
Električni rotacijski stroji - 33. del: Sinhronski hidrogeneratorji, vključno z motor-generatorji - Posebne zahteve

Rotating electrical machines - Part 33: Synchronous hydrogenerators including motor-generators - Specific requirements

Drehende elektrische Maschinen - Teil 33: Besondere Anforderungen an Synchrongeneratoren, angetrieben durch hydraulische Turbinen, einschließlich Motor-Generatoren

Machines électriques tournantes - Partie 33: Hydro-génératrices synchrones y compris les groupes moteur-générateurs - Exigences spécifiques

Ta slovenski standard je istoveten z: prEN IEC 60034-33:2026

ICS:

29.160.20 Generatorji Generators

oSIST prEN IEC 60034-33:2026 **en,fr,de**

Sample Document

get full document from standards.iteh.ai



2/2319/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER: IEC 60034-33 ED2	
DATE OF CIRCULATION: 2026-08-07	CLOSING DATE FOR VOTING: 2026-10-30
SUPERSEDES DOCUMENTS: 2/2317/RR	

IEC TC 2 : ROTATING MACHINERY	
SECRETARIAT: United Kingdom	SECRETARY: Mr Charles Whitlock
OF INTEREST TO THE FOLLOWING COMMITTEES:	HORIZONTAL FUNCTION(S):
ASPECTS CONCERNED:	
☒ SUBMITTED FOR CENELEC PARALLEL VOTING Attention IEC-CENELEC parallel voting The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) is submitted for parallel voting. The CENELEC members are invited to vote through the CENELEC online voting system.	☐ NOT SUBMITTED FOR CENELEC PARALLEL VOTING

This document is still under study and subject to change. It should not be used for reference purposes.

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.

Recipients of this document are invited to submit, with their comments, notification of any relevant "In Some Countries" clauses to be included should this proposal proceed. Recipients are reminded that the CDV stage is the final stage for submitting ISC clauses. (SEE [AC/22/2007](#) OR [NEW GUIDANCE DOC](#)).

TITLE:

Rotating electrical machines - Part 33: Synchronous hydrogenerators including motor-generators - Specific requirements

PROPOSED STABILITY DATE: 2028

NOTE FROM TC/SC OFFICERS:

Copyright © 2026 International Electrotechnical Commission, IEC. All rights reserved. It is permitted to download this electronic file, to make a copy and to print out the content for the sole purpose of preparing National Committee positions. You may not copy or "mirror" the file or printed version of the document, or any part of it, for any other purpose without permission in writing from IEC.

Link to Committee Draft for Vote (CDV) online document:

[Click here](#)

How to access

This link leads you to the Online Standards Development (OSD) platform for National Mirror Committee's (NMC) comments. The project draft may be found further down this document.

Resource materials

We recommend NCs to review the available materials to better understand the member commenting on the OSD platform. This includes the:

- [OSD NC roles overview](#)
- [How to add and submit comments to the IEC](#)

Contact

Should you require any assistance, please contact the [IEC IT Helpdesk](#).

get full document from standards.iteh.ai

CONTENTS

CONTENTS	1
FOREWORD	5
INTRODUCTION	7
1 Scope	8
2 Normative references	8
3 Terms and definitions	9
4 Site operation conditions	11
5 Ratings and parameters	11
5.1 Output	11
5.1.1 Output rating of a hydrogenerator	11
5.1.2 Output ratings of a motor-generator	11
5.1.3 Increase in active power	11
5.1.4 Under-excited operation	12
5.2 Rated voltage	12
5.3 Rated power factor	12
5.4 Rated speed	12
5.5 P-Q capability diagram	12
5.6 Voltage and frequency variations during operation	13
5.7 Efficiency and losses	15
5.7.1 Weighted average efficiency	15
5.7.2 Losses	15
5.7.3 Determination of winding losses	16
5.7.4 Windage Losses	16
5.7.5 Determination of thrust bearing losses for vertical machines	16
5.7.6 Tolerance of the total losses	17
5.8 Electrical parameters and time constants	17
5.8.1 Short-circuit ratio	17
5.8.2 Direct axis transient and subtransient reactances	17
5.8.3 General case	18
5.9 Tolerances on reactance	18
5.10 Total harmonic distortion (THD)	18
5.11 Torques	19
6 Temperature	19
6.1 Temperature rise	19
6.2 Measurements for the stator winding	20
6.3 Measurements for the stator core	20
6.4 Correction due to deviation from reference operation	21
6.5 Bearing temperature	21
7 Operating performances and electrical connections	21
7.1 Special operational requirements	21
7.1.1 Stator excess current	21
7.1.2 Rotor excess current	22
7.1.3 Continuous unbalanced load	22
7.1.4 Short time unbalanced load	22
7.1.5 Mechanical output overload	23

