Australian Government

UEENEEJ165A Evaluate thermodynamic and fluid parameters of refrigeration systems

Release 3

INDUSTRY SKILLS COUNCILS
Creating Australia's Future

UEENEEJ165A Evaluate thermodynamic and fluid parameters of refrigeration systems

Modification History

Not Applicable

Unit Descriptor

Unit Descriptor **1)**

1.1) Descriptor

This unit covers evaluation of thermodynamic and fuild parameters of refrigeration systems. It encompasses working safely, setting up and conducting evaluation measurements, evaluating thermodynamic and fluid parameters from measured parameters and reporting results for use in design work.

Application of the Unit

Application of the Unit **4)**

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

1.2) License to practice

The skills and knowledge described in this unit may require a license to practice in the workplace subject to regulations for undertaking of refrigeration or air conditioning work. Practice in workplace and during training is also subject to regulations directly related to occupational health and safety and where applicable contracts of training such as apprenticeships.

Note:
1. Compliance with permits may be required in various jurisdictions and typically relates to the operation of plant, machinery and equipment such as elevating work platforms, powder operated fixing tools, power operated tools, vehicles, road signage and traffic control, lifting equipment. Permits may also be required for some work environments such as confined spaces, working aloft, near live electrical devices, site rehabilitation.
2. Compliance may be required in various jurisdictions relating to currency in First Aid, confined space, lifting and risk safety measures.

Pre-Requisites

Prerequisite Unit(s) **2)**

2.1) Competencies

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

UEENEEJ127A Establish the thermodynamic parameters of refrigeration and air conditioning systems

UEENEEJ164A Analyse the operation of HVAC air and hydronic systems

UEENEEJ192A Analyse the psychrometric performance of HVAC/R systems

and

UEENEEJ193A 0r Analyse the thermodynamic performance of HVAC/R systems

UEENEEJ109A Verify functionality and compliance of refrigeration and air conditioning installations

Prerequisite Unit(s) **2)**

UEENEEE101A Apply Occupational Health and Safety regulations, codes and practices in the workplace

UEENEEE102A Fabricate, assemble and dismantle utilities industry components

UEENEEE003B Solve problems in extra-low voltage single path circuits

UEENEEE105A Fix and secure electrotechnology equipment

UEENEEE107A Use drawings, diagrams, schedules, standards, codes and specifications

UEENEEE137A Document and apply measures to control OHS risks associated with electrotechnology work

UEENEEJ102A Prepare and connect refrigerant tubing and fittings

UEENEEJ103A Establish the basic operating conditions of vapour compression systems

UEENEEJ104A Establish the basic operating conditions of air conditioning systems

UEENEEJ106A Install refrigerant pipe work, flow controls and accessories

UEENEEJ107A Install air conditioning and refrigeration systems, major components and associated equipment

UEENEEJ108A Recover, pressure test, evacuate, charge and leak test refrigerants

UEENEEJ110A Select refrigerant piping, accessories and associated controls

UEENEEJ111A Diagnose and rectify faults in air conditioning and refrigeration systems and components

UEENEEJ113A Commission air conditioning and refrigeration systems

UEENEEJ153A Find and rectify faults motors and associated controls in refrigeration and air conditioning systems

UEENEEJ170A Diagnose and rectify faults in air conditioning and refrigeration control systems

UEENEEJ194A Solve problems in low voltage refrigeration circuits

UEENEEP012A Disconnect / reconnect composite

Prerequisite Unit(s)	**2)**
	appliances connected to low voltage installation wiring
	UEENEEP017A Locate and rectify faults in low voltage composite appliances using set procedures
	UEENEEP024A Attach cords and plugs to electrical equipment for connection to a single phase 230 Volt supply
	UEENEEP025A Attach cords, cables and plugs to electrical equipment for connection to 1000 Va.c. or 1500 Vd.c. supply

Employability Skills Information

Employability Skills	**3)**
	This unit contains Employability Skills
	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 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 evaluate fluid and thermodynamic parameters of	1.1	OHS procedures for a given work area are identified, identified, obtained and understood
		1.2	Established OHS risk control measures and procedures are followed in preparation for the work.

ELEMENT		PERFORMANCE CRITERIA	
	refrigeration systems		
		1.3	The extent of evaluation is determined from specifications for the refrigeration system and discussion with appropriate personnel.
		1.4	Advice is sought from the work supervisor to ensure the work is coordinated effectively with others.
		1.5	Tools, testing devices, and materials needed to carry out the work are obtained and checked for correct operation and safety.
2	Evaluate fluid and thermodynamic parameters of refrigeration systems.	2.1	OHS risk control measures and procedures for carrying out the work are followed.
		2.2	The need to test or measure live is determined in strict accordance with OHS requirements and when necessary conducted within established safety procedures.
		2.3	In-depth knowledge of the fluid and thermodynamic parameters is applied to the evaluation process
		2.4	Energy evaluation tests are set up in accordance with established test methods and procedures for each particular parameter under scrutiny.
		2.5	Fluid and thermodynamic parameters evaluation tests are carried out methodically and results and comments systematically noted.
		2.6	Unexpected situations are dealt with safely and with the approval of an authorised person.
		2.7	Evaluation is carried out without damage to systems, circuits, the surrounding environment or services and using sustainable energy practices.
3	Report on evaluation of fluid and thermodynamic parameters of refrigeration systems	3.1	OHS work completion risk control measures and procedures are followed.
		3.2	Work site is cleaned and made safe in accordance with established procedures.

