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E-05

GENERATING SETS

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Foreword:

China Classification Society (hereinafter refferred 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 service@ccs.org.cn.

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Main changes and effective date:

1. IEC 60092-301 version updated to 2025 {Ed.4.0}
2. Correct the meanings of Q_{iN} and P_{iN} letters in Article 3.15 to be consistent with GB 13032
3. Delete the content in section 3.2 “If the above-mentioned accessories are not covered by the emergency diesel engine certificate, the accessories are to be certified by CCS.”
4. Editorial modifications

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GENERATING SETS

1 Application

This Guideline applies to inspections of diesel generating sets for main power source and emergency power source in ships.

2 Normative reference documents

Chapter 2&3, Part 4 and Chapter 9&12, Part 3 of China Classification society Rules for Classification of Sea-going Steel ships and its Amendments

IEC 60529:1989+AMD1:1999+AMD2:2013 Degrees of protection provided by enclosures (IP code)

IEC 60092-301:2025~~1994~~{Ed.~~3~~4.0} Electrical installations in ships – Part 301: Equipment-Generators and motors.

IACS UR M80 Requirements for AC Generating sets (May 2019)

3 Definitions

3.1 Diesel generating set is a generating set consisting of a diesel engine, a generator and their common bedplate, including an engine governor and a simple local instrument panel. If the panel is replaced by a local control box with safety and protection functions, the control box is to comply with the requirements of CCS Rules for Classification of Sea-going Steel Ships and be separately inspected, unless the box is indicated in the diesel engine certificate.

3.2 Emergency diesel generating set is a generating set consisting of an emergency diesel engine, an emergency generator and their common bedplate, including an engine governor, a simple local instrument panel, a double power starting device, coolers and cooling fans. ~~If the above-mentioned accessories are not covered by the emergency diesel engine certificate, the accessories are to be certified by CCS.~~ If the panel is replaced by a local control box with safety and protection functions, the control box is to comply with the requirements of CCS Rules for Classification of Sea-going Steel Ships and be separately inspected, unless the box is indicated in the diesel engine certificate.

3.3 Degree of protection means the protection which enables the generating set to operate without any injury or harmful impacts under the environmental conditions as defined in IEC 60529.

3.4 Emergency load means the maximum emergency load to be applied in an emergency on ships.

3.5 Rated power of a diesel engine is the continuous power of the diesel engine under certain environmental conditions, to be corrected for inland-waters ships and sea-going ships according to

the actual environmental conditions.

3.6 Steady-state governing characteristic curve of generating sets

Operating at the rated load and speed, the load of the generating set with a fixed governing mechanism changes reciprocally in single direction within the range from no load to full load and the curve is formed by connecting arithmetrical means of speed power characteristic loops.

3.7 Steady-state speed governing rate of generating sets

Set at rated load and rated speed, with load changing from no-load to full load or in a reverse way evenly or abruptly, the rate of difference between the stable no-load speed n_i and the rated speed n_N to the rated speed n_N is shown in percentage

$$\delta_{st} = \frac{n_i - n_N}{n_N} \times 100 \quad \text{.....(1)}$$

~~$\delta st = \frac{n_i}{n_N} \times 100$ .....(1)~~

where: δ_{st} ~~δst~~ – steady-state speed governing rate, in %;

n_i – stable no-load speed, in r/min;

n_N – rated speed, in r/ min.

3.8 Transient speed governing rate and stabilization time for generating sets

(1) Transient speed governing rate of generating sets means the rate of the difference between the minimum transient speed (nmin) or the maximum transient speed (nmax)and the speed (ni) prior to load change or the rated speed (n_N) to the rated speed (n_N), shown in percentage, where the steady-state speed governing rate is stabilized and a specified symmetrical load is suddenly taken off and then suddenly applied at the rated load and speed.

