Guideline No. W-19 (202307)

W-19

STEEL FORGINGS FOR CONTINUOUS GRAIN-FLOW SEMI-BUILT CRANKSHAFTS

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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 mp@ccs.org.cn

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Main changes:

Translation of the requirements of Ur W 7(Rev. 4 Feb 2022) , a new resolution adopted by the IACS, into the guidelines, with a revision of 7.2. (3) , 9. (4)

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STEEL FORGINGS FOR CONTINUOUS GRAIN-FLOW SEMI-BUILT CRANKSHAFTS

1 Application

This Guideline applies to the works approval and product inspection of the steel forgings for use in the construction of continuous grain-flow semi-built crankshaft of marine diesel engine.

This Guideline is the detailed description of specific requirements as specified in Articles 5.1.3.7, 5.4.2.2 and 5.4.5.2(2), Chapter 5, Part One of *CCS Rules for Materials and Welding*.

2 Basis for approval and inspection

Plans and technical conditions approved by CCS;

Section 4 "FORGINGS FOR CRANKSHAFTS", Chapter 5, Part One of *CCS Rules for Materials and Welding*;

3 Terms and definitions

For the purpose of this Guideline, the following definitions apply.

(1) Works approval: as defined in Article 3.1.2, Chapter 3, Part One of *CCS Rules for Classification of See-going Ships*

(2) Type test: as defined in Article 3.1.2, Chapter 3, Part One of *CCS Rules for Classification of See-going Ships* (3) Sample: as defined in Article 3.1.2, Chapter 3, Part Zero of *CCS Rules for Classification of See-going Ships* (4) Product inspection: as defined in Article 3.1.2, Chapter 3, Part One of *CCS Rules for Classification of See-going Ships*

(5) Unit/Batch inspection: as defined in Article 3.1.2, Chapter 3, Part One of *CCS Rules for Classification of See-going Ships*

(6) Inspection: as defined in Article 3.1.2, Chapter 3, Part One of *CCS Rules for Classification of See-going Ships* (7) *Steel Crankshaft Forging: Including Steel Forgings of Crankthrow, Thrust Shaft, Free End Flange and Main Journal.*

4 Plans and documents to be submitted by the applicant

4.1 The manufacturers that apply for works approval (including the steel-making works and the forging plant) are to submit the Application for Approval (the template may be available from the local branch of CCS) and the following documents to the local branch of CCS:

4.1.1 Particulars of manufacturer: name, address, production history, capacity, main products, affiliates (if applicable), business license, legal representative, trademark, etc;

4.1.2 Details of the product (scope of approval application)

(1) Product name: steel crankshaft forging

(2) Crankshaft type: semi-built

(3) Forging method: continuous grain-flow forging

(4) Material grade: material grade and corresponding standard ref. No.

(5) Product specification: maximum air cylinder diameter applicable to diesel engine

(6) Smelting/deoxidization/casting methods

(7) Heat treatment status: final heat treatment status

(8) Processing and delivery status: blank/rough finished/finished

4.1.3 Production process and inspection instructions:

(1) Production process flow chart indicating the inspection/test hold points

(2) Process documents of main procedures (at least including smelting, refining, casting, forging and heat treatment)

(3) Inspection and test instructions (at least including the requirements for sampling positions and NDT and delivery inspection items)

4.1.4 Information on main production equipment: quantity, name/usage, specification, capacity and other information on the production equipment for smelting, refining, casting, heating, forging (including mold forging), heat treatment, etc.

4.1.5 Information on main test equipment: including equipment for mechanical properties test, chemical composition analysis, metallographic test, NDT and dimensions measurement. For those equipment used for tensile, impact and hardness tests, the manufacturer, model, quantity, serial number and verification status are to be made clear.

4.1.6 Qualification certificates of production and test personnel: at least including the qualification certificates of the personnel to carry out such activities: chemical composition analysis, mechanical properties test, metallographic test and NDT (the NDT personnel are to obtain NDT Certificates acknowledged by CCS);

4.1.7 Organization structure chart and roles and responsibilities of quality control department.

4.1.8 Description on product identification and traceability system, including the method of tracing the product specimen at different stages of production.

4.1.9 Technical conditions for delivery and acceptance: standards on product acceptance and delivery (including NDT, packaging, marking and certification);

4.1.10 Product mark diagram;

4.1.11 Certificate of quality: template of certificate/document of product quality;

4.1.12 Approval test program: type test program prepared by the applicant and approved by CCS or prepared by CCS and confirmed by the manufacturer, including:

(1) scope of approval application

(2) approval basis

(3) description of basic parameters of type test samples

(4) items and acceptance standards of type test

(5) figure of sampling positions

(6) recommended test agency

(7) plans and technical documents (on test samples) approved by CCS

(8) applicable standards and technical conditions

4.2 The manufacturer that applies for unit and batch inspection is to submit the following materials to local CCS branch:

(1) Application of Product Inspection

(2) plans/technical documents approved by CCS

(3) CCS plan approval comments

5 Design and technical requirements

The plans and relevant technical documents on the marine diesel engine crankshaft are to be approved by the reviewing department of CCS. In addition, the technical requirements on the crankshaft material are to be as specified in Section 4, Chapter 5, Part One of *CCS Rules for Metrical and Welding.*

6 Materials and components

Materials and components are to comply with relevant requirements of CCS Rules.

