

**22478VIC**

**Diploma  
of  
Engineering Technology  
and**

**22479VIC**

**Advanced Diploma  
of  
Engineering Technology**

This course has been accredited under Parts 4.4 of the Education and Training Reform Act 2006

**Accredited for the period: 1 July 2018 to 30 June 2023**





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3. **Type of submission** Re-accreditation

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##### **BSB Business Services Training Package**

- BSBINM601 Manage knowledge and information
- BSBMGT502 Manage people performance
- BSBMGT517 Manage operational plan
- BSBMGT605 Provide leadership across the organisation
- BSBMGT608 Manage innovation and continuous improvement
- BSBPMG411 Apply project quality management techniques
- BSBPMG414 Apply project information and communications techniques
- BSBPMG513 Manage project quality
- BSBPMG516 Manage project information and communication
- BSBPMG521 Manage project integration
- BSBPMG522 Undertake project work
- BSBPMG605 Direct quality management of a project program
- BSBPMG609 Direct procurement and contract for a project program
- BSBREL402 Build client relationships and business networks
- BSBRSK501 Manage risk
- BSBSUS501 Develop workplace policy and procedures for sustainability
- BSBWHS501 Ensure a safe workplace
- BSBWHS507 Contribute to managing WHS information systems

##### **CPC08 - Construction, Plumbing and Services Training Package**

- CPCCBC4004A Identify and produce estimated costs for building and construction projects

##### **CPC - Construction, Plumbing and Services Training Package**

- CPCCWHS1001 Prepare to work safely in the construction industry

##### **CPP07 – Property Services Training package**

- CPPBDN5013A Develop and collaborate on building information models for small-scale building design projects

##### **CPP – Property Services Training package**

- CPPBDN4004 Set up BIM-capable software and files for building design drafting projects

##### **MSS – Sustainability Training Package**

- MSS015002 Develop strategies for more sustainable use of resources
- MSS015007 Develop a business case for sustainability improvements
- MSS015008 Develop strategic sustainability plans
- MSS405001 Develop competitive systems and practices for an organisation
- MSS405030 Optimise cost of a product or service

- MSS404052 Apply statistics to operational processes
- MSS405075 Facilitate the development of a new product

### **MSM – Manufacturing Training Package**

- MSMENV272 Participate in environmentally sustainable work practices
- MSMSUP400 Develop and monitor quality systems

### **MEM05 - Metals and Engineering Training package**

- MEM09002B Interpret technical drawing
- MEM09009C Create 2D drawings using computer aided design system
- MEM09010C Create 3D models using computer aided design system
- MEM09011B Apply basic engineering design concepts
- MEM09022A Create 2D code files using computer aided manufacturing system
- MEM09023A Create 3D code files using computer aided manufacturing system
- MEM09157A Perform mechanical engineering design drafting
- MEM09158A Perform mechatronics engineering design drafting
- MEM09155A Prepare mechanical models for computer-aided engineering (CAE)
- MEM09156A Prepare mechatronic models for computer-aided engineering (CAE)
- MEM09213A Produce schematic drawings for hydraulic and pneumatic fluid power systems
- MEM10004B Enter and change programmable controller operational parameters
- MEM10005B Commission programmable controller programs
- MEM12023A Perform engineering measurements
- MEM13014A Apply principles of occupational health and safety in work environment
- MEM14005A Plan a complete activity
- MEM14088A Apply maintenance engineering techniques to equipment and component repairs and modifications
- MEM14091A Integrate manufacturing fundamentals into an engineering task
- MEM14092A Integrate maintenance fundamentals into an engineering task
- MEM16006A Organise and communicate information
- MEM16008A Interact with computing technology
- MEM16010A Write reports
- MEM18001C Use hand tools
- MEM18002B Use power tools/hand held operations
- MEM18052B Maintain Fluid Power Systems for Mobile Plant
- MEM18055B Dismantle, replace and assemble engineering components
- MEM22001A Perform engineering activities
- MEM22002A Manage self in an engineering environment

- MEM22012A Coordinate resources for an engineering project or operation
- MEM22013A Coordinate engineering projects
- MEM22014A Coordinate engineering-related manufacturing operations
- MEM23003A Operate and program computers and/or controllers in engineering situations
- MEM23004A Apply technical mathematics
- MEM23005A Apply statistics and probability techniques to engineering tasks
- MEM23006A Apply fluid and thermodynamics principles in engineering
- MEM23007A Apply calculus to engineering tasks
- MEM23008A Apply advanced algebra and numerical methods to engineering tasks
- MEM23063A Select and test mechanical engineering materials
- MEM23064A Select and test mechatronic engineering materials
- MEM23109A Apply engineering mechanics principles
- MEM23111A Select electrical equipment and components for engineering applications
- MEM23112A Investigate electrical and electronic controllers in engineering applications
- MEM23114A Evaluate thermodynamic systems and components
- MEM23115A Evaluate fluid power systems
- MEM23116A Evaluate programmable logic controller and related control system component applications
- MEM23117A Evaluate microcontroller applications
- MEM23120A Select mechanical machine and equipment components
- MEM23121A Analyse loads on frames and mechanisms
- MEM23122A Evaluate computer integrated manufacturing systems
- MEM23123A Evaluate manufacturing processes
- MEM23134A Evaluate jigs and fixtures
- MEM23125A Evaluate maintenance systems
- MEM23126A Evaluate industrial robotic applications
- MEM23131A Evaluate rapid prototyping applications
- MEM23132A Evaluate rapid manufacturing processes
- MEM23133A Evaluate rapid tooling applications
- MEM23138A Evaluate suitability of materials for engineering-related applications
- MEM234003A Design machines and ancillary equipment
- MEM234004A Design for engineering-related noise and vibration mitigation
- MEM234032A Manage fluid power related technologies in an enterprise
- MEM234010A Design microcontroller applications
- MEM234011A Design programmable logic controller applications

- MEM234014A Design a robotic system
- MEM24012C Apply metallurgy principles
- MEM30007A Select common engineering materials
- MEM30010A Set up basic hydraulic circuits
- MEM30011A Setup basic pneumatic circuits
- MEM30012A Apply mathematical techniques in a manufacturing engineering or related environment
- MEM30014A Apply basic just in time systems to the reduction of waste
- MEM30016A Assist in the analysis of a supply chain
- MEM30017A Use basic preventative maintenance techniques and tools
- MEM30027A Prepare basic programs for programmable logic controllers
- MEM30029A Use workshop equipment and processes to complete an engineering project
- MEM30031A Operate computer-aided design (CAD) system to produce basic drawing elements
- MEM30033A Use computer-aided design (CAD) to create and display 3D models

#### **TLI - Transport and Logistics Training Package**

- TLIL5055 Manage a supply chain
- TLIR5006 Develop, implement and review purchasing strategies
- TLIR5014 Manage suppliers

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#### **22263VIC Certificate IV in Integrated Technologies**

- VU21170 Implement and maintain control systems for industrial processes
- VU21172 Apply instrumentation principles to industrial control systems
- VU21173 Interface control systems to industrial processes and analyse data from SCADA systems
- VU21174 Program control systems
- VU21176 Utilise digital electronics for control applications
- VU21232 Program, operate and select a robotics systems
- VU21270 Implement control processes using PLCs
- VU21545 Evaluate proportional and servo controlled fluid power systems
- VU21546 Monitor and adjust an integrated fluid power control system

- VU21547 Select components for an integrated fluid power design project
- VU21548 Install and commission an integrated fluid power system
- VU21549 Conduct a feasibility study for an integrated fluid power system
- VU21551 Test and monitor fluid power circuits
- VU21609 Install and maintain hydraulic/pneumatic systems

### **22470VIC Certificate II in Engineering Studies**

- VU22330 Select and interpret drawings and prepare three dimensional (3D) sketches and drawings



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- 6. Course accrediting body** Victorian Registration and Qualifications Authority
- 7. AVETMISS information**
- ANZSCO Code – 6 digit**  
 (Australian and New Zealand Standard Classification of Occupations)  
 312512 Mechanical Engineering Technician  
 312212 Civil Engineering Technician
- ASCED Code – 4 digit**  
 (Field of Education)  
 0301 Manufacturing Engineering and Technology
- National course code**  
 22478VIC Diploma of Engineering Technology  
 22479VIC- Advanced Diploma of Engineering Technology
- 8. Period of accreditation** 1 July 2018 – 30 June 2023

## Section B: Course information

1. Nomenclature <i>Standard 1 AQTF Standards for Accredited Courses</i>	
1.1. Name of the qualification	Diploma of Engineering Technology Advanced Diploma of Engineering Technology
1.2. Nominal duration of the course	Diploma of Engineering Technology – a minimum of 900 hours Advanced Diploma of Engineering Technology – a minimum of 1750 hours
2. Vocational or educational outcomes <i>Standard 1 AQTF Standards for Accredited Courses</i>	
2.1. Purpose of the course	<p>The Diploma/Advanced Diploma of Engineering Technology are designed to qualify graduates for employment opportunities at para professional level in a range of engineering, manufacturing and related industries roles.</p> <p>The courses allow for direct entry of school leavers as well as catering for tradespersons and technicians who wish to upskill for entry into para professional positions.</p> <p>Graduates of these courses will have the knowledge and skills to contribute to the capability of the engineering, manufacturing and related industries to maintain their competitiveness in a global market place through the application of advanced engineering and manufacturing practices, value adding to existing products and services and the development of new and innovative products, services and production processes.</p> <p>Specifically graduates of the Diploma of Engineering Technology will be able to:</p> <ul style="list-style-type: none"> <li>• implement and utilise engineering solutions in mechanical, civil and manufacturing engineering applications requiring substantial theoretical concepts</li> <li>• analyse, diagnose and plan with respect to mechanical, civil construction and manufacturing engineering solutions that have a basis in engineering technology</li> <li>• use complex technical information and concepts to plan and implement solutions for a range of engineering environments and contexts</li> <li>• troubleshoot interfacing problems between disparate technical or engineering systems</li> <li>• provide substantial support in managing complex projects within given time and budgetary constraints</li> <li>• manage prescribed technical objectives within organisations that have outputs based on engineering application.</li> </ul> <p>Graduates of the Advanced Diploma of Engineering Technology will be able to:</p> <ul style="list-style-type: none"> <li>• recall and apply engineering and scientific principles in designing mechanical, civil and manufacturing engineering applications based on a well-founded specialist knowledge domain</li> <li>• analyse, diagnose, design and execute judgments with respect to mechanical, civil construction and manufacturing solutions that have a basis in engineering technology</li> <li>• prepare a brief on technical solutions and concepts with options for various engineering environments and contexts</li> </ul>

