

An American National Standard

**IEEE Guide for Planning of Preoperational
Testing Programs for Class 1E Power Systems for
Nuclear Power Generating Stations**

1. Scope

This guide provides guidance for the planning of preoperational test programs for Class 1E Power Systems for nuclear power generating stations. The extent of the systems shall be that covered by ANSI/IEEE Std 308-1980, IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations. An example system is illustrated in ANSI/IEEE Std 308-1980 [2],¹ Fig 1. The power systems are considered to include the ac and dc power supplies, but do not include the equipment which utilizes the ac and dc power.

2. Purpose

The purpose of this guide is to provide direction for establishing an acceptable preoperational testing program for Class 1E Power Systems in nuclear power generating stations. The preoperational tests are performed after the appropriate construction tests have been completed. The purpose of preoperational tests is to verify that the Class 1E Power Systems perform their required function as designed.

¹ Numbers in brackets correspond to those of the references, Section 3 of this standard.

3. References

3.1 References. When the following documents referred to in this guide are superseded by a revision, the latest revision shall apply.

- [1] ANSI/IEEE Std 100-1984, IEEE Standard Dictionary of Electrical and Electronics Terms.²
- [2] ANSI/IEEE Std 308-1980, IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations.
- [3] ANSI/IEEE Std 336-1985, IEEE Standard Installation, Inspection, and Instrumentation, and Control Equipment at Nuclear Facilities.
- [4] ANSI/IEEE Std 338-1977 (R 1984), IEEE Standard Criteria for the Periodic Testing of Nuclear Power Generating Station Safety Systems.
- [5] ANSI/IEEE Std 387-1984, IEEE Standard Criteria for Diesel-Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations.
- [6] ANSI/IEEE Std 450-1980, IEEE Recommended Practice for Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Generating Stations and Substations.

² ANSI documents are available from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018.

[7] IEEE Std 603-1980, IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations.³

[8] IEEE Std 946-1985, IEEE Recommended Practice for the Design of Safety-Related DC Auxiliary Power Systems for Nuclear Power Generating Stations

3.2 Applicable Document in Preparation⁴

4. Definitions

The following specific definitions are listed herein because of their frequent reference in this guide. For other definitions, see Section 3.

construction test. A test to verify proper installation and operation of individual components in a system prior to operation of the system as an entity. It is assumed that the construction test does not verify the interconnected-system equipment external to that component. For example, the protective relays are bench tested by simulating fault conditions to verify conformance with approved characteristics. During bench tests the alarm, trip, and permissive-interlock functions that the protective relay circuits are to perform are not verified.

preoperational system test. A test to confirm that all individual component parts of a system function as a system and the system functions as designed. A preoperational test should be performed prior to fuel loading and appropriate tests should be performed following significant modifications or additions made to the facility at later dates.

5. General Requirements

5.1 Testing Program, Planning, and Administrative Procedures. Planning, administrative procedures, and work instructions for the total plant testing program should be established. Detailed planning, work instructions,

³ IEEE documents are available from IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854.

⁴ When the following document is completed, approved and published, it becomes a part of this listing.

IEEE Standards Project P944 (in preparation), Recommended Practice for Application and Testing of Uninterruptible Power Supplies for Power Generating Stations.

preoperational test procedures, and administrative procedures for preoperational testing of Class 1E Power Systems identified in Section 6 should be prepared. The preoperational test procedures for Class 1E Power Systems should be coordinated with other phases of the overall plant testing program.

5.2 Prerequisites. The Class 1E Power System components should have met all applicable requirements of design, fabrication, installation, and all applicable tests required by applicable codes, standards, and Quality Assurance Programs. The records of construction test results should have been reviewed and compared with design requirements as part of the Quality Assurance Program and checked for appropriate certification.

5.3 Performance. After meeting the requirements of 5.1 and 5.2, the tests outlined in Section 6 and other referenced documents should be performed.

6. Test Plan Guidelines

6.1 General. The preoperational tests should be conducted with bus loads as close as possible to actual system operating conditions for the mode of operation being tested. If testing under actual load is not practical, simulated equivalent load can be substituted if the test results will not be compromised. The loads are not a part of the system being tested.

