Quality Council for Trades & Occupations
www.qcto.org.za
256 Glyn Street, Hatfield, Pretoria, 0083
Private Bag X278, Pretoria, 0001
+27 12 003 1800

OCCUPATIONAL SKILLS PROGRAMME CURRICULUM DOCUMENT

IN LINE WITH THE OQSF POLICY (2021) OCCUPATIONAL QUALIFICATION TYPE (NOMENCLATURE)

SKILLS PROGRAMME	SKILLS PROGRAMMES ID	TITLE (DESCRIPTOR)	NQF LEVEL	CREDITS
	SP-250607	Solar Photovoltaic Modules Manufacturing	5	60
CURRICULUM CODE	900280-000-00-00			
PARTNER DETAILS	ORGANISATION NAME	WEBSITE ADDRESS	TELEPHONE NUMBER	LOGO
QUALITY PARTNER - DEVELOPMENT	EWSETA	https://www,ewseta.org.za	011 2744700	EW SETA

Contents

SECTION 1: CURRICULUM SUMMARY

1.1 Occupational Information:

1.1.1 Associated, Organising Framework for Occupations (OFO) Occupational Code and Title

313109: Solar Photovoltaic Standalone Service Technician

1.1.2 Occupation/Specialisation/Part-Qualification/Skills Programme Type, Title, NQF Level, Credits and Curriculum Code, addressed by this Curriculum.

TYPE	TITLE	NQF LEVEL	CREDITS	CURRICULUM CODE
Skills Programme	Solar Photovoltaic Modules Manufacturing	5	60	900280-000-00-00

1.1.3 Alternative titles used by industry:

- None

1.2 Curriculum Information:

1.2.1 Articulation for Skills Programmes

(a) Work Opportunities:

There are several work opportunities for a person who has successfully completed a Solar Photovoltaic Modules Manufacturing skills programme, they may access employment opportunities in public and private organisations and similar manufacturing environments.

(b) Learning Opportunities:

An individual who has successfully completed a Solar Photovoltaic Modules Manufacturing skills programme may access several further learning opportunities available in the energy or engineering fields.

1.3 Curriculum Structure:

1.3.1 Knowledge/Theory Modules:

Module code	Module title	NQF level	Credits	Mode of delivery
900280-000-00-KM-01	Fundamentals of solar photovoltaic modules manufacturing/production	5	3	Blended
862927-000-00-KM-03	Communication and Administration	4	9	Blended

313109-002-00-KM-05	Maintenance, troubleshooting, fault-finding and repairs to PV systems	5	13	Blended
313109-001-00-KM-08	Components of PV systems	4	20	Blended

Total number of credits: 45

1.3.2 Practical Skills Modules:

MODULE CODE	MODULE TITLE	NQF LEVEL	CREDITS	MODE OF DELIVERY
900280-000-00-PM-01	Operate solar photovoltaic manufacturing machine and produce quality solar photovoltaic modules	5	4	Face-to Face
313109-001-00-PM-03	Use tools measuring instruments and equipment	4	7	Face-to-Face
313109-002-00-PM-05	Maintain, test, diagnose and replace cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses in PV systems	5	4	Face-to-Face

Total credits of credits: 15

1.4 Entry Requirements:

- NQF Level 4 qualification with Mathematics

1.5 Recognition of Prior Learning (RPL):

1.5.1 RPL for Access:

Learners may use the RPL process to gain access to training opportunities for a skills programme if they do not meet the formal, minimum entry requirements for admission. RPL assessment provides an alternative access route into a skills programme.

Such an RPL assessment may be developed, moderated and conducted by the accredited Skills Development Provider which offers that specific skills programme. Such an assessment must ensure that the learner is able to display the equivalent level of competencies required for access, based on the NQF level descriptors.

1.5.2 RPL for Exemption:

For exemption from modules through RPL, learners who have gained the stipulated competencies of the modules of a skills programme through any means of formal, informal or non-formal learning and/or work experience, may be awarded credits towards relevant modules, and gaps identified for training, which is then concluded.

1.5.3 RPL for awarding credits:

Learners who have gained the stipulated competencies of the modules of a skills programme through any means of formal, informal or non-formal learning and/or work experience, may be awarded credits towards relevant modules, and gaps identified for training, which is then concluded.

For a Skills Programme, the accredited Skills Development Provider (SDP) must ensure all modular competency requirements are met prior to the FISA and keep record of such evidence.

Upon successful completion of the FISA, RPL learners will be issued with the QCTO certificate for the skills programme. Quality Partners are responsible for ensuring the RPL mechanism and process for skills programme is approved by the QCTO.

1.6 Quality Partner for Assessment:

Not Applicable

1.7 List of Qualification(s)/Part- Qualification(s)/Skills Programme(s) Related to this Curriculum

- Higher Occupational Certificate: Solar Photovoltaic Standalone Service Technician, NQF Level 5, Credits 133, ID: 120863
- National Occupational Certificate: Solar Photovoltaic Standalone System Installer, NQF Level 4, Credits 211, ID: 120883
- Occupational Certificate: Solar Photovoltaic Standalone System Mounter, NQF Level 4, Credits 84, ID: 120885
- Skills Programme: Solar Photovoltaic (PV) Installation Practitioner, NQF Level 4, Credits 60
- Skills Programme: Solar Photovoltaic (PV) Installation Planner, NQF Level 5, Credits 60
- Skills Programme: Solar Photovoltaic (PV) Installation Tester, NQF Level 5, Credits 60

SECTION 2: OCCUPATIONAL/SPECIALISATION/PART-QUALIFICATION/SKILLS PROGRAMME PROFILE

2.1 Occupational Purpose

The purpose of this skills programme is to prepare a learner to operate in a Solar Photovoltaic Modules Manufacturing environment.

A Solar photovoltaic Modules Manufacturing person read and interpret the designed datasheet to manufacture solar photovoltaic modules, operate and control the manufacturing machine, maintain and manage machinery (automated or indirect processes) for solar photovoltaic modules manufacturing total manufacturing process applying total quality management system in line with legal, regulatory, standard operating procedures, international standards and industry best practice.

2.2 Tasks:

TASK	LINK TO ELO
TASK 01: Interpret and implement a solar photovoltaic manufacturing/production plan and schedules	ELO 1: Use knowledge of production processes and procedures to interpret manufacturing specifications and schematic drawings
TASK 02: Operate, monitor and control solar photovoltaic modules manufacturing machinery for solar photovoltaic modules manufacturing/production	ELO 2: Apply the principles, procedures and techniques to operate the solar photovoltaic modules manufacturing/production process
TASK 03: Test, maintain, diagnose, troubleshoot faulty solar PV modules	ELO 3: Apply testing, diagnosis and troubleshooting techniques and procedures to resolve faults/defects/problems on solar photovoltaic manufacturing/production process
Task 04: Interpret and implement quality control measures in line with total quality management system	ELO 4: Apply quality control measures before, during and after solar photovoltaic modules manufacturing process to ensure compliance with the design specifications and regulatory requirements

2.3 Occupational Task Details

2.3.1 Interpret and implement a solar photovoltaic manufacturing/production plan and schedules, NQF Level 5

Unique Product or Service:

- Compliant, high quality solar PV modules

Occupational Responsibilities:

- Read and interpret solar PV production schedule
- Identify, select and use appropriate materials, equipment and measuring instruments for solar PV manufacturing according to standard operating procedures

Occupational Contexts:

- Solar PV modules manufacturing planning and preparation processes, NQF Level 5

2.3.2 Operate, monitor and control solar photovoltaic modules manufacturing machinery for solar photovoltaic modules manufacturing/production, NQF Level 5

Unique Product or Service:

- Compliant and fully-operational solar photovoltaic modules manufactured to the international standards, specifications and accepted industry best practice

Occupational Responsibilities:

- Communicate with team members and supervisors for effective solar photovoltaic production process
- Evaluate and control the solar photovoltaic modules manufacturing/production process in the plant
- Transform silicon into solar photovoltaic cells

Occupational Contexts

- Solar photovoltaic modules manufacturing machinery operation processes, NQF Level 5

2.3.3 Test, maintain, diagnose, troubleshoot faulty solar PV modules, NQF Level 5

Unique Products or Services:

- Functional and compliant solar PV modules

Occupational Responsibilities:

- Perform visual inspection, test and diagnose faults/defects on finished products
- Identify and troubleshoot the identified faults on solar photovoltaic modules

Occupational Contexts

- Solar photovoltaic testing, troubleshooting and maintenance processes, NQF Level 5

2.3.4 Interpret and implement quality control measures in line with total quality management system, NQF Level 5

Unique Products or Services:

- Quality photovoltaic modules with credibility
- Improved Yield rate
- Reduced downtime
- Reduced carbon footprint
- Eliminated/minimised waste
- Standardised solar photovoltaic modules manufacturing quality control process

Occupational Responsibilities:

- Evaluate and control the solar photovoltaic modules manufacturing/production process in the plant
- Inspect and test the manufacturing processes, products and determine compliance and/or non-compliances during manufacturing
- Measure performance and quality of solar PV system manufacturing/production and implement continuous improvement strategies
- Record and report on photovoltaic modules production/manufacturing, testing and maintenance

Occupational Contexts

- Quality control management processes for solar photovoltaic modules manufacturing/production, NQF Level 5
- Solar PV manufacturing/production recording and reporting processes, NQF Level 5

SECTION 3: CURRICULUM COMPONENT SPECIFICATIONS

3.1 Knowledge Module Specifications:

MODULE TITLE	MODULE CODE	NQF LEVEL	CREDITS	MODE OF DELIVERY
900280-000-00-KM-01	Fundamentals of solar photovoltaic modules manufacturing/production	5	3	Blended
862927-000-00-KM-03	Communication and Administration	4	9	Blended
313109-002-00-KM-05	Maintenance, troubleshooting, fault-finding and repairs to PV systems	5	13	Blended
313109-001-00-KM-08	Components of PV systems	4	20	Blended

3.1.1 Detailing knowledge Module (KM) contents

Knowledge Module (KM) – 01: Fundamentals of solar photovoltaic modules manufacturing/production, NQF level 5, 3 Credits

MODULE CODE	MODULE TITLE	NQF LEVEL	CREDITS	MODE OF DELIVERY
900280-000-00-KM-01	Fundamentals of solar photovoltaic modules manufacturing/production	5	3	Blended

(a) Purpose of the Knowledge Skills Module:

The main focus of learning in this knowledge module is to build an understanding of the elementary concepts, principles and methods of the manufacturing solar photovoltaic modules including communication management in the workplace.

