

Short-Course

Solar PV System Installation and Maintenance

NTQF Level III

Learning Guide -22

Unit of Competence	Diagnose, Repair and Maintain PV System
Module Title	Diagnose, Repair and Maintaining PV System
LG Code	EIS PIM3 M15 0120 LO4-LG22
TTLM Code	EIS PIM3 TTLM 0120v1

LO 4: Maintain PV component-22

Instruction Sheet**Learning Guide: - 22**

This learning guide is developed to provide you with the necessary information, knowledge, skills and attitude regarding the following content coverage and topics:

- Checking solar PV System components maintenance procedure.
- Repairing/ replacing solar PV system components and accessories.
- Performing the task without causing damage to the components, tools, or equipment.

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to: -

- Check solar PV System components maintenance procedure.
- Repair/ replace solar PV system components and accessories.
- Perform the task without causing damage to the components, tools, or equipment.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below:
3. Read the information written in the information Sheet 1 (page: 87), Sheet 2 (page: 92), Sheet 3 (page: 96)
4. Accomplish the Self-Check 1 (page: 91), Self-Check 2 (page: 95), Self-Check 3 (page: 99)

LO4. Maintain PV component

Information Sheet 1	Checking solar PV System components maintenance procedure
----------------------------	--

1 Checking solar PV System components maintenance procedure

The information in this section were adapted from (USAID, 2013)

Manufacturers of PV equipment prescribe certain maintenance procedures for the equipment as well as maintenance intervals. Proper maintenance ensures that solar system life is preserved for as long as possible and the original conditions of the system are sustained, while compensating for normal wear and tear. Solar systems require little maintenance as compared to other electric systems such as diesel generators; however, they are not maintenance free.

1.1 System records

All maintenance actions should be logged in the system records. This is particularly important if there is a maintenance agreement with the client with certain performance indicators.

1.2 Battery Maintenance

Batteries should be regularly and carefully maintained to extend their useful life. These activities include:

- Inspecting and cleaning regularly
- Checking the electrolyte level- see LO2 Information Sheet 7 (not required for Gel Batteries)
- Keeping in a high state of charge

A visual inspection should be done to assess the general condition of the system's batteries. Check for any electrolyte leak, cracks in the batteries, or corrosion at the terminals or connectors. Batteries should be clean, dry and free of electrolyte and corrosion residue. Corrosion at battery terminals is seen as a white coating around the battery terminals. Cleaning should be done once monthly.

To minimize hazards, the following precautions should be taken prior to carrying out battery maintenance.

- Safety goggles must be worn when performing battery maintenance.
- Protective gloves and chemical-resistant rubber gloves must be worn to prevent contact with battery acid.
- If there is acid spillage, neutralize the acid with a water and bi-carbonate soda solution. Metal files should not be used to remove corrosion.
- Use tools with insulated handles to carry out any maintenance.

- Do not smoke or light fire near batteries. Batteries produce hydrogen gas which is highly flammable.



Figure 32: Corroded terminals

1.3 Solar Module maintenance

The solar array (a number of solar panels connected together) is often thought to be maintenance free. However, occasional maintenance and inspection of the solar array must be performed to ensure the optimal use of the solar panels. This can be done by keeping the surface (glass) area of the module clean from any excess dirt.

- To remove a layer of dust and dirt from the modules, simply wash the panel with water. If the module has thick dirt or grime and bird droppings, which are harder to remove, wash with cold water and rub the panel surface with a sponge. Do not use a metal brush to clean solar panel surface. Detergents should not be used. Always check the manufacturer's manual before cleaning the modules to make sure to choose the right method. If the modules are cleaned the wrong way warranty claims no longer apply.
- A visual inspection of the modules can then be done to check for defects in the modules such as cracks, chips, de-lamination, fogged glazing, water leaks and discoloration. If any obvious defects are found, note their location in the system logbook, so they can be monitored in the future in case further deterioration affects the modules' output.
- The condition of the array mounting frame should also be noted. Items to observe should include the array mounting bolts (e.g. bolt rusting) and checks to ensure that the frame and modules are firmly secured. The junction boxes should also be checked to ensure that the wires are not chewed by rodents or insects.
- Take adequate precautions while doing maintenance of the solar panels since these are located on rooftops and there is the risk of falling off.

1.4 Charge Controller and Inverter

This component can be maintained by minimizing dust accumulation. A dry cloth should be used to wipe away any accumulated dirt/dust. A visual inspection should be

done to ensure that all the indicators such as LED lights are working and that the wires leading to and from this device are not loose. Note that the charge controller should indicate that the system is charging when the sun is up.

