

IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications

Sponsor

**Energy Development and Power Generation Committee
of the
IEEE Power Engineering Society**

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Abstract: Maintenance, test schedules, and testing procedures that can be used to optimize the life and performance of permanently installed, vented lead-acid storage batteries used for standby power applications are provided. This recommended practice also provides guidance to determine when batteries should be replaced. This recommended practice is applicable to all stationary applications. However, specific applications, such as emergency lighting units and semiportable equipment, may have other appropriate practices and are beyond the scope of this recommended practice.

Keywords: acceptance test, battery capacity, battery installation, battery maintenance, battery replacement criteria, battery service test, battery terminal voltage, connection resistance readings, electrolyte level, equalize charge, float voltage, modified performance test, performance test, service test, specific gravity, standby power applications, state of charge, test discharge rate, vented lead-acid battery

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Introduction

(This introduction is not a part of IEEE Std 450-1995, IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.)

Stationary lead-acid batteries play an ever increasing role in industry today by providing normal control and instrumentation power and backup energy for emergencies. This recommended practice fulfills the need within the industry to provide common or standard practices for battery maintenance, testing, and replacement. The methods described are applicable to all installations and battery sizes using vented lead-acid batteries.

The installations considered herein are designed for full-float operation with a battery charger serving to maintain the battery in a charged condition as well as to supply the normal dc load.

This recommended practice may be used separately, and when combined with IEEE Std 484-1987, IEEE Recommended Practice for Installation Design and Installation of Large Lead Storage Batteries for Generating Stations and Substations, and IEEE Std 485-1983, IEEE Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations, will provide the user with a general guide to sizing, designing, placing in service, maintaining, and testing a vented lead-acid storage battery installation. IEEE Std 535-1986, IEEE Standard for Qualification of Class 1E Lead Storage Batteries for Nuclear Power Generating Stations, is a companion document.

This recommended practice was prepared by the Working Group on Batteries, Station Design Subcommittee of the Energy Development and Power Generation Committee of the IEEE Power Engineering Society. At the time this recommended practice was completed, the Working Group on Batteries had the following membership:

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IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications

1. Scope

This recommended practice provides maintenance, test schedules, and testing procedures that can be used to optimize the life and performance of permanently installed, vented lead-acid storage batteries used for standby power applications. It also provides guidance to determine when batteries should be replaced. This recommended practice is applicable to all stationary applications. However, specific applications, such as emergency lighting units and semiportable equipment, may have other appropriate practices and are beyond the scope of this recommended practice.

Sizing, installation, qualification, other battery types, and application are also beyond the scope of this recommended practice.

This recommended practice does not include any other component of the dc system, or surveillance and testing of the dc system, even though the battery is part of that system. Preoperational and periodic dc system tests of chargers and other dc components may require that the battery be connected to the system. Details for these tests will depend on the requirements of the dc system and are beyond the scope of this recommended practice.

2. References

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

IEEE Std 100-1992, The New IEEE Standard Dictionary of Electrical and Electronics Terms (ANSI).¹

IEEE Std 308-1991, IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations (ANSI).

IEEE Std 323-1983 (Reaff 1990), IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations (ANSI).

¹IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

IEEE Std 484-1987, IEEE Recommended Practice for Installation Design and Installation of Large Lead Storage Batteries for Generating Stations and Substations (ANSI).

IEEE Std 485-1983, IEEE Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations (ANSI).

IEEE Std 494-1974 (Reaff 1990), IEEE Standard Method for Identification of Documents Related to Class 1E Equipment and Systems for Nuclear Power Generating Stations (ANSI).

IEEE Std 535-1986 (Reaff 1994), IEEE Standard for Qualification of Class 1E Lead Storage Batteries for Nuclear Power Generating Stations (ANSI).

IEEE Std 946-1992, IEEE Recommended Practice for the Design of DC Auxiliary Power Systems for Generating Stations (ANSI).

3. Definitions

The following definitions apply specifically to the subject matter of this recommended practice. For other definitions, refer to the standards listed in clause 2.

3.1 acceptance test: A constant current or power capacity test made on a new battery to determine that it meets specifications or manufacturer's ratings.

3.2 capacity test: A discharge of a battery at a constant current or power to a specified terminal voltage.

3.3 critical period: That portion of the duty cycle that is the most severe, or the specified time period of the battery duty cycle.

3.4 duty cycle: The load currents a battery is expected to supply for specified time periods.

3.5 equalizing voltage: The voltage, higher than float, applied to a battery to correct inequalities among battery cells (voltage or specific gravity) that may develop in service.