(b) List of Knowledge Topics:

TOPIC CODE	TOPIC TITLE	% OF TIME TO BE SPENT
KM-01-KT01	Basic concepts and principles applicable to solar PV module manufacturing	15%
KM-01-KT02	Basics of solar PV modules manufacturing process	25%
KM-01-KT03	Fault-finding, diagnosis and troubleshooting	30%
KM-01-KT04	Testing and quality control measures	30%

(c) Detailing each topic listed above into topic elements:

KM-01-KT01 BASIC CONCEPTS AND PRINCIPLES APPLICABLE TO THE SOLAR PV MODULE MANUFACTURING (15%)		
TOPIC ELEMENT CODE	**TOPIC ELEMENT TITLE**	**% OF TIME TO BE SPENT**
KT0101	Terminologies, concepts, definitions and principles applicable to solar PV	20%
KT0102	Source of components/raw materials of solar PV module	25%
KT0103	Concepts and principles of demand, supply and production	15%
KT0104	Components of the solar PV modules (solar cell types, electrical properties of solar PV module, glass)	35%
KT0105	Communication management planning tools and techniques	5%

(d) Internal Assessment Criteria (IAC) and Weight

IAC CODE	**IAC DESCRIPTION**	**% OF TIME TO BE SPENT**
IAC0101	Define the various terms and concepts used solar PV manufacturing	**5%**
IAC0102	Identify and describe the various components of solar PV modules in terms of their functions	**10%**
IAC0103	Identify and describe the source of components/raw materials of solar PV module in terms of their purpose and functions	**5%**
IAC0104	Explain the concept of intrinsic conductivity using the atomic theory	**5%**
IAC0105	Describe the design and function of the crystalline silicon solar cell	**5%**
IAC0106	Explain the role of a by-passed diode in hot spot instances	**10%**
IAC0107	Explain the principle of photovoltaic effect on solar PV modules manufacturing	**10%**
IAC0108	Explain the electrical specifications or typical parameters of a solar PV module datasheet in terms of their meaning	**10%**
IAC0109	Explain the concepts and principles of production, supply and demand of goods and services and the factors impacting of supply and demand	**10%**
IAC0110	Explain the price determination in the market economy	**5%**
IAC0111	Explain the factors of production in the South African economy	**5%**
IAC0112	Explain the role of technology in the production process	**10%**

IAC0113	Explain the implications for not responding or responding slowly to production at the work station	**5%**
IAC0114	Explain communication requirements analysis, Communication technology, Communication models, Communication methods, Meetings	**5%**

(c) Detailing each topic listed above into topic elements:

KM-01-KT02 BASICS OF SOLAR PV MODULES MANUFACTURING PROCESS (25%)		
TOPIC ELEMENT CODE	**TOPIC ELEMENT TITLE**	**% OF TIME TO BE SPENT**
KT0201	Basic principles and methods of solar PV modules manufacturing	20%
KT0202	Properties and applications of solar PV modules materials	30%
KT0203	Step-by-Step solar PV manufacturing process workflow and techniques	50%

(d) Internal Assessment Criteria (IAC) and Weight

IAC CODE	**IAC DESCRIPTION**	**% OF TIME TO BE SPENT**
IAC0201	Explain the concepts energy, energy efficiency, and waste management in terms of their application in a solar PV modules manufacturing environment in line with legal and regulatory requirements	**15**%
IAC0202	Explain the difference between the types of solar PV modules (e.g glass-white back sheet, glass-black back sheets, glass-glass (bi-facial) solar module, mono-crystalline and poly-crystalline silicon cells)	**25**%
IAC0203	Explain a step-by-step solar PV manufacturing process	40%
IAC0204	Explain the purpose, methods and procedure of machine and tools calibration	20%

(c) Detailing each topic listed above into topic elements:

KM-01-KT03 FAULT-FINDING, DIAGNOSIS AND TROUBLESHOOTING (30%)		
TOPIC ELEMENT CODE	**TOPIC ELEMENT TITLE**	**% OF TIME TO BE SPENT**
KT0301	Types of instruments for fault-finding in the manufacturing process	10%
KT0302	Methods and techniques of fault-finding and troubleshooting	30%
KT0303	Various types of faults in solar PV manufacturing process	20%
KT0304	Root causes and procedures to manage non-conformances during solar PV module manufacturing process	40%

(d) Internal Assessment Criteria (IAC) and Weight

IAC CODE	**IAC DESCRIPTION**	**% OF TIME TO BE SPENT**
IAC0301	**Explain the significance of using the appropriate measuring tools and equipment for solar PV modules manufacturing**	15%
IAC0302	Explain the purpose, methods and procedure to calibrate solar PV manufacturing machine and tools	**15%**
IAC0303	Explain the implications of maintaining a continuous production flow	25%
IAC0304	Evaluate the cost-effectiveness of solar PV modules and methods of production to achieve zero re-work	15%
IAC0305	Identify and explain the possible hazards and risks associated with solar PV modules production to comply with Safety, Health, Environmental and Quality standards and regulations	10%
IAC0306	Explain the impact of defective solar PV modules to the company, internal and external customers	10%
IAC0307	Explain the importance of reporting production performance using the various methods of reporting in line with standard operating procedures	5%
IAC0308	Explain the concept of team dynamics from communication, motivation, people management, conflict resolution and problem-solving perspectives	5%

(c) Detailing each topic listed above into topic elements:

KM-01-KT04 TESTING AND QUALITY CONTROL MEASURES (30%)		
TOPIC ELEMENT CODE	**TOPIC ELEMENT TITLE**	**% OF TIME TO BE SPENT**
KT0401	Incoming quality control	35%
KT0402	In-production quality control	35%
KT0403	Outgoing quality control	30%

(d) Internal Assessment Criteria (IAC) and Weight

IAC CODE	**IAC DESCRIPTION**	**% OF TIME TO BE SPENT**
IAC0401	Identify and explain the various quality control standards applicable solar PV module manufacturing	15%
IAC0402	Discuss the significance of the bill of materials in relation to quantity, appearance, electrical characteristics and soldering capability in line with the accepted international standards	25%
IAC0403	Describe the requirements for packaging solar PV modules in accordance with company-specific standards operating procedures	**20%**
IAC0404	Explain how to package finished solar PV modules to ensure protection during storage and transportation	**20%**
IAC0405	Explain the unpacking procedure to prevent/avoid risk of injury to the employee, and damage of the solar PV module	**20%**

3.1.1.2 Criteria for accreditation

Physical Requirements:

SKILLS DEVELOPMENT PROVIDER (SDP)	
EQUIPMENT & TOOLS	Standard classroom for training, learning materials, facilitation aids (e.g Media, Whiteboard, Projector Screen, Flipchart Stand and Scientific Calculator) If online training, the following equipment and tools must be provided: • Computer/Laptop, • Access to Internet • Software Learning Management System (LMS) and Learning Management Information System (LMIS)

	Quality Management Systems
CONSUMABLES	None

Human Resource Requirements:

SKILLS DEVELOPMENT PROVIDER (SDP)	
QUALIFICATIONS & EXPERIENCE	• Qualification at NQF Level 6 in Electrical Engineering or Renewable Energy related qualification; or; • Qualification in Electrical Engineering or Renewable Energy related qualification at NQF Level 5 with minimum two (2) years' experience in solar PV module manufacturing environment
FACILITATOR/LEARNER RATIO	1: 25

Legal Requirements:

SKILLS DEVELOPMENT PROVIDER (SDP)	
QUALIFICATIONS & EXPERIENCE	• Registered Legal Entity • Display of Labour Laws • Proof of registration with SARS • Compliance to POPI Act • Compliance with relevant occupational health, safety and environmental regulations.
FACILITATOR/LEARNER RATIO	• N/A

3.1.1.3 Exemptions

- None

3.1.2 Detailing Knowledge Module (KM) contents

Knowledge Module (KM) – 03: Communication and Administration, NQF level 4, 9 Credits

MODULE CODE	MODULE TITLE	NQF LEVEL	CREDITS	MODE OF DELIVERY
862927-000-00-KM-03	Communication and Administration	4	9	Blended

(a) Purpose of the Knowledge Module

The main focus of the learning in this knowledge module is to build an understanding of the theory and basic principles of communication and administration.

(b) List of Knowledge Topics:

TOPIC CODE	TOPIC TITLE	% OF TIME TO BE SPENT
KM-03-KT01	Fundamentals of communication theory	50%
KM-03-KT02	Teams and Teamwork	10%
KM-03-KT03	Problem-solving techniques	20%
KM-03-KT04	Administration procedure relating to solar photovoltaic manufacturing production process	20%

(c) Detailing each topic listed above into topic elements:

KM-03-KT01 FUNDAMENTALS OF COMMUNICATION THEORY (50%)		
TOPIC ELEMENT CODE	**TOPIC ELEMENT TITLE**	**% OF TIME TO BE SPENT**
KT0101	Concepts and definitions	15%
KT0102	Principles, channels, methods and process of communication	20%
KT0103	Types and sources of information and information-sharing methods	15%
KT0104	Barriers to effective communication	15%
KT0105	Principles of risk communication	15%
KT0106	Ethical conduct	20%

(d) Internal Assessment Criteria (IAC) and Weight

IAC CODE	IAC DESCRIPTION	% OF TIME TO BE SPENT
IAC0101	Define to concepts 'chain of command', accountability' and 'ethics'	**10%**
IAC0102	Describe various channels, methods and principles of effective communication	**5%**
IAC0103	Explain the communication process for effective transmission of a messages	**5%**

IAC0104	Identify most common barriers of communication in the workplace and ways to overcome them	**5%**
IAC0105	Explain the problem of unresponsive co-workers and how it impacts to workflow in the workplace	**5%**
IAC0106	Explain the importance of and adherence to the correct channels of communication, protocols and chain of command when communicating with both internal and external stakeholders and the consequences of non-compliance	**10%**
IAC0107	Analyse, identify various stakeholders (internal and external), and explain stakeholder communication requirements	**15%**
IAC0108	Identify and describe key messages and/or information to be communicated or shared with external stakeholders	**5%**
IAC0109	Explain the importance of awareness creation in communities regarding renewable energy sources, e.g solar	**5%**
IAC0110	Identify and discuss stress and conflict resolution techniques and how they apply to avoid/reduce/prevent stress and conflict in the workplace	**15%**
IAC0111	Explain the principles of risk communication in terms of their application during stakeholders' meetings	**10%**
IAC0112	Differentiate between responsibility and accountability, and identify the requirements for accountability, and the importance to taking ownership of actions in the workplace	**10%**

