



REGISTERED NATIONAL STANDARD

UNIT OF COMPETENCY

Title:	Apply tools, equipment & materials in complex tasks for operation and maintenance of Solar PV systems <u>Notes:</u> 1) Due to safety issues inherent in working with electricity, all training and assessment activities must be in accordance with local industry and regulatory requirements; 2) This unit of competency has been adapted the Pacific regional unit standard <i>SE3301 Apply tools, equipment & materials in complex tasks in RE & EE for operations and maintenance</i> ;				
TQF Level:	3	Credits:	6	Version:	1
National standard code:	NS087-03				
Associated qualification (and code):	National Certificate in Sustainable Energy (Solar) Level 3 (QR-03-NQ-018-05-0504-23-01)				
Approval date:	31 August 2023		Review date:	31 August 2028	
Purpose:	<p>This unit standard involves working with tools and equipment used for <i>solar photovoltaic (PV)</i> system.</p> <p>Persons credited with this unit standard are able to:</p> <ol style="list-style-type: none"> 1. Identify the different types and uses of tools, equipment and materials used for operating, testing and maintenance of solar PV systems 2. Demonstrate the safe handling of tools, equipment and materials for operating, testing and maintenance of solar PV systems 3. Demonstrate the operating practices for tools, equipment and materials used for solar PV system 4. Demonstrate the maintenance practices for tools, equipment and materials used for solar PV system 				

Learning Outcome 1 (LO1)	Distinguish between a <i>solar photovoltaic (PV) panel</i> and a <i>solar thermal panel</i>
Performance standards	<p>1.1 Describe, orally or in writing, what <i>solar radiation</i> is;</p> <p>1.2 Identify, using a diagram, the parts of the <i>electromagnetic spectrum</i> in terms of the main types of <i>radiation</i>. [Range includes: Radio waves, Microwaves, Infrared, Visible light, Ultraviolet, X-ray, and Gamma]</p> <p>1.3 Describe, orally or in writing what it means by <i>solar energy</i> means.</p> <p>1.4 Describe, orally or in writing, what a <i>solar cell</i> is;</p> <p>1.5 Identify two main types of solar panels [Range of type include but not restricted to Solar PV panels and Solar thermal panels]</p> <p>1.6 Differentiate between the key function of a solar PV panel and that of solar thermal panel</p>
Learning Outcome 2 (LO2)	Identify the different types and uses of tools, equipment and materials used for operating, testing and maintenance of solar PV system
Performance standards	<p>2.1 Describe, orally or in writing, the main types of solar photovoltaic plants which are used in Tonga and other Pacific Islands; [Range of types include but not restricted to on-grid, off-grid, and hybrid systems]</p> <p>2.2 Outline the advantages and disadvantages of the main types of solar PV plants in 2.1 above;</p> <p>2.3 Name the different types of basic tools, equipment and materials – including types of instruments and controls required for the types of solar PV plants in 2.1 above;</p> <p>2.4 Name the tools, equipment, and/or materials required for the decommissioning and assembling of all parts of the solar PV systems in 2.1 above;</p> <p>2.5 Describe, orally or in writing, the specific uses of the tools, equipment, and/or materials named (in 2.4) above;</p> <p>2.6 Discuss the importance of storing and preserving tools, equipment, materials, and accessories in a safe manner.</p>
Learning Outcome 3 (LO3)	Demonstrate the <i>safe handling</i> of tools, equipment and materials for operating, testing and maintenance of solar photovoltaic system
Performance Standards	<p>3.1 Describe, orally or in writing, what ‘safe handling’ means (as used in this LO);</p> <p>3.2 Describe, orally or in writing, what a <i>job safety analysis (JSA)</i> is;</p>