If the components have ventilation openings, check if bugs or other insects got into the components. If so, use insect repellent to keep insects away. Do not cover the ventilation opening, that might cause overheating of the component.

1.5 Wiring and Components Maintenance

Wiring installations should be checked for any cracks, breaks or deterioration in the insulation/conduits. Inspect panel boxes to ensure that they have not become a home for rodents and insects. Also inspect connections for any corrosion and/or burning. Switches should not spark when turned on or off. The following sections of conduit and wiring should be checked for any signs of damage:

- Solar panels to the charge controller
- Charge controller to the battery bank
- Inverter/charger to the battery bank
- Generator to Inverter/charger
- Inverter/charger and Generator to the AC outlets
- Battery bank to the DC outlets/load.
- All ground wires should be checked to ensure they are not broken.
- Generation comparison compared to initial specification/previous years (if data available).

Maintenance Task	Daily	Weekly	Monthly	3 Months
Visual Inspection of system wiring, Lights and vaccine freezer		√		
Solar Panel Maintenance				√
Battery Inspection		√		
Battery Cleaning			√	
Wiring Inspection		√		
Inverter/Battery Charger		√		
Charge Controller		√		
Battery "top-up"			√	

Figure 33: Typical maintenance schedule

Self-Check - 1	Written Test
-----------------------	---------------------

Instruction: Follow the below selected instruction

Answer all the questions listed below.

N°	Questions and answers
1	The following sections of conduit and wiring should be checked for any signs of damage – name 5: (5)

Note: the satisfactory rating is as followed

Satisfactory	4 points
Unsatisfactory	Below 4 points

Answer Sheet

Score = _____

Rating: _____

Name

Date

Information Sheet 2	Repairing/ replacing solar PV system components and accessories
----------------------------	--

2 Repairing/ replacing solar PV system components and accessories

Replacement or repairing of faulty equipment will depend on the type of equipment and type of problem encountered.

2.1 System Problems Areas

Problems can be divided into the following categories:

- PV modules
- DC Cabling
- Connectors and junctions
- Switches and Fuses
- Charge Controller
- Batteries
- Inverter
- AC Circuits
- Appliances

2.1.1 PV Modules

If PV modules need to be replaced, always follow the correct isolation procedure. Never disconnect PV modules under load, always isolate the circuit before disconnecting a PV module. PV Modules can still produce power, therefore care needs to be taken that there are no open wires.

Remove the faulty module(s) and replace. It may be that the exact same module cannot be found anymore. In that case, a module with similar size and characteristics should be sourced. If it is not possible, a whole string may need to be replaced.

In practice, replacing a failed panel on an old system can get tricky because it may be difficult to find a panel with the right specifications. Modern panels may be 300 watts or more, compared to 150 to 250 watts for old panels. The new panel may need to have the same number of cells, depending on how the array is configured, and will most likely need to have the same physical dimensions so it will fit in the array.

2.1.2 DC Cabling

DC cables that are damaged or cracked should be replaced with PV rated cable and not just repaired with isolation tape etc. Isolate the string and replace the cable by first putting the connectors on at both sides before connecting to the array so that there are no exposed ends that can be live.

2.1.3 Connectors and junctions

Similar to cables, connectors and junctions that are damaged should be replaced. Make sure that connectors are not put on cables that are live; first isolate.

2.1.4 Switches and Fuses

Switches and fuses that are damaged or blown should be replaced with the same rating replacements. NEVER replace fuses with pieces of wire, metal etc. Switches and circuit breakers should also be of the same rating.

If fuses blow constantly or circuit breakers trip continuously, review the design to make sure that the sizes are appropriate.



Figure 34: Wrong fuse 'replacement'

2.1.5 Charge Controller

Follow the supplier's instructions. In general, isolate the PV inputs first, then isolate the batteries. Replace the Charge Controller but make sure that the correct settings (e.g. DIP switches) are set as per the original. Connect the Batteries before connecting the PV Modules.

2.1.6 Batteries

When the batteries need to be replaced, the charge controller and inverter need to be isolated from the batteries. Start by isolating the PV side from the charge controller, isolate the loads from the inverter, then isolate the battery. When replacing with a

different battery (specifically Lithium), make sure that the Charge Controller is compatible with the battery and that the Voltages are the same.

2.1.7 Inverter

Replace the inverter by isolating the loads first, and then isolate the inverter from the batteries. Replace the inverter (make sure that all settings are similar to the original), connect it to the batteries and connect the AC loads.

2.1.8 AC Circuits

Work on the AC circuit should be done by a qualified electrician according to the electrical regulations for the country.

