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Reciprocating internal combustion engine driven alternating current generating sets —

Part 2: Engines

Groupes électrogènes à courant alternatif entraînés par moteurs alternatifs à combustion interne —
Partie 2: Moteurs

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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 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 70, *Internal combustion engines*.

This third edition cancels and replaces the second edition (ISO 8528-2:2005), of which it constitutes a minor revision.

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

— the normative references have been updated;

— editorial changes have been made.

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

Reciprocating internal combustion engine driven alternating current generating sets —

Part 2: Engines

1 Scope

This document specifies the principal characteristics of Reciprocating Internal Combustion (RIC) engines when used for alternating current (a.c.) generating set applications.

It applies to RIC engines for a.c. generating sets 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, high rise buildings), supplementary requirements can be necessary. The provisions of this document can be regarded as the basis for establishing any supplementary requirements.

The terms which define the speed governing and speed characteristics of RIC engines are listed and explained where they apply specifically to the use of the engine for driving a.c. generators.

For 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 3046-1, *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 8528-1:2018, *Reciprocating internal combustion engine driven alternating current generating sets — Part 1: Application, ratings and performance*

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

3 Terms, symbols, 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/

An explanation of the symbols and abbreviations used in this document is shown in Table 1.

Table 1 — Symbols, terms and definitions

Symbol	Term	Unit	Definition
n	Engine speed	min^{-1}	
n_r	Declared speed	min^{-1}	Engine speed at declared power corresponding to the rated frequency of the generating set.
n_{sf}	Firing speed	min^{-1}	Engine speed to which an engine must be accelerated from rest by the use of an external supply of energy separate from the fuel feed system before the engine becomes self-sustaining.
n_{max}	Maximum permissible speed	min^{-1}	Speed of the engine specified by the RIC engine manufacturer which lies a safe amount below the speed limit (see NOTE 1 and Figure 3).
n_a	Partial-load speed	min^{-1}	Steady-state engine speed of an engine running at a % of the declared power given by: $a = 100 \times \frac{P_a}{P_r}$ EXAMPLE: at 45 % power, a = 45 (see Figure 2) For a = 45 $n_a = n_{i,r} - \frac{P_a}{P_r}(n_{i,r} - n_r)$ $= n_{i,r} - 0{,}45(n_{i,r} - n_r)$ Note 1 to entry: Corresponding values of declared speed and partial-load speed are based on an unchanged speed setting.
$n_{i,r}$	Declared no-load speed	min^{-1}	Steady-state engine speed without load at the same speed setting as for the declared speed, n_r.
$n_{i,min}$	Lowest adjustable no-load speed	min^{-1}	Lowest steady-state engine speed without load obtainable on the governor speed setting device.
$n_{i,max}$	Highest adjustable no-load speed	min^{-1}	Highest steady-state engine speed without load obtainable on the governor speed setting device.
$n_{d,s}$	Setting speed of overspeed limiting device	min^{-1}	Speed of the engine, the exceeding of which activates the overspeed limiting device (see Figure 3).
$n_{d,o}$	Operating speed of overspeed limiting device	min^{-1}	Speed of the engine at which, for a given setting speed, the limiting device starts to operate (see NOTE 2 and Figure 3).

NOTE 1 The speed limit is the maximum calculated speed which the engine can sustain without risk of damage.

NOTE 2 For a given engine, the operating speed depends on the total inertia of the generating set and the design of the overspeed protection system.

NOTE 3 100 kPa = 1 bar.

Table 1 *(continued)*

Symbol	Term	Unit	Definition
δn_s	Speed setting related range	%	Range of speed setting, expressed as a percentage of the declared speed given by: $\delta n_s = \frac{n_{i,max} - n_{i,min}}{n_r} \times 100$
Δn_s	Speed setting range	min^{-1}	Range between the highest and lowest adjustable no-load speeds given by: $\Delta n_s = n_{i,max} - n_{i,min}$
$\delta n_{s,do}$	Speed setting related downward range	%	Downward range of speed setting, expressed as a percentage of the declared speed given by: $\delta n_{s,do} = \frac{n_{i,r} - n_{i,min}}{n_r} \times 100$
$\Delta n_{s,do}$	Speed setting downward range	min^{-1}	Range between the declared no-load speed and the lowest adjustable no-load speed given by: $\Delta n_{s,do} = n_{i,r} - n_{i,min}$
$\delta n_{s,up}$	Speed setting related upward range	%	Upward range of speed setting, expressed as a percentage of the declared speed given by: $\delta n_{s,up} = \frac{n_{i,max} - n_{i,r}}{n_r} \times 100$
$\Delta n_{s,up}$	Speed setting upward range	min^{-1}	Range between the highest adjustable no-load speed and the declared no-load speed given by: $\Delta n_{s,up} = n_{i,max} - n_{i,r}$
ν_n	Speed setting rate of change	$\%\cdot s^{-1}$	Rate of change of speed setting under remote control, expressed as a percentage of the related range of speed setting per second given by: $\nu_n = \frac{(n_{i,max} - n_{i,min})/n_r}{t} \times 100$
	Adjustment range	min^{-1}	Speed range over which the overspeed limiting device can be adjusted.
δn_{st}	Speed droop	%	Difference between the declared no-load speed and the declared speed at declared power, for fixed speed setting (see Figure 1). It is expressed as percentage of the declared speed given by: $\delta n_{st} = \frac{n_{i,r} - n_r}{n_r} \times 100$

NOTE 1 The speed limit is the maximum calculated speed which the engine can sustain without risk of damage.

