Guideline No.M-13(201510)

M-13 Jacketed High-Pressure Fuel Pipe of Diesel Engine

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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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Jacketed High-Pressure Fuel Pipe of Diesel Engine

1 Application

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2 Basis for approval and inspection

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2.2 Chapters 2, 4 and 5, Part One of *CCS Rules for Materials and Welding*

2.3 Articles 2.2.5.2 and 2.2.5.4, Chapter II-2 of SOLAS

3 Terms and definitions

3.1 For the purpose of this Guideline, the definitions in *CCS Rules For Classification of Sea-going Steel Ships* apply.

4 Plans and documents

4.1 When applying for accreditation, applicants are to submit the following plans and technical documents to CCS for approval:

4.1.1 Main product performance specification table (At least including plan number/model, working pressure, design pressure, proposed model of associated diesel engine, pipe material/dimensions, etc.)

4.1.2 General assembly plan;

4.1.3 Plans of main parts and components (high-pressure fuel pipe, outer casing, pipe joint, screw sleeve, nut and liner);

4.1.4 List of physicochemical properties of main parts;

4.1.5 Factory test program;

4.1.6 Type test program;

4.2 The following plans and documents are to be submitted to CCS for information:

4.2.1 Performance test report of first product (if any);

4.2.2 Calculation book (calculation book of unblocked section area and calculation book of strength of pressure bearing parts);

4.2.3 Product Operation Instructions;

4.2.4 Samples of product nameplate, certificate of inspection/warranty certificate, etc.;

4.2.5 Main process documents, such as pipe bending process and heading process, etc.

4.2.6 Documents required by Article 3.2.1 of Part One "GENERAL" of *CCS Guidelines for Inspections of products*.

5 Materials and components

5.1 Main parts include high-pressure fuel pipe and pipe joint;

5.2 For all pressure-bearing parts like high-pressure fuel pipe, hydraulic test is to be carried out before assembling;

5.3 In case that the main parts described in 5.1 are outsourced, applicants must establish thorough quality control measures for subcontractors to ensure quality and provide material quality certificate;

6 Welding procedures qualification

6.1 **For** conical head of high-pressure fuel pipe where welded structure is adopted, the welding procedure needs to be qualified and approved according to relevant requirements of CCS *Rules for Materials and Welding*.

7 Design and technical requirements of products

7.1 Seamless steel pipe or bar stock used for high-pressure fuel pipe is to meet the provisions of CCS accepted standards and the requirements of plan prepared by diesel engine designer as well.

7.2 Certain clearance is to be reserved between outer casing and high-pressure fuel pipe to accommodate the leaked fuel. Consideration is to be paid to the flow section area formed by the clearance between two pipes that the leaked fuel can be discharged rapidly through that clearance without causing back pressure which is higher than the design pressure of outer casing and damaging outer casing consequently when high-pressure fuel pipe breaks. That is, the fuel discharge quantity of the flow section area under maximum fuel injection pressure is to be more than fuel injection quantity of single cylinder.

7.3 Adjustment is to be made in case that shrinkage of inside diameter is caused after high-pressure fuel pipe is headed.

7.4 Sealed cone is to be free from scratch, bruise and crack and other defects. Crack is not allowable in the transitional area between header and pipe.

7.5 Slight clamp mark which does not impair the strength is allowable on the surface of header clamping section on high-pressure fuel pipe.

7.6 Nondestructive test is to be carried out on the welded position in case that the high-pressure fuel pipe is of welded structure.

7.7 Oxidation or galvanized passivation or other surface rust-proof treatment is to be applied to the surface of high-pressure fuel pipe, outer casing, packing washer and union nut. The zinc coating is to be uniform, tight, glossy and free from air bubble, peeling and show through and other defects. Only slight sling contact point mark is allowable. Internal and external surfaces are to be free from corrosion.

7.8 Cleanness is to be assured on the internal surface of high-pressure fuel pipe and outer casing systems. The cleanliness limit of the internal surface is 15 mg/m.

7.9 Any bending radius (measured from the centerline of fuel pipe) formed by bending process of high-pressure fuel pipe is to be not less than three times the diameter of high-pressure fuel pipe.

7.10 When high-pressure fuel pipe and outer casing are being bended, the concentricity between the two is to be assured. Proper processing measures (e.g. applying a gasket or spring) are allowed for consideration, but the measures can not block the discharge of leaked fuel and stress rupture to high-pressure fuel pipe is to be avoided. Tolerance of clearance between high-pressure fuel pipe and outer casing:

7.10.1 The unilateral clearance between the casing and the fuel pipe is 1 mm with a tolerance of ± 0.5 mm;

7.10.2 The tolerance is ± L for other clearances, L=(D-d)/4, where D means the inside diameter of casing while d means the outside diameter of casing.

7.11 Pressure test requirements

Upon completion of assembling, high-pressure fuel pipe is to be subjected to 1.5 times the maximum working pressure or the maximum working pressure + 30 MPa (whichever is lesser) in the hydraulic test.