(c) Detailing each topic listed above into topic elements:

KM-03-KT02 TEAMS AND TEAMWORK (10%)		
TOPIC ELEMENT CODE	**TOPIC ELEMENT TITLE**	**% OF TIME TO BE SPENT**
KT0201	The concept and benefits of teamwork	20%
KT0202	Roles and responsibilities of team members	40%
KT0203	Organising and managing oneself within a team	40%

(d) Internal Assessment Criteria (IAC) and Weight

IAC CODE	IAC DESCRIPTION	% OF TIME TO BE SPENT
IAC0201	Define the concept of 'teamwork' and the importance of collaborating with others in the workplace to achieve organisational goals and objective and promote effective customer service	**20%**
IAC0202	Explain the principles of self-management	**30%**
IAC0203	State the role and responsibilities of teams, and how effective teamwork benefits both individual employees and the organisation	**50%**

(c) Detailing each topic listed above into topic elements:

KM-03-KT03 PROBLEM-SOLVING TECHNIQUES (20%)		
TOPIC ELEMENT CODE	**TOPIC ELEMENT TITLE**	**% OF TIME TO BE SPENT**
KT0301	Types and causes of problems and problem-solving process	20%
KT0302	Problem-solving methods and strategies	80%

(d) Internal Assessment Criteria (IAC) and Weight

IAC CODE	IAC DESCRIPTION	% OF TIME TO BE SPENT
IAC0301	Explain the importance of problem-solving in the workplace with particular reference to solar photovoltaic manufacturing process fault diagnosis and optimising options	**40%**
IAC0302	Explain the methods and strategies of problem-solving in terms of their application in solar photovoltaic manufacturing process	**50%**
IAC0303	Explain how problem-solving techniques can be applied to identify faults in and optimisation of options to resolve possible problems	**10%**

(c) Detailing each topic listed above into topic elements:

KM-03-KT04 ADMINISTRATION PROCEDURE RELATING TO SOLAR PHOTOVOLTAIC MODULES PRODUCTION PROCESS (20%)		
TOPIC ELEMENT CODE	**TOPIC ELEMENT TITLE**	**% OF TIME TO BE SPENT**
KT0401	Types of records	30%
KT0402	Reporting procedures and formats	70%

(d) Internal Assessment Criteria (IAC) and Weight

IAC CODE	IAC DESCRIPTION	% OF TIME TO BE SPENT
IAC0401	Identify and describe the various types of records to be kept including maintenance and logbooks in terms of their uses	**10%**
IAC0402	Describe the responsibilities and obligations of a Solar Photovoltaic Manufacturing Operator in record-keeping in accordance with organisational policies and standard operating procedures	**30%**
IAC0403	Identify and describe the different types of documentation used in solar photovoltaic manufacturing process	**30%**
IAC0404	Describe the reporting procedures within the solar photovoltaic manufacturing process	**30%**

3.1.2.2 Criteria for accreditation

Physical Requirements:

SKILLS DEVELOPMENT PROVIDER (SDP)	
EQUIPMENT & TOOLS	Standard classroom for training, learning materials, facilitation aids (e.g Media, Whiteboard, Projector Screen, Flipchart Stand and Scientific Calculator) If online training, the following equipment and tools must be provided: • Computer/Laptop, • Access to Internet • Software Learning Management System (LMS) and Learning Management Information System (LMIS) Quality Management Systems
CONSUMABLES	None

Human Resource Requirements:

SKILLS DEVELOPMENT PROVIDER (SDP)	
QUALIFICATIONS & EXPERIENCE	• Relevant qualification at NQF Level 6 in Electrical Engineering or Renewable Energy related qualification; or; • Relevant qualification at NQF Level 5 with minimum two (2) years' experience in solar PV module manufacturing environment
FACILITATOR/LEARNER RATIO	1: 25

Legal Requirements:

SKILLS DEVELOPMENT PROVIDER (SDP)	
QUALIFICATIONS & EXPERIENCE	• Registered Legal Entity • Compliant with Occupational Health and Safety Act • Display of Labour Laws • Valid Tax Compliance / Exemption • Compliance to POPI Act • Compliance with relevant occupational health, safety and environmental regulations.
FACILITATOR/LEARNER RATIO	• N/A

3.1.2.3 Exemptions

- None

3.1.3 Detailing Knowledge Module (KM) contents

Knowledge Module (KM) – 05: Maintenance, troubleshooting, fault-finding and repairs to PV systems, NQF level 5, 13 Credits

MODULE CODE	MODULE TITLE	NQF LEVEL	CREDITS	MODE OF DELIVERY
313109-002-00-KM-05	Maintenance, troubleshooting, fault-finding and repairs to PV systems	5	13	Blended

(a) Purpose of Knowledge Module:

The main focus of the learning in this knowledge module is to build an understanding of the main focus of the learning in this knowledge subject is on maintaining PV systems both on PV farms and domestic (stand-alone) installations.

(b) List of Knowledge Topics:

TOPIC CODE	TOPIC TITLE	% OF TIME TO BE SPENT
KM-05-KT01	Maintenance of PV systems	35%
KM-05-KT02	Troubleshooting PV systems	35%
KM-05-KT03	Repairing and/or replacing components of PV systems	30%

(c) Detailing each topic listed above into topic elements:

KM-05-KT01 MAINTENANCE OF PV SYSTEMS (35%)		
TOPIC ELEMENT CODE	**TOPIC ELEMENT TITLE**	**% OF TIME TO BE SPENT**
KT0101	Types of maintenance (Scheduled [preventative], unscheduled and corrective, opportunity maintenance [when plant is completely shut down])	5%
KT0102	Maintenance schedules and protocols	10%
KT0103	Environmental Impact Assessment (EIA) requirements	10%
KT0104	Manufacturers	5%
KT0105	Monitoring meter and equipment readings.	10%
KT0106	Information analysis	10%
KT0107	Decommission and recommission of whole or part of farm or installation.	10%
KT0108	Switching off procedures to perform maintenance.	10%
KT0109	Isolation of system in cooperation with controller/authorisation	10%
KT0110	Lock-out procedures	10%
KT0111	Improved equipment and upgrades	5%
KT0112	Cleaning (chemical free, ecological cleaning procedures) and OEM cleaning products	5%

(d) Internal Assessment Criteria (IAC) and Weight

IAC CODE	IAC DESCRIPTION	% OF TIME TO BE SPENT
IAC0101	Discuss the different types of maintenance that take place at different PV installations	10%
IAC0102	Describe the kinds of maintenance schedules and protocols involved at PV installations.	20%
IAC0103	Describe EIA requirements and manufacturers" specifications pertaining to maintenance	20%
IAC0104	Describe how to monitor meter and equipment readings and analyse the information available.	10%
IAC0105	Describe decommission and recommission procedures for the whole or part of farm or installation	10%
IAC0106	Describe switching off, isolation and lock-out procedures to perform maintenance.	10%
IAC0107	Identify the kind of improvements and upgrades that can be affected on a PV installation	5%
IAC0108	Describe cleaning procedures and products for modules and other equipment at an installation.	5%
IAC0109	Describe the method of reading the inverters fault display.	10%

(c) Detailing each topic listed above into topic elements:

KM-05-KT02 TROUBLE-SHOOTING PV SYSTEMS (35%)		
TOPIC ELEMENT CODE	**TOPIC ELEMENT TITLE**	**% OF TIME TO BE SPENT**
KT0201	Devices and procedures for fault investigation (multi-meter; pyranometer; special device to measure peak output using PC interface, power meter; current injection probe; temperature sensor; thermographic measurement device; infrared thermometer; thermal imaging camera; insulation resistance tester, device for module testing)	10%
KT0202	Wiring/circuit diagrams for electronic technicians (one-line or block diagram, schematic/elementary diagram and interconnection diagrams and the use of tracing circuits.)	10%
KT0203	Fundamental steps in electronic troubleshooting (Perform an operational check; Analyse the malfunction; Locate the malfunction; Perform corrective action; Perform an operational check)	10%

KT0204	Visual inspections	5%
KT0205	Testing procedures: (testing operating data at the inverter; performing measurement test on AC side and DC side of inverter; checking if there is mains voltage; checking DC cable and the DC main disconnect/isolator switch; measuring insulation resistance; checking the string fuses, surge voltage protector and, where applicable, the string diodes at PV combiner/ junction box and checking for faulty string at PV combiner/junction box; measuring the voltage during operation in parallel at the string fuses and, if applicable, at the string diodes; measuring faulty strings; testing module connections and bypass diodes; measuring the open circuit voltage V0 and the short-circuit current; troubleshooting earth/ground faults or short-circuit faults in a multi-string system by separating and measuring individually; determining the location of a ground fault within a line with a double voltage measurement; measuring voltage from ground to the positive terminal; measuring peak output; performing functional analysis; thermography; electroluminescence measuring)	35%
KT0206	Typical faults in PV installations (faults at inverter, defective string fuses, defects with modules, partial or total failure of a string [bypass diodes etc.]; defective surge protector, insulation fault; component fault; installation faults; external damages; faults at transformers, faults with cables, inter-connections, diodes/ string diodes, fuses, PV combiner/junction box, etc.)	10%
KT0207	Electrostatic discharge (ESD) (ESD sources, failure mechanisms, defect types, ESD control, storing ESD items)	10%
KT0208	Typical electrical faults (opens; shorts [direct, cross, shorted control]; grounds; and low power and their causes, symptoms, and processes for locating them)	10%

(d) Internal Assessment Criteria (IAC) and Weight

IAC CODE	IAC DESCRIPTION	% OF TIME TO BE SPENT
IAC0201	Identify and describe devices and instruments used in fault-finding and explain how and when they are used.	10%
IAC0202	Describe the methods of performing visual inspections on the PV installation and system	10%
IAC0203	Describe the methods and procedures of testing the system.	10%
IAC0204	Explain the importance and purpose of wiring/circuit diagrams in troubleshooting	10%

IAC0205	Identify and describe the three types of wiring diagrams used by electronics technician.	15%
IAC0206	Identify the rules for tracing and extracting circuits from larger diagrams.	10%
IAC0207	Explain how diagrams can be used in troubleshooting.	10%
IAC0208	Identify the five fundamental steps in electronic troubleshooting	10%
IAC0209	Describe the typical faults that can occur in the PV system.	5%
IAC0210	Describe typical electrical faults and identify their causes, symptoms, and methods of locating them	5%
IAC0211	Discuss the precautions to be taken before cleaning modules	5%

