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W-02

ROLLED STAINLESS STEEL

PLATES

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Foreword

CCS Product Inspection and Testing Guideline (hereinafter referred to as this Guideline) contains the technical requirements, inspection and testing criteria related to classification and statutory survey of marine products to be applied for CCS approval/inspection.

This Guideline frees the users to adopt other test methods and requirements which are equivalent to or are stricter than this Guideline.

This Guideline is published and updated by CCS, and is released at <http://www.ccs.org.cn>. Your comments or suggestions are welcomed and may be sent to our email addressed mp@ccs.org.cn.

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ROLLED STAINLESS STEEL PLATES

1 Application

1.1 This Chapter applies to the works approval and inspection of the rolled stainless steel plates manufactured according to CCS Rules for Materials and Welding.

1.2 This Chapter applies austenitic and duplex (austenitic/ferritic) stainless steel plates which are manufactured by RP electric arc furnace, HP electric arc furnace and direct current furnace, and cast in moulds or made by a continuous casting process, with the delivery condition of solid solution or other heat treatments.

2 Normative references

2.1 Chapters 2 and 3 of PART ONE of CCS Rules for Materials and Welding.

2.2 ASTM A 240/A 240M Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

3 Plans and documents

3.1 A manufacturer intending for approval by CCS is to submit an application to CCS for works approval.

3.2 The applicant is to submit the following documents in triplicate to CCS for information.

3.2.1 Particulars of the manufacturer: the name, address and history of the manufacturer; the type and specification of the products; the type, specification and delivery condition of the products for approval; production equipment, inspection/test equipment, the quality and property statistics of the products for approval; other recognized qualification certificates.

3.2.2 Management documents, including quality system documents: organizational structure, quality control points, responsibilities of management departments / managers, quality management system documents, identification and documentary trail or related descriptions.

For manufactures whose raw materials need to be purchased, the source of the materials is to be stated and listed, and the provisions for control of such purchase and acceptance are to be stated.

3.2.3 Main production, inspection/test equipment

Steel production equipment: hot metal pre-treatment converter, BOF, EAF, AOD, LTS, LF, continuous caster, etc.;

Steel rolling equipment: heating furnace, rough rolling mill, finishing mill, high pressure water descaling box, crop fly shear, laminar cooling equipment, etc.;

Heat treatment and pickling process equipment.

Test equipment: those for chemical composition analysis, mechanical property test, nondestructive test, metallographic examination, intercrystalline corrosion test, pitting test.

3.2.4 Process documents

Flow chart of manufacturing process, control criteria of the manufacturer, technological specifications (operation guidance) in which the following are to be included:

(1) steel-making

information on materials;

parameters of electric furnace;

deoxidation method;

ratio of hot metal and compositions, types of discarded steels;

desulphurization method;

refining methods (ladle furnace, vacuum degassing, etc.);

process temperature control target;

(2) casting

casting method;

size and mass of ingots, size of continuous cast billets;

quality control measures;

tundish temperature and corresponding casting speed control;

use of tundish covering agent and crystallizer protecting slag.

(3) rolling

type of heating furnace, relevant parameters, heating system/curve;

billet/slab heating system;

size of materials used;

rough rolling temperature, finishing temperature;

parameters of roll mill (the power of main motor, maximum rolling force, size of roll, main control means of the roll mill);

measurement of temperature and thickness;

descaling, water pressure;

cooling method and parameters, etc.;

(4) heat treatment

heat treatment process;

type, parameters and size of heat treatment furnace (such as normalizing furnace);

temperature control of the furnace;

heat treatment system;

other necessary parameters;

(5) cooling after heat treatment

cooling system after heat treatment;

cooling equipment;

(6) pickling

pickling medium;

pickling speed;

hot wind temperature, etc.;

(7) information on shearing and straightening equipment;

(8) for hot rolled steel plates, the following are to additionally be submitted:

specification and mass of the maximum and minimum coils;

on-line cooling;

reeling temperature;

information on unreeling, straightening, crosscutting, sampling and marking.

