



ESWATINI VOCATIONAL QUALIFICATIONS PACKAGE
FOR

SOLAR PV INSTALLATION AND MAINTENANCE

LEVEL 3



Prepared by the Directorate of Industrial and Vocational Training (DIVT)

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Registration documents can be downloaded at the link:

<https://www.divt.org.sz/qualifications>

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Nathie	Tfwala	TRRC
Malangeni	Dlamini	Tambakulu Estate
Nikitha	Hlophe	ESWASWA
Edgar	Dlamini	REASWA
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Hlob'sile	Hlophe	EEC
Jabulani	Shongwe	Gwamile VOCTIM
Marius	Uys	Simply Swazi
Melusi	Tsabedze	ESERA
Ncamiso	Nkambule	ESERA
Mazambane	Dlamini	Taiwan Technical Mission
Mandla	Vilakati	MNRE
Gcina	Singwane	DIVT
Lucky	Phakathi	DIVT

THE QUALIFICATION

**NATIONAL VOCATIONAL CERTIFICATE SOLAR PHOTO-VOLTAIC (PV)
INSTALLATION AND MAINTENANCE LEVEL 3**

Originator Qualification Developer	DIVT		
Qualification Type:	Certificate	Descriptor:	Solar Photovoltaic Installation and Maintenance
Specialization (if relevant):			
Level:	3	Minimum Credits:	80
Actual Credits	94		
Sub-Framework (Sub-Sector)	TVET		
Field name	Engineering, Manufacturing and Construction	Field no:	07
Sub-field no:	Mechanics and metal trades	Sub-field no:	0715

Rationale

Describe the context of ETSDS

The Technical and Vocational System in Eswatini lacks occupational standards and harmonised curricula for training which has the input for the industry players. There is general dissatisfaction with competences produced by the system in terms of relevance with the labour market. There is currently no correlation between the required industry skills and the qualification the system produces.

Describe how will the qualification impact positively within the sketched context:

The qualification will provide the much-needed correlation between the required industry skills and the competences produced by the system. The qualification will also harmonise curricula for training with input of industry players.

Why do you need the qualification?

This qualification will enhance the status and productivity of the learner as well as contribute to improved quality, production rate and growth within the renewable energy sector of electrical engineering. The range of typical learners at this level could include individuals preparing to qualify as a Solar Photo-voltaic Installation and Maintenance technician. Qualifying learners will obtain a National Vocational Certificate in Solar Photo-voltaic Installation and Maintenance which places the learner in a position to investigate requirements for advancement to qualified artisan status or progress to a National Certificate or Diploma at NQF Level 4.

Purpose

The purpose of the qualification is to develop learners who have the competencies required for performing Solar Photo-voltaic Installation and Maintenance tasks. It is awarded to people who have demonstrated the skills and knowledge of photovoltaic technology; install and maintain photovoltaic systems, demonstrate and apply basic knowledge of data communications and logging for renewable energy systems and mount solar PV and water heating systems.

Learners attracted to this qualification include those who are training in institutions to be Solar Photo-voltaic Installation and Maintenance technician at level 3, learners who are in the apprenticeship training system and those who are in the non-formal sector who will acquire through trade testing.

Graduates will be able to ...

The qualification is developed to produce a Solar Photo-voltaic Installation and Maintenance technician who can work in a solar photovoltaic system with minimum supervision. Graduates will be able to relate their learning to scientific and technological principles and concepts. They will also be able to maintain and support the various policies and procedures related to the safety, health, environment and quality systems that govern their workplace.

Entry Requirements

Minimum requirements for entry:

Electrician Level 2 and/ or RPL

Associated Level Descriptors

Knowledge	• To demonstrate advanced knowledge in specialised and emerging situations to make informed judgements. • To understand key concepts, terms, rules and established principles and theories in one or more fields or disciplines.
Skills	• To apply strategic approaches to tasks that arise in work and using expert sources of information. • To use technology to solve existing and emerging situations.
Personal Attributes	• To demonstrate accountability and responsibility in work/ learning situations. • To show proactivity and reliability in performance of tasks.

Learning Outcomes Statements and Associated Assessment Criteria

This qualification will enable the learner to find employment as a skilled worker to perform Artisan duties in the Solar Photo-voltaic Installation and Maintenance field.

The learner after when competent should be able to:

- Demonstrate knowledge of photovoltaic technology.
- Mount solar PV and water heating systems
- Install and maintain photovoltaic systems.
- Demonstrate and apply basic knowledge of data communications and logging for renewable energy systems

Assessment criteria identify the specific skills, knowledge, and behaviours necessary to achieve the learning outcomes. It makes it clear to learners what they are expected to do. It demonstrates to learners how to achieve the learning outcomes. It also contains range statements.

- Own work is planned and scheduled in terms of productivity, safety, health and the environment.
- A variety of common problems, both familiar and unfamiliar are solved by applying knowledge of advanced Solar Photo-voltaic Installation and Maintenance theory and practice.
- Responsibility for own actions is demonstrated within sphere of operation.
- Effective interaction and communication is conducted with clients, colleagues and management.
- Knowledge of and application of statutory requirements is demonstrated as they relate to integrated systems.

Components of Qualifications

The components of the qualification which, in their combination, make up the complete qualification.

ID	Unit Standard	Level	Credit
EEI210	Carry out basic gas welding, brazing and cutting in an instrumentation environment	4	5
MEW209	Weld carbon steel work-pieces using the shielded metal arc welding process in all positions	4	4
EE301	Understand basic electrical and electronic theory and components	4	4
EE304	Construct basic electrical and electronic circuit	4	10
EE306	Install and maintain electrical metering units, measuring instruments and control devices	4	8
EE312	Install, test and maintain single and three phase domestic and commercial installations	4	10
PVI300	Work at heights	4	4
PVI301	Mount Solar Water Heating Systems	4	10
PVI302	Mount Solar PV Systems	4	6
PVI303	Install and maintain photovoltaic systems	4	4

PVI304	Install and maintain batteries	4	4
PVI305	Demonstrate and apply basic knowledge of data communications and logging for renewable energy systems	4	5
PVI306	Demonstrate knowledge of photovoltaic technology	4	10
PVI307	Design a single-phase photovoltaic power system	4	10
Total Number of Credits			94

Rules of Combination

Specific rules? The learner should be competent in all units in this qualification
Compulsory modules, units learning? All units are compulsory in this qualification.
Any subminimum credits to be achieved? The learner should acquire all 94 credits in this qualification.

Integrated Assessment

How will assessment be done? This qualification will have compulsory theory and practice
How often will the assessment be done? • Trade testing • Institutional theory exams and practice • Formative assessment for apprenticeship training through log books and institutional evidence of theory training
Who will be responsible for assessment? • DIVT • Vocational training institutions • There will be collective awarding of certificates for institutional learners

International Comparability

SADC	This qualification aligns with the level descriptors in the SADC Qualifications Framework.
African Continent	N/A

Globally, including TQF	N/A
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Articulation Possibilities/Learning Pathways

A provision to learners, on successful completion of accredited prerequisites, to move between components of the delivery system.

Vertical	Solar PV Installation and Maintenance Level 4
Horizontal	No match
Diagonal	No match

Notes

Could be used by the office to let the public know the status of various issues. Here are 3 possibilities.

Programmes recorded against this registered qualification
N/A
Accredited Providers
N/A
Registered, re-registered, de-registered?
N/A

Name of Registered Provider

Information on all providers accredited to offer this qualification must be indicated here. In the final database this information must be updatable.

Name:	DIVT
Address:	P. O. Box 1218 Mbabane

UNIT STANDARDS

EE301: Understand basic electrical and electronic theory and components

Title		Understand basic electrical and electronic theory and components			
Domain		Physical Planning and Construction			
Sub-field		Electrical Engineering Core			
SZNQF Level	3	Unit ID	EE301	Credits	4

Purpose

This unit standard specifies the competencies required to understand and explain electronic basic theory and components. It includes understanding and explaining electron theory in terms of current flow, understand and explain the operation of basic electronic components, understand and explain the operation of a P-N junction diode, understanding the operation and function of power supplies, understanding the operation and application of transistors and understanding the principles of opto-electronics and its applications, understanding basic ac theory. This unit standard is for Electrician Level 3.

