

An American National Standard

IEEE Recommended Practice for the Application and Testing of Uninterruptible Power Supplies for Power Generating Stations

Sponsor
**Power Generation Committee
of the
IEEE Power Engineering Society**

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Foreword

(This Foreword is not a part of ANSI/IEEE Std 944-1986, IEEE Recommended Practice for the Application and Testing of Uninterruptible Power Supplies for Power Generating Stations.)

Vital ac power systems play an ever increasing role in generating station control and information systems. This recommended practice fulfills a need within the industry to provide criteria and recommendations for the application and testing of vital ac systems. The features described are applicable to Class IE and non-Class IE installations.

This criteria may be used separately, and, when combined with applicable portions of ANSI/IEEE Std 650-1979, IEEE Standard for Qualification of Class IE Static Battery Chargers and Inverters for Nuclear Power Generating Stations, will provide the user with a general guide to the application and testing of vital ac systems.

The IEEE will maintain this recommended practice current with the state of the technology. Comments on this criteria and suggestions for additional material that should be included are invited.

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1. Scope

This recommended practice is intended to define the application and performance requirements for a low-voltage uninterruptible power supply (UPS) system used for service in power generating stations. This recommended practice addresses only requirements for semiconductor ac to ac converter systems (static) with dc electric energy storage capability. This recommended practice is not intended to address other types of UPS systems.

This recommended practice is intended to cover application requirements, such as load information and service conditions, performance requirements and design, routine testing requirements for inverters with or without rectifier/chargers, and transfer switches only. The application requirements for batteries and battery chargers are excluded from this recommended practice. They can be found in other documents.

This recommended practice is not intended to address equipment or component design requirements, safety-related design criteria, or requirements for equipment qualification and preoperational/surveillance testing.

2. Definitions

ac input: Electric power in the form of alternating current (ac) supplied to the uninterruptible power supplies (UPS) and bypass.

ambient temperature (general): The temperature of the medium, such as air, water, or earth into which the heat of equipment is dissipated.

battery, electric: A device that transforms chemical energy into electric energy.

blocking diode (uninterruptible power supplies) (UPS): A device that prevents the flow of current from the UPS rectifier to the battery, but permits the flow of current from the battery to the UPS inverter.

bypass transformer: A transformer that provides alternating-current power to the UPS loads when the UPS equipment fails, is temporarily overloaded, or is out of service for maintenance.

charger, battery: A device that can maintain an unidirectional current in a battery in the opposite direction to that during discharge thereby converting electric energy into chemical energy within the battery.

class 1E (nuclear power generating station): The safety classification of the electrical equipment and electric systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or are otherwise essential in preventing significant release of radioactive material to the environment.

crest factor (periodic function): The ratio of its crest (peak, maximum) value to its root-mean-square value.

current limit (control): A control function that prevents current from exceeding its prescribed limits.

dc link: The direct-current power interconnection between rectifier or rectifier/charger and inverter function units.

design tests: Tests made to determine the adequacy of the design of a particular type, style, or model of equipment or its component parts to meet its assigned ratings and to operate satisfactorily under normal service conditions or under special conditions if specified.

efficiency (electric conversion): The ratio of output power to input power expressed in percentage.

field tests: Tests made on operating systems usually for the purpose of investigating the performance of the equipment or its component parts under conditions that may not have been duplicated in the factory.

functional unit: A system element that performs a task required for the successful operation of the system.

harmonic: The sinusoidal component of a periodic wave or quantity having a frequency that is an integral multiple of the fundamental frequency.

harmonic distortion (single and total): Distortion characterized by the appearance of harmonics in addition to the fundamental component. The total harmonic distortion is the ratio of the root-mean-square (rms) value of all the harmonics to the rms value of the fundamental.

inverter (electric power): A machine, device, or system that changes direct-current power to alternating-current power.

low-voltage system (electric power): An electric system having a maximum root-mean-square alternating-current voltage of 1000 V or less.

meantime between failures: The arithmetic average of operating times between failures.

meantime to repair: The arithmetic average of time required to complete a repair activity.

nonlinear load: A load with such characteristics that with an applied sinusoidal voltage the load current is not sinusoidal.

output voltage: The root-mean-square (rms) voltage (unless otherwise specified for a particular load) between the output terminals.

power factor (general): The ratio of total watts to the total root-mean-square (rms) volt-amperes.

qualification (nuclear power generating stations): A demonstration that illustrates that the equipment meets the design requirements.

rating (rating of electrical equipment): The whole of the electrical and mechanical quantities assigned to the machine, apparatus, etc, by the designer to define its working in specified conditions indicated in the rating nameplate.

rectifier: A device or assembly of devices that converts ac power into dc power to supply the input power to an inverter but not to a battery.

rectifier/charger: A device that changes alternating-current power to direct-current power to feed either an inverter or a battery, or both.

routine test: Tests made by the manufacturer for quality control on every device or representative samples, or on parts and materials as required to verify during production that the product meets the design specifications.

safety-related (nuclear power generating station): Any Class 1E power or protective system device included in ANSI/IEEE Std 308-1980 [2]¹, Section 2 and ANSI/IEEE Std 603-1980 [3], Section 2.

slew rate: The change in frequency of a periodic waveform from one period to the immediately subsequent period divided by the average of the two periods.

static converter: A unit that employs static switching devices, such as controlled rectifiers, transistors, or magnetic amplifiers.

steady state: The condition in which some value, such as amplitude periodicity or rate of change, exhibits negligible change over an arbitrary long interval of time.

step load change (power supplies): An instantaneous change in load current (for example, zero to full load) for measuring the load regulation and recovery time.

transfer switch (emergency and standby power systems): A device for transferring one or more load conductor connections from one power source to another.

transient (industrial power and control): That part of the change in a variable that disappears during transition from one steady-state operating condition to another.

uninterruptible power supply system: A system that converts unregulated input power to voltage and frequency controlled filtered ac power that continues without interruption even with the deterioration of the input ac power.

vital loads: Vital instrumentation and control power systems identified in ANSI/IEEE Std 308-1980 [2] or other loads as specified that are important to plant operation or personnel safety, or both.

voltage imbalance factor: The ratio of the amplitudes of the negative-sequence component to the positive-sequence component of the line-line output voltage.

voltage regulator: A device that controls output voltage within a specific range when the input voltage and connected load are within specified ranges.

yearly average temperature: The time average of bulk air temperature taken over a period of one year.

3. References

This recommended practice shall be used in conjunction with the following publications:

[1] ANSI C84.1-1982, American National Standard Voltage Ratings for Electric Power Systems and Equipment (60 Hz).²

[2] ANSI/IEEE Std 308-1980, IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations.³

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

[4] ANSI/IEEE Std 650-1979, IEEE Standard for Qualification of Class 1E Static Battery Chargers and Inverters for Nuclear Power Generating Stations.

¹The numbers in brackets correspond to the references listed in Section 3 of this recommended practice.

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

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