

Rotating electrical machines —

Part 3: Specific requirements for cylindrical rotor synchronous machines

The European Standard EN 60034-3:2005 has the status of a
British Standard

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee PEL/2, Rotating electrical machines, which has the responsibility to:

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- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep UK interests informed;
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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 28, an inside back cover and a back cover.

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English version

**Rotating electrical machines
Part 3: Specific requirements for cylindrical
rotor synchronous machines
(IEC 60034-3:2005)**

Machines électriques tournantes
Partie 3: Règles spécifiques
pour les machines synchrones
à rotor cylindrique
(CEI 60034-3:2005)

Drehende elektrische Maschinen
Teil 3: Besondere Anforderungen
an Vollpol-Synchronmaschinen
(IEC 60034-3:2005)

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of document 2/1315/FDIS, future edition 5 of IEC 60034-3, prepared by IEC TC 2, Rotating machinery, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60034-3 on 2005-05-01.

This European Standard supersedes EN 60034-3:1995.

The significant technical changes with respect to EN 60034-3:1995 are as follows:

- the document has been consolidated and completely restructured. It was rewritten to a considerable extent;
- the section on air cooled generators has been combined with that on hydrogen-cooled and liquid cooled generators. Different requirements so far valid for air cooled generators alone were modified in such a way that the requirements are now strictly bound to the generator ratings but not longer to the machine type. As an example for the harmonisation which took place the short circuit ratio of the air cooled generators were adjusted to those for the other generators. The separate cooler sections for air cooled generators were eliminated;
- the standard was generally adjusted to the progress in generator control. The state of the art control systems do not require the previous large power factors. They were reduced to one minimum value instead of several value classes providing the prospects of reduced generator costs. It was considered that standards should not work as an unnecessary cost driving factor;
- a normative Annex A has been added dealing with precautions to be taken when using hydrogen as a coolant on turbine-type synchronous generators. Formerly only a guide was provided. It was considered that aspects dealing with the safe operation of hydrogen cooled generators must be taken seriously and must become normative.

The following dates were fixed:

- | | | |
|--|-------|------------|
| – latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2006-02-01 |
| – latest date by which the national standards conflicting with the EN have to be withdrawn | (dow) | 2008-05-01 |

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60034-3:2005 approved by CENELEC as a European Standard without any modification.

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ROTATING ELECTRICAL MACHINES –

Part 3: Specific requirements for cylindrical rotor synchronous machines

1 Scope

This part of IEC 60034 applies to three-phase cylindrical rotor synchronous machines, having rated outputs of 10 MVA (or MW) and above. It supplements the basic requirements for rotating machines given in IEC 60034-1. The special requirements of machines continuously fed by inverters are not covered by this standard.

Common requirements for all cylindrical rotor machines are prescribed together with specific requirements for air, for hydrogen or for liquid cooled cylindrical rotor synchronous machines.

This part of IEC 60034 also gives the precautions to be taken when using hydrogen cooled machines including

- rotating exciters driven by cylindrical rotor type machines;
- auxiliary equipment needed for operating the machines;
- parts of the building where hydrogen might accumulate.

2 Normative references

The following referenced documents are indispensable for the application 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 60034-4, *Rotating electrical machines – Part 4: Methods for determining synchronous machine quantities from tests*

IEC 60045-1, *Steam turbines – Part 1: Specifications*

IEC 60079 (all parts), *Electrical apparatus for explosive gas atmospheres*

3 Terms and definitions

For the purposes of this document, the terms and definitions in IEC 60034-1 together with the following additions apply.

3.1

mechanical start

change in speed from zero or turning gear speed to rated speed

3.2

turning gear operation

rotation at low speed to maintain thermal equilibrium of the steam turbine and/or rotor

4 General

4.1 General rules

Cylindrical rotor machines shall be in accordance with the basic requirements for rotating machines specified in IEC 60034-1 unless otherwise specified in this standard. Wherever in this standard there is reference to an agreement, it shall be understood that this is an agreement between the manufacturer and the purchaser.

4.2 Rated conditions

The rated conditions are given by the rated values of

- the apparent power for generators and compensators or the power at the shaft end for motors;
- frequency;
- voltage;
- power factor;
- primary coolant temperature (40°C unless otherwise agreed upon);

and where applicable,

- site altitude;
- hydrogen pressure;
- range of hydrogen purity, see IEC 60034-1.

4.3 Rated voltage

The rated voltage shall be fixed by agreement.

4.4 Power factor

The power factor shall be agreed upon between the purchaser and manufacturer. Standardised rated power factors at the generator terminals are 0,8, 0,85 and 0,9 overexcited. Preferred power factors of motors are 0,95 overexcited and 1,0.

NOTE 1 Other values may be agreed upon, the lower the power factor the larger will be the machine.

NOTE 2 It is recommended that the generator should be capable of providing 0,95 underexcited power factor at rated MVA.

4.5 Rated speed

The rated speed shall be

- 1 500 min⁻¹ or 3 000 min⁻¹ for 50 Hz machines;
- 1 800 min⁻¹ or 3 600 min⁻¹ for 60 Hz machines.

In cases of cylindrical rotor synchronous motors with six poles the speeds shall be 1 000 min⁻¹ for 50 Hz and 1 200 min⁻¹ for 60 Hz machines.