7.12 Tightness test result of fuel leaking channel between high-pressure fuel pipe and high-pressure casing ≥ 0.5 MPa without leakage.

8 Strength requirements

8.1 The material selection of high-pressure fuel pipe is to meet the applicable working pressure conditions.

High-pressure fuel pipe is to withstand internal pressure calculated through formula (1) (Von Mises yield criterion) without causing permanent deformation of the inside part. That capability must be confirmed through hydraulic test.

The maximum theoretical test pressure, Pmax, is the product of stress coefficient and upper yield stress, in MPa.

$$Pmax=\frac{k^2-1}{\sqrt{1+3k^4}}ReH \quad \text{……} \quad (1)$$

Where: k =D/d;

D —— outside diameter, in mm;

d —— inside diameter, in mm.

Note: This formula is numerical relational equation only.

9 Selection of typical samples

9.1 For first approval, the selected typical products are to represent the factory's processing capability and manufacturing level. In general, one sample shall be selected for each construction, material and the maximum working pressure of high-pressure fuel pipe subjected for approval;

10 Type test

10.1 Items of type test are to include:

(1) Appearance quality

(2) Dimensions, accuracy, tolerance and fit, surface roughness, etc.

(3) Hydraulic test

(4) Internal surface cleanliness of high-pressure fuel pipe and outer casing system

(5) Material test of high-pressure fuel pipe/outer casing

(6) Nondestructive test (welded structure adopted for conical head)

(7) Tightness test of fuel leaking channel between high-pressure fuel pipe and outer casing

(8) Other test items as deemed necessary by CCS or required by plan/technical conditions.

10.2 Test methods and requirements are to include:

10.2.1 Raw materials physicochemical property test of main parts are to meet the following requirements:

Raw materials physicochemical property test needs to be carried out to both high-pressure fuel pipe and outer casing, except that the raw materials are supplied with CCS product certificate;

10.2.2 Appearance quality inspection of high-pressure fuel pipe is to meet the following requirements:

(1) The internal and external surfaces of high-pressure fuel pipe are to be free from crack, scab, wrinkle, burr, corrosion and loose scale;

(2) The surface oxidation layer of outer casing is to be uniform and free from obvious indentation and other obvious defects;

(3) Sealed cone at two ends are to have sealing protection. Bruise and obvious scratch are not allowed;

(4) The internal cavity of high-pressure fuel pipe is to be clean and free from foreign matters. Other parts installed inside must be kept clean.

10.2.3 Dimensions, accuracy, tolerance and fit and surface roughness are to be in accordance with the provisions in the approved plan and technical documents.

10.2.4 The limit value of internal surface cleanliness inspection value of high-pressure fuel pipe and outer casing is 15 mg/m.

10.2.5 Hydraulic test are to meet the following requirements:

(1) Upon completion of assembling, high-pressure fuel pipe is to be subjected to 1.5 times the maximum working pressure or the maximum working pressure + 30 MPa (whichever is the lesser) in the hydraulic test.

(2) The duration of test is 5 min and high-pressure fuel pipe is to be free from leakage and obvious deformation.

10.2.6 Nondestructive test is to meet the following requirements:

In case that conical head of high-pressure fuel pipe is of welded structure, nondestructive test is to be conducted according to the requirements of Chapter 7 of Part Three of *CCS Rules for Materials and Welding*.

10.2.7 Non-block test of fuel leaking channel between high-pressure fuel pipe and outer casing are to be calculated according to fuel injection quantity of single cylinder of the diesel engine.

10.2.8 In addition to the above, after consultation between the Surveyor and the applicant, special and special-shaped products and other test items are to be tested as deemed necessary by CCS or required by plan/technical conditions.

11 Unit/batch inspection

11.1 After type approval, the factory will be informed in written form of the detailed product inspection method when CCS issues type approval certificate.

11.2 See 11.3 below for sampling ratio of unit/batch inspection. Test items are to be conducted according to 11.4 as follows.

11.3 For site sampling ratio, it is recommended that the Surveyor should sample 1% of the products which are determined as qualified by the manufacture in the self-inspection. But the sampling size is not less than 2 sets and not more than 5 sets.

11.4 Test items are as follows:

11.4.1 Review of material performance test reports of main parts

11.4.2 Review of nondestructive test report (in the case of welded structure)

11.4.3 Review of inspection reports of dimensions, accuracy, tolerance and fit and surface roughness, etc.

11.4.4 Review of cleanliness inspection report

11.4.5 Appearance inspection

11.4.6 Hydraulic test of high-pressure fuel pipe

Note: The above tests may be witnessed on site as deemed necessary by the Surveyor.

11.5 When applying for product inspection, the manufacture is to submit completed inspection reports or documents and product quality certificates. The certificate will be issued after the Surveyor finishes the inspection if CCS requires that the relevant tests be witnessed.

11.6 During the approval/inspection process of high-pressure fuel pipe, in addition to implementation of relevant provisions of this Guideline, detailed requirements in Chapter 3 of Part One of *CCS Rules for Classification of sea-going Steel Ships* are to be referenced.