SLOVENSKI STANDARD
oSIST prEN IEC 60034-33:2021

01-junij-2021

Električni rotacijski stroji - 33. del: Posebne tehnične zahteve za sinhrone hidrogeneratorje, vključno z motornimi generatorji

Rotating electrical machines - Part 33: Specific technical requirements for synchronous hydrogenerators including motor-generators

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COMMITTEE DRAFT FOR VOTE (CDV)

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IEC TC 2 : ROTATING MACHINERY

SECRETARIAT:	SECRETARY:
United Kingdom	Mr Charles Whitlock
OF INTEREST TO THE FOLLOWING COMMITTEES:	PROPOSED HORIZONTAL STANDARD: ☐
	Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.

FUNCTIONS CONCERNED:

☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY

☒ SUBMITTED FOR CENELEC PARALLEL VOTING ☐ NOT SUBMITTED FOR CENELEC PARALLEL VOTING

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The CENELEC members are invited to vote through the CENELEC online voting system.

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Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

TITLE:

Rotating electrical machines – Part 33: Specific technical requirements for synchronous hydrogenerators including motor-generators

PROPOSED STABILITY DATE: 2025

NOTE FROM TC/SC OFFICERS:

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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Rotating electrical machines –

Part 33: Specific technical requirements for synchronous hydrogenerators including motor-generators

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International Standard IEC 60034-33 has been prepared by working group 33: Rotating electrical machines – Part 33: Specific technical requirements for synchronous hydrogenerators including motor-generators, of IEC technical committee 2: Rotating Machinery.

The text of this standard is based on the following documents:

FDIS	Report on voting
XX/XX/FDIS	XX/XX/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60034 series, published under the general title *Rotating electrical machines*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

The National Committees are requested to note that for this publication the stability date is ....

THIS TEXT IS INCLUDED FOR THE INFORMATION OF THE NATIONAL COMMITTEES AND WILL BE DELETED AT THE PUBLICATION STAGE.

1 Scope

This part of IEC 60034 applies to three-phase salient-pole synchronous generators and synchronous motor-generators for hydraulic turbine and pump-turbine applications, that have rated frequency of 50 Hz or 60 Hz, rated output of 10 MVA and above, pole pair number 3 and above, and rated voltage of 6 kV and above.

This document supplements basic requirements for rotating machines given in IEC 60034-1.

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.

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

IEC 60034-2-2, *Rotating electrical machines – Part 2-2: Specific methods for determining separate losses of large machines from tests – Supplement to IEC 60034-2-1*

IEC 60034-4-1, *Rotating electrical machines - Part 4-1: Methods for determining electrically excited synchronous machine quantities from tests*

IEC 60034-9, *Rotating electrical machines – Part 9: Noise limits*

IEC 60034-18-1: *Rotating electrical machines – Part 18-1: Functional evaluation of insulation systems – General guidelines* Amendment 1 (1996)

IEC 60034-18-32: *Rotating electrical machines – Part 18-32: Functional evaluation of insulation systems – Electrical endurance qualification procedures for form-wound windings*

IEC 60034-18-33: *Rotating electrical machines – Part 18-33: Functional evaluation of insulation systems – Test procedures for multifunctional evaluation of form-wound windings by endurance under combined thermal and electrical stresses of insulation systems used in rotating machines*

IEC 60034-27-1, *Rotating electrical machines – Part 27-1: Off-line partial discharge measurements on the stator winding insulation of rotating electrical machines*

IEC TS 60034-27-2, *Rotating electrical machines – Part 27-2: On-line partial discharge measurements on the stator winding insulation of rotating electrical machines*

IEC 60034-27-3, *Rotating electrical machines – Part 27-3: Dielectric dissipation factor measurement on stator winding insulation of rotating electrical machines*

IEC 60034-27-4, *Rotating electrical machines – Part 27-4: Measurement of insulation resistance and polarization index of winding insulation of rotating electrical machines*

IEC TS 60034-32, *Rotating electrical machines – Part 32: Measurement of stator end-winding vibration at form-wound windings*

IEC 60050-411, *International Electrotechnical Vocabulary – Chapter 411: Rotating Machines*

IEC 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60085, *Electrical insulation – Thermal evaluation and designation*

IEC 60417, *Graphical symbols for use on equipment*

IEC 60445, *Basic and safety principles for man-machine interface, marking and identification – Identification of equipment terminals, conductor terminations and conductors*

IEC 63132-1, *Guide for installation procedures and tolerances of hydroelectric machines – Part 1: Common*

IEC 63132-2, *Guide for installation procedures and tolerances of hydroelectric machines – Part 2: Vertical generator*

ISO 5801, *Industrial fans - Performance testing using standardized airways*

ISO 19283, *Condition monitoring and diagnostics of machines – Hydroelectric generating units*

ISO 20816-1, *Mechanical vibration — Measurement and evaluation of machine vibration —Part 1: General Guidelines*

ISO 20816-5, *Mechanical vibration — Measurement and evaluation of machine vibration —Part 5: Machine sets in hydraulic power generating and pump-storage plants*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60034-1, IEC 60034-2-1, IEC 60034-2-2, IEC 60050411, IEC 63132-1, some of which are repeated here for convenience, and those specified below apply.

