Guideline No.M-08 (201610)

M-08 Marine Fan

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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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Main changes and effective date:

The “5 material and components” is amended to coordinate with the rules.

CONTENTS

Marine Fan

1 Application

1.1 This Guideline applies to the approval and inspection of fans intended for installation and use on ships.

1.2 This Guideline applies to the motor-driven marine explosion-proof centrifugal fans, marine explosion-proof axial flow fans, marine centrifugal fans and marine axial flow fans, which may be provided as a reference for other types of marine fans (e.g. water-driven axial flow fan and water-driven centrifugal fan).

2 Basis for approval and inspection

The following standards are the bases for approval and inspection in this Guideline:

(1) *CCS Rules for Classification of Sea-Going Steel Ships*

(2) *CCS Rules for Materials and Welding*

3 Definitions

3.1 For definitions of product inspection, approval, type test, sample, and unit/batch inspection, refer to Article 3.1.2, Chapter 3, Part One of CCS *Rules for Classification of Sea-going Steel Ships*.

3.2 Explosion-proof fan: A fan of integral non-spark airtight structure.

4 Plans and documents

4.1 The following plans and documents are to be submitted for approval:

(1) General assembly plan (sectional plan);

(2) Main product performance specification table (inclusive of the capacity, pressure, speed, power rating of the whole series of products to be approved, as well as the model and parameters of the auxiliary motor for delivering complete sets of fans);

(3) Fan performance curves;

(4) Plans of main parts and components such as the impeller, casing, air inlet, transmission case, prime mover (except for purchased motors);

(5) A list of physicochemical properties of the material for main parts and components (impeller);

(6) Technical conditions for product inspection and delivery;

(7) Approval test program (if developed by the applicant).

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

(1) Main process documents: Welding procedure, riveting procedure, casting procedure (if any);

(2) Product operation instructions, nameplate and certificate of inspection (in both Chinese and English for international sea-going ships);

(3) Qualified supplier list.

5 Materials and components

5.1 Materials and components are to comply with relevant requirements of CCS Rules, and main components include the impeller, casing, air inlet, prime mover, etc.;

5.2 Before assembly, the overspeed test is to be carried out for the impeller of an explosion-proof fan, with the result to be examined and confirmed by the Surveyor or witnessed by the Surveyor; for other types of fans, the impeller overspeed test may be performed at the discretion of the manufacturer depending on the situation.

6 Design and technical requirements

6.1 Marine environmental conditions

When supplying the marine air containing corrosive gases such as salt mist and oil mist, the marine fan is to be capable of working properly at - 25°C ~ + 50°C and ≤ 95%RH, with long-term heeling of 15 ° and trimming of 5 °. An explosion-proof fan is required to supply gases containing hard explosive particles ≤150 mg/m^3 and 2 mm in diameter.

6.2 Structure and material

The structure of a marine fan and the materials for its main parts are to be appropriate for the type, temperature, pressure and other conditions of the medium conveyed. For explosion-proof fans conveying air containing explosive gases, the clearance between the impeller and the casing is to be no less than 0.1 times the diameter of the shaft at the impeller bearing, at least 2 mm and not exceeding 13 mm.

The material of an explosion-proof fan is to be compliant with the following requirements:

(1) The impeller and/or casing is of non-metallic material, with due regard to the exclusion of electrostatic effects;

(2) The impeller and the casing are of non-ferrous metal material;

(3) The impeller is of aluminum alloy or magnesium alloy while the casing is of black metal (including austenitic stainless steel), with a point on the casing to the impeller that is lined with a piece of non-ferrous metal material of appropriate thickness;

(4) The impeller and the casing are of black material (including austenitic stainless steel), with a design clearance ≥ 13 mm at the impeller end.

6.3 Vibration

When operating under the rated condition, the marine fan is to have the maximum vibration intensity V_{rms} (mm/s) as described below:

(1) 4.5 mm/s for motor power ≤15 KW;

(2) 7.1 mm/s for 15 KW < motor power ≤ 75 KW;

(3) 11.2 mm/s for motor power > 75 KW;

(4) ≤ 7.1mm/s for water-driven fans.