Special Notes

1. Entry Requirements/Pre-requisites
None
2. This unit standard is to be delivered and assessed in the context of the Electrical Engineering and should be assessed in conjunction with other relevant technical unit standards selected from this domain.
3. Assessment may be conducted at a real workplace or simulated workplace, or an appropriately realistic environment in which electrical utilisation, generation, transmission and distribution is carried out.
4. Statutory requirements include but not limited to current national regulations applicable to electrical utilization; generation, transmission and distribution, including regulations; ordinances; bylaws; directives; standards; guidelines; and codes; issued by legislative body such as parliament, local authorities and other bodies so empowered by any of the former.
5. Components may include, but not limited to resistors, transistors, diodes, thyristors, diacs, triacs, capacitors, inductors, fuses, light emitting diodes (LED's) and integrated circuits (IC's) fundamentals (i.e. timers, op amps, gates, etc.)

Quality Assurance Requirements

This unit standard and others within this subfield may be awarded by institutions which comply with the accreditation, national assessment and moderation requirements set by the Eswatini Higher Education Council.

Elements and Performance Criteria

Element 1: Understand and explain electronic theory in terms of current flow

Performance Criteria

- 1.1 The structure of the atom is drawn and explained within the context of basic electronic theory.
- 1.2 Free electrons are explained within the context of electron theory principles.
- 1.3 Conduction and different types of current is explained within the context of electronic theory principles.
- 1.4 Bonding processes between different molecule types are explained and lattice structure drawn.
- 1.5 Doping of intrinsic materials is understood and explained in terms of p-type and n-type semiconductor principles.
- 1.6 The effect of heat on semiconductor materials and conductors are explained with relation with its conductivity characteristics.

Element 2: Understand and explain the operation of basic electronic components

Performance Criteria

- 2.1 Different types, values, colour codes and symbols of resistors are listed and explained in relation with basic electronic theory and applications.
- 2.2 Different types, values and symbols of capacitors are listed and explained in relation with basic theory and applications.
- 2.3 Different types, values and symbols of inductors are listed and explained in relation with basic electronic theory and applications.
- 2.4 The combination and effect of different basic electronic components in one circuit is graphically illustrated and explained in relation with basic electronic theory and applications.

Element 3: Understand the operation of a P-N junction diode

Performance Criteria

- 3.1 The creation and biasing of a P-N junction is described and graphically illustrated within the context of semiconductor theory.
- 3.2 The effect of temperature on a P-N junction is described within the context of semi-conductor theory.

- 3.3 Forward biasing and reverse biasing curves are drawn and described within the context of semiconductor theory.
- 3.4 Different types of specialised diodes are identified and described within the context of semiconductor theory.

Element 4: Understand the operation and function of power supplies.

Performance Criteria

- 4.1 The operation of half wave rectifier techniques is explained with the aid of graphics.
- 4.2 The operations of half wave and full wave rectifiers are explained with the aid of graphics.
- 4.3 A basic DC power supply consisting of a transformer and rectifiers are explained with the aid of graphics and the output voltage demonstrated with the aid of an oscilloscope.
- 4.4 Basic calculations of the voltages and currents around rectifier circuits are done in relation with full wave and half wave rectification and verified with the aid of an oscilloscope.

Element 5: Understand the operation and application of a transistor.

Range:

IGBT, MOSFETs, BJT, TRIACs, DIACs

Performance Criteria

- 5.1 Identify and explain operation principles of transistors.
- 5.2 The output and input characteristics for transistors are drawn and explained in terms of transistor theory.
- 5.3 The Quiescent point is defined in relation with transistor theory.
- 5.4 Basic load line calculations are carried out in relation with transistor theory.
- 5.5 The operation of transistor as a switch is explained with the aid of a circuit diagram.
- 5.6 The operation of a transistor as an amplifier is explained with and aid of circuit diagram.

Element 6: Understand the principles of opto-electronics and its applications

Performance Criteria

- 6.1 Operation of photo-emissive and photo-conductive devices are explained within the context of opto-electronic principles.

- 6.2 The characteristic curve for photo diode is drawn and the shape explained.
- 6.3 Difference between photodiodes and light emitting diodes are explained within the context of photovoltaic power systems.
- 6.4 The operation of solar cell is graphically illustrated and explained within the context of photovoltaic power systems.
- 6.5 The number of solar cells required to deliver a particular current and voltage is calculated within the context of photovoltaic power systems.

Registration Data

Date first registered	2022
Anticipated review	2027
Standard setting body (SSB)	Directorate of Industrial and Vocational Training (DIVT)
Body responsible for review	Directorate of Industrial and Vocational Training (DIVT)

EE304: Construct basic electrical and electronics circuits

Title		Construct basic electrical and electronics circuits			
Domain		Physical Planning and Construction			
Sub-field		Electrical Engineering Core			
SZNQF Level		Unit ID	EE304	Credits	10

Purpose

This unit standard specifies the competencies required to install, test and maintain single and three phase domestic, commercial and industrial installations. It includes, planning the electrical tests to be done, testing the electrical installation and complete the required tests and inspection documentation. This unit standard is for electrician level 3.

Special Notes

1. Entry information/Prerequisite
EE301 Understand electrical and electronics theory and components.
2. This unit standard is to be delivered and assessed in the context of electrical engineering and should be assessed in conjunction with other relevant technical unit standards selected from this domain.
3. Assessment may be conducted at a real workplace or simulated workplace, or an appropriately realistic environment in which electrical utilisation, generation, transmission and distribution is carried out.
4. Regulations and legislation relevant to this unit standard may include but not limited to the following:
 - Occupational Health and Safety Act 2001
 - Worker's Compensation Act No.7 of 1983
 - SZNA-SANS 10142-1and all subsequent amendments
5. Statutory requirements include but not limited to current national regulations applicable to electrical utilization, generation, transmission and distribution, including regulations; ordinances; bylaws; directives; standards; guidelines; and codes; issued by legislative body such as parliament, local authorities and other bodies so empowered by any of the former.
6. Electrical drawing includes but not limited to, schematic diagrams, wiring diagrams, connection and or terminal connections and cable schedule.

Quality Assurance Requirements

This unit standard and others within this subfield may be awarded by institutions which comply with the accreditation, national assessment and moderation requirements set by the Eswatini Higher Education Council.

Elements and Performance Criteria

Element 1: Plan and prepare for the electrical installation to be done

Performance Criteria

- 1.1 Job instructions are interpreted and sequence of operations is determined according to the installation environment and the required task.
- 1.2 Tools, equipment and instruments are selected to meet the requirements of the task according to statutory and environmental requirements.
- 1.3 The documentation necessary to complete the task is obtained as per data management requirements.
- 1.4 Safety rules and regulations are followed as per statutory requirements and safe working procedures.
- 1.5 Environmental hazards and safety risks are identified according to environmental standards and safety risks analysis.

Element 2: Carrying out electrical installation

Performance Criteria

- 2.1 Hazard Identification and Risk Assessment (HIRA) is carried out
- 2.2 Components are assembled as per the given task
- 2.3 Statutory regulations and standards adhered to.
- 2.4 Integrity of connections is checked/verified

Element 3: Perform electrical tests on the installation

Performance Criteria

- 3.1 Installation is tested as per statutory requirements from SZNS SANS 10142 codee
- 3.2 Documentation is completed as per data management requirements.
- 3.3 Test instruments are used to obtain readings in accordance with statutory requirements.
- 3.4 Measurements obtained from the test are interpreted as per SZNS SANS 10142 requirements.
- 3.5 All safety precautions are observed and demonstrated during the test as per safe work procedures.

Element 4: Maintain electrical installations

Performance Criteria

- 4.1 All safety requirements are observed and demonstrated during maintenance as per safe working procedures.

4.2 All maintenance activities are carried according to specific procedures

Element 5: Complete the required task documentation

Performance Criteria

- 5.1 All personnel, tools, Instruments and excess equipment are removed from the installation according to work site procedures.
- 5.2 The work area is restored to its original condition on completion of the test and inspection procedures as per safety requirements.
- 5.3 The certificate of compliance completed according to SZNS SANS 10142 requirement.
- 5.4 The results of the inspection and test are communicated to all concerned according to reporting procedures.
- 5.5 A defect list is compiled and corrective action taken, if necessary, as per quality requirements.

Registration Data

Date first registered	2022
Anticipated review	2027
Standard setting body (SSB)	Directorate of Industrial and Vocational Training (DIVT)
Body responsible for review	Directorate of Industrial and Vocational Training (DIVT)

EE306: Install and maintain electrical metering units, measuring instruments and control devices

Title		Install and maintain electrical metering units, measuring instruments and control devices			
Domain		ELECTRICAL OPERATIONS			
Sub-field		Electrical Engineering Core			
SZNQF Level	3	Unit ID	EE306	Credits	8

Purpose

This unit standard specifies the competencies required to demonstrate knowledge of installing and maintaining metering units, measuring instruments and control devices. It includes, demonstrating procedure and requirements to install electrical metering units and or measuring instruments and control devices, planning to install and connect electrical metering units and or measuring instruments with their related control devices, install and connect electrical metering units and or measuring instruments and control devices and complete work activity. This unit standard is for Electrician level 3.