(c) Detailing each topic listed above into topic elements:

KM-05-KT03 REPAIRING AND/OR REPLACING COMPONENTS OF PV SYSTEMS (30%)		
TOPIC ELEMENT CODE	**TOPIC ELEMENT TITLE**	**% OF TIME TO BE SPENT**
KT0301	Replacement procedures for modules	20%
KT0302	Repair and replacement procedures for inverters	10%
KT0303	Repair procedures for transformers	20%
KT0304	Repair and replacement procedures for cables, inter-connections, junction boxes, diodes, fuses, controllers	10%
KT0305	Replacement procedures for batteries	20%
KT0306	Repair and replacement procedures for telemetry systems (telemetry systems on tracking systems, smart boxes, inverters, and charge controllers)	20%

(d) Internal Assessment Criteria (IAC) and Weight

IAC CODE	**IAC DESCRIPTION**	**% OF TIME TO BE SPENT**
IAC0301	Describe replacement procedures for modules	20%
IAC0302	Describe replacement procedures for batteries.	20%
IAC0303	Describe the repair and replacement procedures for the system (modules, inverters, transformers, cables, inter-connections, diodes/ string diodes, fuses, surge voltage protector, PV combiner/junction box, controllers etc.)	30%

IAC0304	Describe repair and replacement procedures for inverters or components of inverters, that are within the scope of a PV Technician	10%
IAC0305	Describe repair procedures for transformers, that are within the scope of a PV Technician	10%
IAC0306	Describe repair and replacement procedures for telemetry systems	10%

3.1.3.2 Criteria for accreditation

Physical Requirements:

SKILLS DEVELOPMENT PROVIDER (SDP)	
EQUIPMENT & TOOLS	Standard classroom for training, learning materials, facilitation aids (e.g Media, Whiteboard, Projector Screen, Flipchart Stand and Scientific Calculator) If online training, the following equipment and tools must be provided: • Computer/Laptop, • Access to Internet • Software Learning Management System (LMS) and Learning Management Information System (LMIS) Quality Management Systems
CONSUMABLES	None

Human Resource Requirements:

SKILLS DEVELOPMENT PROVIDER (SDP)	
QUALIFICATIONS & EXPERIENCE	• Relevant qualification at NQF Level 6 in Electrical Engineering or Renewable Energy related qualification; or; • Relevant qualification at NQF Level 5 with minimum two (2) years' experience in solar PV module manufacturing environment
FACILITATOR/LEARNER RATIO	1: 25

Legal Requirements:

SKILLS DEVELOPMENT PROVIDER (SDP)	
QUALIFICATIONS & EXPERIENCE	• Registered Legal Entity • Compliant with Occupational Health and Safety Act • Display of Labour Laws • Valid Tax Compliance / Exemption • Compliance to POPI Act • Compliance with relevant occupational health, safety and environmental regulations.
FACILITATOR/LEARNER RATIO	• N/A

3.1.3.3 Exemptions

- None

3.1.3 Detailing Knowledge Module (KM) contents

Knowledge Module (KM) – 08: Components of PV systems, NQF level 4, 20 Credits

MODULE CODE	MODULE TITLE	NQF LEVEL	CREDITS	MODE OF DELIVERY
313109-001-00-KM-08	Components of PV systems	4	20	Blended

(a) Purpose of Knowledge Module:

The main focus of the learning in this knowledge subject is the components of a PV system and theoretical concepts related to photovoltaic (PV) system.

(b) List of Knowledge Topics:

TOPIC CODE	TOPIC TITLE	% OF TIME TO BE SPENT
KM-08-KT01	PV array systems and PV applications	5%
KM-08-KT02	Solar radiation/irradiance	5%
KM-08-KT03	The photovoltaic effect	5%
KM-08-KT04	Solar cell types	15%
KM-08-KT05	Electrical properties of solar cells	5%
KM-08-KT06	PV modules	10%
KM-08-KT07	PV junction/string boxes, smart boxes, string diodes, connectors and fuses	10%

KM-08-KT08	Inverters	15%
KM-08-KT09	Cabling, wiring and connection systems, installation materials and switching (direct current load switch [DC main switch] and AC switch disconnector)	10%
KM-08-KT10	Batteries	10%
KM-08-KT11	Charge Controllers	10%

(c) Detailing each topic listed above into topic elements:

KM-08-KT01 PV ARRAY SYSTEMS AND PV APPLICATIONS (13%)		
TOPIC ELEMENT CODE	**TOPIC ELEMENT TITLE**	**% OF TIME TO BE SPENT**
KT0101	Stand-alone systems (without storage, with storage, hybrid systems)	33%
KT0102	Grid-connected systems	34%
KT0103	Components of the two systems	33%

(d) Internal Assessment Criteria (IAC) and Weight

IAC CODE	**IAC DESCRIPTION**	**% OF TIME TO BE SPENT**
IAC0101	Describe stand-alone systems and grid-connected systems	**30%**
IAC0102	Identify their main components and describe their functions	**40%**
IAC0103	Explain the principles of operation of these two systems	**30%**

(c) Detailing each topic listed above into topic elements:

KM-08-KT02 SOLAR RADIATION/IRRADIANCE (5%)		
TOPIC ELEMENT CODE	**TOPIC ELEMENT TITLE**	**% OF TIME TO BE SPENT**
KT0201	Sun as energy source	12%
KT0202	Distribution of solar radiation	12%
KT0203	Direct and diffuse radiation	11%
KT0204	Angle definition	11%
KT0205	Sun position and solar spectrum	11%
KT0206	Solar radiation on an inclined plane	11%

KT0207	Ground reflection	11%
KT0208	Measuring solar radiation	11%
KT0209	Tracking PV rays	10%

(d) Internal Assessment Criteria (IAC) and Weight

IAC CODE	IAC DESCRIPTION	% OF TIME TO BE SPENT
IAC0201	Explain the concepts of irradiance, insolation, energy content and the solar constant	9%
IAC0202	Explain the difference between direct and diffuse radiation	9%
IAC0203	Explain the concept of angle definition and identify some of the symbols used to depict the angles	9%
IAC0204	Explain the relationship between solar altitude and air mass	9%
IAC0205	Describe solar positions and air mass (AM) in different places in the world	9%
IAC0206	Explain the concept of the solar spectrum and describe how the sun‟s position affects the solar spectrum	9%
IAC0207	Identify the factors that reduce the passage of light through the earth's atmosphere	9%
IAC0208	Explain the impact of angle of inclination on solar radiation	9%
IAC0209	Explain the concept of ground reflection in terms of the albedo value	9%
IAC0210	Identify the instruments used to measure radiation and describe their accuracy	9%
IAC0211	Describe the advantages of tracking PV arrays and identify tracker systems	10%

(c) Detailing each topic listed above into topic elements:

KM-08-KT03 THE PHOTOVOLTAIC EFFECT (5%)		
TOPIC ELEMENT CODE	**TOPIC ELEMENT TITLE**	**% OF TIME TO BE SPENT**
KT0301	Operation of a solar cell	50%
KT0302	Design and function of a crystalline silicon solar cell	50%

(d) Internal Assessment Criteria (IAC) and Weight

IAC CODE	IAC DESCRIPTION	% OF TIME TO BE SPENT
IAC0301	Explain the concept of intrinsic conductivity using the atomic theory	33%
IAC0302	Describe the design and function of a crystalline silicon solar cell	34%
IAC0303	Explain the concept of energy balance	33%

(c) Detailing each topic listed above into topic elements:

KM-08-KT04 SOLAR CELL TYPES (13%)		
TOPIC ELEMENT CODE	**TOPIC ELEMENT TITLE**	**% OF TIME TO BE SPENT**
KT0401	Crystalline silicon	5%
KT0402	Monocrystalline (single-crystal) silicon cells	5%
KT0403	Polycrystalline silicon cells	5%
KT0404	Polycrystalline UMG silicon cells	5%
KT0405	Ribbon pulled silicon cells	5%
KT0406	Texturing and anti-reflection coating	5%
KT0407	Front contacts	5%
KT0408	Back contacts	5%
KT0409	Alternatives for wafer production	5%
KT0410	High performance cells (manufacturing processes - float-zone method, optimised cell structures, surface passivation, selective emitters, edge isolation, back surface field, point contacts, back-contacted solar cells [types include MWT, EWT and back-contact (IBC) solar cells]; polarisation effect [HIT solar cells, transparent solar cells, spherical solar cells, silver cells])	10%
KT0411	Thin-film cell technology	10%
KT0412	Amorphous silicon cells	5%
KT0413	Micromorphous solar cells	5%
KT0414	Copper indium diselenide (CIS) cells	5%
KT0415	Cadmium telluride cells (CdTe)	5%

KT0416	Nano-structured solar cells (nano-structured CIS cells, organic solar cells: dyesensitised nano-crystalline cells)	5%
KT0417	Concentrator solar cells and concentrating systems	5%
KT0418	Comparison of solar cell types and trends	5%

(d) Internal Assessment Criteria (IAC) and Weight

IAC CODE	IAC DESCRIPTION	% OF TIME TO BE SPENT
IAC0401	Explain the use of silicon in crystalline solar cells	**25%**
IAC0402	Describe polycrystalline, monocrystalline and amorphous cells in detail	**25%**
IAC0403	Discuss thin-film technology	**25%**
IAC0404	Briefly describe each of the other solar cell types	**25%**

(c) Detailing each topic listed above into topic elements:

KM-08-KT05 ELECTRICAL PROPERTIES OF SOLAR CELLS (5%)		
TOPIC ELEMENT CODE	**TOPIC ELEMENT TITLE**	**% OF TIME TO BE SPENT**
KT0501	Equivalent circuit diagrams of solar cells (additional solar cell models, the effective solar cell model)	40%
KT0502	Spectral sensitivity	30%
KT0503	Efficiency of solar cells and PV modules	30%

(d) Internal Assessment Criteria (IAC) and Weight

IAC CODE	IAC DESCRIPTION	% OF TIME TO BE SPENT
IAC0501	Discuss two solar cell models using circuit diagrams	**35%**
IAC0502	Explain spectral sensitivity of different solar cells	**35%**
IAC0503	Explain efficiency of solar cells and PV modules	**30%**

(c) Detailing each topic listed above into topic elements:

KM-08 -KT06 PV MODULES (10%)		
TOPIC ELEMENT CODE	**TOPIC ELEMENT TITLE**	**% OF TIME TO BE SPENT**
KT0601	Cell stringing	10%
KT0602	Glass and cell encapsulation (EVA, PVB, PTFE, lonomer, TPU, acrylates or silicon (TPSE), new module concepts)	10%
KT0603	Module junction boxes and connection cables	10%
KT0604	Module frames	10%
KT0605	Types of modules and classification of modules (substrate, frame structure, construction- specific additional functions etc.)	10%
KT0606	Design options for PV modules (cell type, glass size, cell coverage, glass type, glass format, cell shape, cell contacting, encapsulation material, cell background etc.)	10%
KT0607	Wiring symbols	10%
KT0608	Module characteristics	10%
KT0609	Irradiance dependence and temperature characteristics	5%
KT0610	Hot spots, bypass diodes and shading	5%
KT0611	Electrical characteristics of thin-film modules	5%
KT0612	Expansion and contraction of modules	5%

(d) Internal Assessment Criteria (IAC) and Weight

IAC CODE	**IAC DESCRIPTION**	**% OF TIME TO BE SPENT**
IAC0601	Explain the importance of conducting a scoping exercise in a work management process	**10%**
IAC0602	Differentiate and discuss the various magnitude between scope of work and job scoping making use of examples	**10%**
IAC0603	Identify and describe the basic planning process steps with regard to work at hand	**10%**
IAC0604	Describe the module frames in terms of use, mounting and types	**10%**
IAC0605	Describe the different types of modules and design options	**10%**

IAC0606	Draw the wiring symbol used for solar cells, solar cell string, PV module, string of PV modules, PV sub-array and PV array	**10%**
IAC0607	Discuss briefly the characteristics of different types of modules	**10%**
IAC0608	Discuss the relationship between irradiation, temperature, power and voltage	**10%**
IAC0609	Explain hot spot and shading and the role of diodes in these instances	**10%**
IAC0610	Explain the electrical characteristics of thin-film modules	**5%**
IAC0611	Explain the aspect of expansion and contraction of modules	**5%**

(c) Detailing each topic listed above into topic elements:

KM-08-KT07 PV JUNCTION/STRING BOXES, SMART BOXES, STRING DIODES, CONNECTORS AND FUSES (8%)		
TOPIC ELEMENT CODE	**TOPIC ELEMENT TITLE**	**% OF TIME TO BE SPENT**
KT0701	PV junction/string boxes	20%
KT0702	Smart boxes	20%
KT0703	String diodes	20%
KT0704	Connectors	20%
KT0705	Fuses	10%
KT0706	Telemetry/intelligence	10%

(d) Internal Assessment Criteria (IAC) and Weight

IAC CODE	**IAC DESCRIPTION**	**% OF TIME TO BE SPENT**
IAC0701	Describe the functions of PV junction/string boxes, smart boxes, string diodes, connectors and fuses	**50%**
IAC0702	Explain telemetry/intelligence system of smart boxes	**50%**

(c) Detailing each topic listed above into topic elements:

KM-08-KT08 INVERTERS (13%)		
TOPIC ELEMENT CODE	**TOPIC ELEMENT TITLE**	**% OF TIME TO BE SPENT**
KT0801	Wiring symbols, inverter symbols (single and three phase)	15%
KT0802	Internal circuit diagrams	15%
KT0803	Self-commuted inverters (with high frequency, transformerless)	15%
KT0804	Specifications, characteristics and properties of inverters (different efficiencies like conversion, static, Euro, Californian, overall)	10%
KT0805	Grid-connected inverter types and construction sizes in various power classes (multiple MPP trackers [multi-string concept]; master slave concept in low power ranges, three phase concept in low power ranges, thin-film optimised inverters, back-up inverters or inverters optimised for self- use, medium voltage inverter)	20%
KT0806	Stand-alone inverters (sine-wave and square-wave)	15%
KT0807	Telemetry/intelligence of inverters	10%

(d) Internal Assessment Criteria (IAC) and Weight

IAC CODE	**IAC DESCRIPTION**	**% OF TIME TO BE SPENT**
IAC0801	Describe the functions of the inverter	**15%**
IAC0802	Identify and explain inverter symbols	**5%**
IAC0803	Draw the internal circuit diagram for an inverter and explain its operating principles	**10%**
IAC0804	Discuss the different efficiencies and overload behaviour of inverters	**15%**
IAC0805	Discuss the inverter's recording of operation data	**10%**
IAC0806	Discuss the characteristics and properties of inverters	**10%**
IAC0807	Explain the principle of grid connection when using an inverter	**10%**
IAC0808	Describe the types of inverters	**10%**
IAC0809	Explain telemetry/intelligence system of inverters	**5%**
IAC0810	Explain how to interpret inverter data sheets	**10%**

(c) Detailing each topic listed above into topic elements:

KM-08-KT09 CABLING, WIRING AND CONNECTION SYSTEMS, INSTALLATION MATERIALS AND SWITCHING (DIRECT CURRENT LOAD SWITCH [DC MAIN SWITCH] AND AC SWITCH DISCONNECTOR) (8%)		
TOPIC ELEMENT CODE	**TOPIC ELEMENT TITLE**	**% OF TIME TO BE SPENT**
KT0901	Module and string cables	10%
KT0902	Connection systems	10%
KT0903	DC main cable	10%
KT0904	AC connection cable	10%
KT0905	Installation materials (PG protective tubing, finned tubing, cable duct, cable ties, cable clamps and nail clamps	10%
KT0906	Direct current load switch (DC main switch)	10%
KT0907	Miniature circuit breakers (MCBs)	10%
KT0908	Residual current device (RCD)	10%
KT0909	Isolation switches and grid integration	10%
KT0910	Integration of decentralised feed-in sources in the grid management process	5%
KT0911	Metering	5%

(d) Internal Assessment Criteria (IAC) and Weight

IAC CODE	IAC DESCRIPTION	% OF TIME TO BE SPENT
IAC0901	Describe module and string cables, connection systems, the DC main cable and the AC connection cable and explain their functions	**20%**
IAC0902	Describe the installation materials and explain their functions	**10%**
IAC0903	Describe the impact of quality of cables in terms of system losses	**15%**
IAC0904	Explain the functions of direct current load switch (DC main switch), miniature circuit breakers (MCBs), residual current device (RCD), isolation switches and grid integration	**20%**
IAC0905	Describe the two types of residual current devices	**15%**
IAC0906	Elaborate on the integration of decentralised feed-in sources in the grid management process	**20%**

(c) Detailing each topic listed above into topic elements:

KM-08-KT10 BATTERIES (10%)		
TOPIC ELEMENT CODE	**TOPIC ELEMENT TITLE**	**% OF TIME TO BE SPENT**
KT01001	Construction and operating principles	10%
KT01002	Types and designs of lead-acid batteries (lead-acid gel batteries, stationary tubular plate batteries [types OPzS and OPzV], block batteries with positive plates [OGi block], excursus modern battery concepts – lithium-ion batteries etc.)	20%
KT01003	Batteries and system specifications	15%
KT01004	Operating behaviour and characteristics of lead-acid batteries (voltage, charging and discharging, state of charge)	10%
KT01005	Ageing effects (acid stratification, sulphation, corrosion, studging, drying out)	10%
KT01006	Battery replacement	10%
KT01007	Battery safety and maintenance	10%
KT01008	Recycling	15%

(d) Internal Assessment Criteria (IAC) and Weight

IAC CODE	**IAC DESCRIPTION**	**% OF TIME TO BE SPENT**
IAC1001	Describe the construction, types and designs of batteries used in PV systems	**20%**
IAC1002	Explain the operating principles, operating behaviour and characteristics of leadacid batteries	**15%**
IAC1003	Discuss ageing effects on batteries	**10%**
IAC1004	Describe the criteria and specifications to be used when selecting batteries for PV system	**15%**
IAC1005	Describe the safety requirements when working with batteries	**15%**
IAC1006	Describe battery replacement procedures	**10%**
IAC1007	Describe battery maintenance and recycling procedures	**15%**

(c) Detailing each topic listed above into topic elements:

KM-08-KT11 CHARGE CONTROLLERS (10%)		
TOPIC ELEMENT CODE	**TOPIC ELEMENT TITLE**	**% OF TIME TO BE SPENT**
KT01101	Deep discharge protection and charging	20%
KT01102	Series controller	20%
KT01103	Shunt controllers	10%
KT01104	MPP charge controllers	20%
KT01105	Stand-alone inverters (sine-wave inverters, square-wave inverters, application criteria for inverters in stand-alone systems)	15%
KT01106	Telemetry/intelligence of charge controllers	15%

(d) Internal Assessment Criteria (IAC) and Weight

IAC CODE	**IAC DESCRIPTION**	**% OF TIME TO BE SPENT**
IAC01101	Describe the main function of a charge controller	**20%**
IAC01102	Describe the essential features expected from a modern charge controller	**15%**
IAC01103	Describe a deep discharge protector and explain its function	**10%**
IAC01104	Explain the 3- or 4-stage charging cycle	**15%**
IAC01105	Describe the functions and operating principles of series controllers, shunt controllers and MPP charge controllers	**20%**
IAC01106	Explain telemetry/intelligence system of charge controllers	**20%**

3.1.4.2 Criteria for accreditation

Physical Requirements:

SKILLS DEVELOPMENT PROVIDER (SDP)	
EQUIPMENT & TOOLS	Standard classroom for training, learning materials, facilitation aids (e.g Media, Whiteboard, Projector Screen, Flipchart Stand and Scientific Calculator) If online training, the following equipment and tools must be provided: • Computer/Laptop,

	• Access to Internet • Software Learning Management System (LMS) and Learning Management Information System (LMIS) Quality Management Systems
CONSUMABLES	None

Human Resource Requirements:

SKILLS DEVELOPMENT PROVIDER (SDP)	
QUALIFICATIONS & EXPERIENCE	• Relevant qualification at NQF Level 6 in Electrical Engineering or Renewable Energy related qualification; or; • Relevant qualification at NQF Level 5 with minimum two (2) years' experience in solar PV module manufacturing environment
FACILITATOR/LEARNER RATIO	1: 25

Legal Requirements:

SKILLS DEVELOPMENT PROVIDER (SDP)	
QUALIFICATIONS & EXPERIENCE	• Registered Legal Entity • Compliant with Occupational Health and Safety Act • Display of Labour Laws • Valid Tax Compliance / Exemption • Compliance to POPI Act • Compliance with relevant occupational health, safety and environmental regulations.
FACILITATOR/LEARNER RATIO	• N/A

3.1.4.3 Exemptions

- None

3.2 Practical Skill Module (PM) Specifications:

MODULE CODE	MODULE TITLE	NQF LEVEL	CREDITS	MODE OF DELIVERY
900280-000-00-PM-01	Operate solar PV manufacturing machine and produce quality solar photovoltaic modules	5	4	Face-to-Face
313109-001-00-PM-03	Use tools measuring instruments and equipment	4	7	Face-to-Face
313109-002-00-PM-05	Maintain, test, diagnose and replace cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses in PV systems	5	4	Face-to-Face

3.2.1 Practical Module (PM) Contents:

Practical Module (PM) – 01: Operate solar photovoltaic manufacturing machine and produce quality solar photovoltaic modules, NQF level 5, 4 Credits

MODULE CODE	MODULE TITLE	NQF LEVEL	CREDITS	MODE OF DELIVERY
900280-000-00-PM-01	Operate solar photovoltaic manufacturing machine and produce quality solar photovoltaic modules	5	4	Face-to-Face

(a) Purpose of the Practical Skills Module:

The focus of the learning in this module is on providing the learner an opportunity to operate solar PV manufacturing machine and produce solar PV modules to industry accepted standards in line with quality control measures and standard operating procedures on-site under close supervision and assessment by a qualified solar photovoltaic manufacturing person.

