Guideline No.: E-04(202009)

E-04

GENERATORS

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Foreword:

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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E-04(201610) Oct 28,2016

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Main changes:

1. In accordance with the current valid rules and standards update.

CONTENT

GENERATORS

1 Application

1.1 This guideline applies to engine-driven three-phase AC synchronous generators rated at 2500 kW and 50 Hz or 60 Hz and 1 kV and their excitation devices, intended for ships and offshore installations. This Chapter is applicable to motors for general purposes. Where motors, which are intended for special purposes or for which special tests are required, are not specifically covered by this Chapter, the standards for such motors apply.

1.2 This guideline applies to three-phase AC synchronous generators (including emergency generators) for general purposes. Where motors, which are intended for special purposes or for which special tests are required, are not specifically covered by this guideline, the standards for such motors apply.

2 Normative reference documents

(1) CCS Rules for Classification of Sea-going Steel Ships, and its amendments;

(2) CCS Rules for Materials and Welding, and its amendments;

(3) CCS GD22-2015 <Guidelines for Type Approval Test of Electric and Electronic Products> (current valid version).

(4) IACS UR E13 (Rev.2 Aug 2015 Corr.1 June 2018) Test requirements for Rotating Machines;

(5) IEC 60092-301:1980{Ed.3.0} Electrical installations in ships - Part 301: Equipment – Generators and motors;

(6) IEC 60034-1:2017{Ed.13.0} Rotating machines Part 1: Rating and performance;

(7) IEC 60034-2-1:2014 Rotating machines - Part 2: Methods for determining losses and efficiency of rotating machinery from tests (excluding machines for traction vehicles)

(8) IEC 60034-4:2018 Rotating machines - Part 4: Methods for determining synchronous machine quantities form tests;

(9) IEC60034-5:2020 Rotating machines - Part 5: Degrees of protection provided by the integral design of rotating electrical machines. Classification;

(10) IEC 60034-6:1991 {Ed.2.0} Rotating machines - Part 6: Methods of cooling;

(11) IEC60034-8:2007/AMD1:2014 {Ed.3.1} Rotating machines - Part 8: Terminal markings and direction of rotation;

(12) IEC 60034-9:2003/AMD1:2007 {Ed.4.1} Rotating machines - Part 9: Noise limits;

(13) IEC 60034-14:2018{Ed.4.0} Rotating machines - Part 14: Mechanical vibration of certain machines with shaft heights 56 mm and higher - Measurement, evaluation and limits of vibration severity;

(14) IEC 60034-15:2009{Ed.3.0} Rotating machines - Part 15: Impulse voltage withstand levels of rotating AC machines with form-wound stator coils;

(15) IEC 60034-16-3:1996 Rotating machines - Part 16: Excitation systems for synchronous machines. Dynamic performance;

(16) IEC 60068-2-30:2005 {Ed.3.0} Environmental testing - Part 2-30: Tests – test Db: Damp heat, cyclic (12h + 12h cycle);

(17) IEC60068-2-11:1981 {Ed.3.0} Environmental testing - Part 2: Tests–test Ka: Salt mist;

(18) IEC 60085:2007{Ed.4.0} Electrical insulation- Thermal classification.

(19) CB /T 3907-1999 Ultrasonic flaw detection of marine forged steel parts.

(20) IACS Rec.68 Guidelines for non-destructive examination of hull and machinery steel forgings

3 Definitions

1.3.1 Series: For the purpose of this Chapter, the same series means one group of products with the same working principles. In the case of any difference in raw material, manufacturing process and optional components, the enterprise is to identify such differences in the enterprise standards and indicate them in type markings. For example, products which are different in degree of protection, voltage rating, single/double supporting and lubrication are to be deemed as being in the same series, while products which are different in excitation, insulation level and methods of cooling may be deemed as being from in different series.

4 Plans and documents

2.1 The following plans and documents are to be submitted for review:

(1) General plans;

(2) Detailed drawings of main parts including assembly of stators, assembly of rotors, turning axle, assembly of collector rings or commuters, bedplates and structure of terminal boxes;

(3) Electrical schematic diagram;

(4) Drawing of external wiring;

(5) Technical specifications of the products;

(6) Type test program.

(7) Drawing of name plate;

(8) List of raw materials (indicating manufacturers);

(9) Essential manufacturing processes (such as immersion and baking);

(10) Operation instructions for the products.

