Guideline No.: W-21(202601)

W-21

STEEL BILLETS

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Foreword

China Classification Society (hereinafter referred to as 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 service@ccs.org.cn.

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Main changes:

1. Included new clauses 1.3,

2. Removed original clauses7.2.10(4),

3. Clauses 7.2.7 has been revised to included exemptions from sulfur print inspection and the corresponding exemption conditions.

4. The logical relationships among concepts such LF, VD/RH , and secondary refining have been revised, involved correction to clauses 4.3 and 4.5(1),

5. The scope of application for ultrasonic test has been revised, involved updated to clause 7.2.8.

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STEEL BILLETS

1 Application

1.1 This chapter applies to the works approval and unit/batch inspection of steel ingots/billets (including rough rolling and forging billets, with the same requirements hereinafter) used for steel forgings manufactured in compliance with the requirements of CCS Rules for Materials and Welding.

1.2 This chapter is not applicable to the works approval and unit/batch inspection of billets for rolled steel (square billets, rectangular billets, plate billets, steel ingots, etc.) (note: the specification for billets for rolled steel are covered in “marine rolled steel materials” of the Guidelines); for steel ingots/billets for other purposes, such as pipe billets, reference may be made to this chapter; however, such steel ingots/billets are to be made into finished products and type tested in accordance with the requirements of CCS rules/guidelines.

1.3 The ingots/billets used for forgings shall be produced by electric arc furnace (EAC) or converter furnace steelmaking and shall possess secondary refining such as LF, VD/RH etc. CCS does not accept ingots/billets produced via medium-frequency induction furnace for forging applications

1.4 Steel ingots/billets used for steel forgings are to be manufactured by the CCS approved manufactory.

2 Normative references

2.1 Chapter 3, PART ONE of CCS Rules for Classification of Sea-going Steel Ships;

2.2 Chapter 5, PART ONE of CCS Rules for Materials and Welding;

2.3 Relevant national/international standards;

3 Terms and definitions

Nil.

4 Drawings and documents

4.1 The manufacturer intended to be approved by CCS are to submit an application for works approval to CCS.

4.2 The applicant is to submit the following documents in triplicate to CCS:

4.3 Details of products for which approval is being applied

Category of steel billets/ingots, material type (e.g. carbon steel and carbon manganese steel, low alloy steel, stainless steel, etc.), steel making method (converter furnace or electric arc furnace +

secondary refining such as LF, VD/RH etc.), casting method (mold casting, continuous casting, vacuum casting), manufacturing method of rough rolling billets and forging billets (hot rolling or quick forging), cooling method (stress relief annealing, cooling in hole, air cooling etc.), etc.;

4.4 Basic information of the manufacturer

The manufacturer's history and current condition, product types and production scale, production/development history of the products to be approved as requested, registered trademark, information on inspection/certification by other inspection/certification organizations;

4.5 List of main production equipment including the main parameters of the following equipment (the capacity should be listed):

(1) Equipment for steel making, secondary refining, vacuum degassing treatment and secondary refining;

(2) Forging billet production equipment (if any);

(3) Rough rolling billet production equipment (if any);

(4) Casting equipment;

(5) Cooling equipment;

(6) Lifting equipment.

4.6 List of main testing equipment, including the main parameters of the following equipment (the testing capacity should be listed):

(1) Chemical components analysis equipment and its methods (e.g. chemical components analysis, spectrum) as well as elements to be analyzed;

(2) Mechanical test equipment (applicable when required to rough rolling billets, forging billets and forgings);

(3) Metallurgical, microscopic and macroscopic test equipment;

(4) Temperature measuring apparatus, furnace front hydrogen determinator (if any), furnace front oxygen determinator (if any);

(5) Nitrogen, hydrogen and oxygen analyzing equipment (generally hydrogen and oxygen analyzing equipment is to be available);

(6) Statutory measurement/calibration units and valid period of the equipment listed above.

4.7 Brief introduction of basic production process, production process card and process specifications or process documents

4.8 Manufacturer's quality management organization, quality manual and related quality control documents

(1) Organization, quality control points, duties and responsibilities of various management departments/managers, quality management system documents;

(2) Procedure for heat number and bath number identification and traceability;

(3) Purchased billets (for manufacturers of rough rolling billets or forging billets) procedure rules or related description.

