**Solar Electric Technician (Level 2)**

**Module 7. Maintenance and troubleshooting**

**E1: Assignment - Maintenance (on-grid system)**

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| **E1: ASSIGNMENT MEMO** | |
| **Date** | …. |
| **To** | Participants |
| **From** | Trainers |
| **Subject** | Maintenance (on-grid system) |
| **What** | Performing maintenance of a three-phase on-grid solar photovoltaic system. |
| **Why** | This practical exercise will guide trainees through the essential maintenance tasks required for a three-phase on-grid solar photovoltaic (PV) system. By the end of the session, trainees will understand how to inspect, clean, test, and troubleshoot key components of the system, ensuring optimal performance and safety. |
| **How** | 1. Work in group of 3 or 4. 2. Collect all the necessary tools and equipment for the task. 3. Read and carefully follow the instruction for the assigned task and record the results. 4. Study the demo system and follow the steps for each phase task. 5. By the end of this practical exercise, trainees will:  * Understand how to perform routine maintenance tasks on a three-phase on-grid solar PV system. * Be able to inspect, clean, and test PV modules, inverters, and other system components. * Know how to use tools like a multimeter and insulation tester to diagnose potential faults. * Learn how to troubleshoot common system issues and resolve them safely. * Document and report maintenance activities in a professional manner.  1. Discuss the results with the trainer. |
| **Time** | 180’ |

**Perform maintenance of on-grid three-phase solar photovoltaic systems as per the instructions and phases outlined.**

* Phase 1: System safety check and shutdown (30 Minutes)
* Phase 2: Visual and physical inspection (40 Minutes)
* Phase 3: Cleaning solar panels (30 Minutes)
* Phase 4: Electrical testing (60 Minutes)
* Phase 5: Inverter monitoring and data analysis (20 Minutes)
* Phase 6: Troubleshooting (Optional, if fault detected) (30 Minutes)
* Phase 7: System re-energization and final check (30 Minutes)
* Summary and review (Final 10 Minutes)

**Required tools/equipment and demo three-phase solar PV system**

1. **Three-phase solar PV system setup**

* Solar panels
* On-grid inverter (with grid-tied functionality)
* Battery bank (optional for backup or hybrid systems)
* DC and AC disconnects
* Wiring (AC and DC)
* Fault simulation components (disconnects, loose wires, bypassed fuses, faulty breakers, etc.)

1. **Tools and equipment**

* Multimeter
* Solar panel cleaning kit (water, soft brush, and cloth)
* Personal Protective Equipment (PPE) – gloves, helmet, safety glasses
* Ladder and harness (for roof access)
* Torque wrench (for checking fasteners)
* Inverter monitoring system/software
* Screwdrivers, spanners
* Fuses, connectors, and other spare parts
* Documentation (system manual, maintenance log, etc.)

**Phase 1: System safety check and shutdown (30 Minutes)**

**Step 1: Preparation**

* Wear PPE: Ensure that all trainees are wearing appropriate PPE for electrical work and rooftop safety.
* Review documentation: Go through the system's wiring diagram and installation manual for a better understanding of the layout.
* Verify permissions: Ensure that the grid operator has been informed of any disconnections (if needed).

**Step 2: System shutdown**

* Disconnect the system: Use the appropriate disconnect switches to safely shut down the system.
* Verify zero voltage: Using a multimeter, verify that there is no current flowing in the AC and DC sides before proceeding with maintenance.
* Lockout/Tagout: Follow lockout/tagout procedures to prevent accidental reconnection during the maintenance activity.

**Phase 2: Visual and physical inspection (40 Minutes)**

**Step 1: Inspect PV modules**

* Visual check: Look for dirt, debris, bird droppings, or physical damage (e.g., cracks or discoloration).
* Tilt and orientation: Ensure that the tilt and orientation of the panels are correct and have not shifted over time.
* Mounting structure: Check for loose bolts, rust, or corrosion on the mounting structure. Tighten any loose fasteners using a torque wrench.

**Step 2: Inspect cables and connections**

* DC cables: Check all DC cables between the PV modules and the inverter for signs of wear, insulation damage, or corrosion.
* AC cables: Check AC cables from the inverter to the grid connection.
* Cable management: Ensure cables are properly supported and not exposed to excessive heat or wear.

