



IEEE Standard for Salient-Pole 50 Hz and 60 Hz Synchronous Generators and Generator/Motors for Hydraulic Turbine Applications Rated 5 MVA and Above

IEEE Power Engineering Society

Sponsored by the
Electric Machinery Committee

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**Electric Machinery Committee
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IEEE Power Engineering Society**

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Abstract: The requirements in this standard apply to all types of 50 Hz and 60 Hz salient-pole synchronous generators and generator/motors rated 5 MVA and above to be used for hydraulic turbine or hydraulic pump/turbine applications.

Keywords: ac generator, generator, hydro generator, salient-pole rotor, synchronous generator

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Introduction

This introduction is not part of IEEE Std C50.12-2005, IEEE Standard for Salient-Pole 50 Hz and 60 Hz Synchronous Generators and Generator/Motors for Hydraulic Turbine Applications Rated 5 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, two 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 turbine 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 [B2], [B11], [B15], [B16].^a

In association with the general initiative by the Electric Machinery Committee to compare different standards for electric machines, the Synchronous Machinery Subcommittee (SMSC) of the EMC commissioned a second working group in 1998 to focus on clarifying and modernizing the ANSI C50 series of standards for synchronous generators. The SMSC Working Group (WG) No. 4 (Revision of ANSI C50.1X series) included the following ANSI C50.1X standards in their scope:

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

The SMSC WG No. 4 has periodically reported their progress [B3], [B4], [B5], [B12]. As has been communicated in these papers, where it has been possible for this group to agree to the appropriateness of requirements recorded in IEC 60034 standards [B6], [B7], those requirements have been incorporated into the revised ANSI C50.1X series of standards.

As the most workable approach to clarify and modernize the IEEE/ANSI standards for cylindrical-rotor synchronous generators the SMSC WG No. 4 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 has been 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, WG No. 4 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 have been incorporated into the modernized IEEE Std C50.12. Also, wherever possible, the modernized IEEE Std C50.12 and IEEE Std C50.13 have been 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.

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IEEE Standard for Salient-Pole 50 Hz and 60 Hz Synchronous Generators and Generator/Motors for Hydraulic Turbine Applications Rated 5 MVA and Above

1. Scope

The requirements in this standard apply to all types of 50 Hz and 60 Hz salient-pole synchronous generators and generator/motors rated 5 MVA and above to be used for hydraulic turbine or hydraulic pump/turbine applications.

Salient-pole generators and generator/motors below this rating are generally covered by NEMA MG 1-2003 [B13].¹

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 or corrigenda) applies.

IEEE Std 1™, IEEE Recommended Practice—General Principles for Temperature Limits in the Rating of Electrical Equipment and for the Evaluation of Electrical Insulation.^{2,3}

IEEE Std 4™, IEEE Standard Techniques for High-Voltage Testing.

IEEE Std 43™, IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery.

IEEE Std 95™, IEEE Recommended Practice for Insulation Testing of AC Electric Machinery (2300 V and Above) with High Direct Voltage.

IEEE Std 115™, IEEE Guide: Test Procedures for Synchronous Machines, Part 1—Acceptance and Performance Testing, Part II—Test Procedures and Parameter Determination for Dynamic Analysis.

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

²The IEEE standards or products referred to in this standard are trademarks of the Institute of Electrical and Electronics Engineers.

³IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (<http://standards.ieee.org/>).

IEEE Std 275™, IEEE Recommended Practice for Thermal Evaluation of Insulation Systems for Alternating-Current Electric Machinery Employing Form-Wound Preinsulated Stator Coils for Machines Rated 6900 V and Below.

IEEE Std 286™, IEEE Recommended Practice for the Measurement of Power Factor Tip-Up of Electric Machinery Stator Coil Insulation.

IEEE Std 421.1™, IEEE Standard Definitions for Excitation Systems for Synchronous Machines.

IEEE Std 433™, IEEE Recommended Practice for Insulation Testing of Large AC Rotating Machinery with High Voltage at Very Low Frequency.

IEEE Std 434™, IEEE Guide for Functional Evaluation of Insulation Systems for Large High-Voltage Machines.

IEEE Std 522™, IEEE Guide for Testing Turn-to-Turn Insulation on Form-Wound Stator Coils for Alternating-Current Rotating Electrical Machines.

IEEE Std 1043™, IEEE Recommended Practice for Voltage-Endurance Testing of Form-Wound Bars and Coils.

IEEE Std 1310™, IEEE Recommended Practice for Thermal Cycle Testing of Form-Wound Stator Bars and Coils for Large Generators.

IEEE Std 1434™, IEEE Guide to Measurement of Partial Discharges in Rotating Machinery.

IEEE Std 1553™, IEEE Standard for Voltage-Endurance Testing of Form-Wound Coils and Bars for Hydrogenerators.

ISO 3746, Acoustics—Determination of Sound Power Levels of Noise Sources Using Sound Pressure-Survey Method Using an Enveloping Measurement Surface Over a Reflecting Plane.¹

ISO 7919-5, Mechanical Vibration of Non-Reciprocating Machines—Measurements on Rotating Shafts and Evaluation Criteria—Part 5: Machine Sets in Hydraulic Power Generation and Pumping Plants.

3. Definitions

For the purposes of this standard, the following terms and definitions apply. *The Authoritative Dictionary of IEEE Standards Terms* [B8] should be referenced for terms not defined in this clause.

Cooling classification

Salient-pole synchronous machines are classified with regard to cooling by one of the following stator and rotor types.

3.1 directly cooled windings: Directly cooled stator windings or rotor windings are those in which coolant flows in close contact with the conductor so that the heat generated within the principal portion of the windings reaches the cooling medium without flowing through the major ground insulation.

¹ISO publications are available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iso.ch/>). ISO publications are also available in the United States from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).