3.1
hydrogenerator
a synchronous machine operated as generator and driven by a hydraulic turbine

3.2
motor-generator
a synchronous machine which can operate in motor mode and generator mode, generally used in pumped-storage power plant

3.3
stator concentricity
the radial distance from the reference centre to the best centre of stator bore

3.4
rotor concentricity
the radial distance from the reference centre to the best centre of rotor outer circle

3.5
stator circularity
the difference between the maximum and minimum radii, measured from the best centre of stator bore

3.6
rotor circularity
the difference between the maximum and minimum radii, measured from the best centre of rotor outer circle

3.7 Air gap

3.7.1
nominal air gap
design air gap value between stator inner surface and rotor at the centre of poleshoe at rated conditions

3.7.2
static air gap
air gap at standstill and in cold condition after full load rejection. This value is used for the purposed of IEC 63132-1 and IEC 63132-2

3.8
stress control coating
paint or tape on the surface of the groundwall insulation that extends beyond the conductive slot portion coating in high-voltage stator bars and coils

3.9
condenser
heat exchanger device by which cooling medium is changed to liquid phase from vapour in evaporative cooling circulation system

3.10
grid
a public electrical network or a local (e.g. industrial) network which is connected to the machine either directly or through a transformer

3.11
SFC starting
operating mode in which synchronous machine is started in motor mode by the method of regulating power frequency, using static frequency converter (SFC) as variable-frequency power supply

3.12
back to back starting
synchronous starting method in which one machine is started in motor mode, driven by the other electric connected machine that is started in generator mode

4 Site operation conditions

The machines shall be able to operate continuously at rated conditions (MVA, MW, voltage, frequency and power factor) at the following site operation conditions:

a) The altitude does not exceed 1 000 m above sea level (based on coupling elevation for vertical machine, centre line of shaft for horizontal machine);

b) The cooling air temperature (primary coolant) does not exceed 40 ℃;

c) The inlet water temperature (secondary coolant) of air coolers, oil coolers and heat exchangers (e.g. of direct water cooled stator windings) is not higher than 25 ℃ and not less than 5 ℃;

d) The inlet water temperature (primary coolant) of direct water cooled stator windings shall be (30 ~ 40) ℃, the water conductivity is in the range of (0,4 ~2,0) μS/cm, the pH value is 6,5~9,0, and the hardness is less than 2 μmol/l, at 25 ℃ of water temperature;

e) Relative humidity in powerhouse (generator floor) does not exceed 85 %;

f) Installed in covered powerhouse on proper foundation;

g) Structural strength of machine shall meet the requirement of seismic accelerations at the location. Appropriate design measures shall be taken to prevent harmful damage to the machine. The acceleration value may be different for different regions due to the local geographical condition. The acceleration values in horizontal direction and vertical direction shall be defined as a technical condition according to the seismic grade at the location by the purchaser.

5 Ratings and parameters

5.1 Output

5.1.1 Output rating of a hydrogenerator

The output rating of a hydrogenerator preferable is the apparent power (in MVA) or the active power (in MW), available continuously at the stator terminals (main leads) at rated frequency, voltage and power factor.

5.1.2 Output ratings of a motor-generator

The output ratings of a motor-generator include two parts:

a) The apparent power (in MVA) or the active power (in MW), available continuously at the stator terminals (main leads) at rated frequency, voltage and power factor during generator mode;

b) Mechanical output power (in MW) available continuously at the shaft during motor mode.

5.1.3 Increase in active power

By agreement between purchaser and manufacturer, it is allowed to increase active power of hydrogenerators to rated output (apparent power) by increasing power factor up to 1,0.

5.1.4 Under-excited operation

Hydrogenerators and motor-generators when operating in generator mode shall be able to operate continuously in under-excited mode at power factor 0,9 with rated active power at rated voltage.

5.2 Rated voltage

The rated voltage (line to line voltage U_N at stator terminals) of the machine shall be defined by purchaser and manufacturer according to rated output, rated speed of machine, as well as other conditions in the system.

5.3 Rated power factor

The power factor shall be agreed upon between purchaser and manufacturer. Preferred rated power factors at generator terminals are 0,85, 0,875, 0,9, 0,925 or 0,95 overexcited.

Rated power factor of motor-generators in motor mode shall be defined as a design condition by purchaser.

5.4 Rated speed

The rated speed (1/min) shall be:

$3000/p$ for 50Hz machines;

$3600/p$ for 60Hz machines;

158 Where *p* is the number of pole pairs.

159 NOTE Following preferred speeds are convenient to design electrical symmetric and balanced windings for the
160 machines.

