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Reciprocating internal combustion engine driven alternating current generating sets —

Part 8: Requirements and tests for low-power generating sets

Groupes électrogènes à courant alternatif entraînés par moteurs alternatifs à combustion interne —

Partie 8: Prescriptions et essais pour groupes électrogènes de faible puissance

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 70, *Internal combustion engines*.

This second edition cancels and replaces the first edition (ISO 8528-8:1995), which has been technically revised.

ISO 8528 consists of the following parts, under the general title, *Reciprocating internal combustion engine driven alternating current generating sets*:

— *Part 1: Application, ratings and performance*

— *Part 2: Engines*

— *Part 3: Alternating current generators for generating sets*

— *Part 4: Controlgear and switchgear*

— *Part 5: Generating sets*

— *Part 6: Test methods*

— *Part 7: Technical declarations for specification and design*

— *Part 8: Requirements and tests for low-power generating sets*

— *Part 9: Measurement and evaluation of mechanical vibrations*

— *Part 10: Measurement of airborne noise by the enveloping surface method*

— *Part 12: Emergency power supply to safety services*

— *Part 13: Safety*

Reciprocating internal combustion engine driven alternating current generating sets —

Part 8: Requirements and tests for low-power generating sets

1 Scope

This part of ISO 8528 defines design requirements, minimum performances and type tests for low-power generating sets driven by reciprocating internal combustion engines for land and marine use (domestic, recreational and industrial application), excluding generating sets used on aircraft.

It concerns mainly low-power generating sets driven by reciprocating internal combustion engines for the generation of single or multiphase alternating current or direct current up to 500 V. The generating sets are standard manufactured sets.

In this part of ISO 8528, "low-power" is taken to mean rated power of a magnitude up to approximately 10 kW/50 Hz, 12 kW/60 Hz. Low-power generating sets, for the purpose of this International Standard, are determined by the following special features:

— the users normally are laymen (for further details, see 3.1);

— the complete generating set is usually transportable or mobile;

— the electrical output is connected by means of plugs, sockets and screwed terminal except for extra low voltages;

— the generating set is ready for use without any additional installation work by the user.

Generating sets for special applications or of higher rated power conforming to the above special features may, by agreement between manufacturer and customer, be tested in accordance with this part of ISO 8528. If supplementary stipulations are required for certain applications, this is to be done taking this part of ISO 8528 as a basis.

This part of ISO 8528 deals with the special requirements of design and test which are observed in addition to the definitions and requirements laid down in ISO 8528-1, ISO 8528-2, ISO 8528-3, ISO 8528-4, ISO 8528-5 and ISO 8528-6, where applicable.

This part of ISO 8528 does not deal with safety requirements in order to protect the user from dangers which are laid down in ISO 8528-13.

NOTE This International Standard does not apply to arc welding equipment (IEC 60974 series).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3046-1, *Reciprocating internal combustion engines — Performance — Part 1: Declarations of power, fuel and lubricating oil consumptions, and test methods — Additional requirements for engines for general use*

ISO 8528-1:2005, *Reciprocating internal combustion engine driven alternating current generating sets — Part 1: Application, ratings and performance*

ISO 8528-5:2013, *Reciprocating internal combustion engine driven alternating current generating sets — Part 5: Generating sets*

ISO 8528-13:2016, *Reciprocating internal combustion engine driven alternating current generating sets — Part-13: Safety*

ISO 15550:2002, *Internal combustion engines — Determination and method for the measurement of engine power — General requirements*

IEC 60034-1:2010, *Rotating electrical machines — Part 1: Rating and performance*

IEC 60335-1:2013, *Household and similar electrical appliances —Safety — Part 1: General requirements*

IEC/TR 60083, *Plugs and socket-outlets for domestic and similar general use — Standardized in members countries of IEC*

CISPR 12, *Vehicles, boats and internal combustion engines — Radio disturbances characteristics — Limit*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
layman
person who does not necessarily recognize potential danger resulting from electricity, moving parts or hot parts

Note 1 to entry: The layman normally has a lack of training, knowledge and experience.