Special Notes

1. Entry Requirements/Prerequisites.

EE301 Understand electrical and electronic theory and components.
EE304 Construct basic electrical and electronics circuits.
EE316 Use and care for measuring and testing instruments.
2. This unit standard is to be delivered and assessed in the context of the Engineering and should be assessed in conjunction with other relevant technical unit standards selected from this domain.
3. Assessment may be conducted at a real workplace or simulated workplace, or an appropriately realistic environment in which electrical utilisation, generation, transmission and distribution is carried out.
4. Regulations and legislation relevant to this unit standard may include but not limited to the following:
 - Occupational Health and Safety Act 2001
 - Worker's Compensation Act No.7 of 1983
 - SZNS SANS 10142-1
 - SZNS SANS 10142-2
 - Road Traffic Act 2007and all subsequent amendments
5. Statutory requirements include but not limited to current national regulations applicable to electrical utilisation, generation, transmission and distribution, including regulations; ordinances; bylaws; directives; standards; guidelines; and codes; issued by legislative body such as parliament, local authorities and other bodies so empowered by any of the former.

6. Planning and preparation includes reading and understanding task instructions, engineering drawings, and breakdown schedules, identification of the equipment to be maintained, obtaining schedules and manufacturer's specifications for specific equipment to be assembled.
7. Control devices may include, but not limited to circuit breakers, voltage transformers and current transformers.
8. Electrical measuring instruments may include, but not limited to voltmeters, ammeters, and frequency meters.

Quality Assurance Requirements

This unit standard and others within this subfield may be awarded by institutions which comply with the accreditation, national assessment and moderation requirements set by the Eswatini Higher Education Council.

Elements and Performance Criteria

Element 1: Demonstrate procedure and requirements to install electrical metering units and or measuring instruments and control devices

Performance Criteria

- 1.1 Documentation is identified and or acquired.
- 1.2 Job instructions are interpreted and sequence of operation is determined.
- 1.3 Applicable circuit, wiring and mounting diagrams are selected.
- 1.4 Meter units and or instruments and control devices are selected.

Element 2: Plan to install and connect electrical metering units and or measuring instruments with their related control devices

Performance Criteria

- 2.1 Instruments and control devices specifications are verified according to job specifications.
- 2.2 Metering units and or measuring instruments and control devices are mounted or installed according to job specifications.
- 2.3 Metering units and or measuring instruments and control devices are connected according to respective circuit diagrams.
- 2.4 Safety, housekeeping and environmental practices are followed before, during and after task.

Element 3: Maintain electrical metering units and or measuring instruments

Performance Criteria

- 3.1 Relevant maintenance procedures are carried out to ensure compliance to statutory and or workplace specifications.
- 3.2 Visual faults are identified and repaired to ensure compliance.
- 3.3 Actual and expected readings are compared for analysis and discrepancies reported or rectified.
- 3.4 Metering units and or measuring instruments are sealed according to specifications.

Element 4: Complete work activity

Performance Criteria

- 4.1 Work area is cleared in accordance with specifications and or workplace requirements.
- 4.2 Tools and equipment are stored in accordance with workplace practice and or manufacturer's specifications.
- 4.3 Waste materials are disposed of as per workplace procedures, statutory requirements and environmental standards.
- 4.4 Documentation is completed in detail and submitted to meet worksite standards and procedures.

Registration Data

Date first registered	2022
Anticipated review	2027
Standard setting body (SSB)	Directorate of Industrial and Vocational Training (DIVT)
Body responsible for review	Directorate of Industrial and Vocational Training (DIVT)

EE312: Install, test and maintain single and three phase domestic and commercial installations

Title		Install, test and maintain single and three phase domestic and commercial installations			
Domain		Physical Planning and Construction			
Sub-field		Electrical Engineering Core			
SZNQF Level	3	Unit ID	EE312	Credits	10

Purpose

This unit standard specifies the competencies required to install, test and maintain single and three phase domestic and commercial installations. It includes, planning the electrical tests to be done, testing the electrical installation and complete the required tests and inspection documentation. This unit standard is for Electrician level 3.

Special Notes

1. Entry information/Prerequisite

EE301	Understand electrical and electronic theory and components.
EE304	Construct basic electrical and electronics circuits.
EE307	Install and maintain lighting system

- This unit standard is to be delivered and assessed in the context of electrical engineering and should be assessed in conjunction with other relevant technical unit standards selected from this domain.
- Assessment may be conducted at a real workplace or simulated workplace, or an appropriately realistic environment in which electrical utilisation, generation, transmission and distribution is carried out.
- Regulations and legislation relevant to this unit standard may include but not limited to the following:
 - Occupational Health and Safety Act 2001
 - Worker's Compensation Act No.7 of 1983
 - SZNS-SANS 10142-1and all subsequent amendments
- Statutory requirements include but not limited to current national regulations applicable to electrical utilisation, generation, transmission and distribution, including regulations; ordinances; bylaws; directives; standards; guidelines; and codes; issued by legislative body such as parliament, local authorities and other bodies so empowered by any of the former.
- Electrical drawing include but not limited to, schematic diagrams, wiring diagrams, connection and or terminal connections and cable schedule.

Quality Assurance Requirements

This unit standard and others within this subfield may be awarded by institutions which comply with the accreditation, national assessment and moderation requirements set by the Eswatini Higher Education Council.

Elements and Performance Criteria

Element 1: Plan and prepare for the electrical installation to be done

Performance Criteria

- 1.1 Job instructions are interpreted and sequence of operations is determined according to the installation environment and the required task.
- 1.2 Tools, equipment and instruments are selected to meet the requirements of the task according to statutory and environmental requirements.
- 1.3 The documentation necessary to complete the task is obtained as per data management requirements.
- 1.4 Safety rules and regulations are followed as per statutory requirements and safe working procedures.
- 1.5 Environmental hazards and safety risks are identified according to environmental standards and safety risks analysis.

Element 2: Carrying out electrical installation

Performance Criteria

- 2.1 Hazard Identification and Risk Assessment (HIRA) is carried out
- 2.2 Components are assembled as per the given task
- 2.3 Statutory regulations and standards adhered to.
- 2.4 Integrity of connections is checked/verified

Element 3: Perform electrical tests on the installation

Performance Criteria

- 3.1 Installation is tested as per statutory requirements from SZNS SANS 10142 code.
- 3.2 Documentation is completed as per data management requirements.
- 3.3 Test instruments are used to obtain readings in accordance with statutory requirements.

- 3.4 Measurements obtained from the test are interpreted as per SZNS SANS 10142 requirements.
- 3.5 All safety precautions are observed and demonstrated during the test as per safe work procedures.

Element 4: Maintain electrical installations

Performance Criteria

- 4.1 All safety requirements are observed and demonstrated during maintenance as per safe working procedures.
- 4.2 All maintenance activities are carried according to specific procedures

Element 5: Complete the required task documentation

Performance Criteria

- 5.1 All personnel, tools, Instruments and excess equipment are removed from the installation according to work site procedures.
- 5.2 The work area is restored to its original condition on completion of the test and inspection procedures as per safety requirements.
- 5.3 The certificate of compliance completed according to SZNS SANS 10142 requirement.
- 5.4 The results of the inspection and test are communicated to all concerned according to reporting procedures.
- 5.5 A defect list is compiled and corrective action taken, if necessary, as per quality requirements.

Registration Data

Date first registered	2022
Anticipated review	2027
Standard setting body (SSB)	Directorate of Industrial and Vocational Training (DIVT)
Body responsible for review	Directorate of Industrial and Vocational Training (DIVT)

EE1210: Carry out basic gas welding, brazing and cutting in an instrumentation environment

Title		Carry out basic gas welding, brazing and cutting in an instrumentation environment			
Field		Physical Planning and Construction			
Subfield		Mechanical Engineering			
SZNQF Level	2	Unit ID	EEI210	Credits	5

Purpose

This unit standard specifies the competencies required to prepare for gas welding, brazing or cutting; describe and demonstrate down hand gas welding and brazing techniques for different metals and also for the gas cutting process for mild steel. This unit standard is intended for persons in Instrumentation Level 2.