(b) List of Practical Skill Activities:

PRACTICAL SKILL CODE	ACTIVITY TITLE
PM-01-PS01	Manufacture solar PV modules and troubleshoot faults/defects
PM-01-PS02	Inspect materials to produce solar photovoltaic modules in line with quality control measures

(c) Scope of each Practical Skill Activity:

PM-01-PS01 MANUFACTURE SOLAR PV MODULES AND TROUBLESHOOT FAULTS/DEFECTS	
PRACTICAL SKILL ACTIVITY SCOPE OUTLINE:	
Give task instructions, simulated /physical worksite, PPE (e.g lint-free uniform, head and shoe covers, masks and gloves), measuring tools, relevant documentation such as production plan, checklist, visual inspection criteria, relevant components and materials such as frames, glasses, silicon, junction boxes ,solar cells, temperature & humidity datalogger, 600a ac clamp meter, mt940 digital light meter, webster hardness tester, calog pressure 2, calog temperature, infrared thermometer, fluke 15b digital multimeter, coating thickness gauge, digital caliper, electronic outside micro-meter 0-25mm, electronic outside micro-meter, insulation-continuity tester, ae adam scale, moisture meter, surftest, force gauge, cn series (scale), micro a12e, steel rulers, measuring tape, spanner, allen key, screw drivers, long nose plisers, shifting spanner, microscope, soildering anti static box and flux PEN	
PRACTICAL SKILL ACTIVITY ELEMENT CODES	**PRACTICAL SKILL ACTIVITY ELEMENTS**
PA0101	Read and interpret the relevant documentation (i.e production plan and schedules)
PA0102	Start-up, operate and shut-down the solar PV manufacturing machine following a step-by-step in line with standard operating procedures
PA0103	Maintain, troubleshoot faults/defects the machine

(d) Applied Knowledge that underpins the Practical Skill

APPLIED KNOWLDEGE CODE	APPLIED KNOWLEDGE
AK0101	Solar PV modules manufacturing /production plan
AK0102	Start-up and shutdown procedures
AK0103	Safety aspects including Personal Protective Equipment (PPE)
AK0104	Types and functions of tools of manufacturing equipment
AK0105	Manufacturer's specifications and guarantees

(e) Internal Assessment Criteria (IAC)

IAC CODE	IAC DESCRIPTION
IAC0101	**A production plan and schedule are read and interpreted correctly**
IAC0102	**A visual inspection criteria and checklist are understood**
IAC0103	**A solar manufacturing machine is start-up and shut-down following a step-by-step solar PV manufacturing process correctly**
IAC0104	Humidity and the level of lighting in-production are monitored and set to meet company-specific manufacturing requirements
IAC0105	Fault -finding activities were carried out through logical and systematic methods and using appropriate equipment, testing instruments and procedures
IAC0106	Potential faults/defects are traced and disconnected or isolated, where appropriate
IAC0107	Probable faults were detected and appropriate corrective action was taken
IAC0108	Test instruments were checked to ensure that they are within current calibration dates and free from damage and defects

(c) Scope of each Practical Skill Activity:

PM-02-PS02 INSPECT MATERIALS TO PRODUCE SOLAR PHOTOVOLTAIC MODULES IN LINE WITH QUALITY CONTROL MEASURES	
PRACTICAL SKILL ACTIVITY SCOPE OUTLINE	
Given a copy of production plan, solar PV modules, maintenance and testing equipment, the learner must be able to:	
PRACTICAL SKILL ACTIVITY ELEMENT CODES	**PRACTICAL SKILL ACTIVITY ELEMENTS**
PA0201	Quantify the solar PV materials for solar photovoltaic modules manufacturing
PA0202	Check ingress protection
PA0203	Perform visual inspection to identify potential damage/defects
PA0204	Inspect solar PV modules packaging
PA0205	Record and report solar photovoltaic modules stock conditions

(d) Applied Knowledge that underpins the Practical Skill

APPLIED KNOWLDEGE CODE	APPLIED KNOWLEDGE
AK0201	Equipment maintenance records
AK0202	Standards Operating Procedures
AK0203	Manufacturer's specifications and instructions
AK0204	Packaging types, processes and procedures
AK0205	Recording and reporting documentation

(e) Internal Assessment Criteria (IAC)

IAC CODE	IAC DESCRIPTION
IAC0201	Visual inspection on produced solar photovoltaic modules is undertaken according to the set criteria
IAC0202	**Sensitive** solar photovoltaic modules **materials are transferred within the set timeframe and standard operating procedures**
IAC0203	**Different** solar photovoltaic modules **material types are clearly labelled**
IAC0204	All expiration dates are clearly visible
IAC0205	All expired and non-forming materials must be clearly labelled and be separated from the conforming materials
IAC0206	First-in-First material management principles must be applied
IAC0207	Standard test condition of the actual control areas must be met (temperature 25 degrees and humidity < 60%)
IAC0208	Level historical daily record available is confirmed, with multiple measurements
IAC0209	Accurate diagnoses are made
IAC0210	Safety requirements are applied when testing and diagnosing inverters
IAC0211	Finished solar PV products packaging is inspected, verified and validated in relation to power and current class and markings
IAC0212	Finished solar PV products packaging is protected and stored in the designated area.

3.2.1.2 Criteria for accreditation

Physical Requirements:

SKILLS DEVELOPMENT PROVIDER (SDP)	
EQUIPMENT & TOOLS	Work area, categories of tools, equipment and materials described in this module which include, amongst others: PPE (e.g lint-free uniform, head and shoe covers, masks and gloves), measuring tools, relevant documentation such as production plan, checklist, visual inspection criteria, relevant components and materials such as frames, glasses, silicon, junction boxes ,solar cells, temperature & humidity datalogger, 600a ac clamp meter, mt940 digital light meter, webster hardness tester, calog pressure 2, calog temperature, infrared thermometer, fluke 15b digital multimeter, coating thickness gauge, digital caliper, electronic outside micro-meter 0-25mm, electronic outside micro-meter, insulation-continuity tester, ae adam scale, moisture meter, surftest, force gauge, cn series (scale), micro a12e, steel rulers, measuring tape, spanner, allen key, screw drivers, long nose plisers, shifting spanner, microscope, soildering anti static box and flux PEN • Learning Management System (LMS) and Learning Management Information System (LMIS)
CONSUMABLES	Soldering wire

Human Resource Requirements:

SKILLS DEVELOPMENT PROVIDER (SDP)	
QUALIFICATIONS & EXPERIENCE	• Qualification at NQF Level 6 in Electrical Engineering or Renewable Energy related qualification; or; • Qualification at NQF Level 5 in Electrical Engineering or Renewable Energy related fields with minimum two (2) years' experience in solar PV module manufacturing environment
FACILITATOR/LEARNER RATIO	1: 12

Legal Requirements:

SKILLS DEVELOPMENT PROVIDER (SDP)	
QUALIFICATIONS & EXPERIENCE	• Registered Legal Entity • Compliant with Occupational Health and Safety Act • Display of Labour Laws • Compliance to POPI Act
FACILITATOR/LEARNER RATIO	N/A

3.2.1.3 Exemptions

- None

3.2.2 Practical Module (PM) Contents:

Practical Module (PM) – 03: Use tools measuring instruments and equipment, NQF level 4, 7 Credits

MODULE CODE	MODULE TITLE	NQF LEVEL	CREDITS	MODE OF DELIVERY
313109-001-00-PM-03	Use tools measuring instruments and equipment	4	7	Face-to-Face

(a) Purpose of the Practical Skills Module:

The focus of the learning in this module is on providing the learner with an opportunity to select, use and care for a range of tools and equipment correctly.

(b) List of Practical Skill Activities:

PRACTICAL SKILL CODE	ACTIVITY TITLE
PM-03-PS01	Select, use and care of engineering hand tools
PM-03-PS02	Select, use and care for power tools and equipment
PM-03-PS03	Perform marking-off activities
PM-03-PS04	Select, use and care for mechanical instruments
PM-03-PS05	Rivet materials together
PM-03-PS06	Perform soft soldering activities
PM-03-PS07	Lift loads

(c) Scope of each Practical Skill Activity:

PM-03-PS01 SELECT, USE AND CARE OF ENGINEERING HAND TOOLS
PRACTICAL SKILL ACTIVITY SCOPE OUTLINE:
Given work instructions, checklists, work area, drawings, documents, templates, forms, safety and quality principles, hand saws, hammers, screw drivers, sockets, spanners, chassis punches, side cutters, pliers, wire strippers, drill bits, measuring and marking off tools, fastening tools, equipment standard operating procedures and, statutory requirements, the learner must be able to:

PRACTICAL SKILL ACTIVITY ELEMENT CODES	PRACTICAL SKILL ACTIVITY ELEMENTS
PA0101	Select engineering hand tools and equipment for serviceability
PA0102	Use engineering hand tools and equipment
PA0103	Respond appropriately to potential hazards and risks related to the use of the engineering hand tools and equipment

(d) Applied Knowledge that underpins the Practical Skill

APPLIED KNOWLDEGE CODE	APPLIED KNOWLEDGE
AK0101	Workshop procedures including housekeeping practices according to statutory requirements
AK0102	Techniques for maintaining hand tools and equipment
AK0103	Techniques for using tools and equipment
AK0104	Practices related to quality, health, safety, and protection of the environment when using hand tools

(e) Internal Assessment Criteria (IAC)