Note 2 to entry: See also Clause 6.

3.2
power rating
electric power available at the outlets or sockets of the generating sets, expressed in kilowatts (kW) at the rated frequency and the rated power factor

3.3
rated power
continuous power (COP) according to ISO 8528-1:2005, 13.3.1, as assigned by the generating set manufacturer

Note 1 to entry: The output voltage at the rated power should be within ±10 % of the nominal rated voltage (i.e. the value on label).

3.4
maximum power
MAX
power given by multiplying the current and voltage that the generating set is capable of delivering for at least 5 min within the voltage and frequency limits

Note 1 to entry: Prescribed output voltage shall be within ±10% of the rated voltage and prescribed output frequency shall be within ±8% of the rated frequency.

Note 2 to entry: The protective device shall not be activated for a period of 5 min and the overload conditions shall meet the requirements of 6.4. The minimum ratio between the power rating (COP) and the maximum power (MAX) shall be $P_{rated}/P_{max} \geq 0{,}75$

3.5
thermal steady state condition
state reached when the temperature rise of the generator does not vary by more than 2 K over a period of 1 hr

Note 1 to entry: Under normal test conditions, the RIC engine has first reached a steady-state condition before a set of measurements is taken. If not, the permissible deviations for the steady-state conditions of the RIC engine according to ISO 3046-3 apply.

Note 2 to entry: For electrical parts, see IEC 60034-1:2010, 3.25; for RIC engines, see ISO 15550:2002, 6.2.4.3.2.

3.6
uncontrolled generator
generator on which there is no load- and speed-dependent adjustment of excitation by an automatic voltage regulator for control of terminal voltage

Note 1 to entry: This includes generators with directly acting load current-dependent excitation devices (compounding).

3.7
automatic voltage regulator-controlled generator
generator on which the terminal voltage is controlled by changing the excitation by means of an automatic voltage regulator as a function of load and speed alternatively, where the terminal voltage is controlled automatically by means of an inverter type of conversion system

4 Regulations and additional requirements

For low-power generating sets, additional regulations depending on the location of its operation shall exist. These shall refer to environmental and safety requirements defined in the laws and regulations of the legal authorities in the different countries where generating sets are used. The regulations are mainly in the following fields:

— noise emission limitation;

— exhaust gas emission limitation;

— electrical safety;

— fuel systems.

5 General notes on tests

Tests according to this part of ISO 8528 are type tests, unless otherwise specified, the tests are made on a single sample as delivered, which shall withstand all the relevant tests.

During the tests, the temperature of the ambient air shall be kept between 15°C and 30°C.

Generating sets built for more than one type of rated voltage, rated frequency or current shall be tested for all relevant operating parameters.

6 Mechanical and electrical design (requirements and tests)

6.1 General

The requirements and tests of this part of ISO 8528 cover mechanical and electrical performance.

Acceptability of the component parts of the generating set shall be judged on the mechanical and electrical strength and resistance to ignition and distortion.

6.2 Electrical equipment

6.2.1 Generator

6.2.1.1 Rating and performance

The generator shall meet the requirements of IEC 60034-1 concerning duty type S1, covering rated values, irregularities of waveform, symmetry of voltages, capability of unbalanced load, temperature rise, dielectric properties and short circuit strength.

Compliance shall be checked by checking manufacturer's documentation.

6.2.1.2 Connection to stator or field

Access to brushes shall not be possible without tools. Screw caps or brush holders shall be screwed against a shoulder or a similar stop and grip with at least three full threads. Brush holders in which the brush is held in position by a locking facility shall be made in such a way as to ensure that locking is not dependent on brush spring pressure if loosening of the locking facility could give access to live parts.

Screw caps of brush holders accessible from the outside surface of the generator shall be made of insulating material or be covered by insulating material of suitable mechanical and electrical strength. They shall not project beyond the surrounding surface of the unit.

Compliance shall be checked by visual inspection, mechanical test according to ISO 8528-13:2016, 6.12 and dielectric strength according to IEC 60335-1:2013, 13.