161

162 **Table 1 – Preferred speed for 50Hz machines Unit: 1/min**

1000	750	600	500	428.6	375	333.3	300	250
214.3	200	187.5	166.7	150	142.9	136.4	125	115.4
107.1	100	93.8	88.2	83.3	75	71.4	68.2	62.5
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164 **Table 2 - Preferred speed for 60Hz machines Unit: 1/min**

1200	900	720	600	514.3	450	400	360	300
257.1	240	225	200	180	171.5	163.7	150	138.5
128.5	120	112.6	105.8	100	90	85.7	81.8	75
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167 **5.5 P-Q capability diagram**

168 The manufacturer shall supply a P-Q capability diagram indicating the limits of operation as
169 shown in Figure 1, where:

170 Curve A represents operation limits with rated stator current and constant apparent power
171 output, which is restricted by temperature rise of the stator winding;

172 Curve B represents operation limits with rated field current, which is restricted by temperature
173 rise of the Excitation winding;

174 Curve C indicates the limit set by the effects of end region heating, steady-state stability, etc.

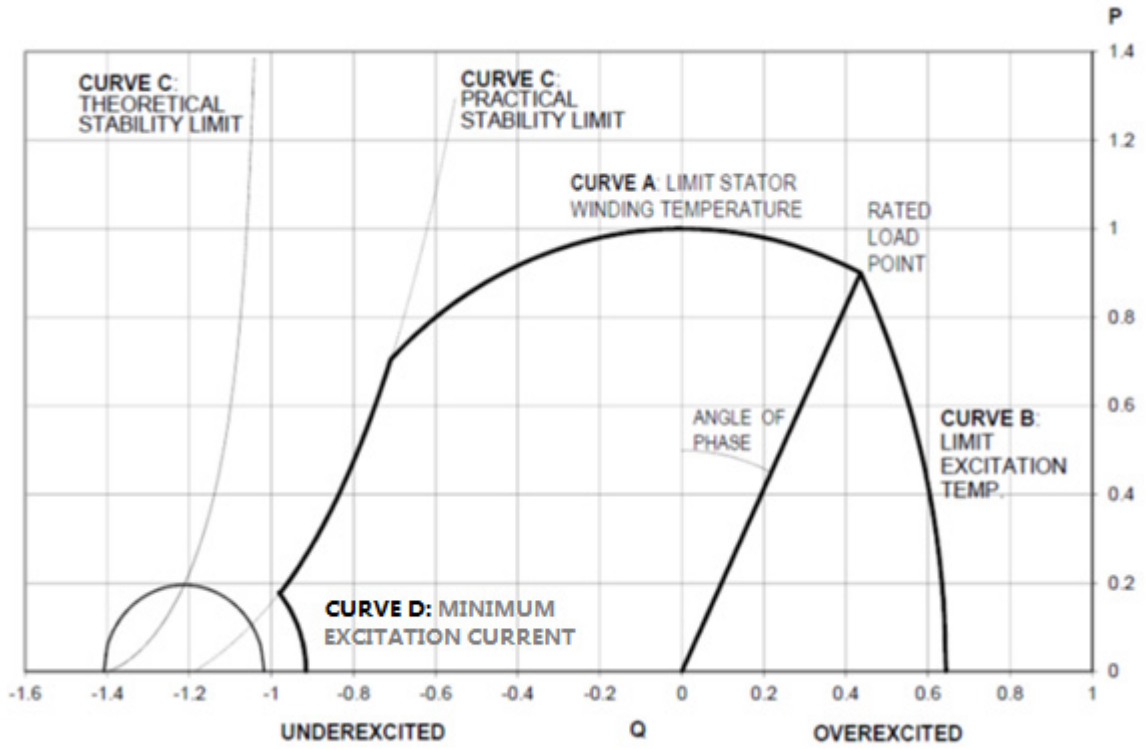

Figure 1 P-Q Capability in p. u.

NOTE Figure 1 is showing the limitation of the electrical machine only and not considering operational limitation of the hydraulic machine.

5.6 Voltage and frequency variations during operation

Synchronous hydrogenerators and synchronous motor-generators shall be capable of continuous rated output at the rated power factor over the ranges of ±5 % in voltage and ±2 % in frequency, as defined by the shaded area of Figure 2.

For machines rated for use on a power supply of fixed frequency supplied from an ac. generator (whether local or via a supply network), combinations of voltage variation and frequency variation are classified as being either zone A or zone B, in accordance with Figure 2 for generators and motor-generators.

A machine shall be capable of operation continuously within zone A, and performing its primary function as specified in Table 3, but need not comply fully with its performance at rated voltage and frequency (see rated point in Figure 2), and may exhibit some deviations. Temperature rises may be higher than the condition for rated voltage and frequency.

A machine shall be capable of operation within zone B, and performing its primary function, but may exhibit greater deviations from its performance at rated voltage and frequency than in zone A. Temperature rises may be higher than at rated voltage and frequency and most likely will be higher than those in zone A. Extended operation at the perimeter of zone B is not recommended.

In practical applications and operating conditions, a machine will sometimes be required to operate outside the perimeter of zone A. Such excursions shall be limited in value, duration and frequency of occurrence. Corrective measures should be taken where practical, within a reasonable time if possible, for example, a reduction in output. Such action may avoid a reduction in machine lifetime because of temperature effects. Detailed permitted output, temperature rises and continuously operating duration shall be agreed between purchaser and manufacturer, and be defined as a design condition.