plate fillet welds, the test assembly is to be cut by mechanical means into four equal parts as shown in Figure 4.2.4.~~6~~8, from which two parts are to be selected for macro-examination of sections A and B (B being the stop/start location). The specimens are to be prepared and etched as per 4.2.4.7. The examination of macro sections is to reveal a regular weld profile, full root penetration and the absence of defects such as cracks, lack of fusion etc.

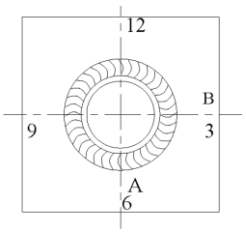


Figure 4.2.4.~~6~~8 Cutting Position of Macro Sections of Pipe-to-Plate Assembly

4.2.~~5~~4.~~6~~9 After ~~bend~~ fracture testing of tack weld specimens, weld fractures throughout the length of each tack are to show neither lack of fusion on the backing strap or both sides of the groove nor slag inclusions or pores exceeding 2 mm.

Section 3 SCOPE OF APPLICATION OF WELDER'S QUALIFICATION

4.3.1 General requirements

4.3.1.1 A welder is to be qualified in relation to the following variables of welding: ~~The welder's qualification approval applies to not only items with the same welding conditions, but also items of which the essential variables are within the specified range. The essential variables include~~ welding process~~es~~, joint type~~s~~, ~~properties and specifications of~~ base metal~~s~~, plate thickness (wall thickness and pipe diameter for pipes), welding consumable~~s~~ type and welding position~~s~~.

4.3.1.2 ~~A grade of qualification for welders engaged in the welding of boilers and pressure vessels covers the same grade of qualification for welders engaged in the welding of ships and offshore structures~~ Welders who passed the qualification test for welding boilers and pressure vessels can be deemed as qualified for welding ships and offshore structures when the welding variables above are same.

~~4.3.1.3 Welders of any grade may be deemed as qualified for tack welding.~~

4.3.2 Welding processes

4.3.2.1 The welding processes for welder's qualification are to be classified in Table 4.3.2.1. Each testing normally qualifies only for one welding process. A change of welding process requires a new qualification test.

Welding processes for welder's qualification Table 4.3.2.1

Symbol	Welding process in actual welding works		ISO 4063
M	Manual welding	Shielded metal arc welding (SMAW)	111
S	Semi-automatic welding/Partly mechanized welding	Metal inert gas (MIG) welding	131
		Metal active gas (MAG) welding	135, 138①
		Flux cored arc (FCA) welding	136②
T	TIG welding	Tungsten inert gas (TIG) welding	141

Notes: Qualification for solid wires, metal cored wires and flux cored wires are as follows:

① A change from MAG welding with solid wires (135) to that with metal cored wires (138), or vice versa is permitted.

② A change from a solid or metal cored wire (135/138) to a flux cored wire (136) or vice versa requires a new welder qualification test.

~~4.3.2.1 The welding processes applicable to welders' qualifications are divided into 3 categories in Table 4.3.2.1. The individual qualifications for welding processes of different categories 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 welding ①~~	~~Group 1~~	~~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~~
	~~Group 2~~	~~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, the welding process of group 2 can cover that of group 1.~~

4.3.2.2 It is permitted for a welder to be qualified for two welding processes, e.g. root run with TIG welding, which are combined by welding a single test piece, applicable to single side welding by root run and double side welding by capping run respectively. The scope of application of thickness is appropriate to the weld thickness.

4.3.3 Types of welds

4.3.3.1 The types of welded joint for welder's qualification are to be classified as shown in Table 4.3.3.1 in accordance with the qualification test.

Types of welded joint for welder's qualification Table 4.3.3.1

Type of welded joint used in the test assembly for the qualification test				**Type of welded joint qualified**
Butt weld	Single sided weld	With backing	A	A, C, F
		Without backing	B	A, B, C, D, F
	Double sided weld	With gouging	C	A, C, F
		Without gouging	D	A, C, D, F
Fillet weld	----	----	F	F

Note: Welders engaged in full/partial penetration T welds are to be qualified for butt welds for the welding process and the position corresponding to the joints to be welded.

