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IEEE Guide for Test and Evaluation of Lead-Acid Batteries Used in Photovoltaic (PV) Hybrid Power Systems

Developed by the
IEEE Standards Coordinating Committee 21 on Fuel Cells, Photovoltaics, Dispersed Generation, and Energy Storage

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(Revision of IEEE Std 1661-2007)

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Abstract: This guide is specifically prepared for a PV/engine generator hybrid power system, but may also be applicable to all hybrid power systems where there is at least one renewable power source, such as PV, and a dispatchable power source, such as an engine generator. Taper-charge parameters for PV hybrid systems are suggested to help in preparing the battery for a capacity test. A test procedure is provided to ensure appropriate data acquisition, battery characterization, and capacity measurements. Finally, a process to review test results and make appropriate decisions regarding the battery is provided. No cycle-life predictions are made.

Keywords: battery testing, IEEE 1661™, lead-acid battery charging, lead-acid battery testing, PV hybrid battery test, PV system testing

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Introduction

This introduction is not part of IEEE Std 1661-2019, IEEE Guide for Test and Evaluation of Lead-Acid Batteries Used in Photovoltaic (PV) Hybrid Power Systems.

Since IEEE Std 1661™ was first published in 2007, off grid hybrid power systems (PV and engine-generator sets) that use lead-acid batteries remain an active practice. This revision to renew this guide allows for re-affirmation of the need for test guidance for this relatively challenging operational scenario; it also establishes a basis for future full revision that may take into consideration a wider range of technologies (e.g., electro chemistries), as well as wider range of charging source configurations.

The hybrid power system in this guide refers to a photovoltaic (PV) energy charging source and a dispatchable charging source, such as an engine generator. The hybrid power system designer depends on the capacity of storage batteries for reliable extended operation of the system load to more effectively utilize and store the PV energy and minimize engine generator run-time. PV hybrid systems, which are the most common hybrid systems, can subject batteries to harsh operational environments as a result of insufficient charging, continuous cycling, and temperature extremes. Typical charge rates for PV hybrid systems can range from very low rates near the 100 h rate to high rates near the 6 h rate. The effect on the battery can be significant with respect to heat generation and charge control parameters.

In daily operation, the variability and limited available PV and engine generator charging sources combined with relatively low charge regulation voltages may be insufficient to provide a full charge to the battery. In an effort to identify appropriate PV hybrid system parameters together with appropriate battery technology, a repeatable test procedure is provided to verify PV hybrid system battery performance based on a field test.

The recommended test plan for evaluating PV batteries includes the following:

— Limitations and expectations

— System parameter selection

— PV hybrid battery capacity test

— Interpretation of test results

This guide may be used in combination with IEEE Std 937™, IEEE Std 1013™ [B4], and IEEE Std 1361™.[1,2] Together, these documents will provide the user with a general guide to sizing, designing, placing in service, maintaining, and testing lead-acid storage batteries for hybrid power systems.

[1]Information on normative references can be found in Clause 2.
[2]Numbers in brackets correspond to those in the Annex A.

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IEEE Guide for Test and Evaluation of Lead-Acid Batteries Used in Photovoltaic (PV) Hybrid Power Systems

1. Overview

1.1 Scope

This guide contains a field test procedure for lead-acid batteries used in PV hybrid power systems. Battery charging parameters are discussed with respect to PV hybrid power systems. The field test procedure is intended to verify the battery's operating setpoints and battery performance. Discussion on how to interpret test results is also included. This guide is applicable to all stand-alone PV hybrid power systems where PV and an engine generator are the only charging sources. This guide does not include stand-alone PV-only systems.

1.2 Purpose

This guide was written to provide a photovoltaic (PV) hybrid power system battery test procedure that can be used to assist in evaluating battery capacity, and appropriate PV battery charging requirements. Use of this guide by funding organizations, battery manufacturers, PV system integrators, and consumers should provide the means to assist in identifying systems that may benefit from improved system design and its subsequent charging specifications.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

IEEE Std 450™, IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.[3,4]

IEEE Std 937™, IEEE Recommended Practice for Installation and Maintenance of Lead-Acid Batteries for Photovoltaic (PV) Systems.

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