



Guideline No. W-19 (201510)

W-19 Steel Forgings for Continuous Grain-Flow Semi-Built Crankshafts

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Foreword

This Guideline is a part of CCS Rules, which contains technical requirements, inspection and testing criteria related to classification and statutory survey of marine products.

This Guideline is published and updated by CCS and can be found through <http://www.ccs.org.cn>. Comments or suggestions can be sent by email to ps@ccs.org.cn.

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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 Zero of *CCS Rules for Materials and Welding*
- (2) Type test: as defined in Article 3.1.2, Chapter 3, Part Zero of *CCS Rules for Materials and Welding*
- (3) Sample: as defined in Article 3.1.2, Chapter 3, Part Zero of *CCS Rules for Materials and Welding*
- (4) Product inspection: as defined in Article 3.1.2, Chapter 3, Part Zero of *CCS Rules for Materials and Welding*
- (5) Unit/Batch inspection: as defined in Article 3.1.2, Chapter 3, Part Zero of *CCS Rules for Materials and Welding*
- (6) Inspection: as defined in Article 3.1.2, Chapter 3, Part Zero of *CCS Rules for Materials and Welding*

(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 thickness 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 product 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 Qualifications required for the works applying for approval to CCS:

(1) The manufacturer must be qualified for managing and producing this product;

(2) The manufacturer must have the production equipment and necessary test equipment adaptive to the product within the approval scope;

(3) The manufacturer is to set up and implement a quality assurance system that complies with at least ISO 9000 or other equivalent quality assurance standards;

(4) The manufacturer must prepare corresponding technical documents and inspection and test instructions for different products and procedures so as to guide the whole production, inspection and test course;

(5) The main production (special procedures) and inspection personnel are to be accordingly qualified and have qualification certificate.

6 Materials and components

Not applicable.

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 Classification of Sea-going Steel Ships*.

9 Selection of typical sampled for type test

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 and one piece of steel free end flange forging are to be made (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. However, a typical sample over 50 t is not subject to this limitation). 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.

10 Type test

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 Ship Welding*.
- (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 Ship Welding*.
- (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.

11 Product inspection after approval

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

- (1) Heat number, product S/N and the mark for traceability of the forging process of such steel forging;
- (2) Name or trademark of manufacturer;
- (3) CCS certificate No. (job control No.)

The stamp is to be legible.

13 Miscellaneous

- (1) 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.
- (2) The approval test report is to be enclosed with the verification certificates of related test equipment.