	<ul style="list-style-type: none"> <li>• integrate and solve interfacing problems between disparate technical or engineering systems</li> <li>• manage complex projects on time and within budget</li> <li>• manage autonomously a range of technical objectives within organisations that have outputs based on engineering application.</li> </ul>
<b>3. Development of the course      <i>Standards 1 and 2 AQTF Standards for Accredited Courses</i></b>	
<b>3.1. Industry / enterprise/ community needs</b>	<p>The engineering, manufacturing and related industries are extremely diverse. They encompass a broad range of industries such as: transport, electrical and electronics, machinery, aerospace and aviation, defence, chemicals and plastics, medical, pharmaceuticals, new energy technology, fabricated metals, non-metallic products, textiles, clothing and footwear (TCF) and food processing.</p> <p>The engineering, manufacturing and related industries are also the cornerstone of the Victorian economy. Victoria is the home of over 13,000 manufacturing firms employing approximately 280,000 people - the State's largest employer, and represents a significant share (about \$27.7 billion or 10%) of the Victoria's gross domestic product (GDP) output.</p> <p>Manufacturing is a changing industry. It is now more complex with inter-dependencies between services, design, and digital technologies and growing connections across value chains. Many of the jobs in the manufacturing industry are now non-production roles and relate to research and development, design, supply chain and logistics, customised goods, post-sales support and services.</p> <p>Victoria's engineering and manufacturing industry leads the nation in research and development (R&amp;D) spending, which not only includes new product development, but also new and innovative manufacturing technologies and production processes. A number of global companies have based their R&amp;D design and engineering operations in Victoria to take advantage of local capabilities. A number of defence related R&amp;D facilities are based in Victoria and includes BAE Systems, Thales, Siemens, BMT Design and Technology and Lockheed Martin. The automotive industry (Ford, GMH and Toyota) have also retained and expanded their R&amp;D facilities in Victoria even though vehicle manufacturing ceased in Australia at the end of 2017.</p> <p>It is important for the State's current and future economy that there continues to be a ready supply of well-trained engineering graduates to meet the industry's need to continue to develop world class products and innovative manufacturing practices to remain competitive in global markets.</p> <p>The current 22229VIC/22228VIC Diploma/Advanced Diploma of Engineering Technology have a sound track record of meeting the engineering and manufacturing industries requirements for well-trained technician and para professional engineers with 92% graduates either employed or completing further study. These courses have provided a post-secondary school/non trade study pathway into the engineering/manufacturing industry for a significant number of years. Enrolments numbers have remained healthy and consistent for the past four years (see Item 3.2 for actual figures) and it is anticipated annual enrolments for the revised qualifications will be similar.</p> <p>Although the current MEM05 Metals and Engineering Training Package Diploma/Advanced Diploma qualifications:</p> <ul style="list-style-type: none"> <li>– MEM50105 Diploma of Engineering - Advanced Trades</li> </ul>

- MEM50212 Diploma of Engineering - Technical
- MEM60112 Advanced Diploma of Engineering

have been updated they continue to have a post trade focus and lack the units of competency that a para profession engineer/technician will require in an advanced manufacturing environment where integration of a range of technologies is becoming the norm rather than the exception. It should be noted however, a large number of existing training package units including a significant number of MEM units have been evaluated and considered suitable for inclusion in each qualification.

The CMM-Engineering Industries will work with relevant Skills Service Organisation (IBSA) now responsible for the MEM training package to upgrade the MEM qualifications with the aim that in the longer term, the Victorian accredited courses can be superseded by qualifications from the MEM training package.

For the reaccreditation of the Diploma and Advanced Diploma of Engineering Technology there has been an extensive review of the existing courses and as consequence a number of changes have been made to ensure the qualifications retain their relevance for the Victorian engineering, manufacturing and related industries.

The re-accredited Diploma and Advanced Diploma of Engineering Technology are designed to:

- generate a training pathway for both new entrants and mature age learners to gain higher-level skills in manufacturing, engineering and related industries
- provide skills and knowledge at para professional level that will assist industry to stay competitive in the global market place
- provide the knowledge and skills to enable industry to add value to its' products and services and play an ongoing role in the economic wellbeing of Victoria.

A Project Steering Committee was established to advise on the review and redevelopment of the courses and to confirm their alignment to industry current and future needs.

The membership of the committee are:

Alan Bradley – (Chairperson)	Engineers Australia – Accreditation Consultant
Greg Warren	Metal, Engineering Skills Advisory Body (MESAB)
Craig Hilton	Australian Industry Group (AiGroup)
Shanti Krishnan	Swinburne University of Technology
Tony Cheers	Hydraulics Specialists Australia
Geoff Wallace	VicRoads
Ian Turnbull	Applied Technology Training and Consulting Australia
Tony Ross	Hospira Company
Arvind Sharma	RMIT
Stuart Gurney	ANCA Pty Ltd
Nick Miller	Australian Industry Group (AiGroup)

	<p>In Attendance:</p> <p>George Adda      Box Hill Institute</p> <p>Dennis Crowley   Box Hill Institute</p> <p>Mark Patman      ANCA</p> <p>Md Aftabuzzaman   Melbourne Polytechnic</p> <p>Robert Presutti    Melbourne Polytechnic</p> <p>These courses:</p> <ul style="list-style-type: none"><li>– do not duplicate, by title or coverage, the outcomes of an endorsed training package qualification</li><li>– are not a subset of a single training package qualification that could be recognized through one or more statements of attainment or a skill set</li><li>– do not include units of competency additional to those in a training package qualification that could be recognised through statements of attainment in addition to the qualification</li><li>– do not comprise units that duplicate units of competency of a training package qualification.</li></ul>															
<p><b>3.2. Review for re-accreditation</b></p>	<p>An extensive review of the current courses was undertaken by the CMM Engineering Industries under the guidance of the Project Steering Committee which included:</p> <ul style="list-style-type: none"><li>– examination of the enrolments history for both qualifications for the past four years (see table below)</li></ul> <table><tr><th>Qualification</th><th>2014</th><th>2015</th><th>2016</th><th>2017</th></tr><tr><td>22229VIC Diploma of Engineering Technology</td><td>380</td><td>431</td><td>405</td><td>345</td></tr><tr><td>22228VIC Advanced Diploma of Engineering Technology</td><td>938</td><td>945</td><td>1074</td><td>1056</td></tr></table> <p>(Totals include both Government funded and Fee for Service enrolments)</p> <ul style="list-style-type: none"><li>– examination of the delivery history of all units in both qualifications over the past four years</li><li>– assessment of the feedback gathered from RTOs including student surveys</li><li>– review of the currency of existing units</li><li>– research of the industry changes/needs especially the impact of advanced manufacturing requirements and</li><li>– preparation of a skills and knowledge profile for each industry stream at Diploma and Advanced Diploma level (refer Appendices 4 and 5).</li></ul> <p>In addition, the Project Steering Committee requested that the structure of the reaccredited courses should continue to provide:</p> <ul style="list-style-type: none"><li>• maximum flexibility to learners when choosing units of competency</li><li>• maximum flexibility for industry in selecting the required skill profiles and</li><li>• the option within each course’s rules to import additional units of competency from endorsed training packages, if they are relevant to industry, enterprises and/or learners.</li></ul> <p>To meet these requirements, a core and electives’ model for both courses has been maintained and the course rules continue to provide as much flexibility as possible when selecting elective units yet at the same time ensuring the integrity of each qualification. In particular:</p>	Qualification	2014	2015	2016	2017	22229VIC Diploma of Engineering Technology	380	431	405	345	22228VIC Advanced Diploma of Engineering Technology	938	945	1074	1056
Qualification	2014	2015	2016	2017												
22229VIC Diploma of Engineering Technology	380	431	405	345												
22228VIC Advanced Diploma of Engineering Technology	938	945	1074	1056												

