

IEEE Standard for Cylindrical-Rotor 50 Hz and 60 Hz Synchronous Generators Rated 10 MVA and Above

IEEE Power and Energy Society

Sponsored by the

Electric Machinery Committee

IEEE
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USA

IEEE Std C50.13™-2014
(Revision of
IEEE Std C50.13-2005)

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IEEE-SA Standards Board

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Abstract: The requirements in this standard are applied to 50 Hz and 60 Hz, two-pole and four-pole, cylindrical-rotor synchronous generators driven by steam turbines and/or by combustion gas turbines. The drive may be direct or through a gearbox or other device that permits different speeds for the turbine and the generator. The generators covered by this standard are to have rated outputs of 10 MVA and above.

Keywords: ac generator, combustion gas turbine-generator, cylindrical-rotor generator, IEEE C50.13™, steam turbine-generator, synchronous generator, turbine generator

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Introduction

This introduction is not part of IEEE Std C50.13™-2014, IEEE Standard for Cylindrical-Rotor 50 Hz and 60 Hz Synchronous Generators Rated 10 MVA and Above.

This introduction provides some background on the rationale used to develop this standard. This information is meant to aid in the understanding and usage of this standard.

From the early 1990s until the date of issue of this standard, three different working groups of the Electrical Machinery Committee (EMC) of the IEEE Power Engineering Society have carefully pursued the modernization of the ANSI C50 standards for large steam and combustion turbine-generators. Throughout the mid-1990s the first working group (IEEE PES EMC Task Force on Standards Harmonization) compared American National Standards Institute (ANSI) standards for several different types of electrical machines with corresponding International Electrotechnical Commission (IEC) standards. In the late 1990s members of the EMC Task Force published several summaries of their work (Bartheld [B1]; Gott [B5]; Kaminski [B16]; Nippes [B20]; Woods [B21]).^a

In association with that general initiative by the Electric Machinery Committee (EMC) to compare different standards for electric machines, the EMC commissioned a second working group in 1998 to focus on clarifying and modernizing the ANSI C50 series of standards for synchronous generators. That working group included the following ANSI C50.1X standards in their scope:

- a) ANSI C50.10-1990, American National Standard for Rotating Electrical Machinery—Synchronous Machines.^b
- b) ANSI C50.12-1982 (Reaff 1989), American National Standard Requirements for Salient-Pole Synchronous Generators and Generator/Motors for Hydraulic Turbine Applications.
- c) ANSI C50.13-1989, American National Standard for Rotating Electrical Machinery—Cylindrical-Rotor Synchronous Generators.
- d) ANSI C50.14-1977, American National Standard Requirements for Combustion Gas Turbine Driven Cylindrical Rotor Synchronous Generators.
- e) ANSI C50.15-1989, American National Standard for Rotating Electrical Machinery—Hydrogen-Cooled, Combustion-Gas-Turbine-Driven, Cylindrical-Rotor Synchronous Generators—Requirements.

That second EMC working group periodically reported their progress (Gott [B6], [B7]; McCown [B18]). As was communicated in these papers, where it was possible for this group to agree to the appropriateness of requirements recorded in the IEC 60034 standards [B8], [B9], those requirements were incorporated into the revised IEEE C50.1X series of standards.

As the most workable approach to clarify and modernize the IEEE standards for cylindrical-rotor synchronous generators this working group chose to consolidate the previously separate ANSI C50.10, ANSI C50.13, ANSI C50.14, and ANSI C50.15 standards into one consolidated IEEE Std C50.13 standard. This modernized IEEE Std C50.13 was written to consolidate the previously separate ANSI C50.13, ANSI C50.14, and ANSI C50.15 standards in their entire scope and to incorporate applicable parts of ANSI C50.10. Similarly, the working group chose to modify ANSI C50.12 to become a consolidated standard for large salient-pole generators and generator/motors for hydraulic turbine applications. All applicable parts of ANSI C50.10 were incorporated into the modernized IEEE Std C50.12™. Also, wherever possible, the modernized IEEE Std C50.12 and IEEE Std C50.13 were harmonized with each other.