7 ~~Welding procedures qualification~~

~~Not applicable, since the steel crankshaft forgings are not allowed to be welded up.~~

~~8 Design and technical requirements~~

~~The plans and relevant technical documents on the marine diesel engine crankshaft are to be approved by the reviewing department of CCS. In addition, the technical requirements on the crankshaft material are to be as specified in Section 4, Chapter 5, Part One of *CCS Rules for Metrical and Welding.*~~

~~9 Selection of typical sampled for~~ ~~t~~Type test

7.1 The typical sample is to be selected on the following principles:

(1) The cylinder diameter of the diesel engine that the typical sample is used in is to be the approved maximum value or 100 mm less than the maximum value.

(2) As the continuous grain-flow forging is a special process only to the crankthrow, the crankthrow must be selected as one of the typical samples. At least two pieces of steel crankthrow forgings are to be made and smelted from different furnaces, one used for disassembly for all type test items, the other only for delivery inspection items.

(3) At least one piece of steel thrust shaft forging or one piece of steel free end flange forging are to be made， generally the weight which one is larger should be chosed. (the steel main journal forging may not be made as a typical sample, since its forging process is relatively simple).

(4) The material grade of the typical sample is to be the same with that of the applied material. Changes to the product material grade, if any, are to be reported to CCS for approval.

(5) The steel thrust shaft forging and the free end flange forging can be typical samples at the same time for the approval of steel forgings for CCS hull structure and shafting and mechanical structures (The finished weight of the typical sample is to be at least more than 80% of the finished weight of the product to be approved.). While the works approval of the steel crankshaft forging is passed, CCS is entitled to award the works approval certificates for steel forgings for both hull structure and shafting and mechanical structures based on the actual weight of the steel thrust shaft forging and steel free-end flange forging.

7.2 Test items：

The type test items, sample quantity, sample dimensions and sampling position are to be consulted with and approved by CCS. At least the following test items are to be included:

(1) Visual inspection: to be carried out carefully on both forged blanks and finished products.

(2) Magnetic particle test (surface NDT): The test position and standard are to meet the relevant requirements as specified in Appendix 7A of *CCS Guidelines for Inspection of Hull Welds or the technical documents approved by CCS.*

(3) Ultrasonic test (internal NDT): The test position and standard are to comply with the relevant requirements as specified in Appendix 7A of CCS Guidelines for Inspection of Hull

Welds or the technical documents approved by CCS.. If advanced non-destructive testing (Andt) technology is used, the requirements of Appendix 2 of Part 3 of the material and welding specification shall be met.

(4) Tensile test: The sampling position is to be approved by CCS;

(5) Impact test: The sampling position is to be approved by CCS;

(6) Hardness measurement: The measurement position is to be approved by CCS;

(7) Material fatigue test: The sampling position is to be approved by CCS;

(8) Chemical composition analysis: C, Si, Mn, P, S, Cr, Ni, Mo, Cu, Nb, V, Ti, Al, N, H, O and other elements intentionally added are to be measured. The smelted sample and the finished sample are to be analyzed respectively.

(9) Microstructure (form of structure and inclusion) inspection: This inspection is to be carried out at the representative positions of the center of integral crankthrow sample, the internal fillet area where the crankweb connects with the crank pin and the circumferential area of the main journal of crankweb. The magnification is to be 100X and 500X respectively.

(10) Ferrite grain size: The test position is to be the same as that in the microstructure inspection. It is to be larger than Grade 5. The grain size is only for reference;

(11) Sulfur print inspection: The section position is to be approved by CCS;

(12) Grain flow direction inspection: The section position is to be approved by CCS;

(13) Macrostructure (all segregation and other macro defects) inspection: The section position is the same as that in the sulfur print inspection.

After the approval test, the manufacturer is to prepare an approval test report which is to be signed by the Surveyor before being submitted to CCS in triplicate. The approval test report is to be enclosed with the verification certificates of related test equipment.

~~11~~8 Unit and batch inspection

(1) Tensile test, for which the sample is to be cut out from the integral sample determined by CCS at approval.

(2) Impact test, for which the sample is to be cut out from the integral sample determined by CCS at approval.

(3) Magnetic particle test

(4) Ultrasonic test

(5) Dimensions/accuracy measurement (if applicable)

~~12~~9 Identification of products

Marks along with CCS notation to be clearly marked on the product having passed inspections:

(1) CCS logo;

(2) cast number or other marking which will enable the full history of the forging to be traced;

(3) brand or grade of forging material;

(4) Date of final inspection;~~abbreviated name of the survey unit and personal stamp of Surveyor responsible for inspection;~~

(5) certificate number.

When the area is not enough for all marks, at least the items (1) to (2) are to be marked. The stamp is to be legible.