ELEMENT	PERFORMANCE CRITERIA
	3.3 Results of fluid and thermodynamic parameters evaluation are documented for use in design work
	3.4 Energy evaluation report is forwarded to appropriate person(s) for endorsement.

Required Skills and Knowledge

REQUIRED SKILLS AND KNOWLEDGE

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

Evidence shall show that knowledge has been acquired of safe working practices and evaluating fluid and thermodynamic parameters of refrigeration systems.

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

KS01-EJ165A Thermodynamics and fluid fundamentals

Evidence shall show an understanding of refrigeration engineering mathematics, thermodynamics and fluid fundamentals, applying safe working practices and relevant Standards, Codes and Regulations to an extent indicated by the following aspects:

T1. Matrices

- The operations: addition (subtraction), scalar multiplication, matrix multiplication up to 3x3 matrices.
- Identity matrix, inverse matrix
- Elementary algebraic manipulation of matrices
- Solve up to three equations (linear) in three unknowns using inverse matrices and determinants.

T2. Quadratic Functions

- Graphs of quadratic functions represented by parabolas and significance of the leading coefficient
- Zeros represented graphically
- Solve quadratic equations by factoring and quadratic formula
- Solve simultaneously linear and quadratic equations algebraically and geometrically.
- Engineering Mathematics- B

T3. 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, graphically
- Change of log base, emphasising 10 and e
- Growth and decay

REQUIRED SKILLS AND KNOWLEDGE

T4. Trigonometric Functions

- The ratios: sin, cos, tan, cosec, sec, 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
- Solve trigonometric equations

T5. 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, 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

T6. Basic Concepts

- Nature of matter - atoms, molecules, inter-molecular forces, molecular motion, states of matter
- Mass and conservation of mass principle
- Volume, density, specific volume, relative density
- Force, weight, pressure (atmospheric, gauge and absolute)
- Temperature (Celsius and Kelvin)
- Systems and black box analysis
- Reciprocating piston and cylinder mechanism – pressure ratio and compression ratio

T7. 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)

REQUIRED SKILLS AND KNOWLEDGE

- 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.

T8. 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

T9. Heat engines

- Definition of a heat engine
- Essentials of a heat engine - heat source, heat sink, working substance, mechanical power output, 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. Joule cycle.
- Thermodynamics 1

T10. Heat engine performance

- Measurement of torque and power output - rope brake, shoe brake, hydraulic dynamometer, electric dynamometer
- Heat supply rate, efficiency, specific fuel consumption
- Measurement of indicated power - mechanical indicator, electric/electronic indicator, Morse test

REQUIRED SKILLS AND KNOWLEDGE

- Friction power, mechanical efficiency, indicated thermal efficiency
- Volumetric efficiency
- Energy balance
- Performance curves - variable load constant speed, variable speed constant throttle setting.

T11. 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, 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

T12. Components

- Pipes, channels, tubes and ducts (rigid and flexible)
- Valves - gate, globe, non-return/foot, needle, ball, plug cock, diaphragm, pressure regulating/reducing, safety
- valves
- Filters and strainers for gases and liquids
- Gauges and instruments - pressure and temperature gauges, liquid level gauges, thermometers, thermocouples, manometers, piezometers
- Pipe fittings - elbows/bends, enlargement/contractions, coupler/unions, tees
- Tanks and vessels - storage tanks, pressure vessels, header and surge tanks, weirs/dams/reservoirs
- Nozzles/spray heads
- Flow measurement instruments - venturi and orifice meters, pitot tube, rotameter, anemometer (fan/hot wire)
- Pumps/compressors, motors/turbines
- Actuators - linear (cylinders) and rotary
- Selection of equipment and instruments considering properties and compatibility

T13. Fluid statics

- Pressure at a point, direction of pressure on a surface
- Pressure variation with depth in a liquid

REQUIRED SKILLS AND KNOWLEDGE

- 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. Total head
- Causes of head loss and modification of the Bernoulli Equation to include a head loss term for real fluids

T14. 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

T15. 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

Evidence Guide

EVIDENCE GUIDE

9) The evidence guide provides advice on assessment and must be read in conjunction with the Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment Guidelines for this Training Package. .

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 nature of working with electricity, electrical equipment, gas or any other hazardous substance/material carries risk in deeming a person competent. Sources of evidence need to be 'rich' in nature to minimise error in judgment.

Activities associated with normal everyday work influence decisions about how/how much 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.

EVIDENCE GUIDE

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 shall be considered holistically. Each Element and associated performance criteria shall be demonstrated on at least two occasions in accordance with the 'Assessment Guidelines - UEE07'. Evidence shall 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 shall 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:
  - Evaluate fluid and thermodynamic parameters of refrigeration systems as described in 8) and including:

A Determining the extent of the evaluation

B Setting up and conducting appropriate examinations and tests

C Documenting evaluation results for use in design work

EVIDENCE GUIDE

D Dealing with unplanned events by drawing on essential knowledge and skills to provide appropriate solutions incorporated in the 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.

Evidence should show demonstrated competency in evaluating fluid and thermodynamic parameters of refrigeration 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)

There are no concurrent assessment recommendations for this unit.

Range Statement

RANGE STATEMENT

8) 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 evaluating and reporting fluid and thermodynamic parameters at least two different types of refrigeration systems.

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

2.2) Literacy and numeracy skills

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

2.2) Literacy and numeracy skills

Competency Field **5**)

Refrigeration and Air Conditioning