The transient speed governing rate δd at the maximum transient speed is to be calculated according to Formula (2).

$$\delta_d = \frac{n_{\max} - n_n}{n_N} \times 100 \quad \text{.....(2)}$$

~~$\delta d = \frac{n_{\max} - n_n}{n_N} \times 100$ .....(2)~~

The transient speed governing rate δd at the minimum transient speed is to be calculated according to Formula (3).

$$\delta_d = \frac{n_{max} - n_i}{n_N} \times 100 \quad \text{.....(3)}$$

~~$\delta d = \frac{n_{max} - n_i}{n_N} \times 100$ .....(3)~~

(2) Stabilization time means the time required from the commencement of speed variation until the speed returns to a level where its deviation from the steady-state speed at the related load is within the range of speed fluctuation rate. See Figure ~~1.~~3.8.(2)

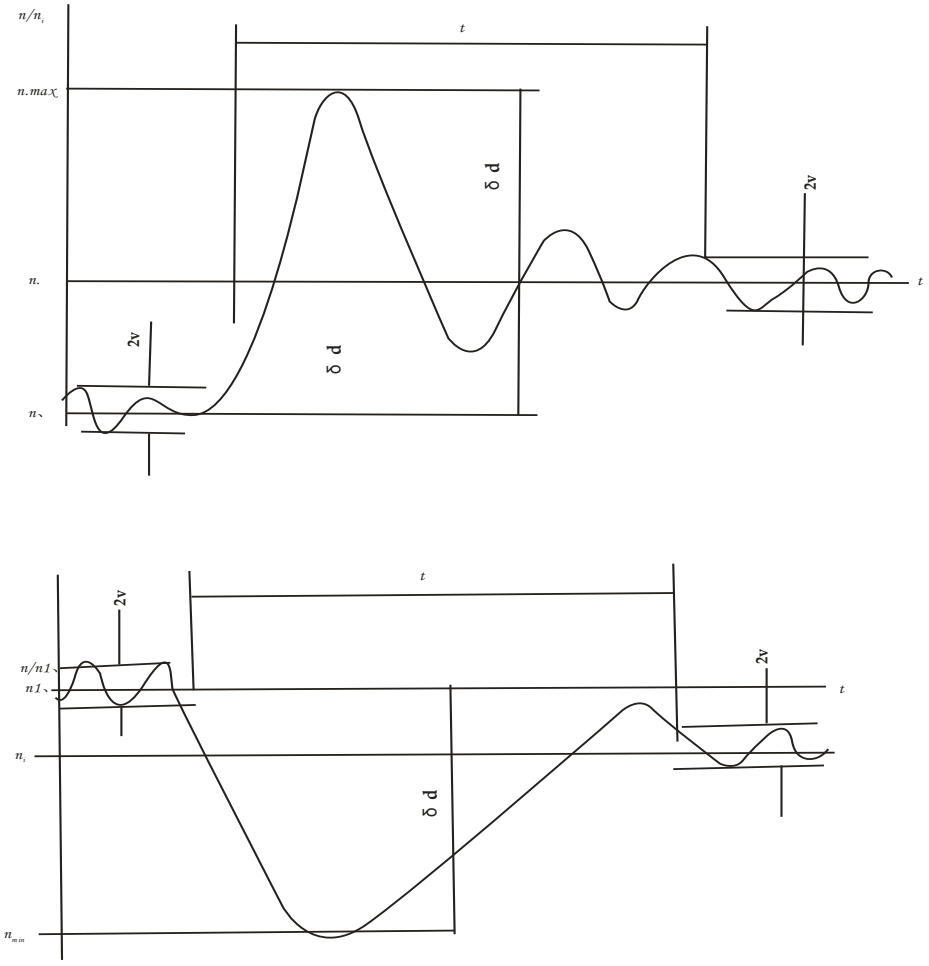

Figure 3.8.(2) Process of Transient Speed Change

n_N – rated speed; n_i – no-load speed; n_{max} , n_{min} – transient speed caused by load change

n_i – steady-state speed at applied load; t – time; ν – speed fluctuation

3.9 Insensitivity of governing system for generating sets

The insensitivity means the ratio of the maximum vertical distance △n between speed power

characteristic loops to the rated speed n_N, shown in percentage, where the steady-state speed governing rate is stabilized and the load of the generating set changes reciprocally in single direction within the range from no load to full load. See Figure ~~1.~~3.9.