5 Design and technical requirements

5.1 The design and manufacture of products are to comply with the requirements of CCS Rules for Classification of Sea-going Steel Ships, CCS Rules for Materials and Welding and IEC 60092-301; thermal classification of electrical insulation is to comply with IEC 60085; methods of cooling are to comply with IEC 60034-6; terminal markings and direction of rotation are to comply with IEC 60034-8; noise limits are to comply with IEC 60034-9; and measurement, evaluation and limits of vibration severity are to comply with IEC 60034-14.

5.2 Applicable environmental conditions and material requirements

5.2.1 Generators and their excitation systems are to operate satisfactorily under the following environmental conditions:

(1) Ambient air temperature: 45℃. In the case of freshwater cooler, primary cooling water

temperature is not to be more than 32℃.

(2) Relative humidity: 95±3%, with condensation of water.

(3) Salt mist, oil vapor and mold.

(4) Inclination of ships from the normal:

Listing: 15°(22.5°for emergency generators)

Rolling: 22.5°;

Trimming: 5°(10°for emergency generators);

Pitching: 7.5°(10°for emergency generators).

For ships carrying liquefied gases or chemicals, the emergency generators is also to remain operable to a athwartship inclination up to a maximum of 30°.The static inclination of column-stabilized units emergency generators is 25°.

(5) Shock or vibration impacts on ships and offshore oil units in service or operation.

5.2.2 Material requirements

(1) Enclosures are to be of steel or cast iron with 196.13 MPa of tensile strength.

(2) Shafting material is to be heat treated in an appropriate process, having tensile strength not less than 441.30 MPa, yield stress not less than 210.84 MPa. The elongation of test samples is not to be less than 24%. The chemical composition of steel is to comply with Table 5.2.2(1).

Chemical Composition of Steel **Table 5.2.2(1)**

Chemical composition (%)	**C**	**Si**	**Mn**	**S**	**P**	**Cr**	**Mo**	**Ni**	**Cu**	**Residual elements**
Carbon steel Carbon manganese steel	⩽ 0.65	⩽ 0.45	0.30 ~ 1.50	⩽ 0.035	⩽ 0.035	⩽ 0.30	⩽ 0.15	⩽ 0.40	⩽ 0.30	⩽ 0.85

(3) Flame-retardant, moisture-, and fungus-resistant as well as low-toxic materials are to be used.

5.3 Technical requirements

4.3.1 Main and emergency generators including their exciters are to be suitable for continuous duty at their full rated output and maximum cooling air temperature for an unlimited period, without the limits of temperature rise as per their insulation levels being exceeded.

5.3.2 Generators are to withstand the following over current or excess torque without injury:

AC generators: 50% over current 2 min

5.3.3 AC generators and their excitation systems are to be capable of maintaining, under steady-state short-circuit conditions, a current of at least 3 times the full load rated current for a duration of 2 s.

5.3.4 Each AC generator, unless of the self-regulated type, is to be provided with separate automatic and manual voltage regulators at the generator control panel.

5.3.5 Each AC generator driven by the prime-mover having governor characteristics complying with CCS Rules for Classification of Sea-going Steel Ships together with its excitation system is to be capable of maintaining the voltage under steady conditions within ±2.5% of the rated voltage for all loads between zero and rated load at rated power factor. These limits may be increased to ±3.5% for emergency sets.

5.3.6 For AC generating sets under no load conditions, when the generator is driven at rated speed, giving its rated voltage, and is subjected to a sudden change of symmetrical load within the limits of 60% of the rated current and the power factor not exceeding 0.4, the voltage is not to fall below 85% nor exceed 120% of the rated voltage. The voltage of generator is then to be restored to within plus or minus 3% of the rated voltage for the main generator sets in not more than 1.5 s. For emergency sets, these values may be increased to plus or minus 4% in not than 5 s, respectively.

5.3.7 For AC synchronous generators, the factor of distortion of the waveform from a sinusoidal fundamental of the line-to-line voltage under no load conditions is not to exceed 5%, except for small size (e.g. less than 24 kW) generators.

5.3.8 AC generators and their excitation systems are to operate under steady conditions for an unlimited period under the environmental conditions as specified in CCS Rules for Classification of Sea-going Steel Ships.

5.3.9 Over speed protection for prime movers of generating sets are to comply with the requirements of IACS UR M 3.2.

5.3.10 Prime movers as main propulsion machines are to comply with the requirements of IACS UR E 17.

6 Main components and parts

6.1 Materials and components are to comply with relevant requirements of CCS Rules. Shaft material for main engine driven generators where the shaft is part of the propulsion shafting is to be certified by CCS. Shaft material for other generators is to be provided by manufacturers as approved by CCS or to have material certificate, and other equivalent documentary evidence.