Special Notes

1. Entry information/Prerequisite

None

2. Assessment may be conducted at a real or simulated workplace.
3. This unit standard may be used as core or elective within any vocationally based qualification.
4. Evidence of competence may be gathered while learner undertaking their study or work.
5. Regulations and legislation relevant to this unit standard include the following
 - Competition Act 2007
 - Labour Act 2005
 - Workmen's Compensation Act No.7 of 1983
 - Occupational Health and Safety (OHS) Act 2001
 - Environmental Management Act 2002

And all subsequent amendments

6. Gas welding, brazing and cutting includes the use of oxygen/acetylene equipment only and the gas welding is limited to maximum thickness of 3mm for butt-welds on mild steel, 5mm maximum

thickness for butt and lap welds on copper. Brazing is limited to mild steel only with maximum thickness of 3mm and gas cutting is limited to mild steel of 5mm maximum thickness.

7. Gas welding, brazing and cutting equipment includes but not limited to: oxygen and acetylene gas cylinders and keys, gas regulators and flashback arrestors, rubber gas hoses and clamps, gas brazing, welding and cutting torches and nozzles, nozzle cleaning equipment and gas lighter.
8. Related materials include but not limited to gas welding and brazing filler materials, flux and metal surface cleaning materials.
9. Safety precautions include the use of all appropriate personal protective equipment (gas welding goggles, leather aprons, gloves, boot protectors, overalls etc.), electrical and fire protection.

Quality Assurance Requirements

This unit standard and others within this subfield may be awarded by institutions which comply with the accreditation, national assessment and moderation requirements set by the Eswatini Qualifications Authority.

Element 1: Prepare for gas welding, brazing or cutting

Performance Criteria

- 1.1 The applicable safety equipment is obtained and inspected as per safe work procedures and statutory requirements.
- 1.2 The gas welding, brazing or cutting equipment and related materials are identified and each item's function described with reference to their inter-relationships.
- 1.3 The gas welding, brazing or cutting equipment is set up and checked for gas leaks and correct cylinder pressures according to safe work procedures and industry requirements.
- 1.4 The relevant gas welding, brazing or cutting equipment materials required for the task is ensured to be ready and available, and rods, flux and nozzles are selected to match the application.
- 1.5 The gas cylinders are handled safely as per safe work procedures and industry requirements.
- 1.6 Safety and proper workplace practices are maintained at all times.

Element 2: Apply basic gas welding techniques

Performance Criteria

- 2.1 The appropriate personal protective equipment is worn throughout the operation as per safe work procedure.

- 2.2 The oxygen and acetylene gas pressures on the regulators are correctly set for gas welding according to application requirements.
- 2.3 The gas torch is lit up in the correct sequence and the gas mixture set as per safe work procedure and industry requirement.
- 2.4 The joining of metals by mean of basic gas welding is carried out and the correct nozzle positioning, movement and puddling are demonstrated according to application requirement.
- 2.5 Safety and proper workshop practices are maintained at all times.

Element 3: Describe and demonstrate the brazing process

Performance Criteria

- 3.1 The appropriate personal protective equipment is worn throughout the operation as per safe work procedure.
- 3.2 The metal surface to be brazed is prepared according to application requirement.
- 3.3 Brazing rods and fluxes are selected correctly for the particular application.
- 3.4 The brazing nozzle is correctly selected and attached to the torch according to job specific requirements.
- 3.5 The gas torch is lit up in the correct sequence and the gas mixture set as per safe work procedure and industry requirement.
- 3.6 The brazing of metals is carried out and nozzle positioning, movement and puddling are demonstrated according to application requirement.
- 3.7 Safety and proper workshop practices are maintained at all times.

Element 4: Apply basic cutting process

Performance Criteria

- 4.1 The appropriate personal protective equipment is worn throughout the operation as per safe work procedure.
- 4.2 The oxygen and acetylene gas pressures on the regulators are correctly set for gas cutting according to application requirements.
- 4.3 The gas cutting torch is lit up in the correct sequence and the gas mixture set as per safe work procedure and industry requirement.
- 4.4 The metal is cut with the gas cutting torch and nozzle positioning and movement is demonstrated according to application requirement.
- 4.5 Safety and proper workshop practices are maintained at all times.
- 4.6 The procedure for shutting down oxygen and acetylene on the torch and cylinder is demonstrated according to safe work procedures and industry requirements.

Element 5: Inspect brazed work piece

Performance Criteria

- 5.1 All residues, brazing flux removed as specified in cleaning procedure.
- 5.2 Brazed workpiece conforms to specifications as reflected on drawing.
- 5.3 Safety precautions adhered to in accordance with OHS Act.

Element 6: Complete the task

Performance criteria

- 6.1 Hot metal surfaces are allowed to cool down as per safe work procedures.
- 6.2 Gas cylinder valves are closed and gauge pressure in the hoses released as per safe work procedure.
- 6.3 Gas welding, brazing or cutting equipment and materials are correctly stored as per applicable safety standards.
- 6.4 Tools, equipment, and materials are accounted for and returned to storage in accordance with workplace procedures.
- 6.5 Waste materials and left over parts are disposed of or processed in accordance with workplace procedures.

Registration Data

Date first registered	2024
Anticipated review	2029
Standard setting body (SSB)	Directorate of Industrial and Vocational Training (DIVT)
Body responsible for review	Directorate of Industrial and Vocational Training (DIVT)

MEW209: Weld carbon steel work-pieces using the shielded metal arc welding process in all positions

Title		Weld carbon steel work-pieces using the shielded metal arc welding process in all positions			
Domain		Engineering, Manufacturing and Construction			
Subfield		Mechanics and Metal Trades			
SZNQF Level	2	Unit ID	MEW 209	Credits	4

Purpose

This unit standard specifies the competencies required to describe the shielded metal arc welding process, select, assemble and conduct pre-operational checks, prepare workpiece and further conduct inspection for welding defects. This unit standard is for Welding and Fabrication Level 2.

Special Notes

1. Entry information/Prerequisite

ME201: Apply and maintain safety rules and regulations

ME202: Communicate in welding and fabrication environment

ME203: Use basic welding definitions and symbols

ME210: Draw and interpret simple plate, pipe and structural steel plate drawings

ME211: Use and maintain hand and power tools in welding and fabrication operations

2. This unit standard is to be delivered and assessed in the context of the welding field and should be assessed in conjunction with other relevant technical unit standards selected from this domain.
3. Assessment may be conducted at a real workplace or simulated workplace, or an appropriately realistic environment in which welding and fabrication is carried out.
4. Regulations and legislation relevant to this unit standard may include but not limited to the following:
 - Workers' Compensation Act No.7 of 1983
 - Occupational Health and Safety Act 2001
 - Environmental Management Act 2002and all subsequent amendments
5. Welding equipment may include but no limited to constant voltage power source, earth clamp, welding cable and welding consumables.
6. The material type to be used may be chosen from the range of carbon steels (plate only), applicable to the material groups 1, 2, 3 or 11 [according to ISO (TR) 15608] and the material thickness range is 3-6mm.

7. Tools, equipment, safety requirements in relation to job requirements.
8. The cause for welding defects may include but not limited to heat input, electrode manipulation, electrode size, joint preparation, welding technique, consumable handling.
9. The welding positions include flat/horizontal, vertical and overhead (fillet and groove welding).

Quality Assurance Requirements

This unit standard and others within this subfield may be awarded by institutions which comply with the accreditation, national assessment and moderation requirements set by the Eswatini Qualification Authority.

Elements and Performance Criteria

Element 1: Describe the shielded metal arc welding process

Performance Criteria

- 1.7 The importance of correct assembly of the shielded metal arc welding equipment, and the consequences of incorrect assembly, are explained with reference to the manufacturer requirements.
- 1.8 Basic and major components of the shielded metal arc welding equipment are identified and the explanation of function and purpose is correct in terms of manufacturer's requirements and standards.
- 1.9 Terms and definitions used are consistent with generally accepted welding terminology as recorded in international welding standards.
- 1.10 Safety precautions in accordance to the OHS Act is explained.

Element 2: Select, set up and conduct pre-operational checks of shielded metal arc welding equipment.

Performance Criteria

- 2.1 Verification of identification and selection of shielded metal arc welding equipment as specified on welding procedure specification.
- 2.2 Identification and rectification of hazards relating to welding process in accordance with standard work site practices.
- 2.3 Equipment is assembled and pre-operational checks are carried out in accordance with manufacturer's specifications.