7.1.6	Sudden short circuit.....	23
7.2	Connection to grid.....	23
7.2.1	Synchronization.....	23
7.2.2	Application of load.....	24
7.3	Starting of motor-generator.....	24
7.4	System earthing.....	24
7.5	Neutral point leads.....	25
7.6	Rotating direction and phase sequence.....	25
7.7	Stator winding.....	26
8	Winding insulation.....	26
8.1	Winding insulation performance.....	26
8.1.1	General.....	26
8.1.2	Winding insulation resistance.....	26
8.1.3	Dielectric dissipation factor measurements on new stator bars or coils.....	27
8.1.4	Partial discharge measurements for stator winding.....	27
8.1.5	Voltage withstand test for turn insulation of multi-turn coil for stator.....	27
8.1.6	Quality inspection for Roebel bars.....	27
8.2	Voltage withstand tests.....	27
8.2.1	Stator bars/coils.....	27
8.2.2	Inserted stator bars/coils.....	28
8.2.3	Stator winding completed before rotor inserted.....	28
8.2.4	Field winding before delivery.....	28
8.2.5	Field winding completed.....	28
8.2.6	Stator winding for completed machine.....	29
8.2.7	Field winding for completed machine.....	29
8.2.8	DC alternative tests.....	29
8.2.9	Global VPI stators.....	29
8.3	Breakdown test for insulation.....	29
8.4	Voltage endurance test for insulation.....	29
8.5	Thermal cycle test.....	30
8.6	Stator winding terminals.....	30
9	Mechanical structural performances and design.....	30
9.1	Rotating part mass moment of inertia.....	30
9.2	Maximum speed.....	31
9.3	Structural strength.....	31
9.4	Critical bending speed.....	32
9.5	Start and stop of motor-generators.....	32
9.6	Start and stop of hydrogenerators.....	32
9.7	Over speed.....	32
9.8	Fatigue verification.....	32
10	Core vibration.....	32
11	Noise.....	33
12	Basic structural requirements.....	34
12.1	General layout.....	34
12.1.1	Structure and general layout of the machines.....	34
12.1.2	Machine components.....	34
12.1.3	Hydraulic or pneumatic braking system.....	34
12.1.4	Hydraulic jacking system.....	34

12.1.5	Dynamical (electrical) braking	34
12.2	Stator	35
12.2.1	Frame and core structure	35
12.2.2	Stator frame connecting structure	35
12.2.3	Stator end winding	35
12.3	Rotor	35
12.3.1	Damper winding	35
12.3.2	Structure with one shaft or segmented shafts	35
12.4	Structure tolerance	35
12.5	Bearings	36
12.5.1	Bearing alloy	36
12.5.2	Bearing lubricant	36
12.5.3	Shaft currents	36
12.5.4	Bearing insulation resistance	36
13	Ventilation and cooling system	36
13.1	Cooling scheme	36
13.1.1	General	36
13.1.2	Air cooling system	36
13.1.3	Evaporative cooling system	37
13.1.4	Water cooling system	37
13.2	Redundancy on the design of coolers and motor fans	37
13.3	Cooling structure	37
13.3.1	Materials	37
13.3.2	Water supply and drainage	37
13.3.3	Cooling water pressure	37
14	Instrumentation required for protection and control	37
14.1	General	37
14.2	Stator and bearing temperature	38
14.3	Bearing vibration and shaft displacement	38
15	Instrumentation for condition monitoring of machines	39
15.1	General	39
15.2	Instrumentation required for condition monitoring	39
16	Marking	39
16.1	Information to be marked on machine nameplate:	39
16.2	Repaired or refurbished machines	40
17	Factory and site tests	40
Annex A (informative)	Special tools	41
Annex B (informative)	Correction of measured windage losses on the machines	42
Annex C (informative)	Correction of measured bearing losses for different oil bath temperatures	44
Annex D (informative)	Scope of supply	46
Annex E (normative)	Test run and guaranteed period	47
E.1	72 h test run	47
E.2	15-day examination test run for motor-generators	47
E.3	Handover and guarantee period	47
Annex F (informative)	Test items	48
F.1	Inspection test for hydrogenerator and motor-generator in factory	48