	<p>3.3 Describe the JSA which may be required during the testing, operation, and maintenance of a solar PV system;</p> <p>3.4 Conduct a JSA to ensure safe handling of tools, equipment and materials when testing a wind power production system;</p> <p>3.5 Conduct a JSA to ensure safe handling of tools, equipment and materials during data gathering from a solar PV system;</p> <p>3.6 Conduct a JSA to ensure <i>safe operation</i> of power tools, equipment and materials during maintenance and replacement of a solar PV system or its parts;</p> <p>3.7 Develop a <i>Hazard (or Emergency) operations plan</i> to address a range of potential safety issues related to the use of tools, equipment, and materials in solar PV systems; <i>[Range safety issues include but not limited to electrical shock from handling solar PV panels in the sun or contact with worn or frayed power cords and lines, fires, falls, or being trapped in confined spaces, etc.]</i></p> <p>3.8 Describe, orally or in writing, safety issues associated with end-use applications of power from a solar PV system.</p>
<p>Learning Outcome 4 (LO4)</p>	<p>Demonstrate the operating practises for tools, equipment and materials used for Solar PV system</p>
<p>Performance standards</p>	<p>4.1 Summarise the procedures for operation of tools, equipment and materials for a solar PV system;</p> <p>4.2 Prepare a range of task lists appropriate for solar PV systems; <i>[Range task lists include but not restricted to: daily tasks, weekly/monthly tasks, and annual tasks.]</i>.</p> <p>4.3 Develop an <i>operation work plan</i> for a solar PV system which includes the tasks listed in PS 4.2 above, to ensure safe use and operation of tools, equipment and materials;</p> <p>4.4 Integrate relevant safety considerations into an operation work plan to ensure safety in practises and procedures while using tools, equipment and materials for solar PV systems;</p> <p>4.5 Use a <i>Hazard operations plan</i> to facilitate safety in maintaining power tools, equipment and materials;</p> <p>4.6 Safely handle maintenance tools and testing equipment while fixing the minor defects in tools, equipment and material;</p> <p>4.7 Test and evaluate the efficiency of the power tools and equipment for solar PV systems;</p>
<p>Learning Outcome 5 (LO5)</p>	<p>Demonstrate the maintenance practices of tools, equipment and materials used for Solar PV systems</p>
<p>Performance standards</p>	<p>5.1 Summarise procedures for identifying and documenting faults in power tools, equipment and materials used solar PV systems.</p>

	<p>5.2 Use power tools, equipment, and materials safely during maintenance activities in accordance to a Hazard operations plan.</p> <p>5.3 Conduct testing and evaluation of power tools and equipment using minimal time and resources;</p> <p>5.4 Develop a maintenance work plan for tools, equipment and materials. <i>[Range maintenance activities include but not restricted to:</i></p> <ul style="list-style-type: none"> • <i>daily maintenance (checks for immediate attention/action - such as cleaning of panel and inverter, checking battery acid-level and heat, checking system data of generation, checking mounting rack etc.)</i> • <i>annual maintenance checks (such as checking for corrosion, breakages and loose ends, replacement needs - panels, cables, inverters, dc or ac system , etc., and repair if necessary.)</i> <p>5.5 Carry out maintenance of tools, equipment and materials used for solar PV systems in accordance with a maintenance work plan.</p>
Pre-requisites	N/A
Co-requisites	N/A
Underpinning skills and knowledge	<p>The following knowledge and skills underpin this unit standard:</p> <ul style="list-style-type: none"> • Basic knowledge of solar radiation in terms of the <i>Electromagnetic spectrum</i> • Basic knowledge of the <i>photovoltaic effect and solar cells</i> • Knowledge of basic operation of a Solar PV system – including the roles of the following: <ul style="list-style-type: none"> ○ solar cells ○ panels ○ batteries ○ inverter ○ charge controller • Knowledge of basic civil works and works involved in Solar PV system/plant installation • Understanding of the Solar PV supply • Knowledge of the environmental and social impacts of Solar PV system/plant. • Knowledge of basic tools and equipment for operation and maintenance of solar PV systems. • <i>Job safety analysis (JSA)</i> • Safe use and maintenance of tools, equipment, and materials – in solar PV systems • Hazard and emergency response planning

Assessment requirements

Methods of assessment:

A range of assessment methods should be used to assess students' knowledge and application of skills. These shall include but not restricted to the following:

- a) Direct observation of students performing certain tasks as described in the context of assessment.
- b) Oral questions to test relevant skills and knowledge during observation
- c) Written assessments such as:
 1. Maintenance and repair reports on applications tools, equipment & materials in complex tasks for operation and maintenance of solar PV systems;
 2. Student portfolios;
 3. Review of workplace attachment reports (e.g. Supervisor/third party reports)

Context of assessment:

To support student assessment and to ensure they are valid, reliable, flexible, and fair, a training provider is encouraged to make the necessary arrangements to involve the relevant key industry organisations such as *Tonga Electricity Commission (TEC)*, *Tonga Power Limited (TPL)* and other trusted licensed private energy and electricity entrepreneurs in the assessment of the required skills and knowledge. Such collaboration between provider institutions and the industry may include but not restricted to the following:

- Experts from the industry contribute to the design and implementation of the curriculum and assessment activities;
- Experts from the industry are engaged as trainers, assessors, or assessment moderators;
- Students are placed in relevant industry organizations for workplace attachment;
- Industry experts act as supervisors of students on workplace attachment
- Etc.