6.4 Noise

Under the rated condition, the noise of a marine fan is to be no greater than:

(1) the specific A-weighted sound level of 25 dB (A) for explosion-proof centrifugal fans, the specific A-weighted sound level of 24 dB (A) for centrifugal fans;

(2) the specific A-weighted sound level of 35 dB (A) for explosion-proof axial flow fans, the specific A-weighted sound level of 34 dB (A) for axial flow fans;

(3) A-weighted sound level of 90 dB (A) for water-driven centrifugal fans, A-weighted sound level of 95 dB (A) for water-driven axial flow fans.

The fan noise at the test condition point, in dB (A), is calculated as follows:

$$L_{SA} = L_A - 10 \lg (QP^2) + 19.8$$

L_{SA} —— specific A-weighted sound level of the fan inlet (or outlet), in dB (A).

L_A —— A-weighted sound level of the fan inlet (or outlet), in dB.

Q —— fan flow at the test condition point, in m^3/min.

P —— full pressure of the fan at the test condition point, in Pa.

6.5 An impeller is to provide the static and dynamic balance precision ≥ G5.6, or G6.3 for diameter > 100 cm.

6.6 Impeller overspeed test

The test is to be carried out with the impeller running at least 10 min at 20% rated speed. After the test, no crack and damage are allowed on the casting impeller; the riveting impeller is required to have no crack and damage on the front and rear disks, no loose rivets and dimension deformation < 0.5‰.

6.7 Operation

Under the rated condition, the fan is to work stably without bumping, abnormal sound and violent vibration.

6.8 The explosion-proof grades of the fan may be divided into ExdIIA, ExdIIB and ExdIIC (C > B > A in the same group, and T4 > T3 at the same level). A water-driven fan may have an explosion-proof grade of CT6. For flammable and explosive gases that may be delivered for each explosion-proof grade, refer to Table B in Appendix B to GB3836.1-2000 *Electrical apparatus for explosive gas atmospheres -- Part 1: General requirements*.

6.9 Aerodynamic performance

A fan is to have the pressure for rated flow not exceeding the rated pressure:

(1) Explosion-proof fans: -10% ~ + 10%;

(2) Non-explosion-proof fans: - 5% ~ + 10%;

(3) Water-driven fans: - 15% ~ + 15%.

6.10 Visual and dimension inspection

A fan is required to have clean and smooth external surface without such defects as dent, irregularity, warp, with the weld finished smooth and flat, and dimension in line with the plans.

7 Type test

7.1 Test items

7.1.1 The type test items are generally to include:

(1) Test of physicochemical properties of raw materials for main parts;

(2) Inspection of fan appearance quality and overall dimensions;

(3) Impeller balance test;

(4) Impeller overspeed test;

(5) Operation test;

(6) Aerodynamic performance test;

(7) Noise test;

(8) Self-excited vibration test;

(9) Inclination test

(10) Explosion-proof test (for explosion-proof fans).

7.1.2 Exemptions

(1) Generally all applicable test items as set forth in 7.1.1 are included in the first approval; where the following conditions are met, the manufacturer may submit a written application to CCS for partial exemption; with due consideration of the factory production, production history and usage record of the product, the Surveyor is to fax his comments together with the written application to the Construction/Product Division of Headquarters for approval on the exemption;

① The applicant could provide a test report of corresponding items recently issued by a technical authority (e.g. AQSIQ, Defence Science and Technology Laboratory);

② The applicant could provide a test report of corresponding items recently signed by members of IACS;

③ Where the product is produced by the applicant based on technology transfer or licensing from another manufacturer, and has been approved by CCS, it may be exempted from the inclination test and explosion-proof test as described in 7.1.1 after assessment of the manufacturing capacity and processing/assembling level of the applicant.

(2) In re-approval for renewal of the certificate of approval, where no change occurs in the product design and the technical requirements of the CCS Rules remain unchanged for products of that type, partial exemption is permitted; however, CCS reserves the right to request the type test to be redone.

7.2 Test requirements

7.2.1 Test site

Any manufacturer’s laboratory/test bench to be serving as the approval test site is required to be inspected and considered satisfactory by the Surveyor according to the following Articles 7.2.2, 7.2.3 and 7.2.4; otherwise, all the tests are to be carried out at the certification/test organization accredited by CCS.

7.2.2 Measuring instrument

The measuring instrument is to have the metrological calibration certificate and is to be within the period of validity, with accuracy of no lower than the relevant requirements of GB1236-2000 *Industrial Fans - Performance Testing Using Standardized Airways*.