**Step 3: Check inverter area**

* Inverter placement: Ensure the inverter has adequate ventilation and is free of dust and debris.
* Inverter integrity: Visually inspect the inverter for signs of damage or overheating.
* Fuses and circuit breakers: Inspect protective devices and replace any blown fuses as needed.

**Phase 3: Cleaning solar panels (30 Minutes)**

**Step 1: Safety precautions**

* Use a ladder and harness: Safely access the rooftop, ensuring proper use of a harness if needed.
* Avoid harsh conditions: Perform cleaning in cooler conditions (morning or evening) to avoid sudden temperature changes on the panels.

**Step 2: Clean the panels**

* Water and brush: Use soft brushes and water to clean the surface of the panels. Do not use abrasive materials or high-pressure washers.
* Rinse: Rinse with clean water and wipe down with a soft cloth to avoid streaks or watermarks.

**Phase 4: Electrical testing (60 Minutes)**

**Step 1: Voltage and current measurement**

* DC side: Using a multimeter, measure the open-circuit voltage (Voc) and short-circuit current (Isc) of the solar panels. Compare these values to the specifications on the data sheet.
* AC side: Measure the output voltage of the inverter to the grid. Ensure that the voltage is within the acceptable range for grid compliance.

**Step 2: Grounding system check**

* Earth resistance test: Use a multimeter to check the earth resistance of the grounding system. Ensure that it is within the recommended range (typically below 5 ohms).
* Inspect grounding connections: Verify that all grounding and earthing connections are secure and free from corrosion.

**Phase 5: Inverter monitoring and data analysis (20 Minutes)**

**Step 1: Access inverter data**

* Connect to the inverter: Use the inverter’s monitoring software or display to access performance data, error logs, and historical trends.
* Identify issues: Review any warnings or error messages logged by the inverter. Pay attention to grid synchronization issues or DC/AC conversion faults.

**Step 2: Analyse system performance**

* Compare data: Compare the current inverter data (voltage, current, power output) with the system's design specifications.
* Log performance: Record any deviations or trends that may indicate performance degradation.

**Phase 6: Troubleshooting (Optional, if fault detected) (30 Minutes)**

**Step 1: Diagnose the problem**

* Common faults: If the inverter reports an issue (e.g., grid synchronization error, low power output), use diagnostic steps such as checking wiring, connections, and input voltages.
* Troubleshooting methods: If the inverter is not syncing with the grid, check the grid voltage and frequency with a multimeter. If power output is low, inspect the panels and check for shading or dirt.

**Step 2: Resolve the fault**

* Correct the issue: Depending on the fault, correct the issue (e.g., clean panels, tighten connections, replace fuses).
* Re-test the system: Once the fault is resolved, re-test the system to ensure it is functioning correctly.

**Phase 7: System re-energization and final check (30 Minutes)**

**Step 1: Reconnect the system**

* Re-check safety: Ensure that all tools and materials are cleared from the site. Double-check that all connections are secure.
* Reconnect the inverter: Re-energize the system by following proper reconnection procedures.

**Step 2: Monitor system performance**

* Check power output: Once the system is re-energized, monitor the inverter’s output for a few minutes to ensure it is working as expected.
* Verify grid synchronization: Confirm that the inverter is syncing properly with the grid.

**Step 3: Log maintenance activities**

* Update records: Document all maintenance activities, including cleaning, testing results, and any corrective actions taken.
* Create a report: Have trainees fill out a system maintenance report, noting any issues encountered and resolved.

**Summary and review (Final 10 Minutes)**

* Review: Gather the trainees and review the maintenance procedures, findings, and lessons learned during the exercise.
* Questions: Encourage trainees to ask questions and clarify any doubts about the maintenance process.
* Emphasize safety: Reiterate the importance of safety and adherence to standard operating procedures.

**Learning outcomes**

By the end of this practical exercise, trainees will:

1. Understand how to perform routine maintenance tasks on a three-phase on-grid solar PV system.
2. Be able to inspect, clean, and test PV modules, inverters, and other system components.
3. Know how to use tools like a multimeter and insulation tester to diagnose potential faults.
4. Learn how to troubleshoot common system issues and resolve them safely.
5. Document and report maintenance activities in a professional manner.