$$\delta = \left|\frac{\Delta n}{n_N}\right| \times 100 \text{ .....(4)}$$

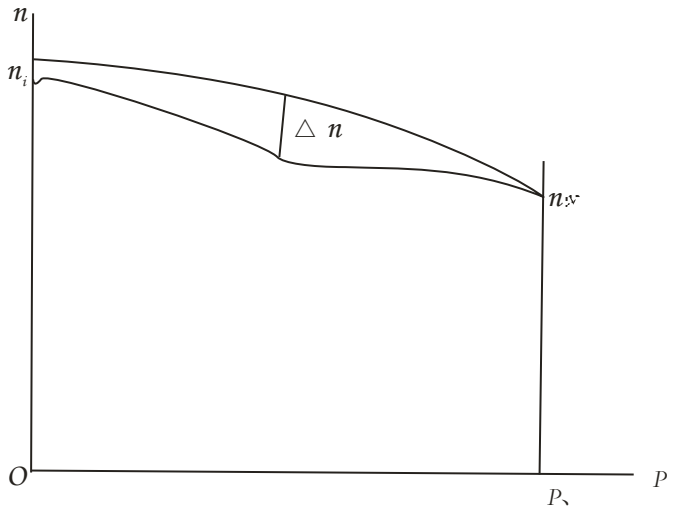

Figure 3.9 Insensitivity e of Governing System

3.10 Non-linearity of steady-state speed governing characteristics

The ratio of the maximum speed deviation as shown between the lines connecting the steady-state governing characteristic curve with the corresponding no load and rated load points to the rated speed, that is, the relative speed difference as shown between the line connecting no load and full load points of the governing characteristic curve and the straight line which is tangential to the steady-state speed governing characteristic curve and parallel to the connecting line. See Figure 3.10.

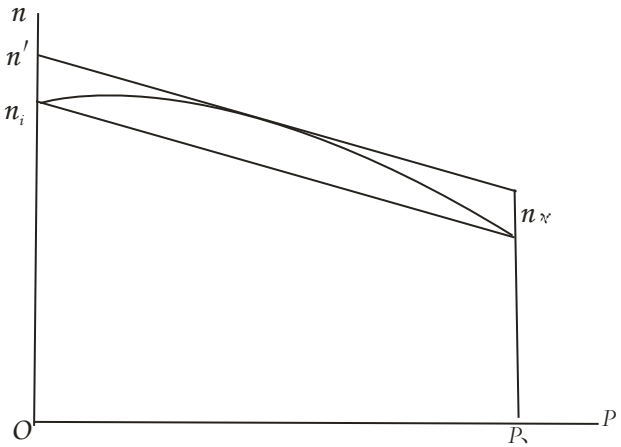

Figure 3.10 Non-Linearity of Steady-Speed Governing Characteristics

3.11 Speed fluctuation rate

Operating at any load within the range of no load to full load, the rate of the difference between the maximum speed n1 or minimum speed n2 measured at certain intervals and their average n_m to the average speed n_m is shown in percentage.

$$v = \frac{n_1 - n_m}{n_m} \times 100 \quad \text{or} \quad v = \frac{n_2 - n_m}{n_m} \times 100 \ldots\ldots (5)$$

where: v – speed fluctuation rate, in %;

m – average speed, i.e. $\frac{n_1 - n_2}{2}$, in r/min;

n_1 ~~n1~~ – maximum speed, in r/min;

n_2 ~~n2~~ – minimum speed, in r/min.

