Australian Government

UEENEEJ181A Design ammonia refrigerated systems

Release 4

INDUSTRY SKILLS COUNCILS
Creating Australia's Future

UEENEEJ181A Design ammonia refrigerated systems

Modification History

Release	Action	Core/Elective	Details	Points
4	Update		Update pre-requisite UEENEEE103A - Solve problems in ELV single path circuits	

Unit Descriptor

Unit Descriptor **1**)

1.1) **Descriptor**

This unit covers the design of refrigeration systems using ammonia as a refrigerant. It encompasses design skills including overall systems design, selection of components and definition of control logic.

Application of the Unit

Application of the Unit **4**)

This competency standard is suitable for employment-based programs under an approved contract of training at the AQF level of the qualification in which the unit is first packaged or higher.

The unit may be selected as an elective from the relevant schedule (see qualification packaging rules) provided that all prerequisite units are undertaken or addressed through recognition processes.

This unit may be included in a skill set provided that it is listed in the schedule of electives (see Qualification Framework) and all prerequisite units are undertaken or addressed through recognition processes.

Delivery and assessment of this unit should be undertaken within regard to the requirements of License to Practice

Application of the Unit **4**)

(1.2 above), Prerequisite Competencies and Literacy and Numeracy skills (2 above) and the recommendations for concurrent assessment and relationship with other units (9.5 below).

Practice in the 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 and lifting equipment. Permits may also be required for some work environments such as confined spaces, working aloft, near live electrical apparatus and site rehabilitation.
2. Compliance may be required in various jurisdictions relating to currency in First Aid, confined space, lifting, risk safety measures etc.

Licensing/Regulatory Information

1.2) License to practice

The skills and knowledge described in this unit do not require a licence to practise in the work place. However practice in this unit is subject to regulations directly related to occupational health and safety, codes of work practice and standard work procedures related to the characteristics and behaviour of material in an engineering environment.

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

Prerequisite Unit(s) **2)**

confirmed.

UEENEEJ178A Apply safety awareness and legal requirements for ammonia refrigerant.

UEENEEJ132A Design commercial refrigeration systems and select components

UEENEEJ129A Establish heat loads for commercial refrigeration and/or air conditioning applications

UEENEEJ165A: Evaluate thermodynamic and fluid parameters of refrigeration systems

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 Analyse the thermodynamic performance of HVAC/R systems

or

UEENEEJ109A Verify functionality and compliance of refrigeration and air conditioning installations

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

UEENEEE102A Fabricate, assemble and dismantle utilities industry components

UEENEEE103A Solve problems in ELV 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

Prerequisite Unit(s) **2)**

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 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 must be consistent with the evidence guide.

Elements and Performance Criteria

ELEMENT	PERFORMANCE CRITERIA
1 Prepare to design ammonia refrigeration systems	1.1 OHS processes and procedures for a given work area are identified, obtained and understood.
	1.2 The extent and nature of the refrigeration system is determined from design specifications.
	1.3 Safety and other regulatory requirements to which the system shall comply are identified, obtained and understood.
	1.4 Work supervisor or customers are consulted to determine which functions of the system are to be used and the parameter of each and written confirmation sought.
	1.5 Design development work is planned to meet scheduled timelines in consultation with others

ELEMENT	PERFORMANCE CRITERIA	
		involved on the work site.
2 Design ammonia refrigeration systems	2.1	Established OHS risk control measures and procedures for carrying out the work are followed.
	2.2	Knowledge of ammonia refrigeration system analysis, ammonia refrigeration system components and piping, performance standards and compliance methods are applied to developing the system design.
	2.3	Safety, functional and budgetary considerations are incorporated in the installation designed.
	2.4	Equipment required for the system is selected in accordance with the design specifications and established requirements.
	2.5	Location of components of the system is documented to ensure correct operation of system functions.
	2.6	System design draft is checked for compliance with the design brief and regulatory requirements.
	2.7	System design is documented for submission to appropriate person(s) for approval.
	2.8	Solutions to unplanned situation are provided consistent with organisation's policy.
3 Obtain approval for engineering computer applications design	3.1	System design is presented and explained to client representative and/or other relevant person(s).
	3.2	Requests for alterations to the design are negotiated with relevant person(s) within the constraints of organisation's policy.
	3.3	Final design is documented and approval obtained from appropriate person(s).
	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

7) 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 single-stage and/or multi-stage ammonia refrigerating systems.

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

KS01-EJ181A Ammonia refrigeration system design

Evidence shall show an understanding of Ammonia refrigeration systems, components and piping design requirements, applying safe working practices and relevant Standards, Codes and Regulations to an extent indicated by the following aspects:

T1 Technical Standards, Codes and Regulations

- Environmental and safety considerations in the use and disposal of ammonia refrigerant
  - Toxicity of ammonia, the effects on human health and the legislative limitations imposed on ammonia refrigerant as a result
  - Flammability of ammonia, concentration, LEL
  - Environmental effects
  - Safe disposal
  - MSDS samples
  - Registration requirements for transport and on-site use
  - Relationship between ammonia system refrigerant charge and Dangerous Goods Storage regulations
  - Engine ventilation requirements and determination of ventilation rates
  - Scrubbers for elimination of the harmful effects of ammonia

T2 Ammonia refrigeration system design requirements

- Applications of refrigerant ammonia (NH3) in industrial refrigeration
  - Introduction to industrial ammonia refrigeration applications and systems
  - Applications in Industrial Refrigeration: Cool and cold storage, food processing, beverage manufacturing plants, fertilizer plants, second compression stage of CO2 systems
  - Application in environment control and air conditioning: Large scale reticulated water/secondary refrigerant systems
  - Advantages and disadvantages of ammonia refrigerant compared with other