~~4.3.3.1The range of qualification for weld details on butt welds is shown in Table 4.3.3.1.~~

~~**Range of Qualification for Weld Details on Butt Welds** **Table 4.3.3.1**~~

~~Type of weld used in the test assembly for the qualification test~~		~~Range of qualification~~			
		~~Single side welding~~		~~Double side welding~~	
		~~With backing~~	~~Without backing~~	~~With gouging~~	~~Without gouging~~
~~Single side welding~~	~~With backing~~	~~*~~	~~–~~	~~×~~	~~–~~
	~~Without backing~~	~~×~~	~~*~~	~~×~~	~~×~~
~~Double side welding~~	~~With gouging~~	~~×~~	~~–~~	~~*~~	~~–~~
	~~Without gouging~~	~~×~~	~~–~~	~~×~~	~~*~~

~~Key: * indicates the weld for which the welder is approved in the qualification test.~~

~~× indicates those welds for which the welder is also qualified.~~

~~indicates those welds for which the welder is not qualified.~~

4.3.3.2 For fillet welding, welders who passed the qualification tests for multi-layer technique welding can be deemed as qualified for single layer technique, but not vice versa.

4.3.3.~~2~~3 Butt welds in pipes greater than 25 mm in outside diameter cover butt welds in plates for appropriate welding positions.

4.3.3.~~3~~4 Butt welds in plates cover butt welds in pipes of not less than 600 mm in outside diameter for appropriate welding positions and pipes of not less than 150 mm in outside diameter for the horizontally rolling welding position.

~~4.3.3.4 Butt welds cover fillet welds (including full penetration fillet welds, partial penetration fillet welds or fillet welds) for appropriate welding positions. Butt welds in plates can only cover fillet welds in plates.~~

~~4.3.3.5 Fillet welds do not cover full penetration fillet welds.~~

4.3.4 Parent material

4.3.4.1 Steels are grouped in Table 4.3.4.1. ~~The welding of any one material in a group confers approval on the welder for the welding of all other materials within the same group.~~ The welding of any one metal in this group covers qualification of the welder or welding operator for the welding of all other metals within this group.

Steel Groups **Table 4.3.4.1**

Material group	Steel type
W01①	Carbon steel/carbon-manganese steel and low-alloy higher tensile steel with yield strength R_{eH} ≤ 390 N/mm^2
W02	CrMo steel and creep-resistant CrMoV steel
W03	Higher tensile steel with yield strength R_{eH} > 390 N/mm^2, and nickel steel with Ni content < 5% ②
W04	Ferritic or martensitic stainless steel with Cr content between 12% and 20%
W05	Nickel steel for low temperature service with Ni content ≥ 5%
W11	Austenitic or duplex stainless steel

Notes: ① Hull structural steels with specified minimum yield point 460 N/mm^2 specified in CCS Guidelines for Inspection of Thick Higher Strength Steel Plates for Ships may be categorized into W01.

② Except for those included in W01.

4.3.4.2 The range of a welder's qualification for parent metals is shown in Table 4.3.4.2.

Range of Welder's Qualification for Parent Metals **Table 4.3.4.2**

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

Notes: ① This Table applies only when parent metal indicated by * and filler metal are in the same group, except for W05.
② 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.

4.3.4.3 The qualification for welding any type of aluminum alloys in the aluminum-magnesium series (5000 series) or the aluminum-silicon-magnesium series (6000 series) cover all aluminum alloys of both series.

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

4.3.5 Welding consumables

4.3.5.1 For manual metal arc welding, qualification tests are required using basic, acid or rutile covered electrodes. ~~For shielded metal arc welding, w~~Welders who have passed the qualification tests for welding with basic electrodes may be deemed as qualified for welding with acid electrodes, but not vice versa. The qualification for welding with cellulose type electrodes does not cover that for welding with other coated electrodes.

~~4.3.5.2 Welders who have passed the qualification tests for gas metal arc welding with solid wires may be deemed as qualified for that with flux-cored wires.~~

4.3.5.~~3~~2 Welders who have passed the qualification tests ~~for argon-shielded tungsten arc welding~~ with filler material~~wire or rod~~ may be deemed as qualified for that without filler material ~~wire or rod~~, but not vice versa.

4.3.6 Thickness and pipe diameter

4.3.6.1 For butt and fillet welds in plates and butt welds in pipes, the qualified thickness range for steel and aluminum alloy is shown in Tables 4.3.6.1(a) and 4.3.6.1(b) respectively.

