

IEEE Guide for Static var Compensator Field Tests

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of the
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Abstract: General guidelines and criteria for the field testing of static var compensators (SVCs), before they are placed in-service, for the purpose of verifying their specified performance are described. The major elements of a commissioning program are identified so that the user can formulate a specific plan that is most suited for his or her own SVC.

Keywords: Mvar, static var compensator, SVC, var

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Introduction

(This introduction is not a part of IEEE Std 1303-1994, IEEE Guide for Static var Compensator Field Tests.)

This guide was prepared by a Task Force of Working Group I₄, Static var Compensators in Substations, of the DC Converter Substations Subcommittee of the Substations Committee of the IEEE Power Engineering Society.

Preparation of this guide began in 1989 with the purpose of establishing SVC field testing guidelines for prospective or first-time users of SVC systems.

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1. Overview

1.1 Scope

This document is a guide for field testing and commissioning of static var compensators (SVCs). As such, the document establishes general guidelines and criteria for field testing to verify the specified performance of SVC systems.

This guide does not

- Cover factory and simulator tests of SVC system components (but it assumes that such tests have been performed beforehand).
- Discuss the division of responsibility between user and supplier, since this division is usually defined in the contract between buyer and supplier. Most often, however, the practice is for the equipment, subsystem, and commissioning tests to be performed by the supplier, and the acceptance tests to be performed by the buyer or user.

1.2 Purpose

The purpose of this guide is to help users of SVCs carry out a field test program prior to placing an SVC into service. The major elements of a commissioning program are identified so that the user can formulate a specific plan that is suited to his or her own SVC. Such a test program should cover the following:

- Equipment tests within the SVC system
- Tests of the various subsystems that comprise the SVC system
- Commissioning tests for the complete SVC system
- Acceptance testing of the SVC system

It should be recognized that there are many ways in which a particular SVC may be commissioned, and also that it is not the purpose of this guide to endorse a specific procedure to the exclusion of other methods.

Depending on the purpose of the SVC design (transmission type or smaller size used for other purposes) some tests may not be required. In particular, some control system tests may be included in the factory tests. Also, acceptance tests may be integrated into any of the categories listed above.

2. References

This guide shall be used in conjunction with the following publications.

IEEE Std 18-1992, IEEE Standard for Shunt Power Capacitors (ANSI).

IEEE Std 80-1986 (Reaff 1991), IEEE Guide for Safety in AC Substation Grounding (ANSI).

IEEE Std 100-1992, The New IEEE Standard Dictionary of Electrical and Electronics Terms (ANSI).

IEEE Std 519-1992, IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems (ANSI).

IEEE Std 693-1984 (Reaff 1991), IEEE Recommended Practices for Seismic Design of Substations (ANSI).

IEEE Std 1031-1991, IEEE Guide for a Detailed Functional Specification and Application of Static VAR Compensators (ANSI).

IEEE Std C37.20.3-1987 (Reaff 1992), IEEE Standard for Metal-Enclosed Interrupter Switchgear (ANSI).

IEEE Std C57.21-1990, IEEE Standard Requirements, Terminology, and Test Code for Shunt Reactors Rated Over 500 kVA (ANSI).

3. Definitions

This clause contains definitions for key terms used in this guide. Further clarification of terminology, as needed, is provided at the appropriate points within the text of this guide.

3.1 as-built drawings: A complete set of drawings which, in addition to the original drawings, includes all drawings that accurately record changes made to the equipment or subsystem to indicate the final installation and commissioning.

3.2 derated operation: Use of equipment or a system at a more restricted performance level than that for which the equipment or system was originally designed. Derated operation is usually implemented either to forestall failures or as a result of system component failure.

3.3 energization test: Any test requiring that system voltage be applied to the equipment.

3.4 inspection and test plan (ITP): A summary of prerequisites, system configurations, step-by-step procedures, and evaluation criteria of the tests in one place for permanent record.

3.5 interface test: A test to check interaction among equipment through permanent interconnections.

3.6 ITP: Acronym for **inspection and test plan**. See 3.4.

3.7 IT product: The inductive influence expressed in terms of the product of its root-mean-square magnitude (I), in amperes, times its telephone influence factor (TIF). (Source: IEEE Std 519-1992.)

3.8 PCC: Acronym for **point of common coupling**. See 3.9.

3.9 point of common coupling (PCC): The connection point between the SVC and the power system at which performance requirements are defined.

3.10 SER: Acronym for **sequence of events recorder**.

3.11 subsystem: An interconnected, interrelated group of equipment intended to serve a single basic purpose within a larger installation or facility.