3.2.5 Qualification certificate of the test and inspection personnel.

3.3 The type test program is to be submitted to CCS for approval.

3.4 Other documents where deemed necessary by CCS.

4 Type test

4.1 Determination of the type test program

Prior to works approval, CCS and the applicant are to determine the type test program through negotiation. The program may be proposed by the applicant and examined and approved by CCS, or proposed by CCS and confirmed by the applicant. The program is to include:

- the type, specification and delivery condition of the products for approval;
- the steel grade, specification, number and delivery condition of the typical samples for test approval;
- the test items and the standard, rules or methods adopted;

- place of test and qualification of the laboratory (if applicable, the qualification of the subcontractor and the equipment).

4.2 Selection of typical samples for type test

4.2.1 The principle is to take the products with maximum and minimum thickness for the type test respectively. If the manufacturing, rolling and heat treatment conditions are different, products manufactured by different methods are to be selected respectively for type test.

4.2.2 For stainless steel approval, each designation is to be tested.

4.2.3 For continuous casting, the samples are to be taken for type test from the plate rolled by the top of the first ladle or the bottom of the final ladle in any casting time, or from the top of the first plate and the bottom of the final plate rolled in the first ladle in any casting time.

4.2.4 For mould casting, the samples are to be taken for type test from the corresponding positions of the top and bottom respectively of the maximum ingot.

4.3 Type test items and requirements

4.3.1 Chemical composition analysis

- (1) In addition to the rules requirements, [H] and [O] content is to be added, depending on the designation of stainless steel. The results of C, Si, Mn, P, S, Cr, Ni, Mo, N, V, Cu, Ti, Nb, Als, H, O are to comply with the rules requirements or other standards acceptable to CCS.
- (2) Ladle and finished plate are to be subject to chemical composition analysis respectively.

4.3.2 Tensile test

- (1) The tensile test is to determine the proof strength $R_{p0.2}$ or $R_{p1.0}$, tensile strength R_m and elongation A at the non-proportional elongation being 0.2% or 1.0% of the original gauge length, and graphs or computer records are to be provided.
- (2) The specimens are to be taken in longitudinal and transverse directions respectively for products in the first approval.

4.3.3 Bend test

The bend test specimens are to be of the full thickness of the material, $b=2t$ in width, $d=2t$ in former diameter and bent to an angle of 180°C . The surface is to be free from defects such as crack after test. Bend test is to be carried out longitudinally and transversely respectively.

4.3.4 Charpy V-notch impact test

- (1) Charpy V-notch impact test is to determine the energy. The austenitic stainless steel is to be tested at -20°C and -196°C (may also be tested depending on the designation used and the technical conditions of the purchaser), and the austenitic/ferritic stainless steel at 0°C , -20°C , -40°C and -60°C .
- (2) The impact test specimens are to be taken in longitudinal and transverse directions respectively.
- (3) For materials of thickness less than 40 mm, the impact specimen is to be taken at $1/4t$; for materials of thickness equal to or more than 40 mm, the specimen is to be taken at $1/4t$ and $1/2t$ respectively.
- (4) For materials of thickness less than 10 mm, an equivalent specimen may be adopted for test and then energy value is to be determined.
- (5) The photos of fractures of the austenitic/ferritic stainless steel specimen are to be provided.
- (6) The austenitic/ferritic stainless steel specimen is to be subject to ageing impact test:
 - ① with 5% plastic deformation and for one hour at 250°C ;
 - ② with the temperatures -20°C and -40°C for the test;
 - ③ the test may be carried out only longitudinally.

4.3.5 Sulphur print test

- (1) The selected materials are of the maximum thickness. The sulphur prints are to be taken for half cross section from the center to the side of the materials.
- (2) For finished plates, the sulphur prints are to be taken from the middle with length of 600 mm.

4.3.6 Macrostructure

Macrostructure is to be taken from the materials and finished products. The sampling position is the same as that for sulphur prints.

4.3.7 Metallographic examination

For austenite stainless steel, the metallographic examination ($\times 100$ and 500 magnification) is to be carried out close to the surface and at the mid-wall thickness respectively to measure actual austenite grain size. For duplex stainless steel, the ratio of austenite and ferrite is to be determined.

4.3.8 Non-destructive test

The austenitic stainless steel and the duplex stainless steel are to be subject to ultrasonic testing (UT).