4.9 Qualification documents of test and inspection personnel;

4.10 Other documents to be submitted as deemed necessary by CCS (e.g. quality certificate, testing equipment calibration certificate, etc.);

4.11 Approval type test plan.

5 Technical requirements

5.1 Requirements of Chapter 5, PART ONE of CCS Rules for Materials and Welding;

5.2 Macrostructure, sulfur print and microstructure are to be in compliance with the relevant accepted standards;

5.3 Non-destructive test (including visual inspection) are to be in compliance with the accepted testing methods and assessment criteria;

5.4 The methods and deviations of chemical components analysis are to be in compliance with the relevant accepted standards.

6 Materials and components

Nil.

7 Type test

7.1 Approval type test plan and principles for selection of typical samples

7.1.1 Determination of test program

7.1.1.1 Prior to approval test for works approval, the program of type test for works approval is to be determined through consultation between CCS and the applicant. Such type test plan is to cover the following details:

(1) Type of steel billets/ingots used to make the products for which the approval is being applied, material type, steel making method, casting method, cooling method (or delivery

condition of the product), manufacturing method of rough rolling and forging billets (if any), etc.;

(2) Basis for approval;

(3) Name, material, weight and dimensions of the typical sample selected for type test;

(4) Manufacturers (approved by CCS) of the steel forgings intended to be made into finished products, the specifications of finished products;

(5) Type test items and acceptance criteria;

(6) Inspection and test location.

7.1.1.2 The type test plan may be proposed by the applicant, confirmed and approved by CCS, or may be presented by CCS and confirmed by the applicant.

7.1.2 Selection of typical samples for type test

7.1.2.1 Principles for selection of typical sample

(1) Billets/ingots are to be selected respectively depending on different steel making and casting types, intended purposes, delivery conditions and material types. Steel billets/ingots are to be forged into finished forgings for relevant tests;

(2) For initial approval, at least one piece of representative typical sample which can reflect more than 80% of the manufacturer's maximum production capacity is to be selected;

(3) Typical samples may be selected taking purchase order into consideration. The design drawings and technical specifications of marine steel forgings are to be recognized or approved by CCS in advance. For steel forgings other than those for marine purposes, the technical specifications of the products' material are generally to be in accordance with the requirements for such type of steel forgings specified by CCS rules.

7.1.2.2 The manufacturers of forging billets used to forge the selected typical samples and the manufacturers of steel forgings are to provide the following documents:

(1) Steel making process card;

(2) Forging process and forging ratio;

(3) Product drawings.

7.2 Approval type test items

7.2.1 Chemical components analysis (including steel making composition analysis and finished forgings composition analysis)

7.2.1.1 The chemical elements to be analyzed for carbon steel, carbon manganese steel, low alloy steel and stainless steel are to include the chemical components for relevant types of steel forgings specified in CCS Rules for Materials and Welding;

7.2.1.2 Elements specified in relevant technical standards, technical conditions and patented products of low alloy steel and stainless steel.

7.2.2 [H], [O] and [N] gas analysis, and the acceptance of tests are to be in accordance with the requirements of relevant accepted standards or technical specifications.

7.2.3 Mechanical tests

Steel billets/ingots are to be manufactured into steel forgings for tensile and impact tests. The quality and location of test specimens are determined according to the single piece weight and dimensions of the steel forging and the following requirements:

(1) Depending on the intended purpose of products, the detailed requirements for test specimen sampling are given in Chapter 5, PART ONE of CCS Rules for Materials and Welding;

(2) Mechanical tests are to be carried out in accordance with the relevant requirements in CCS Rules for Materials and Welding, or may be performed in accordance with the relevant acceptable standards where such requirements are not specified in the said Rules.

7.2.4 Hardness test

Steel billets/ingots are to be manufactured into steel forgings for hardness test. The test specimens for hardness test are to be taken from the steel forging itself.

7.2.5 Metallurgical test (metallographic photos to be attached to the report)

Steel billets/ingots are to be manufactured into steel forgings for metallurgical test and metallographic photos are to be provided along with the metallurgical test report. The metallurgical test is to include analysis of crystal grain size and non-metallic inclusions. The test specimens are to be taken from the riser end. Stainless steel is to comply with the technical requirements of relevant standards or purchase orders. The table below may be used as a reference for acceptance of carbon steel/carbon manganese steel and low alloy steel forgings:

Metallurgical Test Requirements of Carbon Steel/Carbon Manganese Steel and Low Alloy Steel Forging **Table 6.5**

Type of steel	A	B	C	D	Crystal grain size
Carbon steel and carbon manganese steel, low alloy steel	≤2.0	≤1.5	≤1.0	≤1.0	6-8

Reference standard: GB/T 10561 Determination of Content of Non-metallic Inclusions in Steel-Micrographic Method Using Standard Diagrams