Element 3: Prepare work pieces prior to welding

Performance Criteria

- 1.1 The applicable safety equipment is obtained and inspected as per safe work procedures and statutory requirements.
- 1.2 Workpieces prepared prior to welding as specified on drawing and worksite procedures.
- 1.3 Dimensions and alignment checked as specified on drawing.
- 1.4 Workpiece tack welded in position as per drawing specifications.
- 1.5 Inspect workpiece prior to welding.

Element 4: Weld workpieces

Performance Criteria

- 4.1 Welding electrodes selected as specified on welding procedure specification.
- 4.2 Workpiece welded in position as per job requirement.
- 4.3 Workpiece cleaned after welding as per worksite practices.

Element 5: Inspect welded workpiece for defects in compliance with drawing specifications

Performance Criteria

- 5.1 All residues slag and spatter removed as specified in cleaning procedure.
- 5.2 Welded workpiece conforms to job specifications.
- 5.3 Inspection methods and procedures selected are conducive to specifications.
- 5.4 Documentation completed as reflected in worksite practices.

Element 6: Complete the task

Performance Criteria

- 6.1 Hot metal surfaces are allowed to cool down as per safe work procedures.
- 6.2 Tools and equipment cared for as per manufacturer's specifications and stored as per worksite practices.
- 6.3 Welding consumables stored in accordance to manufacturer's specifications and worksite practices.
- 6.4 Waste materials and left over parts are disposed of or processed in accordance with workplace procedures.

Registration Data

Date first registered	2024
Anticipated review	2029
Standard setting body (SSB)	Directorate of Industrial and Vocational Training (DIVT)
Body responsible for review	Directorate of Industrial and Vocational Training (DIVT)

PVI300: Work at heights

Title		Work at heights			
Domain		Engineering, Manufacturing and Construction			
Subfield		Electrical Engineering			
SZNQF Level	3	Unit ID	PVI 300	Credits	4

Purpose

This unit specifies the competencies required to perform work in elevated positions, inspect, care and store fall arrest equipment and apply health and safety principles in working at heights. This unit standard is for Solar PV Installation Level 3.

Special Notes

1. Entry information/Prerequisite
None
2. This unit standard is to be delivered and assessed in the context of the Solar PV Installation field and should be assessed in conjunction with other relevant technical unit standards selected from this domain.
3. Assessment may be conducted at a real workplace or an appropriately realistic environment in which solar PV installation and maintenance is carried out.
4. Regulations and legislation relevant to this unit standard may include but not limited to the following:
 - Workers' Compensation Act No.7 of 1983
 - SANS 10111
 - Occupational Health and Safety Act 2001and all subsequent amendments
5. Elevated surfaces include but not limited to rooftops and surfaces 1.8m above ground level or below working surface.

Quality Assurance Requirements

This unit standard and others within this subfield may be awarded by institutions which comply with the accreditation, national assessment and moderation requirements set by the Eswatini Higher Education Council.

Elements and Performance Criteria

Element 1: Describe the requirements to safely perform work in elevated positions

Performance Criteria

- 1.1 Hazard Identification and risk assessment is carried out.
- 1.2 The requirements to perform work in elevated positions are explained.
- 1.3 The planning process to prepare for work in elevated positions is explained.
- 1.4 The method used to conduct work in elevated positions is explained.

Element 2: Describe the requirements to correctly inspect, care for and store fall arrest equipment

Performance Criteria

- 2.1 The inspection, care and storage of fall arrest equipment and the necessary replacement of faulty equipment is explained.
- 2.2 The need to ensure correct and meticulous record keeping is explained.

Element 3: Describe the safety, health and environmental principles with regards to working platforms, ladders, scaffolds and walkways in elevated positions

Performance Criteria

- 3.1 Knowledge and understanding pertaining to the inspection of working platforms, ladders, scaffolds and walkways in elevated positions is demonstrated.
- 3.2 The procedure required to report in terms of identified deviation from standards is described.
- 3.3 The need to ensure correct record keeping is explained.
- 3.4 The procedure for following up identified deviations is described.

Registration Data

Date first registered	2025
Anticipated review	2030
Standard setting body (SSB)	Directorate of Industrial and Vocational Training (DIVT)
Body responsible for review	Directorate of Industrial and Vocational Training (DIVT)

PVI301: Mount Solar Water Heating Systems

Title		Mount Solar Water Heating Systems			
Domain		Physical Planning and Construction			
Sub-field		Electrical Engineering			
SZNQF Level	3	Unit ID	PVI 301	Credits	10

Purpose

This unit standard specifies the competencies required to explain the theory regarding solar water heating systems, demonstrate and apply knowledge of roof trusses in order to complete installation of solar water heating systems; plan, prepare and install solar water heating systems. This unit standard is for Solar PV Installation and Maintenance Level 3.

Special Notes

1. Entry Requirement/Pre-requisites

None

2. Assessment may be conducted at a real workplace or simulated workplace, or an appropriately realistic environment in which Solar PV installation and maintenance is carried out.
3. Regulations and legislation relevant to this unit standard may include but not limited to the following:
 - Occupational Health and Safety Act 2001
 - Worker's Compensation Act No.7 of 1983
 - Building Operations Regulations of 1969
 - SZNS-SANS 10142
 - SZNS-SANS 10400and all subsequent amendments
4. Solar water heating systems include but are not limited to solar geyser (evacuated tubes, and flat plate), copper pipes, gate valves, control valves etc.

Quality Assurance Requirements

This unit standard and others within this subfield may be awarded by institutions which comply with the accreditation, national assessment and moderation requirements set by the Eswatini Qualification Authority.

Elements and Performance Criteria

Element 1: Demonstrate the knowledge regarding solar heating water systems

Performance Criteria

- 1.1 The basic installation criteria are explained to or in order to ensure that installation is according to manufacturer's instructions and specification.
- 1.2 The dangers of solar heating are explained so that special care is taken during installation to limit exposure.
- 1.3 The aspects pertaining to the various solar water heating configurations are explained to determine impact on installation.
- 1.4 Problems regarding the solar water heating system are identified and reported to plumber or supervisor.

Element 2: Demonstrate and apply knowledge of roof trusses in order to complete installation of solar water heating system

Performance Criteria

- 2.1 Specified dimensions are accurately understood from plumber instructions according to regulations.
- 2.2 Carpentry tools, machines and equipment are identified, checked for functionality and used according to their requirements.
- 2.3 Preparation of trusses is explained and implemented according to the relevant instructions and drawings
- 2.4 Work on roof in preparation for the installation of Solar heating system is explained and performed according to the relevant instructions.
- 2.5 National Building Regulations and relevant regional building regulations are explained and applied in order to ensure compliance.

Element 3: Plan, prepare and install solar water heating system

Performance Criteria

- 3.1 Appropriate hand and power tools and equipment are identified, selected and used according to manufacturer's specifications.
- 3.2 Personal protective equipment is selected according to the work functions to be performed and worn in accordance with manufacturer's recommendations.
- 3.3 The location, orientation and positioning of solar heating components are completed as per instructions and procedure.

- 3.4 Solar water heating systems' components are assembled as per procedure.
- 3.5 Solar heating systems are installed for a variety of roof types.
- 3.6 The heat transfer fluids in solar collectors and cylinder heat exchangers are checked against manufacture's specifications.
- 3.7 The controls are installed, set and programmed to ensure efficient operation.
- 3.8 Solar water heating systems are pressure tested according to specifications.
- 3.9 Site instructions are complied with to ensure that installation is completed safely and to the client's satisfaction.

Registration Data

Date first registered	2025
Anticipated review	2030
Standard setting body (SSB)	Directorate of Industrial and Vocational Training (DIVT)
Body responsible for review	Directorate of Industrial and Vocational Training (DIVT)

PVI302: Mount Solar PV Systems

Title		Mount Solar PV Systems			
Domain		Physical Planning and Construction			
Sub-field		Electrical Engineering			
SZNQF Level	3	Unit ID	PVI 302	Credits	6

Purpose

This unit standard specifies the competencies required to be able to demonstrate knowledge of photovoltaic arrays mounting requirements. This unit standard is for Solar PV Installation Level 3.

Special Notes

1. Entry Requirement/Pre-requisites

None

2. Assessment may be conducted at a real workplace or an appropriately realistic environment in which Solar PV installation and maintenance is carried out.

3. Regulations and legislation relevant to this unit standard may include but not limited to the following:

- Occupational Health and Safety Act 2001
- Worker's Compensation Act No.7 of 1983
- SZNS-SANS 10142
- SZNS-SANS 10400
- SZNS-SANS 10252
- SZNS-SANS 10254
- SZNS AS/NZS 1170.2
- Environmental Management Act 2002

and all subsequent amendments.

