Australian Government

UEENEEK129A Design renewable energy (RE) heating systems

Release: 2

INDUSTRY SKILLS COUNCILS
Creating Australia's Future

UEENEEK129A Design renewable energy (RE) heating systems

Modification History

Not applicable.

Unit Descriptor

Unit Descriptor **1) Scope:**

1.1) Descriptor

This unit covers the design of renewable energy heating systems and their installation. It encompasses following design briefs, incorporating schemes for protection of persons and property from dangers of system malfunction, ensuring other safety and performance standards and functional requirements are meet and documenting design calculations and criteria.

Application of the Unit

Application of the Unit **2)**

This unit is intended for competency development entry-level employment-based programs incorporated in approved contracts of training. It applies to any formal recognition for this standard at the aligned AQF 5 level or higher.

Licensing/Regulatory Information

License to practice **3)**

The skills and knowledge described in this unit do not require a license to practice in the workplace. However, practice in this unit is subject to regulations directly related to occupational health and safety and contracts of training such as new apprenticeships.

Pre-Requisites

Prerequisite Unit(s) **4)**

Competencies **4.1)**

Granting competency in this unit shall be made only after competency in the following unit(s) has/have been confirmed.

UEENEEK128A	Solve problems in stand-alone renewable energy systems

Literacy and numeracy skills **4.2)**

Participants are best equipped to achieve competency in this unit if they have reading, writing and numeracy skills indicated by the following scales. Description of each scale is given in Volume 2, Part 3 'Literacy and Numeracy'

Reading	5	Writing	5	Numeracy	5

Employability Skills Information

Employability Skills **5)**

The required outcomes described in this unit of competency contain applicable facets of Employability Skills. The Employability Skills Summary of the qualification in which this unit of competency is packaged will assist in identifying Employability Skill requirements.

Elements and Performance Criteria Pre-Content

6) Elements describe the essential outcomes of a competency standard unit	Performance Criteria describe the required performance needed to demonstrate achievement of the element. Assessment of performance is to be consistent with the Evidence Guide.

Elements and Performance Criteria

ELEMENT	PERFORMANCE CRITERIA
1 Prepare to design renewable energy heating systems.	1.1 OHS procedures for a given work area are obtained and understood
	1.2 The extent and nature of the electrical installation is determined from design brief
	1.3 Safety and other regulatory requirements to which the electrical installation must comply are obtained and understood
	1.4 Design development work is planned to meet scheduled timelines in consultation with others persons involved in the installation or associated work
2 Develop renewable energy heating systems design.	2.1 Knowledge of renewable energy heating systems performance standards, compliance methods is applied to the design
	2.2 Alternative arrangements for the heating systems design are considered based on the requirements outlined in the design brief
	2.3 Safety, functional and budgetary considerations are incorporated in the design
	2.4 Heating systems design draft is checked for compliance with the design brief and regulatory requirements
	2.5 Heating systems design is documented for submission to appropriate persons for acceptance and approval
	2.6 Solutions to unplanned situation are provided consistent with organisation policy
3 Obtain approval for renewable energy heating systems design.	3.1 Heating systems design is presented and explained to client representative and/or other relevant persons
	3.2 Requests for alterations to the design are negotiated with relevant persons within the constraints of organisation policy

ELEMENT	PERFORMANCE CRITERIA
	3.3 Final design is documented and approval obtained from appropriate persons.
	3.4 Quality of work is monitored against personal performance agreement and/or established organisational or professional standards

Required Skills and Knowledge

REQUIRED SKILLS AND KNOWLEDGE

8) This describes the essential skills and knowledge and their level, required for this unit.

Evidence must show that knowledge has been acquired of safe working practices and designing renewable energy heating systems.

All knowledge and skills detailed in this unit should be contextualised to current industry practices and technologies.