3.6 float voltage: The voltage applied to a battery to maintain it in a fully charged condition during normal operation.

3.7 modified performance test: A test, in the "as found" condition, of a battery's capacity and its ability to provide a high-rate, short-duration load (usually the highest rate of the duty cycle) that will confirm the battery's ability to meet the critical period of the load duty cycle, in addition to determining its percentage of rated capacity.

3.8 performance test: A constant current or constant power capacity test, made on a battery after it has been in service, to detect any change in the capacity.

3.9 service test: A test, in the "as found" condition, of the battery's capability to satisfy the battery duty cycle.

3.10 terminal connection detail: Connections made between rows of cells or at the positive and negative terminals of the battery, which may include terminal plates, cables with lugs, and connectors.

3.11 vented cell: A cell in which the products of electrolysis and evaporation are allowed to escape to the atmosphere as they are generated. These batteries are commonly referred to as "flooded."

4. Maintenance

4.1 General

Proper maintenance will prolong the life of a battery and will aid in ensuring that it is capable of satisfying its design requirements. A good battery maintenance program will serve as a valuable aid in maximizing battery life, preventing avoidable failures, and reducing premature replacement. Battery maintenance should be performed by personnel knowledgeable of batteries and the safety precautions involved.

See IEEE Std 484-1987² for initial installation requirements.

4.2 Safety

The safety precautions listed herein should be followed during battery maintenance. Work performed on batteries should be done only with proper and safe tools and with the protective equipment listed in 4.2.2.

4.2.1 Methods

Work performed on a battery while in service shall use methods to preclude arcing in the vicinity of the battery.

4.2.2 Protective equipment

The following protective equipment shall be available to personnel who perform battery maintenance work:

- a) Goggles and face shields
- b) Acid-resistant gloves
- c) Protective aprons
- d) Portable or stationary water facilities for rinsing eyes and skin in case of contact with acid electrolyte
- e) Bicarbonate of soda, mixed with a ratio of 0.1 kg to 1 liter (1 lb to 1 gal) of water to neutralize acid spillage

NOTE—The removal and/or neutralization of an acid spill may result in the production of a hazardous waste. The user should comply with appropriate governmental regulations.

- f) Class C fire extinguisher

NOTE—Some battery manufacturers do not recommend the use of CO₂ Class C fire extinguishers due to the potential of thermal shock on the battery cases.

- g) Adequately insulated tools

4.2.3 Precautions

The following protective procedures shall be observed during maintenance:

- a) Use caution when working on batteries since they represent an electric shock hazard.
- b) Prohibit smoking and open flames, and avoid the chances of arcing in the immediate vicinity of the battery.

²Information on references can be found in clause 2.

- c) Ensure that the load test leads are clean, in good condition, and connected with a sufficient length of cable to prevent accidental arcing in the vicinity of the battery.
- d) Ensure that all connections to load test equipment include short-circuit protection.
- e) Ensure that battery area ventilation is operable.
- f) Ensure unobstructed egress from the battery area.
- g) Avoid the wearing of metallic objects such as jewelry.
- h) Neutralize static buildup just before working on a battery by having personnel contact nearest effectively grounded surface.
- i) Ensure that all battery monitoring equipment is operational.

4.3 Inspections

Implementation of periodic inspection procedures provides the user with information for determining the operability of the battery. The frequency of the inspections should be based on the nature of the application and may exceed that recommended herein. All inspections should be made under normal float conditions. For specific gravity readings to be meaningful, the electrolyte must be fully mixed. This condition is unlikely to exist following a discharge or water addition. Readings should be taken in accordance with the manufacturer's instructions. Refer to the annexes for more information.

4.3.1 General

Inspection of the battery on a regularly scheduled basis (at least once per month) should include a check and record of the following:

- a) Float voltage measured at battery terminals
- b) General appearance and cleanliness of the battery, the battery rack and/or battery cabinet, and the battery area
- c) Charger output current and voltage
- d) Electrolyte levels
- e) Cracks in cells or leakage of electrolyte
- f) Any evidence of corrosion at terminals, connectors, racks, or cabinets
- g) Ambient temperature and ventilation
- h) Voltage, specific gravity, and electrolyte temperature of pilot cell (if used)
- i) Unintentional battery grounds

4.3.2 Quarterly

At least once per quarter, the general inspection should be augmented as follows. Check and record the following:

- a) Specific gravity of 10% of the battery cells
- b) Voltage of each cell and total battery terminal voltage
- c) Temperature of electrolyte of 10% of the battery cells [suggestion: take the temperature of the cells selected in 4.3.2 item a)]