4.3.9 Welding property test

- (1) For stainless steel plates, the plate with maximum thickness is to be selected for welding property test.
- (2) A butt specimen is to be welded with appropriate heat input. The joint is to be of V, double V or K. The weld is to be perpendicular to the direction of rolling.
- (3) The specimens are to be subject to the following tests:
 - ① two transverse tensile tests;
 - ② two transverse bend tests;
 - ③ a set of three impact test specimens perpendicular to the weld. The notches of specimens are to be located at the center of weld, on the fusion line and at 2 mm, 5 mm and 20 mm from fusion line. The fusion line is to be determined by corrosion test. The temperature for impact test is taken as the temperature of the approved plates in delivery condition. Where the thickness is less than 40 mm, the specimen is to be taken at $1/4t$; where the thickness is more than 40 mm, additional specimen is to be taken at $1/2t$;
 - ④ HV or HB hardness distribution test: an HV or HB point is to be measured every 3 mm on the cross section of the weld 2 mm from the upper and lower surfaces of the plates

respectively. Hardness test is to be carried out on the deposited metal, at the heat affected zones of both sides of weld and on the parent metal. The maximum hardness value is to be referred to in accordance with the requirements of ASTM A240/A240M;

- ⑤ intercrystalline corrosion test in heat affected zones: the test is to determine the difference between the heat affected zone and the surface of parent metal with photos.
- ⑥ The welding parameters, such as consumables designation code and diameter, preheating temperature, interposes temperature, heat input value and welding times, are to be submitted to CCS for review. The welding parameters are to be prepared according to actual stipulated welding parameters of stainless steel plates and welding consumables.
- ⑦ The edge preparation, dimension, passes, hardness value and tested joints photos are to be submitted to CCS.

4.3.10 Corrosion test

The austenitic stainless steel is to be subject to intercrystalline corrosion test, while the duplex stainless steel is to be subject to intercrystalline corrosion test and pitting test. The intercrystalline corrosion test is to be in accordance with CCS Rules, and the pitting test is to be in accordance with ASTM A923-03C, with the test condition of 6%FeCl₃, 6H₂O+0.05N HCl, 25°C, 24 h. For designation code of duplex stainless steel not listed in the rules, whether pitting test is to be carried out may be determined according to relevant provisions in standards accepted by CCS.

4.3.11 Dimensional and visual examination

- (1) At least a piece of steel plate is to be selected for measurement of its length, width, thickness, diagonal and irregularities. The thickness is to be measured at not less than 3 points across the width and 5 points along the length. The tolerance of thickness is to comply with the requirements of CCS Rules for Materials and Welding.
- (2) The external quality is to be in compliance with the relevant standards.

4.3.12 Other test items (such as magnetic permeability, tensile test at elevated temperature, etc.) where deemed necessary by CCS.

4.3.13 The preparation of samples and mark transfer are to be in the presence of the Surveyor.

4.3.14 Except for the test items of chemical analysis, tensile, impact, bend, metallographic examination, visual examination and corrosion test, the other items for type test may be optional as the case may be.

5 Unit/batch inspection

5.1 After works approval by CCS, the stainless steel plates as manufactured according to the approved conditions (including equipment, process, etc.) are to be applied by the manufacturer for unit/batch inspection by CCS, which can be used onboard ships only after satisfactory inspection.

5.2 The detailed requirements for unit/batch inspection after approval are to be notified in written form to the works when CCS issues a certificate of works approval.

5.3 The items and requirements for the inspection are as follows:

- (1) confirmation of the process: on-site supervising or review of process record;
- (2) check of the result of chemical analysis: samples from each cast;
- (3) witnessing of mechanical test: samples from each batch or each unit at discretion of CCS (the sampling process is to be witnessed by the Surveyor);
- (4) non-destructive test (if required);
- (5) visual examination;
- (6) other test or inspection items where deemed necessary by CCS.

5.4 After satisfactory inspection of products, CCS Surveyor is to issue a certificate of marine products or endorse the manufacturer's quality certificate.

5.5 The quality certificate is to contain at least following items and to be submitted to CCS for information during works approval:

- (1) name of the purchaser and order number;
- (2) material descriptions and dimension;
- (3) technical specifications and grade of material;

- (4) cast number and chemical composition;
- (5) results of mechanical property test;
- (6) delivery condition;
- (7) CCS description of identifications on products after satisfactory inspection;
- (8) clarifying manufacturer's statement "According to CCS Rules or approval by CCS, accepted acceptance criteria or relevant standards, tests are satisfactory".