KS01-EK129A Renewable energy heating - design

Evidence shall show an understanding of the design of renewable energy heating to an extent indicated by the following aspects:

T1 Heat transfer encompassing:

- Modes of heat transfer
- Conduction through a flat plate, series flat plates, thick and thin wall pipe, composite pipes (e.g. lagged pipes and drums)
- Convection at a flat surface or tube
- Radiation from a flat surface or tube for black or grey bodies
- Combined conduction and convection through single or multiple flat plates or thin wall tubes
- Combined convection and radiation
- Combined conduction, convection and radiation such as fluid in a tank (convection to wall), through wall and/or insulation (conduction) to outside air (convection and radiation)
- Heat exchangers - parallel, counter flow and cross flow

T2 Combustion and fuels encompassing:

REQUIRED SKILLS AND KNOWLEDGE

- The combustion process
- Fuels - desirable and undesirable characteristics, solid, liquid and gaseous types, their relative advantages and disadvantages and common methods of combustion
- Air/fuel ration - stoichiometric excess or insufficient air
- Emissions and pollutants and their control
- Combustion equations - element mass balance
- Combustion products - gravimetric basis

T3 Steam encompassing:

- Importance of steam for heat transfer and power production
- Steam/water properties and the inter-relationship between the various properties for unsaturated or saturated water or steam either superheated, saturated or wet
- Saturation temperature and pressure, specific enthalpy, specific volume, dryness fraction
- Temperature-specific enthalpy diagram for steam/water
- Use of steam table to determine steam/water properties (any condition except supercritical)
- Steam generation - water tube and fire tube boilers, boiler efficiency
- Safety devices and controls used with boilers
- Steam plant - steam traps, economiser, air, pre-heater, superheater, air/water separators, water treatment, feedwater pump, exhaust gas treatment
- Heat transfer rates to or from steam/water (any condition except supercritical)
- Steam throttling and formation of flash steam
- Steam heat exchangers and barrel calorimeters
- Steam plant for process heating
- Steam plant for power production

T4 Refrigeration/heat pump encompassing:

- Basic principles and terminology
- Vapour compression cycle
- Performance criteria
- Types of refrigerant - designation, properties advantages and disadvantages
- Refrigerant properties using the p-h diagram
- Ideal vapour compression cycle on the p-h diagram
- Energy balance and heat transfers in compressor, evaporator

REQUIRED SKILLS AND KNOWLEDGE

and condenser

- Actual vapour compression cycle and variations from the ideal - pressure loss in lines and non-ideal compression
- Superheating and subcooling with or without suction/liquid heat exchanger
- Carnot principle applied to refrigerator and heat pump Principles of evaporative refrigeration, absorption refrigeration, air cycle refrigeration and thermo-electric refrigeration

T5 Daily irradiation encompassing:

- definition of the terms: declination angle, reflectance, sunshine hours, extraterrestrial irradiation.
- solar radiation data tables and contour maps.
- determination, using field measurements and a sun path diagram, the times and dates when a PV array will be shaded by obstacles at a particular site.
- calculation of the daily average irradiation on a horizontal plane given extraterrestrial irradiation, location constants and sunshine hour data.
- calculation of the monthly mean daily irradiation falling on a PV array for each month of the year, adjusted for the effects of shading, using irradiance and irradiation data tables and a sun path diagram and/or appropriate software.

T6 Energy balance encompassing:

- definitions of the terms: transmittance, absorptance, emittance, specific heat, absorber, heat removal factor, stagnation temperature.
- explain the heat transfer mechanisms of conduction, convection and radiation and their operation in a simple fin and tube collector.
- how the transmittance, absorptance and emittance properties of materials used in the collector affect the performance of the collector.
- ways to reduce heat losses from a collector.
- energy balance and instantaneous efficiency equations for a collector.
- calculation of the collector constants from the instantaneous collector efficiency equation for a linear relationship.

T7 The solar collector encompassing:

- five major factors that affect the selection of materials for

REQUIRED SKILLS AND KNOWLEDGE

solar collectors.

- features of collectors for low, medium and high temperature applications in terms of heat transfer, optical properties and materials of construction.
- the scope and content of AS 2712 or similar standards.
- requirements of AS 2712 or similar standards in one aspect of collector construction.
- tests required by AS 2712 or similar standards with regard to collector construction.

