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Reciprocating internal combustion engine driven alternating current generating sets —

Part 5: Generating sets

Groupes électrogènes à courant alternatif entraînés par moteurs alternatifs à combustion interne — ~~Partie 5:~~
~~Groupes électrogènes~~

Partie 5: 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 document 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 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*.

This sixth edition cancels and replaces the fifth edition (ISO 8528-5:2022), which has been technically revised.

The main changes are as follows:

- ~~Clause 3~~ Clause 3 has been revised;
- a list of symbols has been added in ~~3.2~~ 3.2;
- errors have been corrected in ~~Table 4~~ Table 4;
- previous ~~Figures 3, 7, 8, 14~~ Figures 3, 7, 8, 14 and ~~16~~ 16 have been modified and renumbered;
- previous ~~Figures 1~~ Figures 1 and ~~17~~ 17 have been deleted;
- Annex A has been deleted.

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

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

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Reciprocating internal combustion engine driven alternating current generating sets —

Part 5: Generating sets

1 Scope

This document specifies design and performance criteria arising out of the combination of a reciprocating internal combustion (RIC) engine and an alternating current (AC) generator when operating as a unit. This unit can run in parallel to the grid or not.

This document applies to AC generating sets driven by RIC engines for land and marine use, excluding generating sets used on aircraft, or to propel land vehicles and locomotives.

For some specific applications (e.g. essential hospital supplies and high-rise buildings), supplementary requirements can apply. The provisions of this document are a basis for establishing any supplementary requirements.

For generating sets driven by other reciprocating-type prime movers (e.g. steam engines), the provisions of this document can be used as a 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 3046-5, *Reciprocating internal combustion engines — Performance — Part 5: Torsional vibrations*

ISO 8528-1:2018, *Reciprocating internal combustion engine driven alternating current generating sets — Part 1: Application, ratings and performance*

ISO 8528-3:2020, *Reciprocating internal combustion engine driven alternating current generating sets — Part 3: Alternating current generators for generating sets*

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

3 Terms, definitions and symbols

3.1 Terms and definitions

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

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

**3.1.1 ~~3.1.1~~
frequency**

f
reciprocal of the period

Note 1_to_entry:-The symbol f is mainly used when the period is a time.

**3.1.2 ~~3.1.2~~
no-load frequency**

f_i
frequency at which the generating set is operating without load

**3.1.3 ~~3.1.3~~
rated no-load frequency**

$f_{i,r}$
frequency at which the generating set is designed to operate without load

**3.1.4 ~~3.1.4~~
rated frequency**

f_r
frequency at which the generating set is designed to operate at rated load

**3.1.5 ~~3.1.5~~
maximum safety frequency**

$f_{\max}$
maximum frequency which causes a stop to production

**3.1.6 ~~3.1.6~~
minimum safety frequency**

$f_{\min}$
minimum frequency which causes a stop to production

**3.1.7 ~~3.1.7~~
frequency setting rate of change**

v_f
rate of change of frequency setting under remote control

Note_1_to_entry:- $v_f = \frac{(f_{i,\max} - f_{i,\min}) / f_r}{t} \times 100$; $v_f = \frac{(f_{i,\max} - f_{i,\min}) / f_r}{t} \times 100$

where

$f_{i,\max}$ is the maximum no-load frequency;

$f_{i,\min}$ is the minimum no-load frequency;

f_r is the *rated frequency* (~~3.1.4~~), (~~3.1.4~~).

Note_2_to_entry:-Expressed as a percentage of related range of frequency setting per second.

**3.1.8 ~~3.1.8~~
voltage setting rate of change**

v_U
rate of change of voltage setting under remote control

Note 1 to entry: $v_U = \frac{(U_{s,up} - U_{s,do})}{U_r} \times 100$; $v_U = \frac{(U_{s,up} - U_{s,do})}{U_r} \times 100$

where

U_r is the rated voltage (3.1.11);

$U_{s,do}$ is the downward adjustment of voltage (3.1.9);

$U_{s,up}$ is the upward adjustment of voltage (3.1.10);

Note 2 to entry: Expressed as a percentage of the related range of voltage setting per second.