NOTE 2 For a given engine, the operating speed depends on the total inertia of the generating set and the design of the overspeed protection system.

NOTE 3 100 kPa = 1 bar.

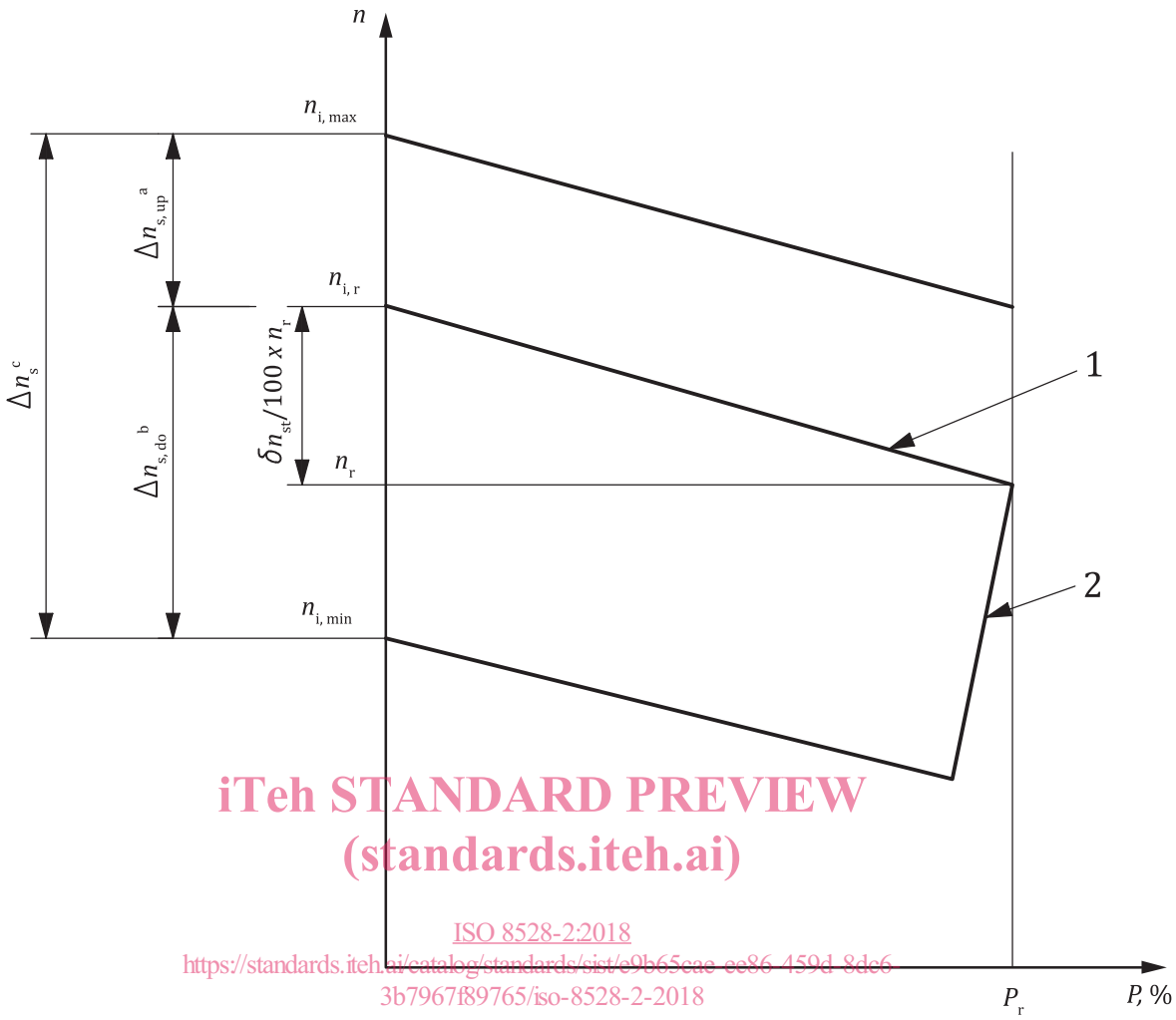
Table 1 *(continued)*

Symbol	Term	Unit	Definition
$\Delta\delta n_{st}$	Speed/power characteristic deviation	%	Maximum deviation from a linear speed power characteristic curve in the power range between no-load and declared power, expressed as percentage of the declared speed (see Figure 2).
	Speed/power characteristic curve		Curve of steady-state speeds in the power range between no-load and declared power plotted against RIC engine power (see Figures 1 and 2).
P	Engine power	kW	
P_a	Actual engine power	kW	
p_{me}	Brake mean effective pressure	kPa	
P_r	Declared engine power	kW	
t_r	Response time	s	Time between activation of the overspeed limiting device and commencement of its operation.
V_{st}	Engine swept volume	l	

NOTE 1 The speed limit is the maximum calculated speed which the engine can sustain without risk of damage.

NOTE 2 For a given engine, the operating speed depends on the total inertia of the generating set and the design of the overspeed protection system.

NOTE 3 100 kPa = 1 bar.



Key

P engine power
n engine speed
1 speed/power characteristic curve
2 power limit
a Upward speed setting.
b Downward speed setting range.
c Range of speed setting.

Figure 1 — Speed/power characteristic, range of speed setting