Qualified Thickness Range for Steel **Table 4.3.6.1(a)**

Thickness of test assembly① T (mm)	Qualified thickness range t (mm)
T ~~<~~≤ 3	$T \le t \le 2T$
3 ~~<~~≤ T ~~≤ 20~~ ≤12	3 ~~<~~≤ $t \le 2T$
T ~~> 20~~ ≥12	t ~~>~~≥ 3

Note: ① For multi-process procedure, T is the thickness of deposited metal for each welding process.

Qualified Thickness Range for Aluminum Alloy **Table 4.3.6.1(b)**

Thickness of test assembly① T (mm)	Qualified thickness range t (mm)
$T \leqslant 6$	$0.5T \leqslant t \leqslant 2T$
$T > 6$	$t \geqslant 6$

Note: ① For multi-process procedure, T is the thickness of deposited metal for each welding process.

4.3.6.2 For butt welds in pipes, the range of qualification for outside pipe diameter is shown in Table 4.3.6.2.

Range of Qualification for Outside Pipe Diameter **Table 4.3.6.2**

Outside pipe diameter of test assembly *D* (mm)	Range of qualification *d* (mm)
$D \leqslant 25$	$D \leqslant d \leqslant 2D$
$D > 25$	$D \geqslant 0.5D$ (25 minimum)

4.3.6.3 The range of qualification for pipe-to-plate fillet welds is as follows:

(1) The qualified range of plate thicknesses is to be in accordance with Tables 4.3.6.1(a) and Table 4.3.6.1(b), regardless of the thickness of pipe wall.

(2) The qualified range of pipe diameters is shown in Table 4.3.6.2.

4.3.7 Welding positions

4.3.7.1 The welding positions qualified as a result of the actual welding position used in a satisfactory welder's qualification test, are shown in Tables 4.3.7.1a, 4.3.7.1b and 4.3.7.1c (Diagrams showing the definitions of weld position used in these Tables are shown in Figure 4.3.7.1 and Table 4,3,7,1d).

A qualification test with fillet welding may be required for welders who are employed to perform fillet welding only. Welders engaged in welding of T joints with partial or full penetration are to be qualified for butt welding.

Qualified welding positions when testing with butt welding of plates **Table 4.3.7.1a**

Qualification Test Position with butt weld of plates	Qualified welding positions in actual welding works	
	Butt welds	Fillet welds
F	F	FF, FH
H	F, H	FF, FH, FHa
Vu	F, Vu	FF, FH, FVu
Vd	Vd	FVd
O	F, H, O	FF, FH, FHa, FO, FOa

Qualified welding positions when testing with fillet welding **Table 4.3.7.1b**

Qualification Test Position with fillet weld	Qualified welding positions in actual welding works
FF	FF
FH	FF, FH
FHa	FF, FH, FHa
FVd	FVd
FVu	FF, FH, FVu
FO	FF, FH, FHa, FO, FOa
FOa	FF, FH, FHa, FO, FOa

Qualified welding positions when testing with butt welding of pipes **Table 4.3.7.1c**

Qualification Test Position with butt weld of pipes	Qualified welding positions in actual welding works			
	Buttt welding of plates①	Butt welding of pipes	Fillet welding of plates①	Pipe-to-plate fillet welding②
1G	F	1G	FF, FH	-
2G	F, H	1G, 2G	FF, FH, FHa	2FG
5G	F, Vu, O	1G, 5G	FF, FH, FVu, FO, FOa	2FG, 4FG, 5FG
2G+5G	F, H, Vu, O	1G, 2G, 5G, 6G	FF, FH, FHa, FVu, FO, FOa	2FG, 4FG, 5FG, 6FG
6G	F, H, Vu, O	1G, 2G, 5G, 6G	FF, FH, FHa, FVu, FO,	2FG, 4FG, 5FG, 6FG

			FOa	
6GR	F, H, Vu, O	1G, 2G, 5G, 6G	FF, FH, FHa, FVu, FO, FOa	2FG, 4FG, 5FG, 6FG

Notes：① Butt weld joints of pipes with an external diameter more than 25 mm only apply to butt weld joint of plates at corresponding position.

② Not applicable to special pipe-to-plate fillet welds (insertion) in boilers and pressure vessels.