4. Solar PV System may include but not limited to PV arrays, frames, cabling, combiner box, AC/DC inverter, isolators etc.

5. Mounting Solar PV panels may include but not limited to mounting PV panels on rooftop and ground-mounted.

Quality Assurance Requirements

This unit standard and others within this subfield may be awarded by institutions which comply with the accreditation, national assessment and moderation requirements set by the Eswatini Qualification Authority.

Elements and Performance Criteria

Element 1: Demonstrate knowledge of photovoltaic arrays mounting requirements

Performance Criteria

- 1.1 State safe methods for working on roofs and other elevated locations and outline OSH requirements.
- 1.2 Describe common methods of roof construction.
- 1.3 Describe waterproofing methods that ensure roof waterproofing integrity.
- 1.4 Describe common types of roof-mounted and ground-mounted PV array frame construction and methods of tilt angle adjustment.
- 1.5 Describe methods for attaching PV array frames to different roof types.
- 1.6 Describe array mounting methods for non-optimal facing roof sections.

Element 2: Plan, prepare and mount photovoltaic arrays

Performance Criteria

- 2.1 Determine required fixing points for a commercial mounting system using tables as per relevant standards.
- 2.2 Outline aesthetic considerations in choosing an array location and type of mounting.
- 2.3 Outline mounting and fixing methods for at least one type of commercially available building integrated PV product.
- 2.4 Determine safe perimeter zone and roof internal zone from roof dimensions for a commercial mounting system.
- 2.5 Describe methods for mitigating harmful effects of PV array frames on roof structures and water run-off capture.
- 2.6 Describe the relationship between mounting arrangements and PV array operating conditions.
- 2.7 Solar PV systems' components are assembled as per manufacturer's manual.
- 2.8 Solar PV systems are installed for a variety of roof types as per manufacturer's specification.

Registration Data

Date first registered	2025
Anticipated review	2030
Standard setting body (SSB)	Directorate of Industrial and Vocational Training (DIVT)
Body responsible for review	Directorate of Industrial and Vocational Training (DIVT)

PVI303: Install and maintain single phase photovoltaic system

Title		Install and maintain single phase photovoltaic system			
Domain		Physical Planning and Construction			
Sub-field		Electrical Engineering			
SZNQF Level	3	Unit ID	PVI 303	Credits	4

Purpose

This unit standard specifies the competencies required to install, maintain and repair photovoltaic supply system. It includes, planning to maintain a photovoltaic supplied system, preparing to maintain a photovoltaic supplied system, finding and repairing faults on a photovoltaic supplied system, maintaining a photovoltaic supplied system and completing the work. This unit standard is for Solar PV Installer level 3.

Special Notes

1. Entry Requirements/Pre-requisites
None
2. This unit standard is to be delivered and assessed in the context of the Engineering and should be assessed in conjunction with other relevant technical unit standards selected from this domain.
3. Assessment may be conducted at a real workplace or simulated workplace, or an appropriately realistic environment in which electrical transmission is carried out.
4. Regulations and legislation relevant to this unit standard may include but not limited to the following:
 - i. Occupational Health and Safety Act 2001
 - ii. Worker's Compensation Act No.7 of 1983
 - iii. SZNS-SANS 10142-1and all subsequent amendments
5. Statutory requirements include but not limited to current national regulations applicable to transmission, including regulations; ordinances; bylaws; directives; standards; guidelines; and codes; issued by legislative body such as parliament, local authorities and other bodies so empowered by any of the former.
6. Electrical drawings include but not limited to, schematic diagrams, wiring diagrams, connection and or terminal connections, cable schedule, layout buildings and floor and or building plans.
7. Photovoltaic system may include but not limited to arrays, inverters, cables etc.
8. Maintenance of PV system may include but not limited to replacing panels, inverter unit and fuses, fastening bolts.
9. Tools include but not limited to gripping, cutting, turning, striking and power tools.

10. Electrical testing instruments include but are not limited to, multimeter, insulation tester, earth leakage tester, impedance tester and polarity tester.

Quality Assurance Requirements

This unit standard and others within this subfield may be awarded by institutions which comply with the accreditation, national assessment and moderation requirements set by the Eswatini Higher Education Council.

Elements and Performance Criteria

Element 1: Install photovoltaic systems

Performance Criteria

- 1.1 Job instructions are obtained and the sequence of the task is planned in accordance with accepted worksite procedures.
- 1.2 Test and measuring instruments equipment, hand tools and material are selected and examined according to task and worksite procedures.
- 1.3 Safety procedures are followed as per statutory requirements.
- 1.4 The required personal protective equipment is selected, examined and used in a manner that protects the individual in accordance with workplace procedures.
- 1.5 Hazardous and associated risks directly related to the installation of photovoltaic systems are identified and addressed in accordance with specifications and work site requirements.
- 1.6 Photovoltaic components are confirmed and tested according to statutory requirements.
- 1.7 Photovoltaic systems are installed according to worksite procedures and statutory requirements.

Element 2: Prepare to maintain a photovoltaic supplied system

Performance Criteria

- 2.1 Electrical layout and wiring diagrams are obtained as per job instructions.
- 2.2 Isolation points of industrial electrical circuits are identified as per circuit diagrams.
- 2.3 Isolation is carried out safely as per worksite procedures.
- 2.4 Safe isolation of electrical circuits verified against job instructions and safe worksite procedures.
- 2.5 Safety and or security lockout systems applied according to worksite procedures and safety practices.
- 2.6 Warning signs are displayed as per worksite procedures.

Element 3: Maintain a photovoltaic system

Performance Criteria

- 3.1 Safety equipment is selected and used according to statutory requirements.
- 3.2 Testing instruments, tools, drawings, equipment, materials and components are selected according to job and statutory requirements.
- 3.3 Photovoltaic systems are correctly identified and selected according to schedule or work instruction.

- 3.4 Photovoltaic systems are safely maintained according to statutory requirements to prevent breakdowns and loss of operation or service.

Element 4: Complete the work

Performance Criteria

- 3.1 Work area is cleaned on completion of the task according to housekeeping requirements.
- 3.2 Waste materials disposed of according to site specific standards, procedures and environmental policies.
- 3.3 Photovoltaic systems are re-commissioned on completion of task as per worksite procedures.
- 3.4 Quality checks conducted and corrective action taken where required as per worksite procedures.
- 3.5 Lockout devices and warning signs are removed.
- 3.6 Job cards and or work orders and check sheets are completed and maintenance reports submitted as per worksite procedures

Registration Data

Date first registered	2025
Anticipated review	2030
Standard setting body (SSB)	Directorate of Industrial and Vocational Training (DIVT)
Body responsible for review	Directorate of Industrial and Vocational Training (DIVT)

PVI304: Install and maintain batteries

Title		Install and maintain batteries			
Domain		Physical Planning and Construction			
Sub-field		Electrical Engineering			
SZNQF Level	3	Unit ID	PVI 304	Credits	4

Purpose

This unit standard specifies the competencies required to planning the work task, preparing work area, installing, maintaining batteries and completing the work. This unit standard is for Solar PV installer level 3.

Special Notes

1. Entry Requirements/Pre-requisites.

None

2. This unit standard is to be delivered and assessed in the context of the Engineering and should be assessed in conjunction with other relevant technical unit standards selected from this domain.
3. Assessment may be conducted at a real workplace or simulated workplace, or an appropriately realistic environment in which electrical generation, distribution and transmission is carried out.
4. Regulations and legislation relevant to this unit standard may include but not limited to the following:
 - Occupational Health and Safety Act 2001
 - Worker's Compensation Act No.7 of 1983
 - SANS-SANS 10142-1
 - and all subsequent amendments
5. Statutory requirements include but not limited to current national regulations applicable to utilization, generation, transmission and distribution, including regulations; ordinances; bylaws; directives; standards; guidelines; and codes; issued by legislative body such as parliament, local authorities and other bodies so empowered by any of the former.
6. Batteries may include, but not limited to primary cells, secondary cells for stationary and mobile installations.
7. Safety requirements may include, but not limited to eye wash bowl, safety shower, first aid kit, running water, lighting and antistatic precautionary methods, symbolic safety signs and ensuring ventilation.
8. Defects may include but not limited to cracks, leaks, inoperative cell and loose terminals.