	<ul style="list-style-type: none"> <li>– the core units of both qualification have been reviewed and reduced to ensure there are only units contained in each qualification that have relevance to all streams</li> <li>– course streams for each qualification were extensively reviewed resulting in some rationalisation e.g. Robotics and Control Systems stream units were integrated to form a new Automation Systems Engineering/Design stream. In addition, most streams have been renamed to reflect their emphasis at each qualification level and current industry nomenclature</li> <li>– all individual stream units were reviewed to ensure their relevance and if imported, they are the current version.</li> </ul> <p>The 22478VIC Diploma of Engineering Technology and the 22479VIC Advanced Diploma of Engineering Technology are deemed as <b>not equivalent</b> to the 22229VIC Diploma of Engineering Technology and the 22228VIC Advanced Diploma of Engineering Technology. There can be no new enrolments in the 22229VIC or 22228VIC after <b>30 June 2018</b>. Transition arrangements between the current and new courses are provided in the <b>Transition Tables</b> – refer <b>Appendix 1</b>.</p>
<b>4. Course outcomes</b>	<b>Standards 1, 2, 3 and 4 AQTF Standards for Accredited Courses</b>
<b>4.1. Qualification level</b>	<p>The 22478VIC Diploma of Engineering Technology aligns to the Diploma level of the Australian Qualifications Framework (AQF) in that graduates will have:</p> <p><b>Knowledge:</b></p> <ul style="list-style-type: none"> <li>• technical and theoretical knowledge and concepts, with depth in some areas within the field of engineering technology</li> </ul> <p><b>Skills:</b></p> <ul style="list-style-type: none"> <li>• cognitive and communication skills to identify, analyse, synthesise and act on information from a range of engineering/manufacturing sources</li> <li>• cognitive, technical and communication skills to analyse, plan, design and evaluate approaches to unpredictable problems and/or management requirements in the field of engineering/manufacturing</li> <li>• specialist technical and creative skills to express ideas and perspectives in their chosen engineering/manufacturing specialisation</li> <li>• communication skills to transfer knowledge and specialist skills to others and demonstrate understanding of engineering/manufacturing technology</li> </ul> <p><b>Application of knowledge and skills:</b></p> <p>Graduate of the Diploma will demonstrate the application of knowledge and skills:</p> <ul style="list-style-type: none"> <li>– with depth in areas of specialisation, in known and changing contexts</li> <li>– to transfer and apply theoretical concepts and/or technical and/or creative skills in a range of engineering/manufacturing situations</li> <li>– with personal responsibility and autonomy in performing complex technical operations with responsibility for own outputs in relation to broad parameters for quantity and quality</li> <li>– with initiative and judgment to organise the work of self and others and plan, coordinate and evaluate the work of teams within broad, but generally well defined parameters</li> </ul>



	<p>The Volume of Learning for the Diploma of Engineering Technology is typically 1 - 2 years. This is made up of structured tuition and assessments, plus unstructured learning such as locating and gathering information for assignments and project work, investigating pathway options for further study and/or future employment in the engineering, manufacturing or related industry.</p> <p>The 22479VIC Advanced Diploma of Engineering Technology aligns to the Advanced Diploma level of the Australian Qualifications Framework (AQF) in that graduates will have:</p> <p><b>Knowledge:</b></p> <ul style="list-style-type: none"> <li>specialised and integrated technical and theoretical knowledge with depth within one or more fields of engineering/manufacturing technology</li> </ul> <p><b>Skills:</b></p> <ul style="list-style-type: none"> <li>cognitive, communication skills to identify, analyse, synthesise and act on information from a range of sources for various engineering/manufacturing activities</li> <li>cognitive and communication skills to transfer knowledge and skills to others and to demonstrate understanding of specialised knowledge with depth in some areas of engineering and/or manufacturing</li> <li>cognitive and communication skills to formulate responses to complex engineering/manufacturing problems</li> <li>wide-ranging specialized technical, creative or conceptual skills to express ideas and perspectives within an engineering or manufacturing context</li> </ul> <p><b>Application of knowledge and skills:</b></p> <p>Graduate of the Advanced Diploma will demonstrate the application of knowledge and skills:</p> <ul style="list-style-type: none"> <li>with depth in areas of engineering/manufacturing specialisation, in contexts subject to change</li> <li>with initiative and judgment in planning, design, technical or management functions in engineering/manufacturing, with some direction;</li> <li>to adapt a range of fundamental principles and complex techniques to known and unknown situations within their area of engineering/manufacturing specialisation</li> <li>across a broad range of technical or management engineering/manufacturing functions, with accountability for personal outputs and personal and team outcomes within broad parameters</li> </ul> <p>The Volume of Learning for the Advanced Diploma of Engineering Technology is typically 1.5 - 2 years. This is made up of structured tuition and assessments, plus unstructured learning such as research for assignment and project work, investigating pathway options for further study and/or future employment in the engineering, manufacturing or related industry.</p>
<p><b>4.2. Employability skills</b></p>	<p><i>Standard 4 AQTF Standards for Accredited Courses</i></p> <p>The Employability Skills Summary for the 22478VIC Diploma of Engineering Technology and 22479VIC Advanced Diploma of Engineering Technology are provided as Appendix 2 and 3.</p>



<b>4.3. Recognition given to the course (if applicable)</b>	Standard 5 AQTF Standards for Accredited Courses Not Applicable
<b>4.4. Licensing/regulatory requirements (if applicable)</b>	Standard 5 AQTF Standards for Accredited Courses No licensing, legislative, regulatory or certification requirements apply to these courses at the time of publication.
<b>5. Course rules</b> <i>Standards 2, 6,7 and 9 AQTF Standards for Accredited Courses</i>	
<p><b>5.1 Course structure</b></p> <p><b>22478VIC Diploma of Engineering Technology</b></p> <p>To fulfil the requirements for the qualification learners must complete a minimum of <b>900 hours</b> of formal training consisting of:</p> <ul style="list-style-type: none"> <li>all the core units listed in <b>Table 1</b> making up <b>400 hours</b></li> <li>elective units to a <i>minimum</i> of <b>500 hours</b></li> </ul> <p>The choice of elective units should be relevant to the student's vocational needs and must be made up of:</p> <ul style="list-style-type: none"> <li><b>500 hours</b> drawn from <b>Table 2</b> or</li> <li>a <i>maximum</i> of <b>150 hours</b> drawn from other endorsed training packages or accredited courses provided the units of competency are at the appropriate AQF level, relevant to an engineering/manufacturing job function, and the balance (<b>minimum 350 hours</b>) drawn from <b>Table 2</b></li> </ul> <p>Note:</p> <p>To receive the Diploma of Engineering Technology with a <b>designated stream attached</b> e.g.</p> <p style="text-align: center;"><i>Diploma of Engineering Technology</i> (Civil Engineering)</p> <p>a minimum of <b>300 hours</b> of units from a designated stream as listed in <b>Table 2</b> must be completed.</p> <p>Learners exiting the course prior to completion will be issued with a Statement of Attainment listing those units of competency they have successfully completed.</p> <p><b>Note:</b> Any units of competency used in the Diploma chosen from the Advanced Diploma (Table 4) cannot be credited towards the hours required to complete the Advanced Diploma</p>	

### Diploma Designated streams:

<b>Diploma of Engineering Technology</b>
Mechanical Engineering
Civil Engineering
Automation Systems Engineering
Mechatronic Engineering
Fluid Power
Manufacturing Systems
Engineering Management
Engineering Maintenance Management

**Table 1 – Diploma of Engineering Technology (Core Units)**

Unit Code	Field of Education code	Unit Title	Pre-requisite	Nominal hours
MEM16006A		Organise and communicate information	Nil	20
MEM16008A		Interact with computing technology	Nil	20
MEM22001A		Perform engineering activities	MEM16006A	60
MEM22002A		Manage self in an engineering environment	MEM16006A	40
MEM23004A		Apply technical mathematics	Nil	80
MEM30007A		Select common engineering materials	Nil	40
MEM30031A		Operate computer-aided design (CAD) system to produce basic drawing elements	Nil	40
VU22451	030799	Investigate advanced technology applications in the manufacturing industry and related industries	Nil	60
VU22452	031305	Use communication network concepts and practices in manufacturing and engineering applications	Nil	40
<b>Total nominal hours of core units</b>				<b>400</b>

**Table 2 – Diploma Designated Stream Electives:**

Unit of competency code	Field of Education Code	Unit of competency title	Pre-requisite	Nominal duration
<b>Mechanical Engineering</b>				
VU22453	030799	Handle engineering materials	Nil	20
VU22330	030199	Select and interpret drawings and prepare three dimensional (3D) sketches and drawings	Nil	20
VU22471	030199	Utilise Augmented Reality (AR) technology for manufacturing	Nil	40
VU22472	030799	Apply electrotechnology principles in an engineering work environment	Nil	20
VU22473	030709	Prepare and document a work plan to fabricate an engineering product or component	Nil	20
VU22474	030701	Apply principles of strength of materials to engineering problems	Nil	60
VU22475	030701	Apply scientific principles to engineering problems	Nil	60
VU22476	031301	Plan for the implementation of mechanical drive systems	Nil	60
VU22477	031301	Select rotating electrical machines	Nil	40
VU22478	031301	Design and prototype components and/or small structures using engineering design principles	Nil	60
VU22479	030703	Apply fluid mechanic principles in mechanical engineering	Nil	80