6.2.2 Connection of electric loads

Except for extra low voltages, low voltages plug-and-socket connections according to IEC/TR 60083 (single phase) and IEC 60309 (multiphase), or relevant national standards, shall be applied.

It shall not be possible to confuse plugs and socket outlets for very low voltage circuits with those plugs and socket outlets for low voltage circuits. (Very low voltage ≤ 50 V and 50 < Low voltage ≤ 1 000 V.)

6.2.3 Screws and connections

Screws and connections shall be designed in accordance with IEC 60335-1:2010, Clause 28. Compliance shall be checked in accordance with IEC 60335-1:2013, Clause 28.

6.3 Temperature rise

6.3.1 General

During the operating of a generating set with given ratings, the permitted temperature limits shall not be exceeded. Thermal steady state condition is verified by measuring surface temperature of winding and/or lubricating oil temperature.

The requirement is met if at average permitted power and for a minimum run of 60 min, the permitted values according to 6.3.2 and 6.3.3 are not exceeded.

6.3.2 Generator

The permitted temperature limits are given in IEC 60034-1:2010, Clause 8.

Compliance shall be checked by the generator being operated at ambient conditions as defined in Clause 5. Temperature rise test and method of measurement shall be in accordance with IEC 60034-1:2010, Clause 8.

During the test the average permitted power for the generating set shall be maintained at a constant level.

According to IEC 60034-1:2010, 8.4 the temperature rise shall be determined immediately after the temperature rise test.

To measure the temperature of the windings the resistance method shall be used.

NOTE In the case of an asynchronous generator, higher temperatures can occur when the generator is running at no-load or in the part-load range than when at rated power. If necessary, a further temperature rise test is required at part-load conditions.

6.3.3 RIC engines and other components

The temperatures are measured at thermal steady-state conditions. They shall not exceed the maximum temperatures specified by the component manufacturers.

Compliance is checked by temperature measurement.

6.4 Overload conditions

6.4.1 General

Overload is likely to occur in normal use. Generating sets which are tested in accordance with this part of ISO 8528 shall not suffer any damage as a result of an overload which could impair safety.

6.4.2 Uncontrolled generator

For generating sets with uncontrolled generators, load limitation is provided by means of the speed and voltage reduction which occurs with increasing load.

This mode of operation shall be checked at ambient conditions in accordance with Clause 5, and at rated power and rated power factor in accordance with 7.1; the generating set shall be loaded with active or apparent power to above its rated power until maximum power occurs or until the voltage drops to 0,8 rated voltage.

A temperature rise test is then performed at the determined working point for a maximum of 30 min or until the protective device provides trips. During this test, the temperature rise of the generator windings shall not exceed the limits laid down in IEC 60034-1:2010, 8.10.1 by more than 20 K (i.e. for S2 a total of 30 K).

6.4.3 Controlled generator

In the case of generating sets with controlled generators, the voltage also remains within set limits with increasing load. The power supplied by the generator increases in proportion to the load. The power of the generating set is generally limited by the reciprocating internal combustion engine.

It is necessary to protect a.c. generator against thermal overloading if underspeed occurs. Where a shutdown function is used for this purpose, the switch back may not occur automatically.

This mode of operation shall be checked by loading the generating set above its rated power up to the maximum available power before voltage collapse. This is then followed by a temperature rise test and assessment in accordance with 6.4.2.

If the maximum power is limited by a protective device the maximum power shall to be maintained for a period of at least 5 min. In all cases, the overload conditions shall meet the requirements of 6.4.

6.5 Improper operation

6.5.1 Generating sets may only be loaded up to rated power under the specified cooling and temperature conditions. If operating conditions do not conform to the reference conditions as stipulated in this part of ISO 8528 and if the cooling of the engine or the generator is impaired (e.g. as a result

of operation in restricted areas), a reduction in power is necessary. This fact shall be stipulated in the operation instructions.

Compliance shall be checked by a check of operating instructions.

6.5.2 Short circuits on any of the electrical outputs of the generating set shall not cause mechanical or electrical damage that could impair safety. This also applies to electrical charging rectifiers, even in the event of reversal of polarity when connected to a charged battery.