To show that learners have the required competence they will need to **demonstrate** and **apply** their knowledge in the workplace (or in an environment that closely resembles the workplace) in relation to:

- a) LO1: Distinguish between a solar photovoltaic (PV) panel and a solar thermal panel
- b) LO2: Identify the different types and uses of tools, equipment and materials used for operating, testing and maintenance of solar PV

	<p>system</p> <ul style="list-style-type: none"> c) LO3: Demonstrate the safety handling of tools, equipment and materials for operating, testing and maintenance of solar photovoltaic system d) LO4: Demonstrate the operating practises for tools, equipment and materials used for Solar PV system e) LO5: Demonstrate the maintenance practices of tools, equipment and materials used for Solar PV systems <p><u>Evidence of competence</u></p> <ul style="list-style-type: none"> 1) The assessment of competence and the collection of evidence must be in accordance with local industry and regulatory requirements; 2) Evidence must show that knowledge and skills have been acquired. All knowledge and skills should be contextualised to current industry practices and technologies; 3) Each LO must be demonstrated on at least TWO occasions. 4) Sources of evidence need to be rich in nature to minimise error in judgment. <p><u>Re-assessment</u></p> <p>Candidates of assessment are eligible to three (3) attempts to achieve the required competency within 14 days of their first attempt:</p> <ul style="list-style-type: none"> 1. Feedback must be provided to the candidate and sufficient time provided to prepare for re-assessment. 2. The trainer/assessor has the discretion to vary the assessment tasks used in each assessment attempt as long as the: <ul style="list-style-type: none"> a) same competencies are being assessed; b) principles of assessment are adhered to. <p>Failure to achieve the required competency after three (3) attempts on the exam or specific part of the assessment will require the person studying this Unit to re-enrol for the same Unit.</p>
<p>Moderation arrangements</p>	<ul style="list-style-type: none"> 1) Training providers must have their own moderation system approved by TNQAB before accreditation is granted: <ul style="list-style-type: none"> a. Relevant internal moderation processes are documented; b. Assessment is planned for each unit, and moderation processes are integrated into such plan 2) External moderation is conducted by the national qualifications unit of TNQAB for all unit components of national qualifications; <ul style="list-style-type: none"> a. Samples of assessed activities are submitted for moderation;

	<p>b. Moderation (external) forms are available on request from the National qualifications unit of TNQAB.</p>
<p>Resource requirements</p>	<ol style="list-style-type: none"> 1) A relevant textbook (or compilation of printed resources) on control system fault analysis, or maintenance and repair, specifically for Solar PV systems at the discretion of the course/unit coordinator or trainer; 2) Solar PV system – containing at least the following components: <ol style="list-style-type: none"> (i) solar panels; (ii) racking/mounting; (iii) batteries; (iv) inverter; (v) cables (vi) charge controllers 3) Solar panels: <ol style="list-style-type: none"> (i) 100W 18V (ii) 150W 18V (iii) 250W 36V 4) Inverters (DC): <ol style="list-style-type: none"> (i) 500W 12V (ii) 700W 12V (iii) 1800W 24V 5) Charge controllers 6) AC Variable Power Supply 7) DC variable Power Supply 8) Deep cycle 12V solar battery 9) GEL Batteries: <ol style="list-style-type: none"> (i) 100 AH 12V (ii) 200AH 12V (iii) 250AH 10) Battery cables: <ol style="list-style-type: none"> (i) 6mm² Red cable (ii) 10mm² Red cable (iii) 1.5mm² PVC single red cable (iv) 2.5mm² PVC Single red cable 11) Scaffolding set 12) Safety Tools and equipment, at least the following: <ol style="list-style-type: none"> (i) Hand gloves for electrical and mechanical lab work

	<ul style="list-style-type: none"> (ii) Safety helmet; (iii) Safety glasses/goggles; (iv) Ear-mask/muff for use in noisy workshop environment; (v) Dust mask; (vi) Electrician safety harness; (vii) Safety tags (e.g. <i>out of service, do not operate, live wire, etc.</i>). <p>13) Tools and Equipment, at least the following:</p> <ul style="list-style-type: none"> (i) Electrician’s Tool Kit includes at least the following: <ul style="list-style-type: none"> a) Insulated screwdrivers, b) Insulated pliers, c) Electrical tester, d) Ratchet set (containing handle, universal joint, extension bar, and coupler etc.); e) Measuring tape. (ii) Drill set for electricians (with bits); (iii) Heat gun - for cable sleeving; (iv) Soldering iron station and solder wire; (v) Termination tools, include at least the following: <ul style="list-style-type: none"> a) Crimping tool; b) Air blower; c) Solder wire; d) Crimp lugs; e) Cables and accessories. (vi) Testing Equipment for electrical, include at least the following: <ul style="list-style-type: none"> a) AC Variable Power Supply; b) DC variable Power Supply; c) Oscilloscope; d) Frequency counter; e) Power factor tester; f) Three-phase power analyser; g) Fused Low-voltage test lamp.
<p>Requirements to complete this unit</p>	<p>There are five (5) Learning Outcomes and thirty-two (32) Performance standards to measure competence.</p> <p>To demonstrate competence, the person studying this unit is:</p> <ol style="list-style-type: none"> 1. Required to attain an <i>Achieved</i> Grade (Competent) to fulfil the requirements of the Unit Standard; 2. Eligible to three (3) attempts to achieve the required competency within 14 days of the first attempt. <p>Failure to achieve the required competency level after three (3) attempts of the exam or specific part of the assessment will require the person studying this Unit to re-enrol for the same Unit.</p>