Quality Assurance Requirements

This unit standard and others within this subfield may be awarded by institutions which comply with the accreditation, national assessment and moderation requirements set by the Eswatini Higher Education Council.

Elements and Performance Criteria

Element 1: Plan work task

Performance Criteria

- 1.1 Job instructions are interpreted and sequence of operation is determined according to standard worksite procedures.
- 1.2 Tools, equipment and materials are selected and checked to meet the requirement of the task.
- 1.3 Mechanical aids and handling equipment are obtained according to the job requirement.
- 1.4 Drawing and documentations are acquired in accordance with job requirement.
- 1.5 Personal protective equipment is selected in accordance with worksite procedures.
- 1.6 Battery is selected as per work instructions.
- 1.7 Affected parties are informed as per reporting procedures.

Element 2: Prepare work area

Performance Criteria

- 2.1 Work area is inspected and prepared according to statutory requirements.
- 2.2 Authorisation is obtained according to worksite procedures.
- 2.3 Safety of working area is ensured according to statutory requirements.
- 2.4 Personal protective equipment is used according to statutory requirement.

Element 3: Install and maintain batteries

Performance Criteria

- Batteries and fixtures are positioned and secured in accordance with job instructions, specifications and statutory requirements.
- Battery cells are filled with electrolyte in accordance with manufacturer's specifications.

- Work is performed in accordance with safe work procedures.
- Battery condition is checked for defects according to maintenance procedures.
- Defective batteries or cells are reported and recorded, when necessary, according to worksite standards.

Element 4: Complete work

Performance Criteria

- 4.1 Work area is restored to serviceable condition as per statutory requirements.
- 4.2 Report, documentation and drawings are completed and returned according to worksite procedures.
- 4.3 Completion of task is reported according to worksite procedures.
- 4.4 Surplus materials are stored safely as per worksite procedures.
- 4.5 Disposal of scrap materials is disposed as per environmental requirement.

Registration Data

Date first registered	2025
Anticipated review	2030
Standard setting body (SSB)	Directorate of Industrial and Vocational Training (DIVT)
Body responsible for review	Directorate of Industrial and Vocational Training (DIVT)

PVI305: Demonstrate and apply basic knowledge of data communications and logging for renewable energy systems

Title		Demonstrate and apply basic knowledge of data communications and logging for renewable energy systems			
Domain		Physical Planning and Construction			
Sub-field		Electrical Engineering			
SZNQF Level	3	Unit ID	PVI 305	Credits	5

Purpose

This unit standard specifies the competencies required to demonstrate knowledge of set up and use data communication links between a computer and an electronic device in a renewable energy system; and set up and operate a simple data-logging system. This unit standard is for Solar PV Installation Level 3.

Special Notes

1. Entry Requirement/Pre-requisites

None

2. Assessment may be conducted at a real workplace or an appropriately realistic environment in which Solar PV Installation is carried out.

3. Regulations and legislation relevant to this unit standard may include but not limited to the following:

- Occupational Health and Safety Act 2001
- Worker's Compensation Act No.7 of 1983
- SZNS-SANS 10142
- SZNS-SANS 10400
- SZNS-SANS 10252
- SZNS-SANS 10254

and all subsequent amendments

4. Definitions

d.c. – direct current

a.c. – alternating current

RES – renewable energy source

5. The data-logging system may include but is not limited to - on-site, remote, monitoring, control, display, interpretation.

6. The range for remote access and control of the device connected to RES include but not limited to: connections – directly, via dial-up modems and telephone network. Electronic devices may include but not limited to –

charge controller, battery monitors, grid connected inverter, dc/ac instrumentation, temperature monitor, humidity monitor, pressure monitor, wind speed monitor, solar radiation monitor, water flow monitor.

Quality Assurance Requirements

This unit standard and others within this subfield may be awarded by institutions which comply with the accreditation, national assessment and moderation requirements set by the Eswatini Qualification Authority.

Elements and Performance Criteria

Element 1: Demonstrate knowledge of and set up and use data communication links between a computer and an electronic device in a renewable energy system

Performance Criteria

- 1.1 Describe common applications of data communications in renewable energy systems.
- 1.2 Describe the functions of types of cables and connectors used in data communications between electronic devices and computers used in renewable energy systems.
Range: three types of cables and connectors
- 1.3 Describe protocols used for serial data communications.
- 1.4 Identify communication ports on palmtop, laptop or desktop computers and describe their functions.
- 1.5 Connect a computer to a remote electronic device connected to a renewable energy system for access and control of the device.
- 1.6 Use a standard terminal programme or proprietary communications software to communicate with an electronic device.
- 1.7 Program and retrieve data from an interactive inverter via a computer and data communications link.
- 1.8 Process, display, and interpret logged data downloaded from an interactive inverter.

Element 2: Set up and operate a simple data-logging system

Performance Criteria

- 2.1 Describe general features and operation of on-site and remote data logging system for monitoring and control of a renewable energy system.
- 2.2 Set up and conduct a simple data logging project including logger programming, data downloading, data display, and interpretation of the results.

Registration Data

Date first registered	2025
Anticipated review	2030
Standard setting body (SSB)	Directorate of Industrial and Vocational Training (DIVT)
Body responsible for review	Directorate of Industrial and Vocational Training (DIVT)

PVI306: Demonstrate knowledge of photovoltaic technology

Title		Demonstrate knowledge of photovoltaic technology			
Domain		Physical Planning and Construction			
Sub-field		Electrical Engineering Core			
SZNQF Level	3	Unit ID	PVI306	Credits	10

Purpose

This unit standard specifies the competencies required to demonstrate knowledge of the photovoltaic effect, PV cell technologies, PV characterisation, methods of determining the irradiation falling on the plane of a collector in a PV array and how the operating point, power and daily energy output of a PV array is determined under a given set of operating and environmental conditions. This unit standard is for Solar PV Installer Level 3.

Special Notes

1. Entry Requirement/Pre-requisites
None
2. Assessment may be conducted at a real workplace or simulated workplace, or an appropriately realistic environment in which electrical utilisation, generation, transmission and distribution is carried out.
3. Regulations and legislation relevant to this unit standard may include but not limited to the following:
 - Occupational Health and Safety Act 2001
 - Worker's Compensation Act No.7 of 1983
 - SZNS-SANS 10142-1
 - SZNS AS/NZS 4509.2and all subsequent amendments
5. The description of a collector in a PV array is limited to: fixed collector, single-axis tracking collector, double-axis tracking collector
6. PV Cell technologies may include, but not limited to mono-crystalline silicon, multi-crystalline silicon, amorphous silicon, CIGS, single junction, multi-junction.
7. Definitions:
CIGS -. Copper indium gallium selenide
PV – photovoltaic
NOCT – nominal operating cell temperature
STC- Standard Testing Condition
MPPT – maximum power point tracker
MPP – maximum power point

I-V curves – a current-voltage (I-V) curve shows the possible combinations of current and voltage output of a photovoltaic (PV) device.

Quality Assurance Requirements

This unit standard and others within this subfield may be awarded by institutions which comply with the accreditation, national assessment and moderation requirements set by the Eswatini Qualifications Authority.

Elements and Performance Criteria

Element 1: Demonstrate knowledge of the photovoltaic effect

Performance Criteria

- 1.1 Define the term 'photovoltaic effect.
- 1.2 Explain the application of the photovoltaic effect in practical devices.

Element 2: Demonstrate knowledge of PV cell technologies

Performance Criteria

- 2.1 Compare the suitability of commercially available PV cell technologies for different applications.
- 2.2 Describe manufacturing technologies of commercially available PV cell technologies.

Element 3: Demonstrate knowledge of PV characterisation

Performance Criteria

1. Describe the parameters that characterize PV cell and module properties.
2. Define common energy output terms from PV arrays
3. Calculate the output of a PV module for a given temperature using NOCT and STC.
4. Compare the main cell technologies in terms of spectral response, temperature response, efficiency, cost and embodied energy.
5. Discuss the implications of efficiency of PV modules.

Element 4: Demonstrate knowledge of methods of determining the irradiation falling on the plane of a collector in a PV array

Performance Criteria

- 4.1 Define common solar irradiation terms.
- 4.2 Describe units of measurement and schematic symbols for irradiation and irradiance.
- 4.3 Interpret samples of solar irradiation data tables and contour maps.
- 4.4 Measure solar irradiance with a solarimeter.
- 4.5 Describe the variation of irradiation on the surface of a collector throughout the year.