Where different rated voltages are possible, incorrect voltage selection shall not cause any consequential damage to the generating set.

Compliance shall be checked by operating the generating set until stable conditions are established, whilst short court-circuiting output terminals or terminations and fuses which are accessible without the aid of a tool. Each check on incorrect running conditions shall be performed separately.

After each test, any protection device that has operated shall be replaced or reset.

For generating sets with a battery charger output, a fully charged battery is connected in reverse to the output terminals or terminations until stable conditions are established.

During these tests, the generating set shall not emit flames or molten metal, or in hazardous amounts, poisonous or ignitable gas and enclosures shall not deform to such an extent as to impair compliance with this part of ISO 8528.

The battery used for this test is a lead acid battery having a rated DC output voltage equal to the rated DC output voltage of the battery-charging circuit of the generating set and a capacity of at least 70 Ah. These conditions are valid unless the marking of the battery charger indicates that it is intended to charge a different type of battery, in which case the test is made with a battery of that type and whose maximum capacity is in accordance with the marking on the generating set or in the owner's manual.

6.5.3 Controls which determine the specified engine speed shall be factory safeguarded by the manufacturer of the generating set against misuse by the user. Where sealing is not possible or if the connecting linkage between the speed governor and the actuator is accessible from the exterior, short-term overspeed to 1,2 times the rated speed shall not cause damage to the generating sets.

Compliance shall be checked by visual inspection and one minute operation at 1,2 times rated speed.

7 Operating characteristics, power output, quality class and fuel consumption

7.1 Standard reference conditions

For the purpose of determining operating characteristics, power output, quality class and fuel consumption, the following standard reference conditions shall be used.

The standard reference conditions according to ISO 3046-1 and ISO 15550 are as follows:

— ambient air temperature: 25 °C, 298 K;

— ambient air pressure: 100 kPa;

— relative humidity: 30 %.

The test conditions shall be according to Clause 5.

7.2 Start-up and operating conditions

Generating sets in accordance with this part of ISO 8528 shall be able to start-up and to operate at ambient temperatures between –15 °C and 40 °C.

7.3 Determination of performance class, quality class and fuel consumption

7.3.1 Performance class

Generating sets shall be prepared and started in accordance with the operating instructions. After approximately 5 min warming-up time for the reciprocating internal combustion engine, the upper limit values for voltage and frequency shall be measured with the generator on no-load.

The generating set shall be run for a minimum of 60 min at rated power (COP) and at the rated power factor. The power test is performed by gradually increasing the load from generator no-load operation to rated power output or up to the power output limit.

A check shall be completed to ascertain whether, during the loading sequence, voltage and frequency parameters comply with class G1 of ISO 8528-5:2013, Table 4.

7.3.2 Quality class

The generating set shall be run for a minimum of 60 min. at rated power (COP) and at the rated power factor. The active power is measured directly using an active-power meter and the apparent power is calculated by taking the product of current and voltage.

Where pressure and/or ambient temperature at the test location deviate during measurement from the standard reference conditions specified in this part of ISO 8528 (see 7.1) the relevant measured values of the RIC engine shall be corrected according to ISO 3046-1.

According to the corrected power, the generating sets shall be classified according to 2 quality classes:

Class A: the value of the corrected power to standard reference conditions shall not be less than 95% of the maximum power.

Class B: the value of the corrected power to standard reference conditions shall not be less than 90% of the maximum power.

7.3.3 Fuel consumption

The specific fuel consumption of low-power generating sets is calculated at 75 % of rated power output (terminal output). The data shall be given in grams per kilowatt hour complying with the stipulations of ISO 15550:2002, Table 4 or alternatively in liters per hour.

7.4 Radio interference suppression

The generating set shall be designed in such a way that the limits of radio interference according to CISPR 12 are met.

The installation of components for the suppression of radio interference voltages shall not have a detrimental effect on the electrical and mechanical safety of the generating set.

Compliance shall be checked in accordance with CISPR 12.

Bibliography

[1] ISO 3046-3:2006, *Reciprocating internal combustion engines — Performance — Part 3: Test measurements*

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