Important notes and definitions

Notes:

1. Due to safety issues inherent in working with electricity and combustible substances, all training and assessment activities must be carried out in accordance with local industry and regulatory requirements;
2. In the event that local legislations and/or regulatory requirements are not available, relevant legislations/regulatory requirements from New Zealand and/or Australian should be used for training;
3. Assessors must comply with Tonga national assessment and moderation requirements.
4. This unit of competency has been adapted from the Pacific regional unit standard SE3301 (B) Apply tools, equipment & materials in complex tasks in RE & EE for operations and maintenance.

Definitions:

1. *Corrective maintenance* refers to maintenance activities that involve resetting the system, repair of any damage to the system identified through monitoring activities, replacement of failed components with spare parts, etc. Corrective maintenance that is considered less urgent may fall into the preventative maintenance category.
2. *Condition-based maintenance* refers to maintenance activities scheduled through the availability of real-time information provided by data loggers. The scheduled activities call for the implementation of preventative measures or as a forecast for corrective maintenance to reduce risks of system downtime, frequency of preventative measures and associated costs.
3. *Electromagnetic spectrum* - refers to the different kinds of energy that make up the sun's total energy. There are seven main types including *radio waves, microwaves, infrared, visible light, ultraviolet, and gamma*. These different kinds of energy differ from each other in their frequencies and respective wavelengths.
4. *Hazard or Emergency operations plan*- is a plan that addresses a wide variety of hazards and incidents (such as accidents, unfavorable weather, pandemics, etc.) and aims to sustain and support the mission of a workplace, before, during, and after an incident. These plans must address readiness, preparedness, response, and recovery.
5. *Job safety analysis (JSA) or Job hazard analysis (JHA)* is a procedure that helps integrate accepted safety and health practices into a particular task or job operation. It involves the breaking down of a job to its main steps, identifying the potential hazards for each main step, and recommending the safest way to do complete each step,
6. *Operation and Maintenance plan* refers to a written plan based on how a

specific system is to be operated and maintained over a period of time to ensure high performance, safety and compliance with applicable regulations.

7. *Preventative maintenance* refers to scheduled maintenance activities that occur at intervals to comply with recommendations made by the manufacturer and aligned with the equipment warranties.
8. *Safe handling* refers to manual handling that does not create the risk of injury to a person from heavy loads, high forces, awkward movements and postures, or excess repetition.
9. *Safe operation* refers to the step-by-step instructions about how to safely perform an activity or use a tool.
10. *Solar cell* is a single electronic device which is capable of converting solar energy into electricity. It is the most component of a solar PV panel.
11. *Solar insolation* refers to the amount of electromagnetic energy (solar radiation) incident on the surface of the earth. In other words, it refers to the amount of sunlight shining down on the area under consideration.
12. *Solar thermal panels* capture the sun's rays and transforms them into heat, which is then reused for domestic hot water or heating.
13. *Solar photovoltaic (PV) panel* – this transforms the sun's rays into electricity to run the various electrical appliances in the home. The electricity from photovoltaic panels can be used continuously, stored in batteries or sold to the grid in case of excess production.
14. *Solar photovoltaics (PV) system* or *solar power system*, is an electric power system designed to supply solar power by means of photovoltaics. It is composed of one or more solar panels combined with an inverter and other electrical and mechanical components that use energy from the Sun to generate electricity.
15. *Photovoltaics (PV)* - is the conversion of light into electricity using semiconducting materials that exhibit the photovoltaic effect.
16. *Radiation* is energy that moves from one place to another in a form that can be described as waves or particles (e.g. solar radiation, gamma radiation, UV radiation, etc.)

Public comments on unit

Please contact TNQAB National Qualifications Unit (email EnquireNQ@tnqab.to or Telephone 28136) if you like to discuss or suggest changes to the details of this unit.