F.2	Site routine test of hydrogenerator and motor-generator	48
F.3	Startup test run of hydrogenerator and motor-generator	49
F.4	Performance test of hydrogenerator	49
Annex G (informative)	Condition monitoring	50
G.1	Air gap distance	50
G.2	Core and frame vibration	50
G.3	Stator end winding vibration	50
G.4	Partial discharge	50
G.5	Air gap magnetic flux	51
G.6	Others	51
Bibliography		52
Figure 1	– P-Q capability in p. u.	13
Figure 2	– Voltage and frequency limits for hydro machines	14
Figure 3	– Location of measuring points in the horizontal plane	33
Table 1	– Preferred speed for 50 Hz machines - Unit: 1/min	12
Table 2	– Preferred speed for 60 Hz machines - Unit: 1/min	12
Table 3	– Reference temperature	16
Table 4	– Temperature rise limits for machine's main part	19
Table 5	– Temperature rise limits for collector ring	19
Table 6	– Permitted excess current multiple vs. time duration	22
Table 7	– Permitted negative phase sequence current for the machines	22
Table 8	– Permitted negative phase sequence current for the machines	23
Table 9	– Material properties for grounding connectors	25
Table 10	– Test voltage for insulating resistance measurement	27
Table 11	– Dielectric dissipation factor	27
Table 12	– Testing values for voltage withstand test of field winding	29
Table 13	– Limits for vibration in the core	33
Table 14	– Temperature sensor locations	38
Table A.1	– Special tools	41

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**Rotating electrical machines -
Part 33: Synchronous hydrogenerators including motor-generators -
Specific requirements**

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.

3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.

4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.

5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.

6) All users should ensure that they have the latest edition of this publication.

7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.

8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document,

IEC [had/had not] received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 60034-33 has been prepared by IEC technical committee 2: Rotating machinery. It is an International Standard.

This second edition cancels and replaces the first edition published in 2022. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) ...;

The text of this International Standard is based on the following documents:

Draft	Report on voting
2/XX/FDIS	2/XX/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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 document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

Sample Document

get full document from standards.iteh.ai

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 60034-2-1, *Rotating electrical machines - Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)*

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 60034-15, *Rotating electrical machines - Part 15: Impulse voltage withstand levels of form-wound stator coils for rotating a.c. machines*

IEC 60034-18-1, *Rotating electrical machines - Part 18-1: Functional evaluation of insulation systems - General guidelines*

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

IEC 60034-27-1, *Rotating electrical machines - Part 27-1: Off-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 60034-33:2022, *Rotating electrical machines - Part 33: Synchronous hydrogenerators including motor-generators - Specific requirements*

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 60287-3-1:2017, *Electric cables - Calculation of the current rating - Part 3-1: Operating conditions - Site reference conditions*

IEC 60417, *Graphical symbols for use on equipment - 12-month subscription to regularly updated online database comprising all graphical symbols published in IEC 60417*

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 7919-5:2005, *Mechanical vibration — Evaluation of machine vibration by measurements on rotating shafts — Part 5: Machine sets in hydraulic power generating and pumping plants*

ISO 10816-5:2000, *Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts — Part 5: Machine sets in hydraulic power generating and pumping plants*

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*

IEEE Std 1043: 1996, *IEEE Recommended practice for voltage-endurance testing of form-wound bars and coils*

IEEE Std 1310: 2012, *IEEE Recommended practice for thermal cycle for voltage-endurance testing of form-wound bars and coils for large rotating machines*

IEEE Std 1553: 2002, *IEEE Trial-use standard for voltage-endurance testing of form-wound coils and bars for hydrogenerators*

EN 50522: 2010, *Earthing of power installations exceeding 1 kV a.c.*

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 60050-411 and IEC 63132-1, as well as the following apply.

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

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

3.1

hydrogenerator

synchronous machine operated as generator and driven by a hydraulic turbine

3.2**motor-generator**

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

3.3**stator concentricity**

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

3.4**rotor concentricity**

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

3.5**stator circularity**

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

3.6**rotor circularity**

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 pole shoe at rated conditions

3.7.2**static air gap**

air gap at standstill and in cold condition after full load rejection

Note 1 to entry: This value is used for the purposes of IEC 63132-1 and IEC 63132-2.

3.8**stress control coating**

paint or tape on the surface of the main 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**

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;
- 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 °C and not less than 5 °C;
- d) The inlet water temperature (primary coolant) of direct water cooled stator windings shall be 30 °C to 40 °C, the water conductivity is in the range of 0,4 µS/cm to 2,0 µS/cm, the pH value is 6,5 to 9,0, and the hardness is less than 2 µmol/l, at 25 °C 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.

Site conditions different from the above shall be agreed between purchaser and manufacturer.

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.