T8 Solar collector performance encompassing:

- scope and content of Australian Standards AS 2535 and AS 2984 or similar standards.
- method for testing the thermal performance of a solar collector or a solar water heater according to AS 2535 and AS 2984 or similar standards.
- instantaneous efficiency of a solar collector for different inlet temperatures and flow rates.
- effect of varying inlet temperature and flow rate on the performance of a solar collector.
- efficiency curves for various types of solar collectors.
- performance of various types of solar water heaters in terms of their design, location and predicted solar fraction

T9 Hydraulic circuits encompassing:

- definition of the terms: equivalent length, static head, dynamic head, heat exchanger.
- configuration of a hydraulic circuit for a pumped storage solar water heating system.
- function of the components in the circuit.
- effects of water quality on the life and performance of components in the hydraulic circuit.
- suitable type and size components to minimise hydraulic and energy losses including pipes, pumps, heat exchangers, expansion tanks, valves and filters for a hydraulic circuit with a given flow rate and head.
- safety requirements of the hydraulic circuit in terms of temperature, pressure and hydrogen gas release.
- requirements to balance flow through parallel/series combinations of collector arrays.
- suitable water and energy conservation measures including user education, water conservation technologies and

REQUIRED SKILLS AND KNOWLEDGE

insulation.

- suitable types and level of insulation for system components to minimise heat losses.

T10 Domestic solar water heaters encompassing:

- definition of the terms: thermosiphon system, pumped storage system, sacrificial anode.
- function of the components in a domestic solar water heater including the collector, storage tank, valves, piping, differential controllers, pumps, insulation and support frames.
- schematic diagram of different types of system configurations showing collectors, storage tank, piping, pumps, filters, valves, heat exchangers and expansion tanks.
- factors which affect system performance including: storage tank and collector design, system location and collector orientation, water quality, hot water demand, usage pattern.
- safety requirements that prevent injury from high temperature water and hydrogen gas explosions during installation, maintenance and use of solar water heaters.
- demand for hot water and irradiation for a given location and collector tilt angle, orientation and shading.
- selection a suitably sized system for a given demand and location to meet a specific solar fraction and/or minimise life cycle cost.
- consequences of under/oversizing of solar water heating systems in terms of: the effect on system performance, safety, life expectancy of components.
- installation, commissioning and maintenance requirements for a given situation including location and mounting of collectors, storage tanks, valves, pumps, pipes and ancillary fittings.
- energy conservation and efficiency measures that will enhance the performance of a solar water heater such as: appropriate usage patterns, insulation, water conservation technologies, auxiliary energy tariffs.
- the capital cost, simple pay back and life cycle cost of solar and electric or gas hot water heaters according to AS3595 and AS4536.

T11 Commercial solar hot water heaters encompassing:

- schematic diagrams for two different types of system configurations showing collectors, storage tank, piping, pumps, filters, valves, heat exchangers and expansion tanks.

REQUIRED SKILLS AND KNOWLEDGE

- steps involved in the design of a commercial solar water heating system.
- assessment of the demand for hot water and irradiation for a given location and collector tilt angle, orientation and shading.
- selection of a suitably sized system for a given demand and location to meet a specific solar fraction and/or minimise life cycle cost.
- consequences of under/oversizing of a solar water heating system in terms of: system performance, safety, life expectancy of components.
- installation, commissioning and maintenance requirements for a given situation including location and mounting of collectors, storage tanks, valves, pumps, pipes and ancillary fittings.
- evaluation of energy conservation and efficiency measures that will enhance the performance of a solar water heater such as: appropriate usage patterns, insulation, water conservation technologies, auxiliary energy tariffs.
- the capital cost, simple payback time and life cycle cost of solar and electric or gas hot water heaters according to AS3595 and AS4536.

T12 Pool solar hot water heaters encompassing:

- function of the components of solar pool heating systems.
- typical system configuration.
- two factors which affect system performance

T13 Heating system technologies encompassing:

- Types and their application
- Operating parameters of common systems
- System component parameters and specifications
- System performance and requirements
- Installation specifications and requirements

Evidence Guide

EVIDENCE GUIDE

9) This provides essential advice for assessment of the unit and must be read in conjunction with the performance criteria and the range statement of the unit and the Training Package Assessment Guidelines.

The Evidence Guide forms an integral part of this unit. It must be used in conjunction with all parts of this unit and performed in accordance with the Assessment Guidelines of this Training Package.

