Australian Government

Assessment Requirements for UEERE0030 Design renewable energy (RE) heating systems

Release: 1

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Modification History

Release 1. This is the first release of this unit of competency in the UEE Electrotechnology Training Package.

Performance Evidence

Evidence required to demonstrate competence in this unit must be relevant to and satisfy all of the requirements of the elements and performance criteria on at least one occasion and include:

- developing outlines of alternative designs
- developing the design within the safety and functional requirements and budget limitations
- documenting and presenting design effectively
- successfully negotiating design alteration requests
- obtaining approval for final design
- dealing with unplanned events
- applying relevant work health and safety (WHS)/occupational health and safety (OHS) requirements, including
  - implementing workplace procedures and practices
  - using risk control measures
- applying sustainable energy principles and practices when designing renewable energy (RE) heating system
- preparing to design RE heating system.

Knowledge Evidence

Evidence required to demonstrate competence in this unit must be relevant to and satisfy all of the requirements of the elements and performance criteria and include knowledge of:

- design of RE heating, including:
  - heat transfer encompassing:
    - modes of heat transfer
    - conduction through a flat plate, series flat plates, thick and thin wall pipe, and 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
- combustion and fuels encompassing:
  - 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
- steam encompassing:
  - importance of steam for heat transfer and power production
  - steam/water properties and the interrelationship between the various properties for unsaturated or saturated water or steam either superheated, saturated or wet
  - saturation temperature and pressure, specific enthalpy, specific volume and 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, and 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 and 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
- 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 pH diagram
  - ideal vapour compression cycle on the pH diagram
  - energy balance and heat transfers in compressor, evaporator and condenser
  - actual vapour compression cycle and variations from the ideal - pressure loss in lines and non-ideal compression
  - superheating and sub-cooling 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
- daily irradiation encompassing:
    - definition of the terms: declination angle, reflectance, sunshine hours and extraterrestrial irradiation
    - solar radiation data tables and contour maps
    - determination, using field measurements and a sun path diagram, the times and dates when a photovoltaic (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
- energy balance encompassing:
    - definitions of the terms: transmittance, absorptance, emittance, specific heat, absorber, heat removal factor and stagnation temperature
    - 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
- solar collector encompassing:
    - five major factors that affect the selection of materials for 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 Australian Standards (AS) AS/NZS 2712 Solar and heat pump water heaters, or similar standards
    - requirements of AS/NZS 2712 Solar and heat pump water heaters, or similar standards in one aspect of collector construction
    - tests required by AS/NZS 2712 Solar and heat pump water heaters, or similar standards with regard to collector construction
- solar collector performance encompassing:
    - scope and content of AS/NZS 2535 Test methods for solar collectors, and AS 2984 Solar water heaters – Method of test for thermal performance – Outdoor test method, or similar standards
    - method for testing the thermal performance of a solar collector or a solar water heater according to AS/NZS 2535 Test methods for solar collectors. and AS 2984 Solar water heaters – Method of test for thermal performance – Outdoor test method, 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

- hydraulic circuits encompassing:
  - definition of the terms: equivalent length, static head, dynamic head and 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 insulation
  - suitable types and level of insulation for system components to minimise heat losses
- domestic solar water heaters encompassing:
  - definition of the terms: thermosiphon system, pumped storage system and 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 and 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 and 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 and auxiliary energy tariffs
    - the capital cost, simple pay back and life cycle cost of solar and electric or gas hot water heaters according to AS 3595 and AS/NZS 4536 Life cycle costing
- 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
    - 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 and 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 and auxiliary energy tariffs
    - the capital cost, simple payback time and life cycle cost of solar and electric or gas hot water heaters according to AS 3595 and AS/NZS 4536 Life cycle costing
- pool solar hot water heaters encompassing:
    - function of the components of solar pool heating systems
    - typical system configuration
    - two factors which affect system performance
- 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
- relevant job safety assessments or risk mitigation processes
- relevant manufacturer specifications
- relevant WHS/OHS legislated requirements
- relevant workplace documentation
- relevant workplace policies and procedures.

Assessment Conditions

Assessors must hold credentials specified within the Standards for Registered Training Organisations current at the time of assessment.

Assessment must satisfy the Principles of Assessment and Rules of Evidence and all regulatory requirements included within the Standards for Registered Training Organisations current at the time of assessment.

Assessment must occur in suitable workplace operational situations where it is appropriate to do so; where this is not appropriate, assessment must occur in simulated suitable workplace operational situations that replicate workplace conditions.

Assessment processes and techniques must be appropriate to the language, literacy and numeracy requirements of the work being performed and the needs of the candidate.

Resources for assessment must include access to:

- a range of relevant exercises, case studies and/or simulations
- relevant and appropriate materials, tools, facilities and equipment currently used in industry
- resources that reflect current industry practices in relation to designing RE heating systems
- applicable documentation, including workplace procedures, equipment specifications, regulations, codes of practice and operation manuals.

Links

Companion Volume implementation guides are found in VETNet - - https://vetnet.gov.au/Pages/TrainingDocs.aspx?q=b8a8f136-5421-4ce1-92e0-2b50341431b6