3.12 TCR: Acronym for **thyristor-controlled reactor**. See 3.15.

3.13 TFR: Acronym for **transient fault recorder**.

3.14 test coordinator: A person typically responsible for organizing and scheduling tests; deciding how, when, and where the system and its components will be tested; and determining the test equipment that is needed.

3.15 thyristor-controlled reactor (TCR): A series connection thyristor controller, typically connected between two halves of a reactor, that forms one leg of the connected circuit. The thyristor controller consists of antiparallel phase angle controlled thyristors for vernier control of the reactor susceptance (current).

3.16 thyristor-switched capacitor (TSC): A series connection thyristor switch, typically connected between a capacitor bank and a current limiting reactor, that forms one leg of the connected circuit. The thyristor switch consists of antiparallel thyristors that are blocked or fired for full conduction (on/off control).

3.17 thyristor-switched reactor (TSR): A series connection thyristor switch, typically connected between two halves of a reactor, that forms one leg of the connected circuit. The thyristor switch consists of antiparallel thyristors that are blocked or fired for full conduction (on/off control).

3.18 TNA: Acronym for **transient network analyzer**. See 3.20.

3.19 TPC: Acronym for **trigger pulse converter**. See 3.22.

3.20 transient network analyzer (TNA): An analog test circuit representing a scaled down version of the pertinent power circuit components, used mainly for control response and performance testing.

3.21 trial operation: A period during which the equipment or system is placed under service conditions and is also monitored for stable, smooth, and reliable performance.

3.22 trigger pulse converter (TPC): A device in the control system that converts the control signal to a signal that can be transmitted to the thyristor valve.

3.23 TSC: Acronym for **thyristor-switched capacitor**. See 3.16.

3.24 TSR: Acronym for **thyristor-switched reactor**. See 3.17.

3.25 valve base electronics (VBE): Electronic circuitry that directs gate pulses into the thyristor valve.

3.26 valve electronics (VE): Electronic circuitry associated with the thyristors and mounted at thyristor level potential.

3.27 VBE: Acronym for **valve base electronics**. See 3.25.

3.28 VE: Acronym for **valve electronics**. See 3.26.

4. Preparation of a field test program

The purpose of this clause is to describe how a comprehensive field test program can be applied to SVC systems.

In general, every SVC has been designed and installed for a specific reason and purpose. This reasoning and purpose should be clearly defined for the test program and understood by the participants.

A specific set of inspection and test plans (ITPs) should be prepared for each SVC project. In the field, these ITPs will demonstrate that the specific purposes of that SVC are being met in accordance with the performance specifications.

4.1 Test program phases

A comprehensive field test program includes the following major phases:

- a) Overall test planning and organization, including the definition and line of authority for performing the tests
- b) Document and data survey, including contract, system study, factory test review, drawing, user's manual availability, and definition of ac system requirements or limitations
- c) Preparation of ITPs for equipment, subsystem, commissioning, and acceptance tests of the SVC system
- d) Review and approval of, or concurrence with test program by user
- e) Schedule, including coordination of installation/test schedule and coordination with system operation
- f) Dissemination of information, including as-built drawings

Only phase c), the preparation of ITPs for SVC equipment, subsystem, commissioning, and acceptance tests, is discussed in this guide.

4.2 Inspection and test plans (ITPs)

It is suggested that a format be adopted that breaks down the overall test program into a series of single purpose ITPs.

4.2.1 Contents of the ITP

The ITP should contain at least the following information:

- a) Descriptive title and test number. The title should convey the purpose of the test, equipment, and subsystem or system being tested.
- b) Person (by title) responsible for directing the test and the person with whom the performance of the test is to be coordinated.
- c) List of preceding tests that should have been completed before this test can be attempted.
- d) Estimate of time required to complete the test.
- e) System configuration prior to the test. This could be in the form of a single-line diagram at the beginning of the test, a table of switch or breaker positions, or other format that describes the pretest configuration.
- f) Step-by-step description of the test execution, along with the expected results of each step.
- g) Description of the expected final results.
- h) Summary of the records required to document successful completion of the test.
- i) Identification and description of relevant reference information, such as industry standards, particular requirements from the specifications, or potential impact on the utility.
- j) Test equipment used, including type, serial number, calibration, etc.
- k) Test sheets with measured data (suitable for future fault diagnosis).

A sample ITP is provided in figure 1. This ITP is for example purposes only, and should be modified to fit the circumstances of the specific project and organization.