

IEEE Guide for the Preparation of Excitation System Specifications

Sponsor
**Excitation Systems Subcommittee
of the
Power Generation Committee of the
IEEE Power Engineering Society**

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Abstract: IEEE Std 421.4-1990, IEEE Guide for the Preparation of Excitation System Specifications, is intended to be a narrative description of items and functions that should be considered in the preparation of excitation system specifications. This guide applies to excitation systems for synchronous machines rated at 5000 kVA or larger.

Keywords: Excitation control systems, excitation system specifications, exciter, synchronous machine regulators, synchronous machines

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Foreword

(This Foreword is not a part of IEEE Std 421.4-1990, IEEE Guide for the Preparation of Excitation System Specifications.)

This guide is intended as resource material for specification writers preparing a specification for procurement of an excitation system for a synchronous machine. It is intended that IEEE Std 421.1-1986, IEEE Standard Definitions for Excitation Systems for Synchronous Machines; IEEE Std 421.2-1990, IEEE Guide for Identification, Testing, and Evaluation of the Dynamic Performance of Excitation Control Systems; and IEEE Std 421B-1979, IEEE Standard for High-Potential Test Requirements for Excitation Systems, be used in conjunction with this guide in preparing the specification. This guide is not intended to be a “fill-in-the-blanks” guide, but rather is intended to be a narrative description of items and functions that should be considered in preparing excitation system specifications. Much of the information presented in this guide may be unnecessary for the writer’s particular specification. The writers should judge for themselves the applicability of information to be included in their specifications, and remove all inapplicable portions. Some tutorial material is included for the specification writer who may be relatively inexperienced in selecting parameters and requirements for each particular application.

It should be noted that although this guide is recommended for application to machines of 5000 kVA and above, there may be applications where the detailed requirements as proposed by this guide may be useful for smaller machines. It should also be noted that this document defines an “excitation control system” as one that includes the synchronous machine. The definition is included here for clarity as the term is not defined in IEEE Std 421.1-1986; however, it is included in IEEE Std 100-1988, IEEE Standard Dictionary of Electrical and Electronics Terms.

This is a new guide. Suggestions for its improvement are welcomed. They should be sent to the Secretary, IEEE Standards Board, Institute of Electrical and Electronics Engineers, 345 East 47th Street, New York, NY 10017.

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IEEE Guide for the Preparation of Excitation System Specifications

1. Introduction

This guide is intended to provide to the specification writer the necessary material to prepare a specification for the procurement of an excitation system for a synchronous machine. The information presented in this guide is given in narrative form, with the descriptions and functions of particular items that should be examined in preparing the specifications.

1.1 Purpose and Scope

The purpose of this guide is to aid in the preparation of procurement specifications for excitation systems for synchronous machines. This guide applies to excitation systems for synchronous machines rated 5000 kVA or larger. Some information presented in this guide may be inapplicable for a specific excitation system application, and may be omitted in the writer's specification.

The term "excitation control system" is used throughout this guide. An excitation control system is a feedback control system that includes the synchronous machine and its excitation system. Figure 1 contains a block diagram of an excitation control system. An excitation system is the equipment providing field current for a synchronous machine including all power, regulating, control, and protective elements. An exciter is the equipment that provides the field current for the excitation of a synchronous machine. A synchronous machine regulator is a regulator that couples the output variables of the synchronous machine to the input of the exciter through feedback and forward controlling elements for the purpose of regulating the synchronous machine output variables (see IEEE Std 421.1-1986 [9]).¹ The influence of the power system upon the operation of the excitation control system must be considered when the synchronous machine is connected to the power system.

1.2 References

This standard shall be used in conjunction with the following publications:

[1] ANSI C50.10-1977, General Requirements for Synchronous Machines.²

[2] ANSI C50.12-1982 (Reaff. 1989), Requirements for Salient Pole Synchronous Generators and Generators/Motors for Hydraulic Turbine Applications.

¹The numbers in brackets refer to the references that are listed in 1.2 in this guide. IEEE publications are available from the Institute of Electrical and Electronics Engineers, IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08855-1331, USA.

²ANSI publications are available from the Sales Department of the American National Standards Institute, 1430 Broadway, New York, NY, USA.

- [3] ANSI C50.13-1989, Requirements for Cylindrical Rotor Synchronous Generators.
- [4] ANSI C50.14-1977 (Reaff. 1989), Requirements for Combustion Gas Turbine Driven Cylindrical Rotor Synchronous Generators.
- [5] IEEE C37.18-1979, IEEE Standard Enclosed Field Discharge Circuit Breakers for Rotating Electric Machinery (ANSI).
- [6] IEEE C57.12.00-1980, General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers (ANSI).
- [7] IEEE C57.12.91-1979, IEEE Test Code for Dry-Type Distribution and Power Transformers.
- [8] IEEE Std 100-1988, IEEE Standard Dictionary of Electrical and Electronics Terms.
- [9] IEEE Std 421.1-1986, IEEE Standard Definitions for Excitation Systems for Synchronous Machines.
- [10] IEEE Std 421.2-1990, IEEE Guide for Identification, Testing, and Evaluation of the Dynamic Performance of Excitation Control Systems.
- [11] IEEE Std 421B-1979 (Reaff. 1984), IEEE Standard for High-Potential Test Requirements for Excitation Systems.
- [12] IEEE Committee Report. Excitation System Models for Power System Stability Studies, *IEEE Transactions on Power Apparatus and Systems*, vol. PAS-100, no. 2, Feb. 1981, pp. 494–509.