2.1.9 Appliances

If appliances are faulty, replace with similar rating appliances. Be careful of appliances with much higher ratings as the original as it can drain the battery quicker or overload the inverter.

Self-Check - 2	Written Test
-----------------------	---------------------

Instruction: Follow the below selected instruction

Answer all the questions listed below.

N°	Questions and answers
1	What needs to be considered when the exact PV module cannot be found for replacement? (3)
2	Why should faulty appliances not be replaced with higher power rating appliances? (2)

Note: the satisfactory rating is as followed

Satisfactory	4 points
Unsatisfactory	Below 4 points

Answer Sheet

Score = _____
Rating: _____

Name

Date

3	Performing the task without causing damage to the components, tools, or equipment
----------	--

3 Performing the task without causing damage to the components, tools, or equipment

When replacing or repairing PV system components, always follow the same supplier procedures as when the system is installed. To prevent causing damage to the installations, always use:

- The correct tools for the job
- The correct handling of the equipment
- The correct installation procedure as per manufacturer's specifications
- The correct safety equipment

PV Modules are particularly prone to damage caused by bad handling. Micro cracks in solar cells are a genuine problem for PV modules. Improper handling of modules during transportation, unpacking, storage and installation can cause various cracks inside the module.

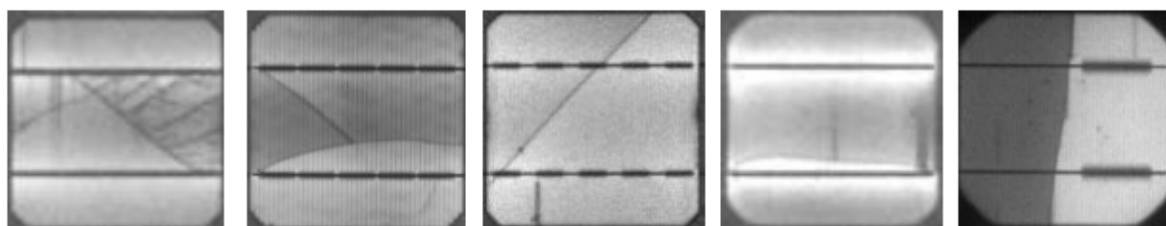


Figure 35: Micro cracks

The following precautions should be taken:

- Two people should carry modules, do not carry on your head or back
- Place modules down on a protected surface with the glass facing down
- Wear gloves when handling modules
- Do not put objects on the module or modules on top of each other without protective material
- Do not use the module surface as a workbench
- Do not lean modules against something. A gust of wind may blow the module over
- Do not walk on modules
- Do not lean on modules with your body weight



Figure 36: Carrying modules



Figure 37: Wrong way to carry a module



Figure 38: Do not walk on modules

TASK	RISKS	PREVENTATIVE MEASURES
Manual Handling of Modules	Falling objects during handling	- Use of safety shoes - Avoid distraction
	Hitting standing/moving objects	- Avoid distraction - Neat and tidy work area
	Cuts	- Use of safety gloves - All cutters or other type of bladed implement should be a safety version
	Overexertion and back injuries	- Training and information to workforce regarding the correct way to handle loads and the potential risks (according to the laws of the country in question) - Whenever possible use mechanical lifters
	Tripping	- Avoid distraction - Use of safety shoes - Neat and tidy work area
	Physical tiredness	- Take rest as necessary according to risk evaluation
Mechanical Handling of Modules (forklift truck and loading bays)	Accidents involving vehicles	- Signposting the loading area and warehouse as required by law of the country in question. - Only use the lanes signaled and set aside for vehicle movement, ensuring that visual and audio warnings are clear. - Regular servicing of vehicles (as necessary in EU, NA & MOW and according to the law of the country in question) - Employees should receive necessary training before using such equipment.
	Objects falling through collapsing or slippage	- Keep surfaces in good repair, avoiding slippery areas or non-uniformity - Respect maximum loads for all equipment
	Pallets falling during handling	- As the measurements of the pallets are above Standard size, it is recommended that extensions are used to help stability. (at least 1,6m or 1.9m long)

Figure 39: Extract from Risen PV Modules Instructions

Self-Check – 3	Written Test
-----------------------	---------------------

Instruction: Follow the below selected instruction

Answer all the questions listed below.

N°	Questions and answers
1	Name 4 precautions when working with PV modules to prevent damage: (4)

Note: the satisfactory rating is as followed

Satisfactory	4 points
Unsatisfactory	Below 4 points

Answer Sheet

Score = _____
Rating: _____

Name

Date