3.1.9 3.1.9

downward adjustment of voltage

$U_{s,do}$

lower limit of adjustment of voltage at the generator terminals at rated frequency, for all loads between no-load and rated output and within the agreed range of power factor

3.1.10 3.1.10

upward adjustment of voltage

$U_{s,up}$

upper limit of adjustment of voltage at the generator terminals at rated frequency, for all loads between no-load and rated output and within the agreed range of power factor

3.1.11 3.1.11

rated voltage

U_r

line-to-line voltage at the terminals of the generator at rated frequency and rated output

3.1.12 3.1.12

set voltage

U_s

maximum obtainable steady-state voltage for a specified load condition or line-to-line voltage for defined operation selected by adjustment

3.1.13 3.1.13

no-load voltage

U_0

line-to-line voltage at the terminals of the generator at rated frequency and no-load

3.1.14 3.1.14

voltage modulation

$\hat{U}_{mod,s}$

quasi-periodic voltage variation (peak-to-peak) about a steady-state voltage having typical frequencies below the fundamental generation frequency

Note 1 to entry: Expressed as a percentage of average peak voltage ($=\hat{U}_{mean,s}$) at rated frequency and constant speed.

$$\hat{U}_{mod,s} = 2 \times \frac{\hat{U}_{mod,s,max} - \hat{U}_{mod,s,min}}{\hat{U}_{mod,s,max} + \hat{U}_{mod,s,min}} \times 100$$

Note 2 to entry:

$$= \frac{a_f}{\hat{U}_{mean,s}} \times 100$$

Note 2 to entry:

$$\hat{U}_{\text{mod},s} = 2 \times \frac{\hat{U}_{\text{mod},s,\text{max}} - \hat{U}_{\text{mod},s,\text{min}}}{\hat{U}_{\text{mod},s,\text{max}} + \hat{U}_{\text{mod},s,\text{min}}} \times 100$$

$$= \frac{a_f}{\hat{U}_{\text{mean},s}} \times 100$$

where

$\hat{U}_{\text{mod},s,\text{max}}$ is the maximum peak of voltage modulation;

$\hat{U}_{\text{mod},s,\text{min}}$ is the minimum peak of voltage modulation.

Note 3 to entry:—This is a cyclic or random disturbance which can be caused by regulators, cyclic irregularity or intermittent loads. Flickering lights are a special case of voltage modulation (see Figures 8 and 9).

3.1.15 3.1.15

steady-state frequency tolerance band

Δf
agreed frequency band about the steady-state frequency which the frequency reaches within a given governing period after increase or decrease of the load

3.1.16 3.1.16

related range of frequency setting

δf_s
range of frequency setting

Note 1 to entry:—See Figure 1.

Note 2 to entry:—Expressed as a percentage of rated frequency.