4.6 Ranges of voltage and frequency

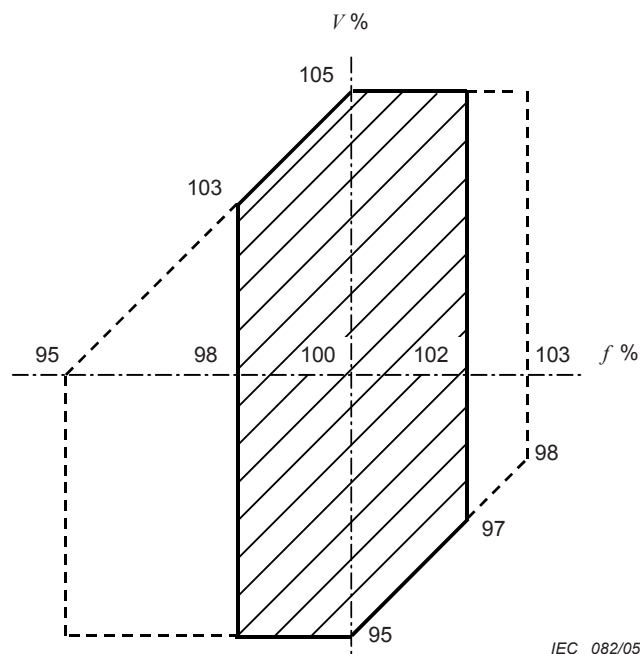
Machines shall be capable of continuous rated output at the rated power factor over the ranges of $\pm 5\%$ in voltage and $\pm 2\%$ in frequency, as defined by the shaded area of Figure 1.

The temperature rise limits in Tables 7 and 8, or the temperature limits in Table 12 of IEC 60034-1 shall apply at the rated voltage and frequency only.

NOTE 1 As the operating point moves away from the rated values of voltage and frequency, the temperature rise or total temperatures may progressively increase. Continuous operation at rated output at certain parts of the boundary of the shaded area causes temperature rises to increase by up to 10 K approximately. Machines will also carry output at rated power factor within the ranges of $\pm 5\%$ in voltage and $\pm 3\%$ in frequency, as defined by the outer boundary of Figure 1, but temperature rises will be further increased. Therefore, to minimize the reduction of the machine's lifetime due to the effects of temperature or temperature differences, operation outside the shaded area should be limited in extent, duration and frequency of occurrence. The output should be reduced or other corrective measures taken as soon as practicable.

If an operation over a still wider range of voltage or frequency or deviations from rated frequency and voltage of generators for combustion gas turbine application at peak load are required, this should be the subject of an agreement.

NOTE 2 It is considered that overvoltage together with low frequency, or low voltage with over-frequency, are unlikely operating conditions. The former is the condition most likely to increase the temperature rise of the field winding. Figure 1 shows operation in these quadrants restricted to conditions that will cause the machine and its transformer to be over- or under-fluxed by no more than 5 %. Margins of excitation and of stability will be reduced under some of the operating conditions shown. As the operating frequency moves away from the rated frequency, effects outside the generator may become important and need to be considered. As examples: the turbine manufacturer will specify ranges of frequency and corresponding periods during which the turbine can operate; and the ability of auxiliary equipment to operate over a range of voltage and frequency should be considered.



(See 4.6 for conditions relating to operation over the voltage and frequency shown above.)

Figure 1 – Operation over ranges of voltage and frequency

4.7 Direction of rotation

The generator has only one direction of rotation, which is determined by the driven or driving machine. The direction of rotation shall be shown on the generator or on its rating plate, and the time-phase sequence of the stator voltage shall then be indicated by marking the terminals in the sequence in which their voltages reach maximum, for example, U_1 , V_1 , W_1 . Synchronous motors are commonly designed for an operation in both directions of rotation.

NOTE Terminal markings may not be consistent with IEC 60034-8.

For machines having one driving end, this shall be the reference end for the direction of rotation.

For machines having two drive ends, the more powerful drive end shall be the reference end. If not applicable, the end opposite to the excitation leads shall be the reference end for the direction of rotation.

The sense of rotation (clockwise or counter-clockwise) shall be defined when facing the generator rotor coupling from the reference side.

4.8 Stator winding

Unless otherwise agreed upon, rated machine voltage corresponds to star connection. On generators all winding ends shall be brought out and arranged in an agreed arrangement of the external connections to the machine.

4.9 Machine rated field current and voltage

The machine rated field current and voltage are those values needed for the machine to operate at rated conditions.

4.10 Machine insulation

4.10.1 Thermal class

Insulation systems used for the windings shall be of thermal class 130 or higher.

4.10.2 Withstand voltage tests

Withstand voltage tests shall be in accordance with IEC 60034-1, Table 16.

4.11 Insulation against shaft current

Suitable precautions shall be taken to prevent harmful flow of shaft current and to earth the rotor shaft adequately. Any insulation needed shall preferably be arranged so that it can be measured while the machine is operating. Shaft voltage spikes caused by static excitation with controlled rectifiers shall be kept down by suitable means to non-critical values. These spikes could cause damage, for example, in the bearing lubrication film.