VU22480	030701	Implement basic materials science principles to engineering applications	Nil	40
VU22481	031305	Apply network concepts and practices for engineering systems	Nil	40
VU22482	030701	Use advanced mathematics for engineering	Nil	60
CPCCWHS1001		Prepare to work safely in the construction industry	Nil	6
MEM09002B		Interpret technical drawing	Nil	40
MEM13014A		Apply principles of occupational health and safety in the work environment	Nil	10
MEM23005A		Apply statistics and probability techniques to engineering tasks	MEM23004A	40
MEM23006A		Apply fluid and thermodynamics principles in engineering	MEM23004A	80
MEM23007A		Apply calculus to engineering tasks	MEM23004A	80
MEM23008A		Apply advanced algebra and numerical methods to engineering tasks	MEM23004A	120
MEM23063A		Select and test mechanical engineering materials	MEM23004A MEM23109A	60
MEM23109A		Apply engineering mechanics principles	MEM23004A	60
MEM23114A		Evaluate thermodynamic systems and components	MEM23004A MEM23006A	60
MEM24012C		Apply metallurgy principles	Nil	40
MEM30012A		Apply mathematical techniques in a manufacturing engineering or related environment	Nil	40
MEM30029A		Use workshop equipment and processes to complete an engineering project	Nil	60
MSMENV272		Participate in environmentally sustainable work practices	Nil	30
<b>Civil Engineering</b>				
VU22330	030199	Select and interpret drawings and prepare three dimensional (3D) sketches and drawings	Nil	20
VU22471	030199	Utilise Augmented Reality (AR) technology for manufacturing	Nil	40
VU22478	031301	Design and prototype components and/or small structures using engineering design principles	Nil	60
VU22482	030701	Use advanced mathematics for engineering	Nil	60
VU22484	030901	Implement site investigation procedures	Nil	60
VU22485	030901	Apply construction principles to civil engineering works	Nil	60
VU22486	030911	Apply principles of materials testing to civil engineering applications	Nil	60
VU22487	030901	Apply surveying for civil engineering projects	Nil	40
VU22488	030901	Perform measurements and layout tasks on construction site	Nil	40
VU22489	030903	Produce reinforced concrete drawings	Nil	40
VU22490	030903	Produce structural steel drawings	Nil	40
VU22491	030903	Produce structural steel shop drawings	Nil	40
VU22492	030901	Produce engineering drawings for a rural road	Nil	40
VU22493	030901	Produce drawings to enable urban road construction	Nil	40
VU22494	030907	Produce engineering drawings for a stormwater reticulation scheme	Nil	20

CPCCWHS1001		Work safely in the construction industry	Nil	6
CPPBDN4004		Set up BIM-capable software and files for building design drafting projects	Nil	40
CPCCBC4004A		Identify and produce estimated costs for building and construction projects	Nil	60
MEM09002B		Interpret technical drawing	Nil	40
MEM23109A		Apply engineering mechanics principles	MEM23004A	60
MEM30012A		Apply mathematical techniques in a manufacturing engineering or related environment	Nil	40
MSMENV272		Participate in environmentally sustainable work practices	Nil	30
<b>Automation Systems Engineering</b>				
VU22471	030199	Utilise Augmented Reality (AR) technology for manufacturing	Nil	40
VU22482	030701	Use advanced mathematics for engineering	Nil	60
VU22495	031301	Analyse the performance of AC motors	Nil	80
VU21170	031301	Implement and maintain control systems for industrial processes	Nil	120
VU21172	030199	Apply instrumentation principles to industrial control systems	Nil	80
VU21173	031301	Interface control systems to industrial processes and analyse data from SCADA systems	Nil	120
VU21174	031301	Program control systems	Nil	60
VU22496	031301	Utilise analog electronics for control applications	Nil	60
VU21176	031301	Utilise digital electronics for control applications	Nil	60
VU21270	031301	Implement control processes using PLCs	Nil	80
VU22497	030199	Annotate and create assemblies using solid models	Nil	80
VU22498	031301	Interface and program mechatronics engineering systems	Nil	60
VU21232	030701	Program, operate and select a robotics system	Nil	60
MEM09002B		Interpret technical drawing	Nil	40
MEM09009C		Create 2D drawings using computer aided design system	MEM09002B MEM16008A	80
MEM09010C		Create 3D models using computer aided design system	MEM09002B MEM09009C MEM16008A	40
MEM10004B		Enter and change programmable controller operational parameters	MEM09002B MEM16008A	20
MEM10005B		Commission programmable controller programs	MEM09002B MEM10004B MEM16008A	40
MEM23003A		Operate and program computers and/or controllers in engineering situations	MEM16008A	80
MEM23007A		Apply calculus to engineering tasks	MEM23004A	80
MEM23109A		Apply engineering mechanics principles	MEM23004A	60
MEM23111A		Select electrical equipment and components for engineering applications	MEM23004A	40
MEM23112A		Investigate electrical and electronic controllers in engineering applications	MEM23004A MEM23111A	40
MEM30027A		Prepare basic programs for programmable logic controllers	Nil	20

Mechatronic Engineering				
VU22330	030199	Select and interpret drawings and prepare three dimensional (3D) sketches and drawings	Nil	20
VU22471	030199	Utilise Augmented Reality (AR) technology for manufacturing	Nil	40
VU22472	030799	Apply electrotechnology principles in an engineering work environment	Nil	20
VU22479	030703	Apply fluid mechanic principles in mechanical engineering	Nil	80
VU22482	030701	Use advanced mathematics for engineering	Nil	60
VU21170	031301	Implement and maintain control systems for industrial processes	Nil	120
VU21172	030199	Apply instrumentation principles to industrial control systems	Nil	80
VU21174	031301	Program control systems	Nil	60
VU21176	031301	Utilise digital electronics for control applications	Nil	60
VU21270	031301	Implement control processes using PLCs	Nil	80
VU22498	031301	Interface and program mechatronics engineering systems	Nil	60
VU21232	031301	Program, operate and select a robotics system	Nil	60
VU21546	030703	Monitor and adjust an integrated fluid power control system	MEM23006A VU21270 VU21547	60
VU21547	030703	Select components for an integrated fluid power design project	MEM23006A VU21546	40
VU21549	030703	Conduct a feasibility study for an integrated fluid power system	MEM23006A VU21546 VU21547 VU21548 VU21270	80
VU22497	030199	Annotate and create assemblies using solid models	Nil	80
MEM09002B		Interpret technical drawing	Nil	40
MEM09009C		Create 2D drawings using computer aided design system	MEM09002B MEM16008A	80
MEM09010C		Create 3D models using computer aided design system	MEM09002B MEM09009C MEM16008A	40
MEM09155A		Prepare mechanical models for computer-aided engineering	MEM23004A MEM23109A	60
MEM09156A		Prepare mechatronic models for computer-aided engineering (CAE)	MEM23004A MEM23109A MEM23111A MEM23112A	60
MEM10005B		Commission programmable controller programs	MEM09002B MEM10004B MEM16008A	40

MEM23003A		Operate and program computers and/or controllers in engineering situations	MEM16008A	80
MEM23006A		Apply fluid and thermodynamics principles in engineering	MEM23004A	80
MEM23109A		Apply engineering mechanics principles	MEM23004A	60
MEM23111A		Select electrical equipment and components for engineering applications	MEM23004A	40
MEM23112A		Investigate electrical and electronic controllers in engineering applications	MEM23004A MEM23111A	40
MEM30027A		Prepare basic programs for programmable logic controllers	Nil	20
MEM30029A		Use workshop equipment and processes to complete an engineering project	Nil	60
<b>Fluid Power</b>				
VU22471	030199	Utilise Augmented Reality (AR) technology for manufacturing	Nil	40
VU22482	030701	Use advanced mathematics for engineering	Nil	60
VU22499	030703	Apply hydraulic principles to achieve an engineering task	Nil	60
VU22500	030703	Apply pneumatic principles to achieve an engineering task	Nil	60
VU21545	030703	Evaluate proportional and servo controlled fluid power systems	MEM23006A VU21546 VU21547 VU21548 VU21270	80
VU21546	030703	Monitor and adjust an integrated fluid power control system	MEM23006A VU21270 VU21547	60
VU21547	030703	Select components for an integrated fluid power design project	MEM23006A VU21546	40
VU21548	030703	Install and commission an integrated fluid power system	MEM23006A VU21270 VU21547	80
VU21549	030703	Conduct a feasibility study for an integrated fluid power system	MEM23006A VU21546 VU21547 VU21548 VU21270	80
VU21551	030703	Test and monitor fluid power circuits	Nil	60
VU21609	030703	Install and maintain hydraulic/pneumatic systems	Nil	60
VU22497	030199	Annotate and create assemblies using solid models	Nil	80
MEM09002B		Interpret technical drawing	Nil	40
MEM09009C		Create 2D drawings using computer aided design system	MEM09002B MEM16008A	80
MEM09010C		Create 3D models using computer aided design system	MEM09002B MEM09009C MEM16008A	40

MEM09213A		Produce schematic drawings for hydraulic and pneumatic fluid power systems	MEM09002B MEM09204A	60
MEM12023A		Perform engineering measurements	Nil	30
MEM18001C		Use hand tools	Nil	20
MEM18002B		Use power tools/hand held operations	Nil	20
MEM18052B		Maintain fluid power systems for mobile plant	MEM09002B MEM12023A MEM18001C MEM18002B MEM18055B	40
MEM18055B		Dismantle, replace and assemble engineering components	MEM09002B MEM12023A MEM18001C MEM18002B	30
MEM23007A		Apply calculus to engineering tasks	MEM23004A	80
MEM23109A		Apply engineering mechanics principles	MEM23004A	60
MEM30010A		Set up basic hydraulic circuits	Nil	40
MEM30011A		Set up basic pneumatic circuits	Nil	40
<b>Manufacturing Systems</b>				
<b>Production</b>				
VU22501	030101	Set up manufacturing processes for engineering applications	Nil	40
VU22502	030101	Design jigs and fixtures for manufacturing	Nil	40
MEM23134A		Evaluate jigs and fixtures	MEM23004A MEM23109A	40
MEM30014A		Apply basic just in time systems to the reduction of waste	Nil	40
<b>CAD (Drafting)</b>				
VU22330	030199	Select and interpret drawings and prepare three dimensional (3D) sketches and drawings	Nil	20
VU22497	030199	Annotate and create assemblies using solid models	Nil	80
VU22503	030199	Create and modify surfaces for simple consumer products	Nil	80
MEM09002B		Interpret technical drawing	Nil	40
MEM09009C		Create 2D drawings using computer aided design system	MEM09002B MEM16008A	80
MEM09010C		Create 3D models using computer aided design system	MEM09002B MEM09009C MEM16008A	40
MEM09011B		Apply basic engineering design concepts	MEM09002B	60
MEM09022A		Create 2D code files using computer aided manufacturing system	MEM09002B MEM16008A MEM12023A	40