^a The numbers in brackets correspond to those of the bibliography in Annex A.

^b ANSI publications are available from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

The logic to consolidate ANSI C50.13, ANSI C50.14, and ANSI C50.15 into one standard was primarily that ANSI C50.14 and ANSI C50.15 contained a significant amount of content that had been duplicated from ANSI C50.13 solely to cover different applications of the same basic configuration of generators covered by ANSI C50.13. Additionally, because some newer applications to which no C50 standards directly pertained had occurred since the creation of the separate ANSI C50.14 and ANSI C50.15, the working group had to choose between creating additional highly duplicated standards, or finding a way to consolidate them. The decision to drop the general standard, ANSI C50.10, and to incorporate appropriate parts of its content into IEEE Std C50.12 and IEEE Std C50.13 was made after an initial attempt to retain and update ANSI C50.10. During that effort it was recognized that the content directly applicable to IEEE Std C50.12 and IEEE Std C50.13, respectively, was not that great. It was also recognized that most ultimate users of the generator standards would significantly benefit from having a single standard for each of these two major types of machines. This approach would provide a better focus and alignment of the standards to purchasers and manufacturers knowledgeable in each product affected by the standard. That better focus and alignment would minimize the risk of conflict or ambiguity between the general and type-specific standards, reduce the risk of missed requirements or ineffectively communicated requirements, and also ease future maintenance of the standards.

A significant improvement to the 2005 issue of IEEE Std C50.13 was the addition of Annex B. The specification of a large generator covered by IEEE Std C50.13 is a complex task. Unfortunately, it is not as simple as specifying a single point power rating and also specifying IEEE Std C50.13. Annex B was included to assist purchasers of generators covered by IEEE Std C50.13 to provide the necessary requirements and data to the generator manufacturer that will ensure that a generator designed to meet the specified requirements will meet the long-term needs of the purchaser without over specifying and adding unnecessary cost. The core guidelines in Annex B are contained in Table B.1 through Table B.4. These tables may be used as a checklist to show which party in the process typically originates each requirement. These tables also provide some explanation as to the basis of many requirements that must be provided by the purchaser and their potential impacts on the generator design.

In 2007, two years after the 2005 issue of the extensively modernized IEEE Std C50.13, the Electric Machinery Committee convened a third working group to continue refining this standard to clarify its text and, where appropriate, to adjust its content to accommodate recent revisions to the IEC 60034 standards. This working group has periodically reported their progress (Chen et al. [B2], [B3]; Mayor et al. [B17]). One major milestone was the successful reaffirmation of IEEE Std C50.13 in 2010. A second major milestone is the 2014 release of the present version of this standard.

Members of the IEEE working group that have issued the present revision of IEEE Std C50.13 plan to continue to refine this standard, with progressively closer association with IEC working groups that are maintaining the IEC 60034 standards. Additionally, this IEEE working group plans to explore possible ways to harmonize requirements specified by IEEE and IEC standards for synchronous generators with conflicting requirements being independently specified by grid codes now being written by transmission system operators around the world.

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1. Overview

1.1 Scope

The requirements in this standard apply to all 50 Hz and 60 Hz, two-pole and four-pole, cylindrical-rotor synchronous generators driven by steam turbines and/or by combustion gas turbines. The drive may be direct or through a gearbox or other device that permits different speeds for the turbine and the generator.

The generators covered by this standard are to have rated outputs of 10 MVA and above. Cylindrical-rotor, two-pole and four-pole generators below this rating are generally covered by NEMA MG 1 [B19].¹

1.2 Purpose

The purpose of this standard is to establish a base set of accepted requirements for 50 Hz and 60 Hz cylindrical-rotor electrical generators above 10 MVA driven by steam turbines or combustion turbines that can be used in the specification of a new generator. It is also intended that the standard provides guidance

¹The numbers in brackets correspond to those of the bibliography in Annex A.