



PV SYSTEM OPERATIONS AND MAINTENANCE FUNDAMENTALS

Prepared by

Josh Haney
Adam Burstein
Next Phase Solar, Inc

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Report Overview

As the photovoltaic (PV) market grows and matures, the industry's focus is shifting from manufacturing PV module technology, inverters, and components to properly and safely operating and maintaining installations. PV installation lifetimes are expected to be 25 years or more, so safe and proper maintenance is an integral part of successful and reliable operation. Regular operations and maintenance (O&M) is key to maximizing system production and return on investment (ROI), and as PV systems evolve to higher voltages, the need for qualified service personnel and clear safety procedures is becoming increasingly important.

This preliminary O&M guide is intended to help qualified individuals safely maintain and inspect PV systems. It identifies currently recognized major safety requirements during PV servicing and repair and provides details for a number of O&M tasks. Within the broader PV community, there are currently three working groups focused on this issue. It is expected that they will publish a comprehensive O&M guide in the next few years. In the meantime, this report serves as an introduction to O&M for PV installations.

This introductory report includes practical guidelines for PV system maintenance and options for inspection practices for grounded PV systems. This report does not cover bi-polar, ungrounded, stand-alone, or battery backup systems.

Why the Report is Important

Clear, detailed O&M guidelines help ensure a safe working environment for technicians and optimal PV system production and ROI for owners and investors.

Examples of Basic Safety Issues from the Report

The dangers of working with live electrical equipment require that PV O&M personnel be aware of safety procedures intended to prevent accident or injury. Although this is not an exhaustive list, the authors suggest the following steps as crucial to working safely on PV systems:

- Before operating the PV system, read all instructions for each product.
- All system components must be assumed to be energized with maximum direct current (dc) voltages (up to 1,000 volts [V]) until personnel verify that the voltage has been removed.
- All enclosure doors should remain closed with latches tightened, except when they must be open for maintenance or testing.
- Only qualified personnel who meet all local and governmental code requirements for licensing and training for the installation of electrical power systems with alternating current (ac) and dc voltages up to 1,000 V (or 600 V, when applicable) should perform PV system servicing.
- To reduce the risk of electric shock, only qualified persons should perform servicing other than that specified in the installation instructions.
- In order to remove all sources of voltage from the inverter, the incoming power must be de-energized at the source.
 - Always follow lockout/tagout procedures.
 - Always check for ground faults.



- Do not work alone when servicing PV equipment.
- Do not open a string (also known as a source circuit) combiner fuse holder without first confirming that there is no current flowing on the circuit.
- Do not disconnect (unplug) module leads, jumpers, or homerun wires under load.

Key Findings

Key findings of this introductory report include:

- To maintain quality control and safety standards, it is important that only qualified personnel work on PV installations. It is not always easy, however, to identify qualified personnel. The authors suggest skill and knowledge guidelines for PV technicians.
- Safety is a serious concern when servicing PV installations. Early PV systems often had maximum system voltages less than 50 V_{dc}, but 600 V_{dc} systems are now common, and 1,000 V_{dc} systems are allowed by code in commercial and large-scale installations. Safety considerations require that qualified personnel use properly rated equipment and be trained for servicing the higher voltage systems.
- Qualified personnel should always work in teams of two people when working on live equipment. In addition, on a given jobsite, there should always be at least two qualified persons trained in cardiopulmonary resuscitation.
- Not all installations have appropriate signage, and qualified persons must be trained to recognize potential hazards with or without signage present.
- System uptime and availability is a key objective of O&M. Inverters that are offline can have a dramatic negative impact on the ROI of a PV system. Inverter failure rates are important to ROI, but even more important than how often an inverter goes offline is how quickly it can be placed back into service.
- Low power production also impacts ROI, and O&M personnel need effective strategies for identifying and correcting problems quickly. One specific recommendation is to stock critical parts that have long supply lead times.

For more information please contact

Mr. Larry Sherwood, 303-413-8028,
larry@sherwoodassociates.com.

Download the full report:

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