1.3 Definitions

The following definitions should be used in conjunction with this guide:

excitation control system: —is a feedback control system that includes the synchronous machine and its excitation system.

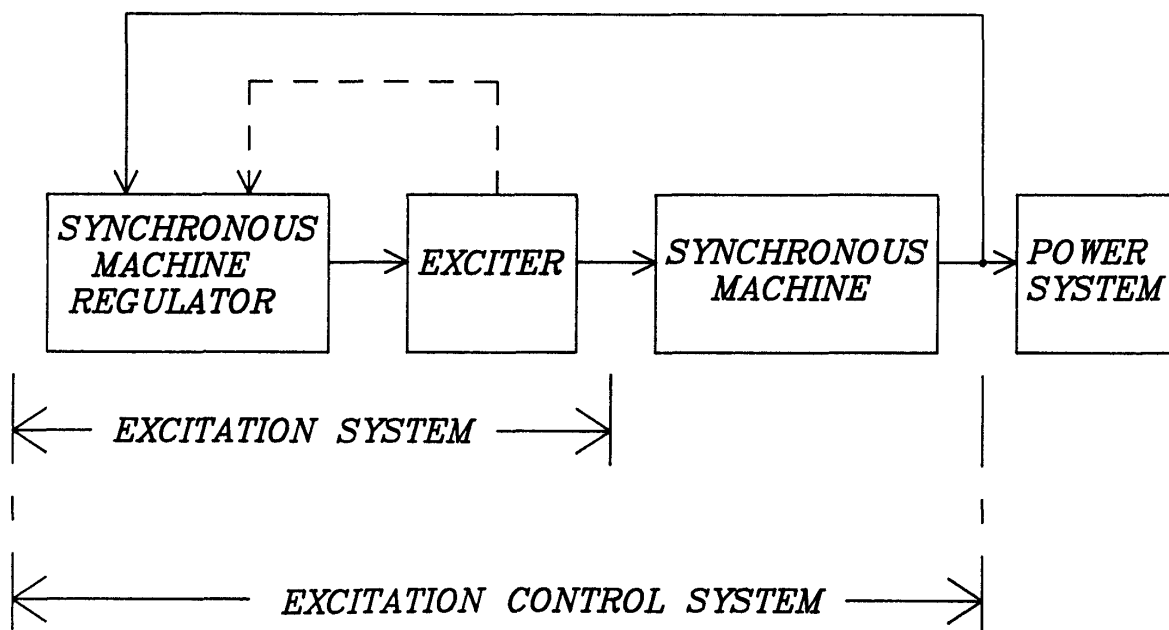


Figure 1—Block Diagram of the Components of an Excitation Control System

excitation system: —is the equipment providing field current for a synchronous machine including all power, regulating, control, and protective elements.

excitation system stabilizer: —is a control element that is used to stabilize the excitation control system.

exciter: —is the equipment that provides the field current for the excitation of a synchronous machine.

load regulation: —is the magnitude of voltage change resulting from a load change.

power system stabilizer (PSS): —is used to provide damping at power system frequencies associated with local and intertie modes of oscillation.

synchronous machine regulator: —is a regulator that couples the output variables of the synchronous machine to the input of the exciter through feedback and forward controlling elements for the purpose of regulating the synchronous machine output variables (see IEEE Std 421.1-1986 [9]).

2. General

2.1 Basic

The primary function of an excitation system is to provide the field current required by a synchronous machine to meet a specified range of power system operating conditions. In addition to fulfilling this requirement, there are a number of other factors that should be considered by a purchaser when writing specifications for an excitation system. Power system stability studies have been found to be useful in identifying dynamic performance requirements. These performance evaluations help establish the required response characteristics and also may identify the need for a power system stabilizer. Modern excitation systems may include various auxiliary control elements and protective devices in addition to a basic voltage regulator. The specification should functionally identify all the auxiliary excitation control equipment (compensators, limiters, power system stabilizer, etc.), and protective equipment (volts/hertz protection, overexcitation protection, etc.) which are to be included in the excitation system.

The specification should include items relevant to the excitation system design even though they do not directly affect the performance of the voltage regulation task. To assist the manufacturer in identifying applicable standards and possible design constraints, a description of the type of installation should be included, i.e., nuclear, fossil fueled, hydroelectric, etc.

2.2 Operating Modes

An important consideration in the design of an excitation system is the identification of the operating mode or modes of the plant. The specification should clearly state all possible modes of operation, i.e., generation, pumped storage, synchronous condenser, etc. The most severe duty cycle expected for each possible mode should be provided. In addition, the specification should indicate the extent of unattended operation, i.e., automatic startup, remote operation, etc.

2.3 Installation

The specification for an excitation system should clearly state whether the excitation control equipment is to be utilized as an outdoor or an indoor installation. Special storage requirements for the system before installation should be included in the specification, as well as special handling and shipping instructions. If there is a preferred method of shipping, it should be stated in addition to all known minimum clearances and maximum weight limitations. In addition, the specification could state the capacity and availability of cranes at the installation site.