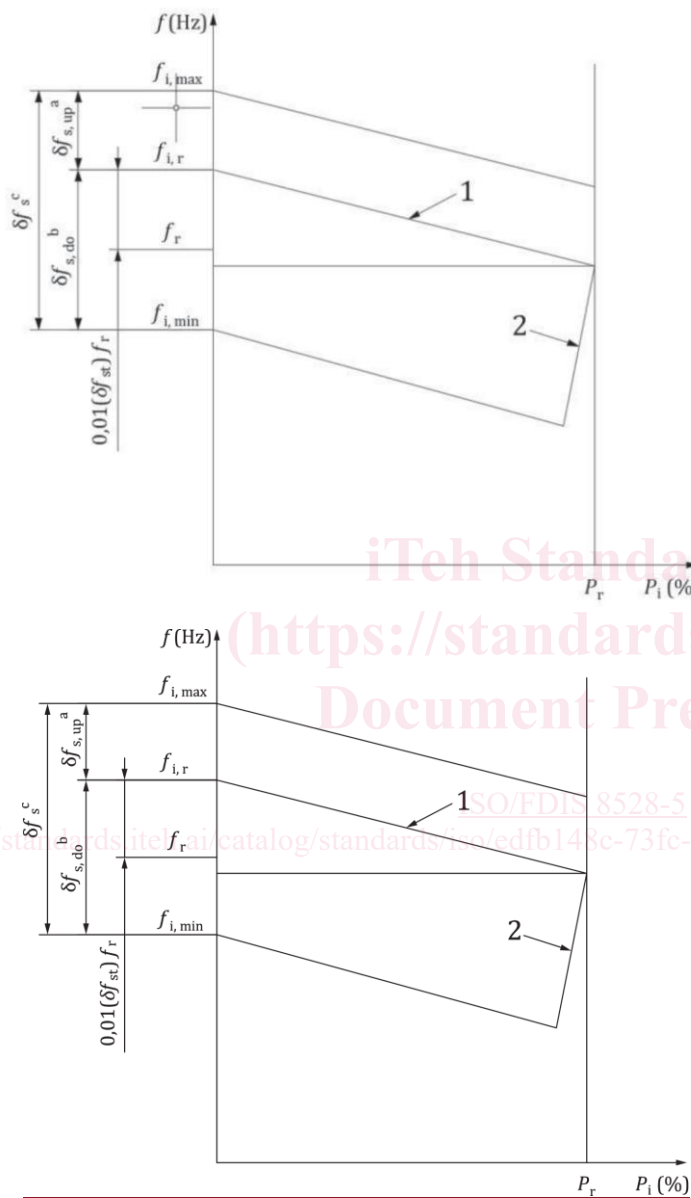
Note 3 to entry:— $\delta f_s = \frac{f_{i,\text{max}} - f_{i,\text{min}}}{f_r} \times 100$, $\delta f_s = \frac{f_{i,\text{max}} - f_{i,\text{min}}}{f_r} \times 100$

where

$f_{i,\text{max}}$ is the maximum no-load frequency;

$f_{i,\text{min}}$ is the minimum no-load frequency;

f_r is the rated frequency (3.1.4).



- Key**
- P power
 - f frequency
 - P_r rated power
 - 1 frequency/power characteristic curve

- 2 power limit [the power limit of the generating set depends upon the power limit of the RIC engine (e.g. fuel stop power) taking into account the efficiency of the AC generator]
- a Related upward range of frequency setting.
- b Related downward range of frequency setting.
- c Related range of frequency setting.

Figure 1 — Frequency/power characteristic, range of frequency setting

3.1.17 ~~3.1.17~~

downward range of frequency setting

$\Delta f_{s,do}$

range between the declared no-load frequency and the lowest adjustable no-load

Note_1_to_entry: $\Delta f_{s,do} = f_{i,r} - f_{i,min}$ $\Delta f_{s,do} = f_{i,r} - f_{i,min}$

where

$f_{i,r}$ is the *rated no-load frequency* (3.1.3); (3.1.3);

$f_{i,min}$ is the minimum no-load frequency.

3.1.18 ~~3.1.18~~

upward range of frequency setting

$\Delta f_{s,up}$

range between the highest adjustable no-load frequency and the declared no-load frequency

Note_1_to_entry: See Figure 1. Figure 1.

Note_2_to_entry: $\Delta f_{s,up} = f_{i,max} - f_{i,r}$ $\Delta f_{s,up} = f_{i,max} - f_{i,r}$

where

$f_{i,max}$ is the maximum no-load frequency;

$f_{i,r}$ is the *rated no-load frequency* (3.1.3); (3.1.3);

3.1.19 ~~3.1.19~~

range of voltage setting

ΔU_s

range of maximum possible upward and downward adjustments of voltage at the generator terminals at rated frequency, for all loads between no-load and rated output and within the agreed range of power factor

Note_1_to_entry: $\Delta U_s = \Delta U_{s,up} - \Delta U_{s,do}$ $\Delta U_s = \Delta U_{s,up} - \Delta U_{s,do}$

where

$\Delta U_{s,up}$ is the upward range of voltage setting;

$\Delta U_{s,do}$ is the downward range of voltage setting.

Note_2_to_entry: $\Delta U_{s,up} = \frac{U_{s,up} - U_r}{U_r} \cdot 100\%$ $\Delta U_{s,up} = \frac{U_{s,up} - U_r}{U_r} \cdot 100\%$