MEM09023A		Create 3D code files using computer aided manufacturing system	MEM09002B MEM16008A MEM12023A MEM09022A	60
MEM09155A		Prepare mechanical models for computer-aided engineering	MEM23004A MEM23109A	60
MEM09156A		Prepare mechatronic models for computer-aided engineering (CAE)	MEM23004A MEM23109A MEM23111A MEM23112A	60
MEM09157A		Perform mechanical engineering design drafting	Nil	80
MEM09158A		Perform mechatronics engineering design drafting	Nil	80
<b>Computer Numerical Control</b>				
VU22504	030101	Program a 3D milling machine centre	Nil	60
VU22505	030101	Write and modify basic CNC programs	Nil	40
VU22506	030101	Write advanced CNC programs and operate a vertical machining centre	Nil	80
VU22507	030101	Write advanced CNC programs and operate a multi axis turning centre	Nil	60
VU22508	030101	Produce engineering components by programming and operating a CNC manufacturing cell	Nil	60
VU22509	030101	Apply computer aided manufacturing (CAM) processes	Nil	40
VU22510	030101	Apply computer aided manufacturing (CAM) 2D programming	Nil	40
VU22511	030101	Apply computer aided manufacturing (CAM) lathe programming	Nil	40
<b>Metrology</b>				
VU22512	030101	Conduct and analyse precision engineering measurements	Nil	40
VU22513	030101	Apply principles of metrology in manufacturing	Nil	60
<b>Engineering Management</b>				
<b>Management and Quality Management</b>				
BSBINM601		Manage knowledge and information	Nil	80
BSBMGT502		Manage people performance	Nil	70
BSBMGT517		Manage operational plan	Nil	70
BSBMGT605		Provide leadership across the organisation	Nil	60
BSBMGT608		Manage innovation and continuous improvement	Nil	70
BSBPMG411		Apply project quality management techniques	Nil	40
BSBPMG414		Apply project information management and communications techniques	Nil	40
BSBPMG513		Manage project quality	Nil	40
BSBPMG516		Manage project information and communication	Nil	40

BSBPMG521		Manage project integration	Nil	60
BSBPMG522		Undertake project work	Nil	60
BSBPMG605		Direct quality management of a project program	Nil	50
BSBPMG609		Direct procurement and contract for a project program	Nil	50
BSBREL402		Build client relationships and business networks	Nil	50
BSBRISK501		Manage risk	Nil	60
BSBSUS501		Develop workplace policy and procedures for sustainability	Nil	50
BSBWHS501		Ensure a safe workplace	Nil	60
BSBWHS507		Contribute to managing WHS information systems	Nil	50
MEM14005A		Plan a complete activity	Nil	20
MEM14091A		Integrate manufacturing fundamentals into an engineering task	MEM23004A	60
MEM16010A		Write reports	MEM14005A	20
MEM22012A		Coordinate resources for an engineering project or operation	Nil	60
MEM22013A		Coordinate engineering projects	Nil	60
MEM22014A		Coordinate engineering-related manufacturing operations	MEM23004A MEM14091A	60
MSS015002		Develop strategies for more sustainable use of resources	Nil	70
MSS015007		Develop a business case for sustainability improvements	Nil	50
MSS015008		Develop strategic sustainability plans	Nil	100
MSS405001		Develop competitive systems and practices for an organisation	Nil	60
MSS405030		Optimise cost of a product or service	Nil	60
MSS404052		Apply statistics to operational processes	Nil	40
MSS405075		Facilitate the development of a new product	MSS404052	80
MSMSUP400		Develop and monitor quality systems	Nil	50
<b>Supply Chain Management</b>				
VU22514	089901	Manage inventory and operational controls within the supply chain	Nil	80
VU22515	089901	Manage supply chain forecasting and materials planning	Nil	80
VU22516	089901	Manage supply chain quality	Nil	80
VU22517	089901	Manage and maintain supply chain network communication and relationships	Nil	80
VU22518	089901	Manage global sourcing and supply of domestic supply chains	Nil	100
VU22519	089901	Manage warehouse packaging, materials handling and operational performance	Nil	60
VU22528	089901	Manage and review supply chain continuous improvement and benchmarked performance	Nil	80
VU22529	089901	Perform competitive bidding, contract preparation and contract management tasks	Nil	100
TLIL5055		Manage a supply chain	Nil	60
TLIR5006		Develop, implement and review purchasing strategies	Nil	60

TLIR5014		Manage suppliers	Nil	60
MEM30016A		Assist in the analysis of a supply chain	Nil	20
<b>Engineering Maintenance Management</b>				
VU22530	030199	Plan, implement and apply preventative maintenance procedures	Nil	80
VU22531	030199	Establish and manage maintenance systems	Nil	80
VU22532	030199	Select and apply lubrication principles	Nil	40
VU22533	030199	Maintain bearing and rotary shaft assemblies	Nil	40
VU22534	030199	Perform vibration measurement and control	Nil	60
MEM14088A		Apply maintenance engineering techniques to equipment and component repairs and modifications	MEM14092A	80
MEM14092A		Integrate maintenance fundamentals into an engineering task	MEM23004A	60
MEM23125A		Evaluate maintenance systems	MEM23004A MEM14088A MEM14092A	60
MEM30017A		Use basic preventative maintenance techniques and tools	Nil	40

### 5.1 Course structure (cont.)

#### 22479VIC Advanced Diploma of Engineering Technology

To fulfil the requirements for the qualification learners must complete a minimum of **1750 hours** of formal training consisting of:

- all the core units listed in **Table 3** making up **500 hours**
- elective units to a *minimum* of **1250 hours**

The choice of elective units should be relevant to the student's vocational needs and must be made up of:

- a minimum of **400 hours** of elective units must be drawn from **Table 4**.
- the balance of elective units are to be drawn from **Table 2** and/or **Table 4** or other endorsed training packages or accredited courses to a maximum of **150 hours** provided the units of competency are at the appropriate AQF level and relevant to an engineering/manufacturing job function.

**Note:** To receive the Advanced Diploma of Engineering Technology with a **designated stream attached** e.g.

*Advanced Diploma of Engineering Technology  
(Civil Engineering Design)*

a minimum of **600 hours** of units from a designated stream as listed also in **Table 2** and **Table 4** must be completed with a minimum of **400 Hours** of units from **Table 4**.

Learners exiting the course prior to completion will be issued with a Statement of Attainment listing those units of competency they have successfully completed.

**Note:** Any units of competency used in the Diploma chosen from the Advanced Diploma (**Table 4**) cannot be credited towards the hours required to complete the Advanced Diploma

#### Advanced Diploma Designated streams:

Advanced Diploma of Engineering Technology
Mechanical Engineering Design
Civil Engineering Design
Automation Systems Design
Mechatronic Engineering Design
Fluid Power Engineering Design
Integrated Manufacturing Systems

**Table 3 – Advanced Diploma of Engineering Technology (Core units)**

Unit code	Field of Education Code	Unit Title	Pre-requisites	Nominal duration
MEM16006A		Organise and communicate information	Nil	20
MEM16008A		Interact with computing technology	Nil	20
MEM22001A		Perform engineering activities	MEM16006A	60
MEM22002A		Manage self in an engineering environment	MEM16006A	40
MEM23004A		Apply technical mathematics	MEM16006A	80

MEM30007A		Select common engineering materials	Nil	40
MEM30031A		Operate computer-aided design (CAD) system to produce basic drawing elements	Nil	40
VU22451	030799	Investigate advanced technology applications in the manufacturing industry and related industries	Nil	60
VU22452	031305	Use communication network concepts and practices in manufacturing and engineering applications	Nil	40
MEM22013A		Coordinate engineering projects	Nil	60
MEM30033A		Use computer-operated design (CAD) to create and display 3-D models	MEM30031A	40
<b>Total nominal hours of core units</b>				<b>500</b>

**Table 4 – Advanced Diploma Designated Stream Electives:**

Unit of competency code	Field of Education Code	Unit of competency title	Pre-requisite	Nominal duration
<b>Mechanical Engineering Design</b>				
VU22535	030701	Apply advanced statics principles to engineering problems	MEM23007A MEM23109A	60
VU22536	030701	Apply advanced dynamics principles to engineering problems	VU22475	80
VU22537	030701	Apply finite element analysis	Nil	60
VU22538	030701	Design mechanical engineering systems	Nil	60
VU22539	030701	Design mechanical machines	Nil	80
VU22540	030701	Generate design solutions	Nil	60
VU22541	039999	Implement advanced materials science principles to engineering applications	Nil	60
VU22542	030199	Use advanced 2D & 3D computer aided drafting (CAD) techniques	Nil	80
MEM234003A		Design machines and ancillary equipment	Nil	60
MEM234004A		Design for engineering-related noise and vibration mitigation	Nil	60
MEM23120A		Select mechanical machine and equipment components	MEM23004A MEM23109A	80
MEM23121A		Analyse loads on frames and mechanisms	MEM23004A MEM23007A MEM23109A	80
MEM23138A		Evaluate suitability of materials for engineering-related applications	MEM23004A	40
<b>Civil Engineering Design</b>				
VU22535	030701	Apply advanced statics principles to engineering problems	MEM23007A MEM23109A	60