3.12 Steady-state voltage regulation rate

This is the ratio of the difference between the maximum or minimum voltage u within the loop reciprocally changing in single direction from no load to full load and the rated voltage u_N to the rated voltage u_N, shown in percentage, where the steady-state speed governing rate is stabilized and the excitation voltage regulation system remains unchanged to maintain the load power factor at its rated value.

$$\delta u = \frac{u - u_n}{u_n} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

where: δu– steady-state voltage regulation rate, in %;

u – maximum or minimum voltage, in V;

u_N ~~uN~~ – rated voltage, in V.

3.13 Transient voltage variation and stabilization time

The rate of the difference between the minimum or maximum transient voltage u‘ and the voltage u_0 prior to load change to the rated voltage u_N is shown in percentage where the steady-state speed

governing rate is stabilized and a specified symmetrical load, of which the power factor is 0.4 (lag) or less, is suddenly applied and then suddenly taken off at the voltage regulation rate.

$$\Delta u = \frac{u' - u_0}{u_n} \times 100 \quad \text{.....(7)}$$

~~$\Delta u = \frac{U' - u_0}{u_n} \times 100$ .....(7)~~

where: △u – transient voltage variation, in %;

u'~~'U'~~ – minimum or maximum transient voltage, in V;

u_0 – voltage prior to load change, in V~~;~~

u_N – rated voltage, in V.

Setting time is the time period starts from the voltage changes till the deviation between voltage and required voltage falls within 1-3% of rated voltage.

3.14 Voltage fluctuation rate

Operating at the set governing characteristics at any load from no load to full load, the rate of the difference between the maximum voltage u1 or the minimum peak voltage u2 measured at certain intervals and their average value um to the average voltage um is shown in percentage.

$$\theta = \frac{u_1 - u_m}{u_m} \times 100 \quad \text{or} \quad \theta = \frac{u_2 - u_m}{u_m} \times 100 \quad \text{..... (8)}$$

~~$\theta = \frac{u1 - u_m}{um} \times 100$ or $\theta = \frac{u2 - u_m}{um} \times 100$ ..... (8)~~

where: θ – voltage fluctuation rate, in %;

u_m ~~um~~ – average voltage, i.e. $\frac{u_1 - u_2}{2}$ $\frac{u1 - u2}{2}$ ~~,~~ in V;

u_1 – maximum voltage, in V;

u_2 – minimum voltage, in V.

3.15 Difference of load sharing

The difference between the actual load on the ith one of generating sets operating in parallel and the total average load.

$$\Delta P_i = \left| \frac{P_i}{P_{iN}} - \frac{\sum P_i}{\sum P_{iN}} \right| \times 100 \quad \text{..... (9)}$$

$$\Delta Q_i = \left| \frac{Q_i}{Q_{iN}} - \frac{\Sigma Q_i}{\Sigma Q_{iN}} \right| \times 100 \quad \text{..... (10)}$$

~~$\Delta Pi = \left| \frac{Pi}{PiN} - \frac{SPi}{SPiN} \right| \times 100$ ..... (9)~~

~~$\Delta \Sigma i = \left| \frac{\Sigma i}{\Sigma iN} - \frac{S\Sigma i}{S\Sigma iN} \right| \times 100$ ..... (10)~~

where: $\triangle P_i$ ~~$\triangle Pi$~~ – difference of active load sharing, in %;

$\triangle Q_i$ ~~Qi~~ – difference of passive load sharing, in %;

P_i ~~Pi~~ – actual active power for the ith generating set, in KW;

Q_i ~~Qi~~ – actual passive power for the ith generating set, in Kvar;

ΣP_i ~~ΣPi~~ – total actual active power for generating sets in parallel operation, in KW;

ΣQ_i ~~ΣQi~~ – total actual passive power for generating sets in parallel operation, in Kvar;

P_{iN} ~~PiN~~ – actual active power for the ith generating set, in KW;

Q_{iN} ~~QiN~~ – actual passive power for the ith generating set, in Kvar;

ΣP_{iN} ~~ΣPiN~~ – total rated active power of generating sets in parallel operation, in KW;

ΣQ_{iN} ~~ΣQiN~~ – total rated passive power of generating sets in parallel operation, in Kvar.