~~4.3.7.1 The principle for welding positions is that a higher welder grade covers low welder grades.~~

~~4.3.7.2 The welding positions for fillet welds in respect to welder qualification grades are shown in Table 4.3.7.2.~~

~~Welding positions for fillet welds in respect to welder qualification grades~~ **~~Table 4.3.7.2~~**

~~Grade~~	~~Range of qualification for fillet welding of plates~~	~~Range of qualification for pipe-to-plate fillet welding①~~
~~Ⅰ~~	~~FF、FH~~	~~—~~
~~Ⅱ~~	~~FF、FH、FVu~~	~~—~~
~~Ⅲ~~	~~FF、FH、FVu、FO~~	~~—~~
~~$Ⅰ_p$~~	~~FF、FH~~	~~—~~
~~$Ⅱ_p$~~	~~FF、FH②~~ ~~FF、FH、FVu、FO③~~	~~2FG ②~~ ~~2FG、4FG、5FG ③~~
~~$Ⅲ_p$~~	~~FF、FH、FVu、FO~~	~~2FG、4FG、5FG、6 FG~~
~~$Ⅲ_{pR}$~~	~~FF、FH、FVu、FO~~	~~2FG、4FG、5FG、6 FG~~

~~Note：① Not applicable to pipe-to-plate fillet welds (insertion) in boilers and pressure vessels.~~