VU22474	030701	Apply principles of strength of materials to engineering problems	Nil	60
VU22475	030701	Apply scientific principles to engineering problems	Nil	60
VU22543	030903	Produce an advanced engineering design for a reinforced concrete structure	Nil	40
VU22544	030903	Produce an advanced engineering design for a steel structure	Nil	60
VU22545	030901	Apply environmental solutions to civil engineering projects	Nil	40
VU22546	030903	Apply principles of mechanics to engineering structures	Nil	40
VU22547	030907	Produce an engineering design for drainage pipes and culverts	Nil	60
VU22548	030907	Produce an engineering design for a stormwater reticulation scheme	Nil	40
VU22549	030907	Produce an engineering design for a sewerage reticulation scheme	Nil	40
VU22550	030903	Produce an engineering design for a reinforced concrete structure	Nil	40
VU22551	030903	Produce an engineering design for a steel structure	Nil	60
VU22552	030903	Produce advanced engineering drawings for a reinforced concrete structure	Nil	40
VU22553	030903	Produce advanced engineering drawings for a steel structure	Nil	40
VU22554	030901	Apply surveying computations to civil engineering projects	Nil	40
VU22555	030907	Analyse piping designs	Nil	80
VU22556	030901	Design process plant layout	VU22555	100
VU22557	030907	Design piping systems	VU22555	100
VU22558	030901	Analyse and design foundations and footings	Nil	40
VU22559	030901	Design timber structures	Nil	60
VU22542	030199	Use advanced 2D & 3D computer aided drafting (CAD) techniques	Nil	80
VU22560	030901	Produce geometric designs for roads	Nil	60
VU22561	030903	Analyse the strength of civil structural elements	MEM23109A	60
VU22562	030911	Apply principles of soil mechanics to civil engineering	MEM23004A	60
CPPBDN5013A		Develop and collaborate on building information models for small-scale building design projects	Nil	100
MEM23005A		Apply statistics and probability techniques to engineering tasks	MEM23004A	40
MEM23006A		Apply fluid and thermodynamics principles in engineering	MEM23004A	80
MEM23007A		Apply calculus to engineering tasks	MEM23004A	80
MEM23008A		Apply advanced algebra and numerical methods to engineering tasks	MEM23004A	120
<b>Automation Systems Design</b>				
VU22542	030199	Use advanced 2D & 3D computer aided drafting (CAD) techniques	Nil	80
VU22563	030703	Set up mechatronics engineering systems	Nil	60
VU22564	030701	Plan and manage a robotics system	Nil	60

MEM23116A		Evaluate programmable logic controller and related control system component applications	MEM23004A MEM23111A MEM23112A	60
MEM23117A		Evaluate microcontroller applications	MEM23004A MEM23111A MEM23112A	60
MEM234010A		Design microcontroller applications	Nil	40
MEM234011A		Design programmable logic controller applications	Nil	60
MEM23064A		Select and test mechatronic engineering materials	MEM23004A MEM23109A	60
MEM23126A		Evaluate industrial robotic applications	MEM23004A MEM23111A MEM23112A MEM23116A MEM23117A	60
MEM234014A		Design a robotic system	Nil	40
<b>Mechatronic Engineering Design</b>				
VU22535	030701	Apply advanced statics principles to engineering problems	MEM23007A MEM23109A	60
VU22536	030701	Apply advanced dynamics principles to engineering problems	VU22475	80
VU22474	030701	Apply principles of strength of materials to engineering problems	Nil	60
VU22475	030701	Apply scientific principles to engineering problems	Nil	60
VU22538	030701	Design mechanical engineering systems	Nil	60
VU22539	030701	Design mechanical machines	Nil	80
VU22563	030703	Set up mechatronics engineering systems	Nil	60
VU22498	030703	Interface and program mechatronics engineering systems	Nil	
VU22564	030701	Plan and manage a robotics system	Nil	60
VU22565	030703	Set up fluid power controlled engineering systems	Nil	80
VU22566	030703	Design fluid power controlled engineering systems	Nil	60
VU22542	030199	Use advanced 2D & 3D computer aided drafting (CAD) techniques	Nil	80
MEM23007A		Apply calculus to engineering tasks	MEM23004A	80
MEM23064A		Select and test mechatronic engineering materials	MEM23004A MEM23109A	60
MEM23109A		Apply engineering mechanics principles	MEM23004A	60
MEM23116A		Evaluate programmable logic controller and related control system component applications	MEM23004A MEM23111A MEM23112A	60
MEM23115A		Evaluate fluid power systems	MEM23004A MEM23006A	60
MEM23117A		Evaluate microcontroller applications	MEM23004A MEM23111A MEM23112A	60
MEM23120A		Select mechanical machine and equipment components	MEM23004A MEM23109A	80



MEM23126A		Evaluate industrial robotic applications	MEM23004A MEM23111A MEM23112A MEM23116A MEM23117A	60
MEM234003A		Design machines and ancillary equipment	Nil	60
MEM234004A		Design for engineering-related noise and vibration mitigation	Nil	60
MEM234010A		Design microcontroller applications	Nil	40
MEM234011A		Design programmable logic controller applications	Nil	60
MEM234014A		Design a robotic system	Nil	40
MEM234032A		Manage fluid power related technologies in an enterprise	Nil	40
<b>Fluid Power Engineering Design</b>				
VU22565	030703	Set up fluid power controlled engineering systems	Nil	80
VU22566	030703	Design fluid power controlled engineering systems	Nil	60
VU22542	030199	Use advanced 2D & 3D computer aided drafting (CAD) techniques	Nil	80
MEM23115A		Evaluate fluid power systems	MEM23004A MEM23006A	60
MEM234032A		Manage fluid power related technologies in an enterprise	Nil	40
<b>Integrated Manufacturing Systems</b>				
<b>Production</b>				
MEM23122A		Evaluate computer integrated manufacturing systems	MEM23004A MEM23111A MEM23112A	80
MEM23123A		Evaluate manufacturing processes	Nil	60
MEM23131A		Evaluate rapid prototyping applications	MEM23004A	60
MEM23132A		Evaluate rapid manufacturing processes	MEM23004A	60
MEM23133A		Evaluate rapid tooling applications	MEM23004A	60
<b>CAD (Drafting)</b>				
VU22542	030199	Use advanced 2D & 3D computer aided drafting (CAD) techniques	Nil	80
VU22567	030199	Use extended features of computer aided drafting (CAD)	Nil	40
VU22568	030199	Manage computer aided drafting (CAD) systems	Nil	40
VU22569	030199	Manage computer aided drafting (CAD) in a business	Nil	80
<b>Computer Numerical Control</b>				
VU22570	030301	Program 4th axis applications	Nil	60
VU22571	030301	Create advanced programs for CNC machine centres	Nil	60
<b>Metrology</b>				
VU22572	030701	Apply principles of advanced metrology in manufacturing	Nil	60
VU22573	030301	Program and set up co-ordinate measuring machines (CMM)	Nil	60

<b>5.2. Entry requirements</b>	<p><i>Standard 9 for Accredited Courses</i></p> <p>The Diploma/Advanced Diploma of Engineering Technology is designed to cater for a wide range of learner needs and educational backgrounds. Learners are best equipped to achieve the outcomes of the courses if they have minimum language, literacy and numeracy skills that are equivalent to level 3 of the Australian Core Skills Framework (ACSF).</p> <p>Details can be found on the website <a href="#">here</a>.</p>
<b>6. Assessment</b> <span style="float: right;"><b>Standards 10 and 12 AQTF Standards for Accredited Courses</b></span>	
<b>6.1. Assessment strategy</b>	<p>All assessment, including Recognition of Prior Learning (RPL) must be compliant with the requirements of:</p> <ul style="list-style-type: none"> <li>• Standard 1 of the Australian Quality Training Framework (AQTF): Essential Conditions and Standards for Initial/Continuing Registration and Guidelines 4.1 and 4.2 of the VRQA Guidelines for VET Providers,</li> <li>or;</li> <li>• the Standards for Registered Training Organisations 2015 (SRTOs),</li> <li>or;</li> <li>• the relevant standards and guidelines for Registered Training Organisations at the time of assessment.</li> </ul> <p>Assessment strategies must therefore ensure that:</p> <ul style="list-style-type: none"> <li>• all assessments are valid, reliable, flexible and fair</li> <li>• learners are informed of the context and purpose of the assessment and the assessment process</li> <li>• feedback is provided to learners about the outcomes of the assessment process and guidance given for future options</li> <li>• time allowance to complete a task is reasonable and specified to reflect the industry context in which the task takes place</li> </ul> <p>Assessment strategies should be designed to:</p> <ul style="list-style-type: none"> <li>• cover a range of skills and knowledge required to demonstrate achievement of the course aim</li> <li>• collect evidence on a number of occasions to suit a variety of contexts and situations</li> <li>• be appropriate to the knowledge, skills, methods of delivery and needs and characteristics of learners</li> <li>• be equitable to all groups of learners</li> </ul> <p>Assessment methods are included in each unit and include:</p> <ul style="list-style-type: none"> <li>• oral and/or written questioning</li> <li>• inspection of final process outcomes</li> <li>• portfolio of documented on-site work evidence</li> <li>• practical demonstration of required physical tasks</li> <li>• investigative research and case study analysis</li> </ul>