6.2 Shaft material for generators can be used the recognized international standards and national standards/industry standards for NDT. For the following Table 3.2 usual NDT standards, the acceptance criteria as specified below are applied. When using other standards, to be evaluated by CCS and confirmed the determination level before use.

The acceptance criteria of marine products NDT specified below① Table6.2

UT		**MT**		**PT**	
Standard No.	Level	Standard No.	Level	Standard No.	Level
CB/T3907	II				
IACS Rec.69	acceptable	IACS Rec.69	acceptable	IACS Rec.69	acceptable

①The manufacturer's acceptance criteria could be accepted, if the manufacturer has the acceptance criteria for the equipment component.

7 Type Test

7.1 Types and specifications of type test samples are to cover the products for which approval is sought and be technically representative for determining, through type test, whether the manufacturer has the capability to manufacture the approval products as required by CCS. At least one of the samples taken from different series is to be rated not less than 80% of the maximum power to be approved.

7.2 Samples selected from different series of three-phase AC synchronous generators at the same manufacturer are to be representative in terms of power, speed, insulation level, degree of

protection, voltage rating, single/double supporting, lubrication, means and/or method of cooling, and manufacturing process.

7.3 The type test of three-phase AC synchronous generators is to be in accordance with Table 7.3.

7.4 The international standards referred to in this guideline are their respective latest versions.

7.5 In lieu of the standards of test methods referred to in this guideline, other equivalent or recognized standards may be applied as appropriate.

Type Test Items for Three-Phase Synchronous Generators – General Tests Table 7.3

No.	Test item	Technical requirements
1	Visual examination	Approved plans and technical documents
2	Measurement of insulation resistance	3.2.9.6, PART FOUR of CCS Rules for Classification of Sea-going Steel Ships
3	Measurement of winding resistance	Technical specifications
4	Verification of voltage regulation system	3.2.8.2 and 3.2.8.3, PART FOUR of CCS Rules for Classification of Sea-going Steel Ships
5	Overload/overcurrent test	3.2.5.1, PART FOUR of CCS Rules for Classification of Sea-going Steel Ships
6	Overspeed test	IEC 60034-1 para. 9.7
7	Withstand voltage test	IEC 60034-1 para. 9.2
8	No load test	3.2.9.14, PART FOUR of CCS Rules for Classification of Sea-going Steel Ships
9	Examination of bearings	3.2.9.16, PART FOUR of CCS Rules for Classification of Sea-going Steel Ships
10	Rated load test and measurement of temperature rise	3.2.3, PART FOUR of CCS Rules for Classification of Sea-going Steel Ships
11	Verification of steady-state short-circuit	3.2.9.11, PART FOUR of CCS Rules for Classification of Sea-going Steel Ships
12	Inclination test①	<Guidelines for Type Approval Test of Electric and Electronic Products> (current valid version), para.2.6
13	Damp heat test- cyclic	<Guidelines for Type Approval Test of Electric and Electronic Products> (current valid version), para.2.10
14	Salt mist test Ka②	<Guidelines for Type Approval Test of Electric and Electronic Products> (current valid version), para.2.13
15	Test of degree of enclosure protection	IEC6 0034-5
16	Measurement of conducted emissions	<Guidelines for Type Approval Test of Electric and Electronic Products> (current valid version), para.3.2

①Ensuring the generator under the condition of lubrication and cooling are not affected, the Inclination test can be considered to exempt.

②The statement "Not suitable for installation on open deck" is to be contained in approval certificates and product certificates for products not subjected to salt mist test.

8 Unit/batch inspection

8.1 The manufacturers holding a CCS Type Approval B Certificate are still to carry out unit/batch

inspection for all generators and submit reports of material quality of bedplates (cast irons) and shafting and other equivalent documentary evidence and test reports. The unit/batch inspection reports are to contain test results, the manufacturer's serial number of the motor and the type approval certificate number of the motor.

8.2 Unit/batch inspection items are at least to include items 1 to 9 listed in Table6.1.Subject to CCS' approval, such voltage regulation during transient conditions may be calculated values based on the previous type test records, and need not to be tested during factory testing of a generator, however the calculation report is to be submitted by the manufacturer to demonstrate that the requirements of rule are met.

8.3 Additional test items may be required where deemed necessary by the Surveyor.

8.4 The number of generators to be inspected by CCS is to be 5% of the total number of submitted ones, but not less than 2 sets, unless the inspection is requested for one generator only.