7.2.3 Test equipment

The manufacturer is to provide test equipment of sufficient specification, and instruments and apparatus meeting the test requirements.

7.2.4 Test personnel

The manufacturer is to provide technicians familiar with the test requirements and experienced at performing the aerodynamic performance test.

7.3 Test equipment and method

7.3.1 The test is to be carried out according to GB1236-2000 *Industrial Fans - Performance Testing Using Standardized Airways*.

7.3.2 Test of physicochemical properties of raw materials for main parts

(1) Range: Casting impellers except for purchased raw materials or castings with the product certificate issued by CCS;

(2) Sampling: Where conditions permit, samples of casting impellers are to be taken and sealed as far as possible under the witness of the Surveyor at the foundry where delivery is made to the applicant, if field sampling is inconvenient, the attached test coupon of the purchased casting body may be used, provided that the surface is clean without any coating and casting defect;

(3) The test method and interpretation of the results are to be in accordance with the requirements of relevant guideline sections in the *CCS Rules for Materials and Welding*.

7.3.3 Inspection of structural dimension, appearance and working accuracy of main parts

(1) The main machined parts are to be inspected for structural dimension, appearance and working accuracy in accordance with the plans approved by CCS and relevant CCS standards, and the out-of-tolerance parts are to be rejected;

(2) The casting impeller surface is to be free of shrinkage cavity, sand hole, crack, porosity and other defects impairing the quality. Repair is permitted without reducing the strength; however, the use of knocking, blocking, impregnating or painting is prohibited for eliminating defects. No repair welding is allowed for castings with cellular blowhole.

7.3.4 Rotor balancing test

(1) Static balance

The fan impeller must be subject to the static balance test under the single-plane static balance conditions which are

① Maximum operating speed n < 1500 r/min, impeller width-diameter (D) ratio ≤ 0.2;

② Maximum operating speed n ≥ 1500 r/min, impeller width-diameter (D) ratio ≤ 0.1, static balancing equipment meeting the required balancing quality and only single-plane balancing is possible.

(2) Dynamic balance

Where the rotor does not meet the conditions for static balance or the dynamic balance is explicitly stipulated in the plan, the amount of unbalance may be calculated by using Eq. (1):

$$U \le e \bullet M \qquad \text{..... (1)}$$

Where: e —— allowable mass eccentricity of the rotor, in μm

M —— rotor mass, in kg.

U —— allowable amount of unbalance of the rotor, in g.mm

$$e = \frac{9550G}{n} \qquad \text{..... (2)}$$

G —— balancing quality grade, in mm/s;

n —— maximum operating speed of the rotor, in r/min

7.3.5 Operation test

The operation test is mainly to inspect the assembly quality of the fan which is required to work stably without bumping, abnormal sound and violent vibration under the rated condition. Where abnormal sound, noise or excess temperature of the bearing occurs, the test is to be immediately stopped until the cause is identified and the fault is eliminated.

7.3.6 Aerodynamic performance test

(1) The test is to determine the relationship between the pressure and shaft power at the rated flow, so as to verify the accuracy of performance curves such as the flow, pressure, shaft power provided by the manufacturer (applicant). The test is to be performed after the success of the operation test.

(2) The test condition point (measuring point) is to be as close as possible to the specified value, however which allows deviation of some extent:

① The test is to be performed starting from full-opening of the inlet control valve, generally at the nearest five condition points within the specified flow range but evenly distributed over the entire performance curve;

② If the fan has a very narrow design pressure (flow) range, the measuring points may be reduced as appropriate;

③ The stable state is to be maintained for sufficient time at each measuring point, in order to obtain consistent results and intended accuracy. Any manufacturer's site serving as the approval test site is to allow all items specified in the test program to be performed, and is to be inspected and considered satisfactory by CCS in terms of test capability, method and personnel, otherwise, a site regarded qualified by CCS is to be used.

(3) Measurement is to be performed for the following data at each test condition point as described above:

① Inlet pressure

② Static pressure of the inlet

③ Ambient temperature (only one measurement to be done if no obvious change occurs in temperature difference)

④ Rotation speed

⑤ Motor power (hydraulic pressure and capacity to be measured for water-driven fans)

⑥ Vibration

⑦ Noise

(4) Test data analysis

The measured data is to be calculated and made into the fan performance curves, and then compared with and proven to approximately agree with the one provided by the manufacturer (applicant) within the allowable operating range given by the manufacturer (applicant), and the allowance at the rated condition point is to be compliant with 6.9.