	<p>While the Evidence Guide in each unit provides information specific to the unit outcomes a holistic approach to assessment is encouraged. This may be achieved by combining the assessment of more than one unit where it better replicates working practice.</p> <p>Units maybe assessed on-the-job, of-the-job or a combination of both. Where assessment occurs off-the-job, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations.</p> <p>Assessment of the imported endorsed or accredited units must reflect the requirements of the Assessment Guidelines for the relevant training package or accredited course.</p>
<b>6.2. Assessor competencies</b>	<p><i>Standard 12 AQTF Standards for Accredited Courses</i></p> <p>Assessment must be undertaken by a person or persons in accordance with:</p> <ul style="list-style-type: none"> <li>• Standard 1.4 of the Australian Quality Training Framework (AQTF): Essential Conditions and Standards for Initial/Continuing Registration and Guideline 3 of the VRQA Guidelines for VET Providers,</li> <li>or;</li> <li>• <i>Standards for Registered Training Organisations 2015 (SRTOs)</i>, or;</li> <li>• the relevant standards and guidelines for RTOs at the time of assessment.</li> </ul> <p>Assessors of the imported endorsed or accredited units of competence must meet the requirements for assessors specified in the relevant training package or accredited course.</p>
<b>7. Delivery</b> <span style="float: right;"><b><i>Standards 11 and 12 AQTF Standards for Accredited Courses</i></b></span>	
<b>7.1. Delivery modes</b>	<p><i>Standard 11 AQTF Standards for Accredited Courses</i></p> <p>Delivery strategies should be selected to reflect the nature of the industry specific competencies, incorporating employability skills, and the need of the learner.</p> <p>Due to the potential for a dispersed distribution of learners, course providers may wish to consider non-traditional strategies in the delivery of training. The facilitation of distance learning and the achievement of competencies through workplace activities or on-the-job training should be fostered and encouraged where possible.</p> <p>It is recommended that the courses be conducted using project based delivery and assessment methods involving the clustering of units, to maximise opportunities for learners to have learning experiences which are as close as possible to a real-work environment.</p> <p>Delivery methods may include, but are not limited to:</p> <ul style="list-style-type: none"> <li>• classroom presentation</li> <li>• work-based projects</li> <li>• case study analyses</li> <li>• practical work</li> <li>• project-based learning encompassing the clustering of units</li> </ul> <p>Delivery of the imported endorsed and accredited units of competency must be consistent with the guidelines in the relevant training package or accredited course.</p>

<b>7.2. Resources</b>	<p><i>Standard 12 AQTF Standards for Accredited Courses</i></p> <p>Successful delivery of these courses requires access to current engineering systems and equipment. For this to occur, providers and engineering enterprises may form partnerships to deliver realistic and authentic training and assessment.</p> <p>The resources that should be available for these courses relate to normal work practice using procedures, information and resources typical of a workplace. This should include:</p> <ul style="list-style-type: none"> <li>• WHS/OHS policy and work procedures and instructions;</li> <li>• access to an engineering workplace environment</li> <li>• operational access to relevant machines, tools, materials, and consumables</li> <li>• access to relevant plans, drawing facilities, CAD system and relevant software and instructions</li> <li>• manufactures' specifications/manuals</li> </ul> <p>Training must be undertaken by a person or persons with competencies compliant with:</p> <ul style="list-style-type: none"> <li>• Standard 1.4 of the Australian Quality Training Framework (AQTF): Essential Conditions and Standards for Initial/Continuing Registration and Guidelines 3 of the VRQA Guidelines for VET providers,</li> </ul> <p>or;</p> <ul style="list-style-type: none"> <li>• The <i>Standards for Registered Training Organisations 2015</i> (SRTOs),</li> </ul> <p>or;</p> <ul style="list-style-type: none"> <li>• the relevant standards and guidelines for RTOs at the time of assessment.</li> </ul>
<b>8. Pathways and articulation</b>	<p>Applicants who have already successfully completed any endorsed or accredited unit of competency from previous study will receive direct credit transfer for the same unit/s in these courses. Likewise, graduates of these courses will also gain direct credit transfer of units successfully completed in any future courses containing the same units.</p> <p>The revised Diploma of Engineering Technology fully articulates into the revised Advanced Diploma of Engineering Technology. However, the transition table in Item 3.2 will need to be consulted for articulation/credit transfer arrangements for graduates who have completed an earlier version of the Diploma and wish to entry the new Advanced Diploma of Engineering Technology.</p> <p>There are no formal articulations arrangements between the Advanced Diploma and higher education courses.</p> <p>Providers intending to arrange articulation with other VET or higher education course should refer to the:</p> <p><a href="#">AQF Second Edition 2013 Pathways Policy</a></p>
<b>9. Ongoing monitoring and evaluation</b>	<p><i>Standard 13 AQTF Standards for Accredited Courses</i></p> <p>The Curriculum Maintenance Manager - Engineering Industries is responsible for the ongoing monitoring and maintenance of the courses during their accreditation period.</p>

	<p>The Curriculum Maintenance Manager - Engineering Industries will undertake a formal review of the courses at the mid - point of the accreditation period. The review will involve consultation with:</p> <ul style="list-style-type: none"> <li>• course participants and graduates</li> <li>• manufacturing and engineering industry representatives</li> <li>• teaching/assessing staff</li> </ul> <p>Any significant changes to the courses resulting from the review will be reported to the VRQA through a formal amendment process.</p> <p>The review of the courses may also indicate that the course or courses in total should be expired if a suitable qualification becomes available through the continuous improvement of a MEM05 Metals and Engineering Training Package.</p>
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## Appendix 1:

### Transition Table

22229VIC – Diploma of Engineering Technology 22228VIC – Advanced Diploma of Engineering Technology		22478VIC - Diploma of Engineering Technology 22479VIC - Advanced Diploma of Engineering Technology		
Unit code	Unit Title	Unit code	Unit Title	Comments
AUMATA5008	Produce drawings manually			Deleted
CPCCOHS1001A	Work safely in the construction industry	CPCCWHS1001	Work safely in the construction industry	Equivalent
		CPPBDN4004	Set up BIM-capable software and files for building design drafting projects	New Unit
		CPPBDN5013A	Develop and collaborate on building information models for small-scale building design projects	New Unit
		CPCCBBC4004A	Identify and produce estimated costs for building and construction projects	New Unit
		BSBMGT502	Manage people performance	New Unit
BSBMGT515A	Manage operational plan	BSBMGT517	Manage operational plan	Equivalent
		BSBMGT605	Provide leadership across the organisation	New Unit
		BSBMGT608	Manage innovation and continuous improvement	New Unit
		BSBINM601	Manage knowledge and information	New Unit
BSBPMG404A	Apply quality management techniques	BSBPMG411	Apply project quality management techniques	Equivalent
BSBPMG406A	Apply communication management techniques	BSBPMG414	Apply project information and communications techniques	Equivalent
		BSBPMG513	Manage project quality	New Unit
BSBPMG501A	Manage application of project integrative processes	BSBPMG521	Manage project integration	Equivalent
BSBPMG507A	Manage project communication	BSBPMG516	Manage project information and communication	Equivalent
BSBPMG510A	Manage projects	BSBPMG522	Undertake project work	Equivalent
		BSBPMG605	Direct quality management of a project program	New Unit
		BSBPMG609	Direct procurement and contract for a project program	New Unit
BSBREL402A	Build client relationships and business networks	BSBREL402	Build client relationships and business networks	Equivalent
		BSBRISK501	Manage risk	New Unit
		BSBSUS501	Develop workplace policy and procedures for sustainability	New Unit
		BSBWHS501	Ensure a safe workplace	New Unit
BSBWHS507A	Contribute to managing WHS information systems	BSBWHS507	Contribute to managing WHS information systems	Equivalent
		MEM09002B	Interpret technical drawing	New Unit
		MEM09009C	Create 2D drawings using computer aided design system	New Unit
		MEM09010C	Create 3D models using computer aided design system	New Unit

		MEM09011A	Apply basic engineering design concepts	New Unit
		MEM09022A	Create 2D code files using computer aided manufacturing system	New Unit
		MEM09023A	Create 3D code files using computer aided manufacturing system	New Unit
MEM09155A	Prepare mechanical models for computer-aided engineering	MEM09155A	Prepare mechanical models for computer-aided engineering	Equivalent
MEM09156A	Prepare mechatronic models for computer-aided engineering (CAE)	MEM09156A	Prepare mechatronic models for computer-aided engineering (CAE)	Equivalent
MEM09157A	Perform mechanical engineering design drafting	MEM09157A	Perform mechanical engineering design drafting	Equivalent
MEM09158A	Perform mechatronics engineering design drafting	MEM09158A	Perform mechatronics engineering design drafting	Equivalent
		MEM09213A	Produce schematic drawings for hydraulic and pneumatic fluid power systems	New Unit
		MEM10004B	Enter and change programmable controller operational parameters	New Unit
		MEM10005B	Commission programmable controller programs	New Unit
		MEM12023A	Perform engineering measurements	New Unit
MEM12024A	Perform computations			Deleted
MEM13014A	Apply principles of occupational health & safety in work environment	MEM13014A	Apply principles of occupational health & safety in work environment	Equivalent
		MEM14005A	Plan a complete activity	New Unit
		MEM14088A	Apply maintenance engineering techniques to equipment and component repairs and modifications	New Unit
		MEM14091A	Integrate manufacturing fundamentals into an engineering task	New Unit
		MEM14092A	Integrate maintenance fundamentals into an engineering task	New Unit
MEM16006A	Organise and communicate information	MEM16006A	Organise and communicate information	Equivalent
MEM16008A	Interact with computing technology	MEM16008A	Interact with computing technology	Equivalent
MEM16010A	Write reports	MEM16010A	Write reports	Equivalent
MEM18001C	Use hand tools	MEM18001C	Use hand tools	Equivalent
MEM18002B	Use power tools/hand held operations	MEM18002B	Use power tools/hand held operations	Equivalent
		MEM18052B	Maintain Fluid Power Systems for Mobile Plant	New Unit
		MEM18055B	Dismantle, replace and assemble engineering components	New Unit
MEM22001A	Perform engineering activities	MEM22001A	Perform engineering activities	Equivalent
MEM22002A	Manage self in an engineering environment	MEM22002A	Manage self in an engineering environment	Equivalent
MEM22012A	Coordinate resources for an engineering project or operation	MEM22012A	Coordinate resources for an engineering project or operation	Equivalent
MEM22013A	Coordinate engineering projects	MEM22013A	Coordinate engineering projects	Equivalent
MEM22014A	Coordinate engineering-related manufacturing operations	MEM22014A	Coordinate engineering-related manufacturing operations	Equivalent
MEM23003A	Operate and program computers and/or controllers in engineering situations	MEM23003A	Operate and program computers and/or controllers in engineering situations	Equivalent
MEM23004A	Apply technical mathematics	MEM23004A	Apply technical mathematics	Equivalent