REQUIRED SKILLS AND KNOWLEDGE

natural and synthetic refrigerants

- Properties, application and limitations of ammonia refrigerant
  - General classification of ammonia refrigerant according to AS 1677 Refrigerating Systems
  - Common contaminants in ammonia refrigeration systems, water, oil, non-condensable and the effects of same on cycle efficiency and system wear
  - Refrigeration machine oils soluble in ammonia, oil type, applications, reactions with water
  - Thermal and transport properties of ammonia in comparison with other natural and synthetic refrigerants including the behaviour in a vapour compression cycle
- Application concepts and principles
  - Single stage vapour compression cycles with dry expansion refrigerant feed
  - Single and dual stage vapour compression cycles with liquid overfeed
  - Single stage vapour compression cycles with screw compressors and liquid overfeed
  - Cascade NH3/CO2 systems with dry expansion and liquid overfeed
  - Single and dual stage vapour compression cycles with gravity flooded refrigerant feed
  - Single and dual stage vapour compression cycles with NH3 used as a volatile secondary refrigerant
  - Dual stage vapour compression cycles with multiple (>2) saturation temperature levels
  - Automatic defrost principles including off-cycle air defrost, ambient air defrost, hot gas defrost, electric defrost and water defrost
  - Selection and sizing of ammonia pumps for liquid overfeed systems
  - Selection and sizing of high pressure and low pressure vessels
  - Refrigerant pipe sizing using Ammonia refrigerant
  - Selection of suitable refrigerant oil

T3 Ammonia refrigeration system components and piping

- Corrosion and Material selection
  - Materials compatibility table
  - Thermal and other properties of materials in use
  - Pipe material and jointing methods/materials
  - Compressors
  - Pumps, impellers and seals
  - Isolation and control valves
  - Heat exchangers

REQUIRED SKILLS AND KNOWLEDGE

- Pipe and insulation materials, pipe stresses and pipe suspension methods
  - Mild steel pipe
  - Stainless steel pipe
  - Sharpy tested pipe
  - Post-installation insulation (in situ foaming, formed insulation, closed cell flexible insulation
  - Pre-insulated pipe material
  - Vapour barrier – importance and maintenance
- Heat exchangers
  - Finned air coolers or evaporators - induced draught, forced draught, stainless steel/aluminium, mild steel galvanized, all aluminium, stainless steel/AlMg3, all stainless steel; description of what materials are used where and for what reason; various refrigerant feed methods including advantages/disadvantages i.e. top feed, bottom feed, vertical up flow/down flow of air; fin spacing, fin thickness; impact of geometry on fluid pressure drops
  - Condensers – evaporative, air cooled, air cooled adiabatically assisted, water cooled shell and tube, water cooled plate/plate, water cooled plate and shell, cascade shell and tube, cascade plate/plate, cascade plate and shell; material selection for condensers, importance of discharge temperature for condenser design
  - Cooling towers
  - Intercoolers and economizers of the closed type, sizing of liquid subcooling coils and tube bundles
  - Liquid coolers or evaporators – plate/plate, plate/shell, shell and tube; material selections, refrigerant feed methods, oil management
  - Screw compressor oil coolers – plate/plate type, shell and tube type, water cooled, refrigerant cooled, surface enhancement options
  - Heat recovery – shell and tube de-superheaters, plate/plate de-superheaters, heat recovery condensers of various types
- System control and monitoring
  - Compressor capacity control – pressure and temperature signals
  - Room temperature and humidity control – understanding the principle of cooling and re-heating air streams to control absolute moisture contents
  - Control of condensers – optimization of overall plant C.O.P.
  - Floating condensing pressures
  - Control of fluid temperatures within the system – oil, secondary refrigerants, subcooling
  - Control of flows – thermostatic expansion valves, low pressure floats, high pressure floats, motorized valves, electronic expansion valves, hand regulating valves, oil return systems between compressor oil separators and compressors

REQUIRED SKILLS AND KNOWLEDGE

- Pressure controllers - evaporating pressure controllers, thermostatic controllers, hot gas bypass valves, crankcase pressure regulators, overflow valves, NH3 pump pressure control, flow controllers, defrost pressure controllers
- Defrost control
- PLC control systems
- SCADA systems

- Water treatment and desiccant dehumidifiers
  - Condenser water treatment – purpose and legislative requirement
  - Treatment of secondary refrigerant loops including monitoring
  - Desiccant dehumidifiers and their role in infiltration minimization, defrost control and energy savings
- Equipment Selection
  - Use computer software and manufacturers data to select major components of an Ammonia refrigeration plant

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.

EVIDENCE GUIDE

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 - UEE07'. 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:

EVIDENCE GUIDE

- 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 ammonia refrigeration systems as described in 8) and including:

    A Understanding required operating functions and parameters from the design specification

    B Developing the design within the safety, regulatory 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

EVIDENCE GUIDE

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 ammonia 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.

The critical aspects of occupational health and safety covered in unit UEENEEE001B and other discipline specific occupational health and safety units shall be incorporated in relation to 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 designing ammonia refrigeration systems in any of the following:

- In relation to at least two of the following types of (2 single-stage or 2 multi-stage or 1 single-stage and 1 multi-stage) ammonia refrigeration systems encompassing major components (i.e. condenser, compressors, evaporator, and flash chamber/flash intercooler), associated components and controls and on at least two occasions:

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

Custom Content Section

Competency Field **5**)

Refrigeration and Air Conditioning