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Reciprocating internal combustion engine driven alternating current generating sets —

Part 3:
Alternating current generators for generating sets

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

Partie 3: Alternateurs pour groupes électrogènes

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 shall be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document can be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 70, *Internal combustion engines*, together with IEC/TC 2, *Rotating electrical machines*, by merging this document with IEC 60034-22:2009.

This third edition cancels and replaces the second edition (ISO 8528-3:2005), which has been revised.

The main changes compared to the previous edition are as follows:

— clause 9 updated with requirements for isochronous operation and grid parallel operation;

— requirements for asynchronous generators integrated in clause 10;

— new power rating “GPO” introduced for grid parallel operation;

— revision of operating limits;

— new clauses added for specifying “bearings” and “maintenance”;

— new Annex B describing voltage and frequency range for grid parallel operation.

— elimination of identification markings BR and PR;

A list of all parts in the ISO 8528 series can be found on the ISO website.

Any feedback or questions on this document shall be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Reciprocating internal combustion engine driven alternating current generating sets —

Part 3: Alternating current generators for generating sets

1 Scope

This document specifies the principal characteristics of alternating current (a.c.) generators under the control of their excitation control system when used for reciprocating internal combustion (RIC) engine driven generating set applications and supplements the requirements given in IEC 60034-1. It covers the use of such a.c. generators for land and marine applications, excluding generating sets used on aircraft or to propel land vehicles and locomotives.

NOTE 1 For some specific applications (e.g. essential hospital supplies, high-rise buildings, operation parallel with the grid), supplementary requirements can be necessary. The provisions of this document can be regarded as the basis for establishing any supplementary requirements.

NOTE 2 Attention is drawn to the need to take note of additional regulations or requirements imposed by various regulatory bodies. Such regulations or requirements can form the subject of agreement between the a.c. generator manufacturer and the generating set manufacturer when conditions of use of the product invoke such requirements.

NOTE 3 Examples of regulatory authorities:

— classification societies, for generating sets used on ships and offshore installations;

— government agencies;

— inspection agencies, local utilities, etc.

For a.c. generating sets driven by other reciprocating-type prime movers (e.g. steam engines) the provisions of this document can be used as basis for establishing these requirements.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 281, *Rolling bearings — Dynamic load ratings and rating life*

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

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

IEC 60034-5, *Rotating electrical machines — Part 5: Degrees of protection provided by the integral design of rotating machines (IP code) — Classification*

IEC 60034-6, *Rotating electrical machines — Part 6: Methods of cooling (IC code)*

IEC 60034-7, *Rotating electrical machines — Part 7: Classification of types of construction, mounting arrangements and terminal box position (IM code)*

IEC 60050 (all parts), *International Electrotechnical Vocabulary*

CISPR 11, *Industrial, scientific and medical equipment — Radio-frequency disturbance characteristics — Limits and methods of measurement*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

NOTE 1: This document uses suffix "r" for "rated" whereas in IEC standards the suffix "N" is used.

NOTE 2: Voltage terms relate to an a.c. generator running at constant (rated) speed under the control of the normal excitation and voltage control system.

3.1
rated output
rated apparent power
S_r
product of the rated rms voltage, the rated rms current and a constant m

Note 1 to entry: Where

$m = 1$ for single-phase;

$m = \sqrt{2}$ for two-phase;

$m = \sqrt{3}$ for three-phase.

Note 2 to entry: $\sqrt{2}$ is applicable only when the a.c. generator is specifically designed in two-phase, an angle of 90° electrical between the two poles.

Note 3 to entry: S_r is expressed in volt-amperes (VA) or its multiples.

3.2
rated active power
P_r
product of the rated rms voltage, the in-phase component of the rated rms current and a constant m

Note 1 to entry: Where

$m = 1$ for single-phase;

$m = \sqrt{2}$ for two-phase;

$m = \sqrt{3}$ for three-phase.

Note 2 to entry: $\sqrt{2}$ is applicable only when the a.c. generator is specifically designed in two-phase, an angle of 90° electrical between the two poles.

Note 3 to entry: P_r is expressed in watts (W) or its decimal multiples.

3.3
rated power factor
$\cos \varphi_r$
ratio of the rated active power (3.2) to the rated output (3.1)

$$cos\varphi_r = \frac{P_r}{S_r}$$

3.4
rated reactive power
Q_r
geometrical difference of the rated output (3.1) and the rated active power (3.2)

$$Q_r = \sqrt{S_r^2 - P_r^2}$$

Note to entry: Q_r is expressed in volt-amperes reactive (var) or its decimal multiples.