IAC CODE	IAC DESCRIPTION
IAC0101	The correct application of tools is used for cutting steel, copper, aluminium, plastics and synthetic materials as per manufacturers‟ specifications
IAC0102	The correct application of tools is used to loosen or fasten a range of different types and sizes of nuts or bolts and different types and sizes of screws as per manufacturer's specifications
IAC0103	The correct application of tools is used to strip or cut a range of different types and sizes of electrical wire as per manufacturer’s specifications
IAC0104	Sharp edges on chisel/punch type tool heads with "mushroom effect" are removed to ensure that they can be used safely; then tips with burs or chips are sharpened for effective use
IAC0105	Flat screw driver tips with burs or chips are filed and prepared to manufacturer's specification ensuring that they are serviceable
IAC0106	The adjusting/moving mechanisms of shifting spanners, gas pump pliers, vice grip, dividers, stilson wrench are lubricated to ensure free movement and serviceability
IAC0107	Engineering files cutting edge are cleaned using a wire brush to ensure serviceability
IAC0108	Scribers, dividers and centre punches are sharpened to ensure serviceability

(c) Scope of each Practical Skill Activity:

PM-03-PS02 SELECT, USE AND CARE FOR POWER TOOLS AND EQUIPMENT	
PRACTICAL SKILL ACTIVITY SCOPE OUTLINE	
Given work instructions, work area, documents, templates, drilling machines (portable and pedestal), grinders, and saws, bench grinder, standard operating procedures and, statutory requirements, the learner must be able to:	
PRACTICAL SKILL ACTIVITY ELEMENT CODES	**PRACTICAL SKILL ACTIVITY ELEMENTS**
PA0201	Select a power tool or equipment pertaining to specific job requirements
PA0202	Use fixed power or equipment tools
PA0203	Use portable power or equipment tools
PA0204	Care for and store power tools or equipment and their accessories
PA0205	Respond appropriately to potential hazards and risks related to the use of power tools

(d) Applied Knowledge that underpins the Practical Skill

APPLIED KNOWLDEGE CODE	**APPLIED KNOWLEDGE**
AK0201	Workshop procedures including housekeeping practices according to statutory requirements
AK0202	Safety practices relating to the use of power tools including the use of personal protective equipment, electrical and fire protection
AK0203	Types and uses of fixed and portable power tools and equipment

(e) Internal Assessment Criteria (IAC)

IAC CODE	**IAC DESCRIPTION**
IAC0201	Power tools and equipment are selected according to the task requirements
IAC0202	Pre-operational check is carried out in terms of safety requirements and function
IAC0203	Hazards associated with the use of power tools or equipment are recognised and necessary precautions taken according to workshop procedures
IAC0204	Faulty and unsafe tools or equipment are identified and reported in accordance with standard operating procedures

IAC0205	Personal safety equipment is selected and used according to tool or equipment requirement
IAC0206	Fixed and portable power tools are selected and set up according to job requirements
IAC0207	All guards and securing mechanisms are effectively utilised in terms of job requirements
IAC0208	Fixed and portable power tools and equipment are used safely and in accordance with manufacturer's specifications
IAC0209	Power tools and equipment are inspected, cleaned and lubricated after use according to workshop practices and/or manufactures specifications
IAC0210	Loose items are secured and minor defects repaired in accordance to workshop procedures
IAC0211	Portable power tools, equipment and accessories are stored in accordance to workshop procedures

(c) Scope of each Practical Skill Activity:

PM-03-PS03 PERFORM MARKING-OFF ACTIVITIES	
PRACTICAL SKILL ACTIVITY SCOPE OUTLINE	
Given appropriate tools and equipment, dimensions, raw materials, instructions, templates and assignments to perform marking-off, the learner must be able to:	
PRACTICAL SKILL ACTIVITY ELEMENT CODES	**PRACTICAL SKILL ACTIVITY ELEMENTS**
PA0301	Plan and prepare for the marking-off of materials using templates
PA0302	Select marking-off tools appropriate for different materials and sizes and to prevent negative influences on the final product
PA0303	Interpret job instructions and engineering drawings
PA0304	Perform marking-off using drawings, tools and equipment according to job specifications

(d) Applied Knowledge that underpins the Practical Skill

APPLIED KNOWLDEGE CODE	**APPLIED KNOWLEDGE**
AK0301	Method of checking and evaluating marking-off dimensions from working drawings (including methods of transferring dimensions)
AK0302	Tests for strength, flexibility and defects in raw materials

AK0303	Marking off tools and equipment include to centre punch and hammer, V-shaped block, marking-off scribe, steel rule, steel compass, block and flat table, height gauge, dividing heads, marking agents (pens, paint, chalk, marking blue), rotary tables, trammels and parallels
AK0304	Marking off templates

(e) Internal Assessment Criteria (IAC)

IAC CODE	IAC DESCRIPTION
IAC0301	Preparations for marking-off are made to ensure smooth operation
IAC0302	Check and evaluate marking-off dimensions from working drawings
IAC0303	Check and test raw materials to be marked-off defects
IAC0304	Convert scales from working drawings using various suitable methods
IAC0305	The sequence of activities for the marking-off process is planned to ensure a smooth process
IAC0306	Templates are used on material as per standard procedure, to maintain accuracy
IAC0307	Marking off is concluded to specifications and checked for quality
IAC0308	Work shows consideration for quality

(c) Scope of each Practical Skill Activity:

PM-03-PS04: SELECT, USE AND CARE FOR MECHANICAL INSTRUMENTS	
PRACTICAL SKILL ACTIVITY SCOPE OUTLINE	
Given work instructions, work area, documents, including but not limited to inclinometers, tape measures, digital and laser distance meters, thermometers, steel rulers, engineer's squares, vernier callipers, torque wrench standard operating procedures and, statutory requirements the learner must be able to:	
PRACTICAL SKILL ACTIVITY ELEMENT CODES	**PRACTICAL SKILL ACTIVITY ELEMENTS**
PA0401	Identify and select mechanical measuring instruments
PA0402	Use and interpret mechanical measuring instrument readings
PA0403	Care for mechanical measuring instruments

(d) Applied Knowledge that underpins the Practical Skill

APPLIED KNOWLDEGE CODE	APPLIED KNOWLEDGE
AK0401	Handling procedures related to measuring instrument
AK0402	Basic operating principles of electrical measuring instruments
AK0403	Types, applications and functions of electrical measuring instruments

(e) Internal Assessment Criteria (IAC)

IAC CODE	IAC DESCRIPTION
IAC0401	Job instructions are interpreted correctly and sequence of operation is determined
IAC0402	Unsafe and faulty measuring instruments are identified visually and marked for repair or replacement
IAC0403	Mechanical measuring instruments are checked for correct operation and functionality
IAC0404	Mechanical measuring instruments are set-up and used in accordance with their specifications
IAC0405	Mechanical measuring instruments are read correctly
IAC0406	Results are recorded on appropriate documentation
IAC0407	Results are accurately interpreted against the specifications of the job requirements
IAC0408	Mechanical measuring instruments are placed and stored in accordance with manufacturer's specifications and workshop standards

(c) Scope of each Practical Skill Activity:

PM-03-PS05 RIVET MATERIALS TOGETHER	
PRACTICAL SKILL ACTIVITY SCOPE OUTLINE	
Given two sheets of metal or plastic, drilling machine, pop rivet, rivets, washers etc. the learner must be able to:	
PRACTICAL SKILL ACTIVITY ELEMENT CODES	**PRACTICAL SKILL ACTIVITY ELEMENTS**
PA0501	Make holes using the drilling machine and appropriate measuring and marking tools
PA0502	Rivet the sheets together

(d) Applied Knowledge that underpins the Practical Skill

APPLIED KNOWLDEGE CODE	APPLIED KNOWLEDGE
AK0501	Equipment for riveting: riveting machine, drilling machine, washers, rivets (standard, countersunk, blind)
AK0502	Technique for riveting

(e) Internal Assessment Criteria (IAC)

IAC CODE	IAC DESCRIPTION
IAC0501	Materials to be riveted together are marked where holes will be made
IAC0502	Drilling machine is used correctly to make holes
IAC0503	Appropriate rivet and washer sizes are chosen
IAC0504	Pop rivet is used correctly to complete the task
IAC0505	Safety requirements are adhered to

(c) Scope of each Practical Skill Activity:

PM-03-PS06 PERFORM SOFT SOLDERING ACTIVITIES	
PRACTICAL SKILL ACTIVITY SCOPE OUTLINE	
Given work instructions, work area, checklists, soldering irons; insulation strippers (thermaltype insulation strippers and mechanical wire strippers); wire bending tools; solder; flux; basic soldering connections (turret, bifurcated, hook, surface mounts, cups), solder sucker, accessories, standard operating procedures and statutory requirements the learner must be able to:	
PRACTICAL SKILL ACTIVITY ELEMENT CODES	**PRACTICAL SKILL ACTIVITY ELEMENTS**
PA0601	Solder various wire joints
PA0602	Solder components on a PC board or Vero board or joints
PA0603	De-solder components

(d) Applied Knowledge that underpins the Practical Skill

APPLIED KNOWLDEGE CODE	APPLIED KNOWLEDGE
AK0601	Soldering techniques and applications

AK0602	Safety practices relating to the use of soldering equipment including the use of personal protective equipment
AK0603	De-soldering methods
AK0604	Handling and storage of soldering equipment and accessories

(e) Internal Assessment Criteria (IAC)

IAC CODE	IAC DESCRIPTION
IAC0601	Work area is inspected for safe working conditions and corrective action is taken where required
IAC0602	Applicable soldering equipment is selected as required by task
IAC0603	Soldering material is correctly selected as required by the task
IAC0604	All connections are cleaned of any dirt or oxidation
IAC0605	Tinning of wire and connections are done according to manufacturer's specifications
IAC0606	Connections are soldered according to specifications and techniques
IAC0607	Components are laid out on the circuit board according to the circuit diagram
IAC0608	Components are soldered according to soldering techniques

(c) Scope of each Practical Skill Activity:

PM-03-PS07 LIFT LOADS	
PRACTICAL SKILL ACTIVITY SCOPE OUTLINE	
Given appropriate lifting tools and equipment and assignments, the learner must be able to:	
PRACTICAL SKILL ACTIVITY ELEMENT CODES	**PRACTICAL SKILL ACTIVITY ELEMENTS**
PA0701	Assess the nature of the lifting task and the associated risks
PA0702	Plan the lifting process (including making simple calculations)
PA0703	Identify and select lifting equipment in accordance with load requirements
PA0704	Inspect the lifting equipment for safety and defects
PA0705	Sling loads in accordance with load requirements and worksite procedures
PA0706	Use applicable communication methods during slinging operations
PA0707	Lift, convey and place/stack loads safely