3.16 COP: Continuous power

3.17 PRP: Prime power

3.18 LTP: Limited-time running power.

4 Plans and documents

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

(1) General plans;

(2) List of components, including diesel engine and generator;

(3) Power load calculation of ship (where applicable)

(4) Nameplate

4.2 Torsional vibration calculations should been approved by CCS (applicable to diesel engines rated power is 110 kW or above for sea-going ships and diesel engines rated power is 220 kW or above for inland-waters ships).

5 Materials and components

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

6 Design and technical requirements

6.1 Generating sets are to comply with the requirements regarding main/emergency power sources in ships as specified in CCS Rules for Classification of Sea-going Steel Ships.

6.2 Diesel engines and generators of generating sets are to comply with the requirements regarding diesel engines and generators as specified in CCS Rules for Classification of Sea-going Steel Ships.

6.3 The rated power shall be appropriate for the actual use of the generator set. In general, the rated power of a generating set is not to be more than 85% of the rated power of the diesel engine (note: different cooling conditions in inland-waters ships and sea-going ships lead to different rated powers of diesel engines), unless the diesel engine is associated to the set such as to ensure compliance of the dynamic performance test with the requirements of CCS Rules for Classification of Sea-going Steel Ships.

6.4 The results of torsional vibration calculations are to comply with the requirements of CCS Rules for Classification of Sea-going Steel Ships. The generating set shall show torsional vibration levels which are compatible with the allowable limits for the alternator, shafts, coupling and damper. The coupling selection for the generating set shall take into account the stresses and torques imposed on it by the torsional vibration of the system.

6.5 the generating set shall install a rating plate marked with at least the following information:

(1) the generating set manufacturer’s name or mark;

(2) the set serial number;

(3) the set date of manufacture (month/year);

(4) the rated power (kW) and the rated capacity (KVA) with one of the prefixes COP, PRP (or, only foremergency Generating sets, LTP)

(5) the rated power factor;

(6) the set rated frequency (Hz);

(7) the set rated voltage (V);

(8) the set rated current (A);

(9) the mass (kg).

7 Type test

（Nil.）

8 Unit/batch inspection

8.1 Upon drawing approval and after completion of installation, commissioning and routine inspections by the assembling manufacturer, the unit/batch inspection is to be carried out.

8.2 The routine inspection report is to be submitted together with an application for inspection to CCS.

8.3 Where generating sets in large batches are to be delivered not ship by ship, the Surveyor is to sample at least 5% of them, based on 100% routine tests by the manufacturer.

8.4 Unit/batch test is to include the following items:

(1) Visual Examination;

(2) Cold insulation resistance test;

(3) Alarm for low pressure of lubricating oil;

(4) Alarm for high temperature of cooling water;

(5) Over speed protection test;

(6) Starting test (applicable to generating sets with starting batteries or starting air supply only);

(7) Operating test;

(8) Load test for 2 h and overload test for 0.5 h;

(9) Measurement of steady-state governing characteristics;

(10) Measurement of speed fluctuation rate;

(11) Measurement of transient speed governing and stabilization time;

(12) Measurement of voltage regulation range;

(13) Measurement of steady-state voltage regulation;

(14) Measurement of voltage fluctuation rate;

(15) Measurement of transient voltage variation and stabilization time;

(16) Parallel operation test or load bridging test;(if applicable)

(17) Thermal insulation resistance test.

8.5 Diesel engines and/or generators of the generating sets without CCS product certificate shall be supplemented by type tests of diesel engines and/or generators.