When tests are conducted by manually initiating the normally automatic function of a device, it should also be verified that the device itself functions automatically in accordance with approved manufacturers' data. This method of overlap testing checks individual parts of a system in a manner which ensures that the entire system function is verified.

The preoperational tests should encompass all applicable postulated operating modes considered in the design basis events. The tests should demonstrate that the system is capable of performing all design safety functions.

6.2 Preoperational Tests for Medium-Voltage Class 1E Power Systems

6.2.1 Equipment and Accessories. The medium-voltage Class 1E system may include but

is not limited to the following equipment and accessories:

- (1) Transformers
- (2) Switchgear
- (3) Power distribution buses
- (4) Cable
- (5) Protective devices
- (6) Control devices
- (7) Monitoring devices

6.2.2 Preoperational Tests

6.2.2.1 No-Load Test. After the construction tests are completed and the test results found satisfactory, the system should be energized from the preferred power source(s) and any alternate source(s). The system voltage and frequency, with no load connected to the system, should be verified to be within the design limits.

6.2.2.2 Current Monitoring and Overcurrent Protection. The testing required to demonstrate system overcurrent protection may consist of simulating phase-to-phase and phase-to-ground faults. One way of simulating an abnormal current condition is to manually activate the relay contacts, and then provide separate overlap testing of the relay. The alarm, trip functions, and permissive interlocking features involved should be verified during the testing.

6.2.2.3 Voltage Monitoring and Protection. The testing required to demonstrate system voltage protection may consist of simulating undervoltage and overvoltage conditions. One way of simulating an abnormal voltage condition is to manually activate the relay contacts, and then provide separate overlap testing of the relay. The alarm, trip functions, and permissive interlocking features involved should be verified during this testing.

6.2.2.4 Control. The testing required to demonstrate system control should include all manual and automatic features of the system, including source transfers, and load sequencing. The alarm, trip functions, and permissive interlocking (including circuit-breaker alignment) should be verified during this test. Breaker position switch interlocking should be verified by overlap testing of the breaker cell switches.

6.2.2.5 Instrumentation. All instrument reading values should be verified to be within allowable limits for the system being monitored.

6.2.2.6 Load Verification. These tests should verify that the system loads are within design parameters for all modes of operation.

6.2.2.7 Independence. These tests should verify that each Class 1E load group and its

power source can function independent of any redundant-load group and power source. Independence between the standby-power source and the preferred power source(s) should be demonstrated for each redundant-load group.

6.2.2.8 Bus Transfers. Bus transfer schemes should be verified to operate per design specifications. One way to verify the scheme is by simulation of loss of voltage on the bus.

6.2.2.9 Functional Test. A system functional test which simulates failure modes for each of the preferred power supplies should be performed. This simulation should be as close as possible to the actual power system failure condition. The system permissive interlocks, annunciation, control logic, voltage, and frequency design limits should be verified during this test.

6.3 Preoperational Tests for Low-Voltage Class 1E Power Systems

6.3.1 Equipment and Accessories. The low voltage Class 1E Power System may include but is not limited to the following equipment and accessories:

- (1) Transformers
- (2) Switchgear
- (3) Power distribution buses
- (4) Load distribution centers
- (5) Panelboards
- (6) Cable
- (7) Protective devices
- (8) Control devices
- (9) Monitoring devices

6.3.2 Preoperational Tests

6.3.2.1 No-Load Test. After the construction tests are completed and the test results determined to be satisfactory, the system should be energized from its normal and any alternate sources. The system voltage and frequency should be verified to be within design limits with no load connected to the system.

6.3.2.2 Current Monitoring and Overcurrent Protection. The testing required to demonstrate system overcurrent protection may consist of simulating phase-to-phase and phase-to-ground faults. One way of simulating an abnormal current condition is to manually activate the relay contacts and then provide separate overlap testing of the relay. The alarm, trip functions, and permissive interlocking features involved should be verified during this testing.

6.3.2.3 Voltage Monitoring and Protection. The testing required to demonstrate system voltage protection may consist of simulating