- 4.6 Describe the use of field measurements and a sun path diagram to determine the times and dates when a PV array will be shaded by obstacles at a particular site.
- 4.7 Describe methods of calculating daily average irradiation on a horizontal plane.
- 4.8 Describe methods of calculating monthly mean daily irradiation falling on a PV array for each month of the year after adjustment for the effects of shading.
- 4.9 Describe how tilt angles are selected for fixed and seasonally-adjustable PV arrays at a given latitude.
- 4.10 Describe how tilt angles are selected to optimize for stand-alone or for grid-connected systems.

Element 5: Demonstrate knowledge of how the operating point, power and daily energy output of a PV array is determined under a given set of operating and environmental conditions

Performance Criteria

- 5.1. Describe the configuration of a PV cell with reference to the elements and terminal polarities.
- 5.2. Describe the effects of variations in irradiance and cell temperature on PV modules
- 5.3. Determine major ratings of a PV module from manufacturers' information or nameplate data.
- 5.4. Determine the operating point of a PV module with a resistive load, a constant voltage source, or any other load with known I-V characteristics, using the load line method.
- 5.5. Describe the configuration of a typical PV array, including the function, placement, and ratings of blocking and bypass diodes.
- 5.6. Describe the effect of partial shading of a PV module or array.
- 5.7. Describe the impact of bypass diodes and the significance of their configuration on output current in typical operating conditions.
- 5.8. Calculate the power at MPP, and the power under typical battery charging conditions of a PV module at given irradiance and ambient air temperature
- 5.9. Calculate daily energy output of a PV array in accordance with SZNS AS/NZS 4509.2, and by using “rule of thumb” de-rating factors.
- 5.10. Outline advantages and disadvantages of MPPT in water pumping applications and in battery charging applications.

Registration Data

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PVI307: Design single phase photovoltaic power systems

Title		Design single phase photovoltaic power systems			
Domain		Physical Planning and Construction			
Sub-field		Electrical Engineering			
SZNQF Level	4	Unit ID	PVI 307	Credits	10

Purpose

This unit standard specifies the competencies required to determine design requirements for a PV system, perform a site survey for a PV system and record findings, specify and design a stand-alone PV power system for residential or commercial premises, specify and design a residential grid connected PV system without battery storage; and specify and design a residential grid connected PV system with battery storage. This unit standard is for Solar PV Installation Level 4.

Special Notes

1. Entry Requirement/Pre-requisites

None

2. Assessment may be conducted at a real workplace or simulated workplace, or an appropriately realistic environment in which Solar PV Installation is carried out.

3. Regulations and legislation relevant to this unit standard may include but not limited to the following:

- Occupational Health and Safety Act 2001
- Worker's Compensation Act No.7 of 1983
- SZNS-SANS 10142
- SZNS-SANS 10400
- SZNS-SANS 10252
- SZNS-SANS 10254
- NRS 052

and all subsequent amendments

4. The range of ancillary components is limited to switchboard or distribution board, cabling, inverter (max 500V) or charge controller, regulator, array junction box, backup battery, backup generator cabling hardware, protection and isolation devices, electrical enclosures.
5. Load assessment include but not limited to total daily energy, maximum demand, surge demand, load management requirements.

Quality Assurance Requirements

This unit standard and others within this subfield may be awarded by institutions which comply with the accreditation, national assessment and moderation requirements set by the Eswatini Qualification Authority.

Elements and Performance Criteria

Element 1: Determine design requirements for a PV system

Performance Criteria

- 1.1 Describe factors that impact on the implementation of a PV system.
- 1.2 Determine system design requirements in consultation with client.
- 1.3 Assess end-user services and energy demand for each service.
- 1.4 Perform a detailed load assessment in accordance with Standards.
- 1.5 Establish load management and logging equipment requirements.
- 1.6 Produce load profiles from usage data for all electrical loads including expected variations to establish average and maximum demands.
- 1.7 Determine load management strategies and/or energy source switching options to reduce maximum and surge demand based on load profile analysis.

Element 2: Perform a site survey for a PV system and record findings

Performance Criteria

- 2.1 Estimate solar availability for the site.
- 2.2 Determine locations for monitoring panels or screens in accordance with the site owner's specification.
- 2.3 Determine suitability of the roof or other selected platform for mounting the array.
- 2.4 Determine the method for mounting PV modules.
- 2.5 Determine location of ancillary components.
- 2.6 Determine cabling routes and estimate cable lengths.

Element 3: Specify and design a stand-alone single phase PV power system for residential or commercial premises

Performance Criteria

- 3.1 Describe the operation of a stand-alone PV power system for residential or commercial premises.
- 3.2 Compare costs of a stand-alone PV system with other power supply options.
- 3.3 Perform a detailed load assessment consistent with Standards.
- 3.4 Calculate system voltage and main component sizes including minimum and maximum number of PV modules in a string for the specified voltage.

- 3.5 Determine the operating window of the inverter for the expected minimum and maximum effective cell temperatures.
- 3.6 Select and size an inverter rating with respect to the output power of the array.
- 3.7 Develop a system specification based on site and customer requirements.
- 3.8 Select a PV array that meets the design requirements in accordance with the specification and Standards.
- 3.9 Select ancillary components in accordance with the specification and Standards.
- 3.10 Select PV array mounting frame design and materials in accordance with the specification and Standards.
- 3.11 Design battery accommodation in accordance with the specification and Standards.
- 3.12 Produce a schematic diagram of the grid-connected inverter circuit configuration including metering arrangements, isolation and connection with respect to RCDs.
- 3.13 Perform energy calculations for the system.
- 3.14 Produce a design for the PV power system that uses a series or switched configuration in accordance with the specification and Standards.
- 3.15 Estimate the capital cost and running costs for the PV system.
- 3.16 Produce a manual for the PV system in accordance with Standards.
- 3.17 Produce an installation specification for a single-phase grid connected PV system.

Element 4: Specify and design a single-phase grid connected PV system without battery storage

Performance Criteria

- 4.1 Describe the operation of a grid connected PV power system without energy storage.
- 4.2 Compare costs of grid connected PV power system without energy storage with other power supply options.
- 4.3 Perform a detailed load assessment consistent with Standards.
- 4.4 Calculate system voltage and main component sizes including minimum and maximum number of PV modules in a string for the specified voltage.
- 4.5 Determine the operating window of the inverter for the expected minimum and maximum effective cell temperatures.
- 4.6 Select and size an inverter rating with respect to the output power of the array.
- 4.7 Develop a system specification based on site and customer requirements.
- 4.8 Select a PV array that meets the design requirements in accordance with the specification and Standards.
- 4.9 Select ancillary components in accordance with the specification and Standards.

- 4.10 Select PV array mounting frame design and materials in accordance with the specification and Standards.
- 4.11 Produce a schematic diagram of the grid-connected inverter circuit configuration including metering arrangements, isolation and connection with respect to RCDs.
- 4.12 Perform energy calculations for the system.
- 4.13 Produce a design for the PV power system that uses a series or switched configuration in accordance with the specification and Standards.
- 4.14 Estimate the capital cost and running costs for the PV system.
- 4.15 Produce a manual for the PV system in accordance with Standards.
- 4.16 Produce an installation specification for the single-phase grid connected PV system.

Element 5: Specify and design a grid connected PV system with battery storage

Performance Criteria

- 5.1. Describe the operation of a grid connected PV power system with energy storage.
- 5.2. Compare costs of grid connected PV power system with energy storage with other power supply options.
- 5.3. Perform a detailed load assessment consistent with Standards.
- 5.4. Calculate system voltage and main component sizes including minimum and maximum number of PV modules in a string for the specified voltage.
- 5.5. Determine the operating window of the inverter for the expected minimum and maximum effective cell temperatures.
- 5.6. Select and size an inverter rating with respect to the output power of the array.
- 5.7. Develop a system specification based on site and customer requirements.
- 5.8. Select a PV array that meets the design requirements in accordance with the specification and Standards.
- 5.9. Select ancillary components in accordance with the specification and Standards.
- 5.10. Select PV array mounting frame design and materials in accordance with the specification and Standards.
- 5.11. Design battery accommodation in accordance with the specification and Standards.
- 5.12. Produce a schematic diagram of the grid-connected inverter circuit configuration including metering arrangements, isolation and connection with respect to RCDs.
- 5.13. Perform energy calculations for the system.
- 5.14. Produce a design for the PV power system that uses a series or switched configuration in accordance with the specification and Standards.
- 5.15. Estimate the capital cost and running costs for the PV system.
- 5.16. Produce a manual for the PV system in accordance with Standards.
- 5.17. Produce an installation specification for the residential grid connected PV system with battery storage.

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