3.5
rated speed of generator rotation
n_r
speed of rotation necessary for voltage generation at rated frequency

For a synchronous generator, the rated speed of generator rotation is given by

$$n_r = 60 \frac{f_r}{p}$$

Note 1 to entry: Where

p is the number of pole pairs;

f_r is the rated frequency (according to load requirements), expressed in (Hz).

For an asynchronous generator the rated speed of generator rotation is given by

$$n_r = 60 \frac{f_r}{p}(1 - s_r)$$

Note 2 to entry: Where

p is the number of pole pairs;

f_r is the rated frequency (according to load requirements) expressed in (Hz);

s_r is the rated slip (3.6).

Note 3 to entry: n_r is expressed in (min^{-1}).

Note 4 to entry: Since the slip of an asynchronous generator is always negative, the rated speed (3.5) is above the synchronous speed.

3.6
rated slip
s_r
difference between the synchronous speed and the rated speed (3.5) of the rotor divided by the synchronous speed, when the generating set is operated at its rated active power (3.2)

$$s_r = \frac{60\,\frac{f_r}{p} - n_r}{60\,\frac{f_r}{p}}$$

Note to entry: s_r is only relevant to an asynchronous generator.

3.7
rated voltage
U_r
line-to-line voltage at the terminals of the a.c. generator at rated frequency and at rated output (3.1)

Note 1 to entry: Rated voltage (3.7) is the voltage assigned by the a.c. generator manufacturer for operating and performance characteristics.

Note 2 to entry: U_r is expressed in volts (V) or its decimal multiples.

3.8
no-load voltage
U_0
line-to-line voltage at the terminals of the a.c. generator at rated frequency and no-load

Note to entry: U_0 is expressed in volts (V) or its decimal multiples.

3.9
operating voltage
U_c
value of the voltage under normal conditions at a given instant and given point of the system

[SOURCE: IEC 60050-601:1985, 601-01-22]

Note 1 to entry: U_c is expressed in volts (V) or its decimal multiples.

Note 2 to entry: This value can be expected, estimated or measured.

3.10
range of voltage setting
ΔU_s
range of possible upward and downward adjustment of voltage at a.c. generator terminals at rated frequency, for all loads between no-load and rated output (3.1)

$$\Delta U_s = |\Delta U_{s,up}| + |\Delta U_{s,do}|$$

with

a) The upward range of voltage setting

$$\Delta U_{s,up} = \frac{U_{s,up} - U_r}{U_r} \cdot 100\ \%$$

Note 1 to entry: $U_{s,up}$ is the upward adjustable limit for voltage settings, expressed in volts (V) or its decimal multiples.

b) The downward range of voltage setting

$$\Delta U_{s,do} = \frac{U_{s,do} - U_r}{U_r} \cdot 100\ \%$$

Note 2 to entry: $U_{s,do}$ is the downward adjustable limit for voltage settings, expressed in volts (V) or its decimal multiples.

Note 3 to entry: ΔU_s is expressed as a percentage of rated voltage (3.7).

Note 4 to entry: Special controllable excitation equipment can provide a range of voltage adjustment for asynchronous generators.

3.11
steady-state voltage tolerance band
ΔU
agreed voltage band about the steady-state voltage that the voltage can reach within a given voltage recovery time (3.14) after a specified sudden increase or decrease of load

Note to entry: ΔU is expressed as a percentage of rated voltage (3.7).

3.12
steady-state voltage regulation
ΔU_{st}
change in steady-state voltage for all load changes between no-load (3.8) and rated output (3.1), considering the influence of temperature but ignoring the effect of quadrature current compensation voltage droop

$$\Delta U_{st} = \frac{U_{st,max} - U_{st,min}}{U_r} \cdot 100\ \%$$

Note 1 to entry: Where

$U_{st,max}$ is the maximum steady-state voltage deviation, expressed in volts (V) or its decimal multiples;

$U_{st,min}$ is the minimum steady-state voltage deviation, expressed in volts (V) or its decimal multiples.

Note 2 to entry: The initial set voltage is usually rated voltage (3.7) but can be anywhere within the range of voltage setting (3.10).

Note 3 to entry: ΔU_{st} is expressed as a percentage of rated voltage (3.7).

3.13
transient voltage regulation
δU_{dyn}
maximum voltage change following a sudden change of load

a) with load increase

maximum transient voltage drop
δU_{dyn}^{-}
maximum voltage drop, when the a.c. generator, driven at rated speed (3.5) and at rated voltage