7.2.6 Macrostructure examination

Steel billets/ingots are to be manufactured into steel forgings for macrostructure examination and photos are to be provided along with the inspection report. The test specimens are to be taken from the riser end. Stainless steel is to comply with the technical requirements of relevant standards or purchase orders. The table below may be used as a reference for acceptance of carbon steel/carbon manganese steel forgings:

Macrostructure examination Requirements of Carbon Steel/Carbon Manganese Steel
Table 6.6

Type of macrostructure	Scattered porosity	Center porosity	Ingot shape segregation	Ordinary heart-shaped segregation	Subsurface gassy	Flakers
Carbon steel and carbon manganese steel	3.0	3.0	3.0	3.0	1.5	None

The macrostructure templates or fractures with acid-etched cross sections are to be free of any visible shrinkage cavity, gassy, cracking, inclusion, flaking and flakers.

Reference standards:

GB/T 226 Test Method for Macrostructure and Defect of Steel by Etching;

GB/T 1979 Standard Diagrams for Macrostructure and Defect of Structural Steels;

GB/T 1814 Inspection Method for Steel Work Fractures.

7.2.7 Sulfur print inspection

Steel billets/ingots are to be manufactured into steel forgings for sulfur print inspection. The requirements for test specimens are the same as those for macrostructure examination. The inspection (photos to be attached to the report) is to be carried out in accordance with CCS rules and accepted standards (e.g. GB/T 4236 Steel Examination by Sulphur Print (Baumann Method)) and the results of inspection are for reference.

If the factory adopted a low sulfur process and confirmed it in their technical documentations, sulfur print inspection may be waived for steel ingots/billets with [S]<0.008%.

7.2.8 Ultrasonic testing

Steel billets/ingots are to be manufactured into steel forgings for ultrasonic testing. The ultrasonic testing of steel forgings used for vessel is to comply with the requirements of level II in CB/T 3907 or Appendix 7A of CCS Guidelines for Inspection of Hull Welds. Other steel forgings are to be examined by means of UT in accordance with the technical requirements determined by the

manufacturer.

7.2.9 Inspection of surface quality and dimensions

The surfaces of steel billets/ingots are to be free of the visible defects or deficiencies such as rejoining, flaking, scar, inclusion and cracking. For allowable minor defects or deficiencies, the requirements of relevant standards are to be complied with.

The geometric dimensions of steel billets/ingots are to comply with the requirements of relevant standards.

7.2.10 Other tests

(1) For forgings intended to be used in a working temperature higher than 350 °C, the high temperature mechanical properties are to be tested;

(2) For hollow steel forgings used for boilers, pressure vessels and pipes, necessary hydrostatic test is to be carried out;

(3) For austenitic stainless steel forgings, intercrystalline corrosion test is to be carried out;

(4) For annular steel forgings (used for support bearings), CTOD test and fatigue test are to be carried out (refer to GB/T4337 Metals-Rotating Bar Bending Fatigue Testing for the requirements for these tests)

7.2.11 During the approval, the sampling locations of test specimens for chemical components analysis, mechanical, metallurgical and macrostructure tests are to be increased as appropriate based on the casting and cooling methods of steel billets/ingots, for example, the test specimens may be taken from the fluid entrance end in addition to the riser end.

8 Unit/batch inspection

Steel billets/ingots are to be manufactured by the CCS approved manufactory. In general, product inspection is not required, provided that the manufacturer presents manufacturer quality certificates + CCS works approval certificate copies to the ordering party; where the unit/batch inspection is required, the following requirements are to be complied with:

8.1 Unit/batch inspection items:

(1) Steel making chemical components analysis;

(2) Gas components analysis (when specified by technical requirements for ordering);

(3) Macrostructure examination;

(4) Mechanical tests (when required for rough rolling and forging billets);

(5) Inspection of surface quality and dimensions.

8.2 Certificate: marine product certificates or equivalent documents.

8.3 Manufacturer quality certificates are to include at least:

(1) Code of works approval certificate issued by CCS;

(2) Name of ordering party and contract number;

(3) Name, specifications and material of steel billets/ingots;

(4) Heat number/batch number of steel billets/ingots;

(5) Chemical components and gas components analysis results;

(6) Mechanical tests (if conducted) results;

(7) Macrostructure examination (if conducted) results.

8.4 Product identification:

Steel billets/ingots are to be identified with the following marks at least:

(1) Product material (steel grade);

(2) Product specifications (or weight);

(3) Traceability marks such as heat number and batch number;

(4) Refining type (e.g. VD, RH);

(5) Manufacturer identification, etc.

The marks listed above are to be easily visible and legible.

9 Others

Nil.