7.3.7 Noise test

(1) This test may be part of the operation test or performance test;

(2) The noise measuring point is to be located:

① at an angle of 45 °and 1 m to the center of the inlet;

② at a height of 1 m if the central plane of the fan is 1 m below the ground;

③ at a height equal to that of central plane of the fan if the latter is 1 m above the ground;

④ more than 1 m to any reflecting surface if the noise test is performed indoors.

(3) The measured noise value is to be compliant with 6.4.

7.3.8 Self-excited vibration test

(1) This test may be part of the operation test or performance test where rated condition is reached;

(2) The test point may be selected as follows:

① The fan casing at the bearing end and the flange at the outlet end may be taken as the main test points.

② The vibration intensity V_{rms} (mm/s) is to be measured in X, Y, Z directions at each test point.

(3) The measured maximum vibration intensity V rms is to be compliant with 6.3.

7.3.9 Inclination test

The fan is required to operate correctly under the rated condition, with heeling of 15 °in left-right direction for 30 min and trimming of 5 °in forward-backward direction for 30 min.

7.3.10 Explosion-proof test

All explosion-proof fans are to be subject to this test at a test organization accredited by the state or CCS, and obtained with a certificate.

7.4 Selection of typical prototype for type approval test

7.4.1 For the first approval, generally two prototypes are to be selected per model according to the flow and size of the product to be approved such that the processing capacity and manufacturing level of the manufacturer are covered; if the product has a very narrow range of model and performance, one prototype with maximum flow may be used. Selection of prototype is to take into account the market sales volume, inventory status of the manufacturer as well as the test equipment and conditions of the selected test site; for the inclining test and the explosion-proof test (for explosion-proof fans), two models are to be selected from the same series.

7.4.2 For re-approval, at least two models/specifications which are the most representative or demanded in the market may be selected from each series as the prototype.

8 Delivery inspection

The application for CCS product inspection is permitted only for those fans which have passed the manufacturer's inspection/test and proven to be deliverable.

8.1 For unit/batch inspection of products obtaining the type B approval by CCS

8.1.1 The inspection plan (related content in quality control plan) ratified at the time of approval is to be complied with but inclusive of, at a minimum, the following specified inspection items:

(1) Inspection of appearance quality and dimension;

(2) Static or dynamic balance of the impeller;

(3) Impeller overspeed test (require for each explosion-proof fan);

(4) Operation test.

8.1.2 The above tests may be carried out independently by the manufacturer, with a complete test report to be submitted to the Surveyor for approval; the Surveyor may randomly take at least 5% (or 1 unit) of fans per batch/specification for re-test of "appearance quality", "impeller overspeed test and operation test" or for witness during the test at the manufacturer;

8.1.3 In each application for unit/batch inspection, the quality proof documents of raw materials for main parts of the batch are to be provided at the same time to the Surveyor for approval.

8.1.4 Explosion-proof motors for marine explosion-proof fans are to be of the Exd type approved by CCS, and Type II electrical apparatus is to provide an explosion-proof grade conforming to the requirements of the group level in which explosive gases are contained in the supplied air.

8.2 For inspection of products obtaining the type A approval by CCS

8.2.1 The inspection is to be performed mainly based on the report audit, and all the test items are to be independently fulfilled by the manufacturer; before delivery of products, the manufacturer is required to submit an application for product inspection, together with the report/record/document inclusive of all the test/inspection items as set forth in 8.1.1 and 8.1.4 for approval by the Surveyor;

8.2.2 Manufacturers obtaining the type A approval by CCS are to submit an application on time for periodic examination according to Section 4, Chapter 3, Part One of the *Rules*.

8.3 Unit/batch inspection of manufactured products not approved by CCS

8.3.1 The inspection content is to include plan approval and type test.

8.3.2 Plan approval

The manufacturer is to prepare and submit plans/documents as specified in 4.1 and 4.2 of this Guideline to CCS for approval/information.

8.3.3 Type test

At least one of fans for product inspection is to be randomly taken per model to the type test for all items specified in Article 7 of this Guideline;

8.3.4 Alternates not selected are to be inspected and tested at least according to 8.1 of this Guideline.