(d) Applied Knowledge that underpins the Practical Skill

APPLIED KNOWLDEGE CODE	APPLIED KNOWLEDGE
AK0701	Lifting equipment (chain slings, rope slings, steel wire slings, synthetic web slings, shackles, eyebolts, guide ropes, plate grabs, chain blocks, rope tackles/rope blocks jacks, come-alongs, small floor cranes, hoists [tirfor, coffin], lifting brackets, fasteners, colour codes of slings)
AK0702	Equipment defects (include wear, corrosion, stretched links, deterioration of splices, cracks, nicks and broken strands, contamination through oil and paint [synthetic slings])
AK0703	Load capacity of lifting equipment and the reason for not exceeding it
AK0704	Communication methods used may include the use of two-way radios, standard hand signals and warning devices such as hooters and whistles
AK0705	Lifting techniques
AK0706	Safety requirements
AK0707	Caring and storage procedures
AK0708	Load capacity for this practical skill not to exceed 2t (two metric tons)

(e) Internal Assessment Criteria (IAC)

IAC CODE	IAC DESCRIPTION
IAC0701	The task is assessed and an appropriate lifting technique is chosen
IAC0702	Risks are assessed and mitigated
IAC0703	Lifting task is planned in accordance with the task
IAC0704	Lifting equipment is selected and checked and its lifting capacity is noted
IAC0705	Lifting task is completed keeping in consideration all safety requirements
IAC0706	Equipment is cleaned, lubricated and stored according to procedures

3.2.2.2 Criteria for accreditation

Physical Requirements:

SKILLS DEVELOPMENT PROVIDER (SDP)	
EQUIPMENT & TOOLS	Work area, categories of tools, equipment and materials described in this module

	If online training, the following equipment and tools must be provided: • Computer/Laptop, • Access to Internet • Software Learning Management System (LMS) and Learning Management Information System (LMIS)
CONSUMABLES	None

Human Resource Requirements:

SKILLS DEVELOPMENT PROVIDER (SDP)	
QUALIFICATIONS & EXPERIENCE	• Relevant qualification at NQF Level 6 in Electrical Engineering or Renewable Energy related qualification; or; • Relevant qualification at NQF Level 5 with minimum two (2) years' experience in solar PV module manufacturing environment
FACILITATOR/LEARNER RATIO	1: 12

Legal Requirements:

SKILLS DEVELOPMENT PROVIDER (SDP)	
QUALIFICATIONS & EXPERIENCE	• Registered Legal Entity • Compliant with Occupational Health and Safety Act • Display of Labour Laws • Compliance to POPI Act
FACILITATOR/LEARNER RATIO	N/A

3.2.2.3 Exemptions

- None

3.2.3 Practical Module (PM) Contents:

Practical Module (PM) – 05: Maintain, test, diagnose and replace cables, cable inter connections, smart boxes, PV junction/string boxes, string diodes, connectors, and fuses in PV systems, NQF level 5, 4 Credits

MODULE CODE	MODULE TITLE	NQF LEVEL	CREDITS	MODE OF DELIVERY
313109-002-00-PM-05	Maintain, test, diagnose and replace cables, cable inter connections, smart boxes, PV junction/string boxes, string diodes, connectors, and fuses in PV systems	5	4	Face-to-Face

(a) Purpose of the Practical Skills Module:

The focus of the learning in this module is on providing the learner an opportunity to the focus of the learning in this module is on providing the learner an opportunity to: maintain; test, troubleshoot and diagnose problems/faults; and replace cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors, and fuses.

(b) List of Practical Skill Activities:

PRACTICAL SKILL CODE	ACTIVITY TITLE
PM-05-PS01	Prepare for scheduled maintenance on cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors, and fuses.
PM-05-PS02	Test, troubleshoot and diagnose problems on cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors, and fuses.
PM-05-PS03	Remove and replace cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors, and fuses.

(c) Scope of each Practical Skill Activity:

PM-05-PS01: Prepare for scheduled maintenance on cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses	
PRACTICAL SKILL ACTIVITY SCOPE OUTLINE:	
Given maintenance schedules, documentation, diagrams, checklists, safety and quality principles, standard operating procedures, the learner must be able to:	
PRACTICAL SKILL ACTIVITY ELEMENT CODES	**PRACTICAL SKILL ACTIVITY ELEMENTS**
PA0101	Identify and interpret maintenance schedules, documentation and diagrams

PA0102	Identify and implement authorisation procedures for maintenance
PA0103	Select tools and testing equipment
PA0104	Lock out or isolate the cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses or system (if necessary)

(d) Applied Knowledge that underpins the Practical Skill

APPLIED KNOWLDEGE CODE	APPLIED KNOWLEDGE
AK0101	Maintenance schedules, documentation, diagrams
AK0102	Lock out or isolation procedures
AK0103	Safety aspects including PPE
AK0104	Types and functions of tools and maintenance equipment
AK0105	Manufacturer's specifications and guarantees

(e) Internal Assessment Criteria (IAC)

IAC CODE	IAC DESCRIPTION
IAC0101	Authorisation procedures are implemented to perform scheduled maintenance
IAC0102	A range of maintenance schedules, documentation etc is used to plan scheduled maintenance

(c) Scope of each Practical Skill Activity:

PM-05-PS02: Test, troubleshoot and diagnose problems on cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses	
PRACTICAL SKILL ACTIVITY SCOPE OUTLINE	
Given testing equipment, cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses, the learner must be able to:	
PRACTICAL SKILL ACTIVITY ELEMENT CODES	**PRACTICAL SKILL ACTIVITY ELEMENTS**
PA0201	Carry out visual inspection of cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses
PA0202	Maintain cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses as per manufacturer's requirements

PA0203	Test cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses
PA0204	Diagnose problems on cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses

(d) Applied Knowledge that underpins the Practical Skill

APPLIED KNOWLDEGE CODE	APPLIED KNOWLEDGE
AK0201	Structure and composition of cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses
AK0202	Types of cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses
AK0203	Operating principles of cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses
AK0204	Visual inspection procedures
AK0205	Maintenance procedures for cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses
AK0206	Types of maintenance problems on cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses
AK0207	Telemetry on smart boxes (communication system)
AK0208	Testing and diagnosing procedures
AK0209	Testing diagnosing tools and equipment

(e) Internal Assessment Criteria (IAC)

IAC CODE	IAC DESCRIPTION
IAC0201	Visual inspections are performed on cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses
IAC0202	Cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses are maintained as per manufacturer's requirements
IAC0203	Testing tools and equipment are used correctly to carry out a range of tests on cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses (including telemetry on smart boxes
IAC0204	Readings on testing equipment are interpreted correctly
IAC0205	Accurate diagnoses are made

IAC0206	Safety requirements are applied when testing and diagnosing cables, cable inter connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses

(c) Scope of each Practical Skill Activity:

PM-05-PS03: REMOVE AND REPLACE CABLES, CABLE INTER-CONNECTIONS, SMART BOXES, PV JUNCTION/STRING BOXES, STRING DIODES, CONNECTORS AND FUSES	
PRACTICAL SKILL ACTIVITY SCOPE OUTLINE	
Given tools and equipment and manufacturer's specifications, the learner must be able to:	
PRACTICAL SKILL ACTIVITY ELEMENT CODES	**PRACTICAL SKILL ACTIVITY ELEMENTS**
PA0301	Repair faults/problems on switchgear and control gear
PA0302	Replace switchgear and control gear or their components
PA0303	Complete a re-commissioning test on switchgear and control gear
PA0304	Prepare report

(d) Applied Knowledge that underpins the Practical Skill

APPLIED KNOWLDEGE CODE	APPLIED KNOWLEDGE
AK0301	Removal and replacement techniques
AK0302	Techniques to carry out commissioning tests
AK0303	Risks, hazards and safety precautions
AK0304	Cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses maintenance report requirements

(e) Internal Assessment Criteria (IAC)

IAC CODE	IAC DESCRIPTION
IAC0301	Cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses are correctly and safely isolated and locked-out according to isolation and lock-out procedures
IAC0302	Cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors, fuses and telemetry components are removed and replaced according to manufacturer specifications

IAC0303	Risks associated with repair/replacement of cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses are correctly identified and safety precautions taken
IAC0304	Correct re-commissioning testing is completed according to standard operating procedure
IAC0305	Report is written on the repair/replacement work

3.2.3.2. Criteria for accreditation

Physical Requirements:

SKILLS DEVELOPMENT PROVIDER (SDP)	
EQUIPMENT & TOOLS	Work area, categories of tools, equipment and materials described in this module Learning Management System (LMS) and Learning Management Information System (LMIS)
CONSUMABLES	None

Human Resource Requirements:

SKILLS DEVELOPMENT PROVIDER (SDP)	
QUALIFICATIONS & EXPERIENCE	• Relevant qualification at NQF Level 6 in Electrical Engineering or Renewable Energy related qualification; or; • Relevant qualification at NQF Level 5 with minimum two (2) years' experience in solar PV module manufacturing environment
FACILITATOR/LEARNER RATIO	1: 12

Legal Requirements:

SKILLS DEVELOPMENT PROVIDER (SDP)	
QUALIFICATIONS & EXPERIENCE	• Registered Legal Entity • Compliant with Occupational Health and Safety Act • Display of Labour Laws • Compliance to POPI Act
FACILITATOR/LEARNER RATIO	N/A

3.2.3.3 Exemptions

- None

3.4 POSSIBLE SEQUENCING AND INTEGRATION

ORDER	MODULE TITLE	MODULE CODE	LEVEL	CREDITS
1.	Fundamentals of solar photovoltaic modules manufacturing/production	900280-000-00-KM-01	5	3
2.	Use tools measuring instruments and equipment	313109-001-00-PM-03	4	7
3.	Components of PV systems	313109-001-00-KM-08	4	20
4.	Communication and Administration	862927-000-00-KM-03	4	9
5.	Operate solar photovoltaic manufacturing machine and produce quality solar photovoltaic modules	900280-000-00-PM-01	5	4
6.	Maintenance, troubleshooting, fault-finding and repairs to PV systems	313109-002-00-KM-05	5	13
7.	Maintain, test, diagnose and replace cables, cable inter-connections, smart boxes, PV junction/string boxes, string diodes, connectors and fuses in PV systems	313109-002-00-PM-05	5	4