Overview of Assessment **9.1)**

Longitudinal competency development approaches to assessment, such as Profiling, require data to be reliably gathered in a form that can be consistently interpreted over time. This approach is best utilised in Apprenticeship programs and reduces assessment intervention. It is the industry-preferred model for apprenticeships. However, where summative (or final) assessment is used it is to include the application of the competency in the normal work environment or, at a minimum, the application of the competency in a realistically simulated work environment. In some circumstances, assessment in part or full can occur outside the workplace. However, it must be in accordance with industry and regulatory policy.

Methods chosen for a particular assessment will be influenced by various factors. These include the extent of the assessment, the most effective locations for the assessment activities to take place, access to physical resources, additional safety measures that may be required and the critical nature of the competencies being assessed.

The critical safety issues inherent in working with electricity, electrical equipment, gas or any other hazardous substance/material present a challenge for those determining competence. Sources of evidence need to be 'rich' in nature to minimise error in judgment.

Activities associated with normal everyday work have a bearing on the decision as to how much and how detailed the data gathered will contribute to its 'richness'. Some skills are more critical to safety and operational requirements while the same skills may be more or less frequently practised. These points are raised for the assessors to consider when choosing an assessment method and developing assessment instruments. Sample assessment instruments are included for Assessors in the Assessment

Guidelines of this Training Package.

Critical aspects of evidence required to demonstrate competency in this unit

9.2)

Before the critical aspects of evidence are considered all prerequisites must be met.

Evidence for competence in this unit must be considered holistically. Each element and associated performance criteria must be demonstrated on at least two occasions in accordance with the 'Assessment Guidelines – UEE11'. Evidence must also comprise:

- A representative body of work performance demonstrated within the timeframes typically expected of the discipline, work function and industrial environment. In particular this must incorporate evidence that shows a candidate is able to:
  - Implement Occupational Health and Safety workplace procedures and practices including the use of risk control measures as specified in the performance criteria and range statement
  - Apply sustainable energy principles and practices as specified in the performance criteria and range statement
  - Demonstrate an understanding of the essential knowledge and associated skills as described in this unit. It may be required by some jurisdictions that RTOs provide a percentile graded result for the purpose of regulatory or licensing requirements.
  - Demonstrate an appropriate level of skills enabling employment
  - Conduct work observing the relevant Anti Discrimination legislation, regulations, polices and workplace procedures
- Demonstrated consistent performance across a representative range of contexts from the prescribed items below:
  - Design renewable energy heating systems as described in 8) and including:

A Developing outlines of alternative designs,

B Developing the design within the safety and functional requirements and budget limitations,

C	Documenting and presenting design effectively,
D	Successfully negotiating design alteration requests
E	Obtaining approval for final design
F	Dealing with unplanned events by drawing on essential knowledge and skills to provide appropriate solutions incorporated in a holistic assessment with the above listed items

Context of and specific resources for assessment

9.3)

This unit should be assessed as it relates to normal work practice using procedures, information and resources typical of a workplace. This should include:

- OHS policy and work procedures and instructions.
- Suitable work environment, facilities, equipment and materials to undertake actual work as prescribed by this unit.

These should be part of the formal learning/assessment environment.

Note:

Where simulation is considered a suitable strategy for assessment, conditions must be authentic and as far as possible reproduce and replicate the workplace and be consistent with the approved industry simulation policy.

The resources used for assessment should reflect current industry practices in relation to designing renewable energy heating systems.

Method of assessment

9.4)

This unit shall be assessed by methods given in Volume 1, Part 3 'Assessment Guidelines'.

Note:

Competent performance with inherent safe working practices is expected in the Industry to which this unit applies. This requires assessment in a structured environment which is intended

primarily for learning/assessment and incorporates all necessary equipment and facilities for learners to develop and demonstrate the essential knowledge and skills described in this unit.

Concurrent assessment and relationship with other units **9.5)**

For optimisation of training and assessment effort, competency development in this unit may be arranged concurrently with unit:

UEENEED10 Use computer applications relevant to a workplace 1A

Range Statement

RANGE STATEMENT

10) This relates to the unit as a whole providing the range of contexts and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

This unit must be demonstrated in relation to designing renewable energy heating systems and their installation.

Generic terms used throughout this Vocational Standard shall be regarded as part of the Range Statement in which competency is demonstrated. The definition of these and other terms that apply are given in Volume 2, Part 2.1.

Unit Sector(s)

Not applicable.

Competency Field

Competency Field **11)**

Renewable and Sustainable Energy