Australian Government

Assessment Requirements for UEERA0042 Evaluate thermodynamic and fluid parameters of refrigeration 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, performance criteria and range of conditions on at least one occasion and include:

- determining the extent of the evaluation
- setting up and conducting appropriate examinations and tests
- documenting evaluation results for use in design work
- dealing with unplanned events
- applying environmental and sustainable energy principles and practices
- applying relevant legislation, industry standards, codes of practice and regulations
- applying relevant work health and safety (WHS)/occupational health and safety (OHS) requirements, including:
  - applying safe working practices
  - hazard identification and reporting
  - implementing risk control measures
- determining need to test or measure live work
- documenting results of evaluation
- evaluating fluid and thermodynamic parameters of refrigeration systems
- performing fluid and thermodynamic evaluation tests
- preparing to evaluate fluid and thermodynamic parameters of refrigeration systems
- reporting on evaluation of fluid and thermodynamic parameters of refrigeration systems.

Knowledge Evidence

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

- thermodynamics and fluid fundamentals, refrigeration engineering mathematics, safe working practices and relevant standards, codes and regulations, including:
  - matrices:
    - the operations: addition (subtraction), scalar multiplication and matrix multiplication up to 3x3 matrices

- identity matrix and inverse matrix
- elementary algebraic manipulation of matrices
- solve up to three equations (linear) in three unknowns using inverse matrices and determinants

- quadratic functions:
  - graphs of quadratic functions represented by parabolas and significance of the leading coefficient
  - zeros represented graphically
  - quadratic equations by factoring and quadratic formula
  - simultaneously linear and quadratic equations algebraically and geometrically
  - engineering mathematics - B
- exponential and logarithmic functions:
  - laws of indices
  - graph of f(x) = kabx, emphasising a = 10, e
  - definition of the logarithm to any base
  - graph of f(x) = k loga bx, emphasising a = 10, e
  - solve exponential and simple log equations using indices, logs, calculator and graphically
  - change of log base, emphasising 10 and e
  - growth and decay
- trigonometric functions:
  - the ratios: sin, cos, tan, cosec, sec and cot
  - degrees, radians
  - graphs of k f(ax + b) where f(x) = sin x, cos x, tan x, and significance of k,a,b, for example V = Vm sin (wt+ f)
  - trigonometric identities
- energy and humanity:
  - need for energy and relationship between energy usage and standard of living
  - energy conversion - typical processes and efficiencies
  - sources of energy
  - solar energy - direct heating, photosynthesis, solar cells, power tower, hydrogen for solar energy, ocean thermal energy collector, solar ponds, wind and wave energy, and hydro-electric power
  - geothermal energy
  - tidal energy
  - nuclear energy - fission and fusion, burner and breeder reactors
  - stored fuel reserves
  - fuel conservation - reduction in wastage, recycling, greater usage efficiency and use of waste heat
  - thermodynamics
- basic concepts:

    - nature of matter - atoms, molecules, inter-molecular forces, molecular motion and states of matter
    - mass and conservation of mass principle
    - volume, density, specific volume and relative density
    - force, weight and pressure (atmospheric, gauge and absolute)
    - temperature (Celsius and Kelvin)
    - systems and black box analysis
    - reciprocating piston and cylinder mechanism – pressure ratio and compression ratio
- energy:
    - definition and principles
    - potential energy
    - kinetic energy
    - work (linear and rotational), constant and variable force, relationship to pressure and volume change
    - power (linear and rotational)
    - sensible heat - specific heat capacity (constant pressure and constant volume)
    - latent heat
    - chemical energy - energy content of a fuel
    - internal energy
    - energy transfer in closed and open systems
    - definition of a closed system
    - calorimetry as an example of a closed system (with or without phase change)
    - thermodynamics 1
    - non-flow energy equation - typical applications such as stirring with simultaneous heating or cooling
    - definition of an open system
    - mass and volume flow rate and continuity equation
    - steady flow energy equation (negligible change in kinetic or potential energy) leading to the concept of enthalpy - typical applications such as turbines, compressors, boilers and heat exchangers
- gases:
    - definition of a perfect or ideal gas in terms of the molecular model
    - general gas equation
    - characteristic gas equation (equation of state)
    - constant pressure process
    - constant volume process
    - isothermal process
    - polytropic process
    - adiabatic process
- heat engines:

- definition of a heat engine
- essentials of a heat engine - heat source, heat sink, working substance, mechanical power output and working cycle
- energy balance for a heat engine (as a black box) and efficiency
- maximum possible efficiency (Carnot efficiency)
- types of heat engines according to working substance, heat source, mechanical arrangement and working cycle
- typical practical cycles - Stirling, Otto, diesel, dual, two stroke (spark and compression ignition) and Joule cycle
- thermodynamics 1

- heat engine performance:
  - measurement of torque and power output - rope brake, shoe brake, hydraulic dynamometer and electric dynamometer
  - heat supply rate, efficiency and specific fuel consumption
  - measurement of indicated power - mechanical indicator, electric/electronic indicator and Morse test
  - friction power, mechanical efficiency and indicated thermal efficiency
  - volumetric efficiency
  - energy balance
  - performance curves - variable load constant speed, and variable speed constant throttle setting
- basic properties of fluids:
  - description of a fluid and the difference between solids and fluids, liquids and gases, hydraulics and pneumatics
  - chemical properties, reaction with metals, corrosiveness, flammability, toxicity, pollution and environmental
  - effects
  - dissolves gases and particles in liquids (slurries)
  - foaming of liquids: basic properties and units - mass, volume, density, specific volume, relative density, force and weight, pressure (absolute, atmospheric and gauge), temperature (Celsius and Kelvin), viscosity and surface tension
  - vapour pressure of a liquid - saturation vapour pressure
  - temperature and pressure effects on the basic properties
  - ideal/perfect gases and liquids
  - gas laws for ideal gases
  - fluid mechanics 1
- components:
  - pipes, channels, tubes and ducts (rigid and flexible)
  - valves - gate, globe, non-return/foot, needle, ball, plug cock, diaphragm, pressure regulating/reducing and safety
  - valves

- filters and strainers for gases and liquids
- gauges and instruments - pressure and temperature gauges, liquid level gauges, thermometers, thermocouples, manometers and piezometers
- pipe fittings - elbows/bends, enlargement/contractions, coupler/unions and tees
- tanks and vessels - storage tanks, pressure vessels, header and surge tanks, and weirs/dams/reservoirs
- nozzles/spray heads
- flow measurement instruments - venturi and orifice meters, pitot tube, rotameter and anemometer (fan/hot wire)
- pumps/compressors and motors/turbines
- actuators - linear (cylinders) and rotary
- selection of equipment and instruments considering properties and compatibility

- fluid statics:
  - pressure at a point, direction of pressure on a surface
  - pressure variation with depth in a liquid
  - Pascal's Principle
  - manometer/piezometer calculations (vertical and inclined)
  - forces due to fluid pressure on vertical, horizontal and inclined surfaces
  - centre of pressure
  - Archimedes Principle - buoyancy, flotation, apparent weight and centre of buoyancy
  - fluid flow
  - steady and unsteady flow, streamlines and eddies
  - velocity - average or mean and local
  - mass and volume flow rate
  - conservation of mass leading to the Continuity Equation for fluid flow
  - modification of the Continuity Equation for volume flow of liquids or gases with small changes in density
  - Bernoulli Equation for ideal fluids, meaning of pressure, velocity and potential head and total head
  - causes of head loss and modification of the Bernoulli Equation to include a head loss term for real fluids
- fluid power:
  - definition and units for work, torque and power
  - relationship between force, velocity and power and torque, angular velocity and power
  - work done by a gas expanding at constant pressure
  - relationship between fluid power, mass flow rate and head
  - relationship between fluid power, volume flow rate and pressure
  - efficiency of a pump or turbine
  - modification of the Bernoulli Equation to include a pump or turbine in the fluid circuit as well as a head loss term
- forces developed by flowing fluids:

    - impulse-momentum equation for fluid flow
    - force developed by a jet striking a stationary plate - perpendicular, inclined or curved
    - force developed by a jet striking a moving plate or blade
    - force developed by a jet striking a series of moving plates or blades - power developed and efficiency
- refrigeration system specifications
- relevant manufacturer specifications
- relevant test methods
- relevant WHS/OHS legislated requirements, including:
    - risk control measures
- 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 suitable simulated 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 other simulations
- relevant and appropriate materials, tools, equipment and personal protective equipment (PPE) currently used in industry
- 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