~~② For test item 2G.~~

~~③ For test item 5G.~~

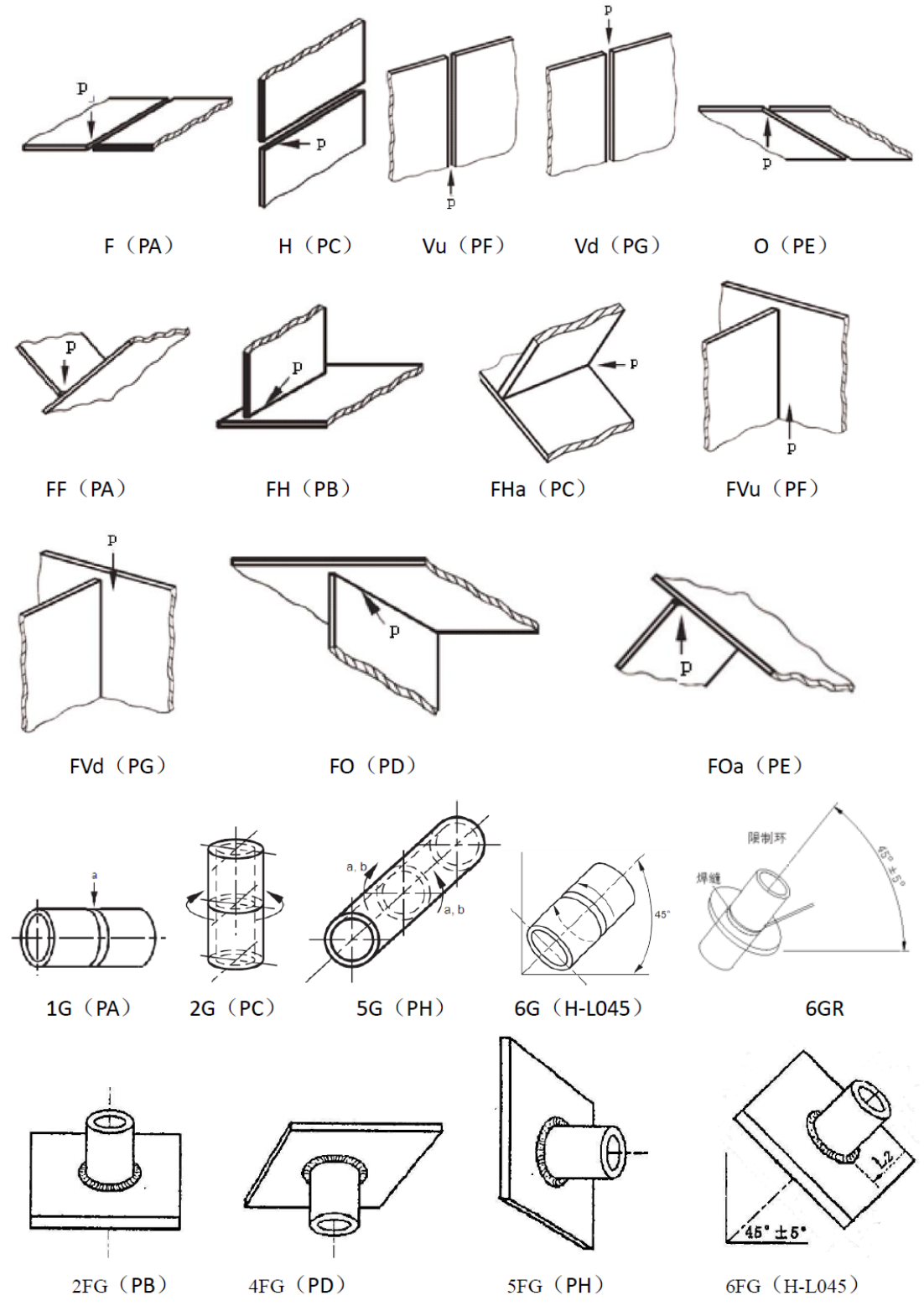


Figure 4.3.7.1 Welding Positions

Code of ~~Test Items~~ Welding Positions **Table4.3.7.1d~~4.1.4.2~~**

Type of assembly	Code of ~~test items (~~welding position~~)~~	Welding positions	ISO6947 corresponding code
Butt welding	F	Flat (downhand) welding	PA

Type of assembly	Code of ~~test items (~~welding position~~)~~	Welding positions	ISO6947 corresponding code
of plates	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	PA
	FH	Fillet horizontal 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

4.3.8 Tact welding

4.3.8.1 A welder qualified for butt or fillet welding according to the requirements of Section 2 of this Chapter can be engaged in tack welding for the welding process and position corresponding to those permitted in his certificate.

Alternatively, welders engaged in tack welding only can be qualified on the test assemblies shown in Figure 4.2.2.7(a) or Figure 4.2.2.7(b).

Section 4 QUALIFICATION TESTS AND EVALUATION OF UNDERWATER WELDERS

4.4.1 Test requirements

4.4.1.1 The qualification tests of underwater welders is to be in accordance with the provisions of this Section. Welding of test assemblies and testing of test specimens are to be witnessed by the Surveyor. ~~consist of a basic knowledge test and an operational skill test. An applicant is qualified to take the operational skill test only after he has successfully passed the basic knowledge test.~~

~~4.4.1.2 The basic knowledge test is in general to include the basic knowledge of normal base metals, welding consumables, welding equipment, welding procedures, common underwater welding defects and underwater inspection technologies, offshore structures as well as safety of underwater welding. The scope of the test is subject to approval by CCS.~~

4.4.1.~~3~~2 Prior to the ~~operational skill~~ qualification test, the Qualification Test Committee is to

submit the intended ~~qualification grades of welders~~ welding positions, material groups, thickness of test assemblies (pipe diameter), joint types and edge preparation dimensions to CCS for confirmation.

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

4.4.1.~~5~~3 The ~~operational skill~~ qualification test of underwater welders 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~~4 Welders who have passed the test of wet welding can only be engaged in wet welding. Welders who have passed the test of local dry welding can only be engaged in local dry welding.

4.4.1.~~7~~5 Welding consumables for the tests are to be suitable for base metals.

4.4.1.~~8~~6 The applicant may select a depth of water at his discretion according to the actual working conditions.

4.4.6 **Application**

4.4.6.4 The range of welding positions are the same as those specified in Table 4.3.7.1a and 4.3.7.1c in this Chapter. ~~The principle for welding positions is that a higher welder grade covers low welder grades. The welding positions for fillet welds in respect to welder qualification grade are shown in Table 4.4.6.4.~~

~~Welding positions for test items of various joint types Table 4.4.6.4~~

~~Welder grade~~	**~~Range of qualification for fillet welding of plates~~**	**~~Range of qualification for pipe-to-plate fillet welding~~**
~~Ⅰ~~	~~PF、FH~~	~~—~~
~~Ⅱ~~	~~PF、FH、FVd~~	~~—~~
~~Ⅲ~~	~~PF、FH、FVd、FO~~	~~—~~
~~$Ⅰ_P$~~	~~PF、FH~~	~~2FG~~
~~$Ⅱ_P$~~	~~PF、FH、FVd、FO~~	~~2FG、4FG、5FG~~
~~$Ⅲ_P$~~	~~PF、FH、FVd、FO~~	~~2FG、4FG、5FG、6FG~~