		MEM23005A	Apply statistics and probability techniques to engineering tasks	New Unit
		MEM23006A	Apply fluid and thermodynamics principles in engineering	New Unit
MEM23007A	Apply calculus to engineering tasks	MEM23007A	Apply calculus to engineering tasks	Equivalent
		MEM23008A	Apply advanced algebra and numerical methods to engineering tasks	New Unit
		MEM23063A	Select and test mechanical engineering materials	New Unit
		MEM23064A	Select and test mechatronic engineering materials	New Unit
MEM23109A	Apply engineering mechanics principles	MEM23109A	Apply engineering mechanics principles	Equivalent
MEM23111A	Select electrical equipment and Components for engineering applications	MEM23111A	Select electrical equipment and Components for engineering applications	Equivalent
		MEM23112A	Investigate electrical and electronic controllers in engineering applications	New Unit
		MEM23114A	Evaluate thermodynamic systems and components	New Unit
		MEM23115A	Evaluate fluid power systems	New Unit
		MEM23116A	Evaluate programmable logic controller and related control system component applications	New Unit
		MEM23117A	Evaluate microcontroller applications	New Unit
		MEM23120A	Select mechanical machine and equipment components	New Unit
		MEM23121A	Analyse loads on frames and mechanisms	New Unit
		MEM23122A	Evaluate computer integrated manufacturing systems	New Unit
		MEM23123A	Evaluate manufacturing processes	New Unit
		MEM23125A	Evaluate maintenance systems	New Unit
		MEM23126A	Evaluate industrial robotic applications	New Unit
		MEM23131A	Evaluate rapid prototyping applications	New Unit
		MEM23132A	Evaluate rapid manufacturing processes	New Unit
		MEM23133A	Evaluate rapid tooling applications	New Unit
		MEM23134A	Evaluate jigs and fixtures	New Unit
		MEM23138A	Evaluate suitability of materials for engineering-related applications	New Unit
MEM234003A	Design machines and ancillary equipment	MEM234003A	Design machines and ancillary equipment	Equivalent
MEM234004A	Design for engineering-related noise and vibration mitigation	MEM234004A	Design for engineering-related noise and vibration mitigation	Equivalent
		MEM234010A	Design microcontroller applications	New Unit
		MEM234011A	Design programmable logic controller applications	New Unit
		MEM234014A	Design a robotic system	New Unit

MEM234032A	Manage fluid power related technologies in an enterprise	MEM234032A	Manage fluid power related technologies in an enterprise	Equivalent
MEM24001B	Perform basic penetrant testing			Deleted
MEM24002B	Perform penetrant testing			Deleted
MEM24003B	Perform basic magnetic particle testing			Deleted
MEM24004B	Perform magnetic particle testing			Deleted
MEM24005B	Perform basic eddy current testing			Deleted
MEM24006B	Perform eddy current testing			Deleted
MEM24007B	Perform ultrasonic thickness testing			Deleted
MEM24008B	Perform ultrasonic testing			Deleted
MEM24009B	Perform basic radiographic testing			Deleted
MEM24010B	Perform radiographic testing			Deleted
MEM24011B	Establish non-destructive tests			Deleted
MEM24012C	Apply metallurgy principles	MEM24012C	Apply metallurgy principles	Equivalent
MEM30007A	Select common engineering materials	MEM30007A	Select common engineering materials	Equivalent
MEM30010A	Set up basic hydraulic circuits	MEM30010A	Set up basic hydraulic circuits	Equivalent
MEM30011A	Setup basic pneumatic circuits	MEM30011A	Setup basic pneumatic circuits	Equivalent
MEM30012A	Apply mathematical techniques in manufacturing, engineering or related environment	MEM30012A	Apply mathematical techniques in manufacturing, engineering or related environment	Equivalent
		MEM30014A	Apply basic just in time systems to the reduction of waste	New Unit
		MEM30016A	Assist in the analysis of a supply chain	New Unit
		MEM30017A	Use basic preventative maintenance techniques and tools	New Unit
		MEM30027A	Prepare basic programs for programmable logic controllers	New Unit
		MEM30029A	Use workshop equipment and processes to complete an engineering project	New Unit
MEM30031A	Operate computer-aided design (CAD) system to produce basic drawing elements	MEM30031A	Operate computer-aided design (CAD) system to produce basic drawing elements	Equivalent
MEM30033A	Use computer-aided design (CAD) to create and display 3-D models	MEM30033A	Use computer-aided design (CAD) to create and display 3-D models	Equivalent
		MSS015002	Develop strategies for more sustainable use of resources	New Unit
		MSS015007	Develop a business case for sustainability improvements	New Unit
		MSS015008	Develop strategic sustainability plans	New Unit
		MSS404052	Apply statistics to operational processes	New Unit
MSACMT630A	Optimise cost of product	MSS405030	Optimise cost of a product or service	Equivalent
MSACMT675A	Facilitate the development of a new product			Deleted
MSAENV272B	Participate in environmentally sustainable work practices	MSMENV272	Participate in environmentally sustainable work practices	Equivalent

MSAPMSUP400A	Develop and monitor quality systems	MSMSUP400	Develop and monitor quality systems	Equivalent
MSS405001A	Develop competitive systems and practices for an organisation	MSS405001	Develop competitive systems and practices for an organisation	Equivalent
MSS405075A	Facilitate the development of a new product	MSS405075	Facilitate the development of a new product	Equivalent
MTMPS5603B	Develop, manage and maintain quality systems			Deleted
		TLIL5055	Manage a supply chain	New Unit
		TLIR5006	Develop, implement and review purchasing strategies	New Unit
		TLIR5014	Manage suppliers	New Unit
<b>Accredited units</b>		<b>Corresponding units</b>		
		VU22451	Investigate advanced technology applications in the manufacturing industry	New Unit
		VU22452	Use communication network concepts and practices in manufacturing and engineering applications	New Unit
VU20903	Produce basic engineering components and products using fabrication and machining			Deleted
VU20904	Perform cutting, grinding and turning operations			Deleted
VU20909	Develop an individual career plan for the engineering industry			Deleted
VU20910	Produce basic engineering sketches and drawings	VU22330	Select and interpret drawings and prepare three dimensional (3D) sketches and drawings	Equivalent
VU20911	Handle engineering materials	VU22453	Handle engineering materials	Equivalent
VU20912	Perform basic machining processes			Deleted
VU20913	Apply basic fabrication techniques			Deleted
VU20914	Form, bend and shape engineering materials			Deleted
VU20915	Perform basic welding and thermal cutting processes to fabricate engineering			Deleted
VU21092	Apply advanced statics principles to engineering problems	VU22535	Apply advanced statics principles to engineering problems	Equivalent
VU21093	Apply advanced dynamics principles to engineering problems	VU22536	Apply advanced dynamics principles to engineering problems	Equivalent
VU21094	Apply finite element analysis	VU22537	Apply finite element analysis	Equivalent
VU21095	Apply electrotechnology principles in an engineering work environment	VU22472	Apply electrotechnology principles in an engineering work environment	Equivalent
VU21096	Use basic engineering concepts to plan the manufacture of engineering components	VU22473	Prepare and document a work plan to fabricate an engineering product or component	Equivalent
VU21099	Apply statistical methods for quality control and reliability			Deleted
VU21100	Apply principles of mechanics to engineering problems			Deleted

VU21101	Apply principles of strength of materials to engineering problems	VU22474	Apply principles of strength of materials to engineering problems	Equivalent
VU21400	Apply scientific principles to engineering problems	VU22475	Apply scientific principles to engineering problems	Equivalent
VU21102	Apply chemical principles to standard engineering problems			Deleted
VU21103	Apply calculus to engineering problems			Deleted
VU21110	Plan for the implementation of mechanical drive systems	VU22476	Plan for the implementation of mechanical drive systems	Equivalent
VU21112	Design mechanical engineering systems	VU22538	Design mechanical engineering systems	Equivalent
VU21113	Apply thermodynamic principles in engineering			Deleted
VU21114	Design mechanical machines	VU22539	Design mechanical machines	Equivalent
VU21115	Select rotating electrical machines	VU22477	Select rotating electrical machines	Equivalent
VU21154	Generate design solutions	VU22540	Generate design solutions	Equivalent
VU21155	Implement design solutions			Deleted
VU21158	Design and prototype components and/or small structures using engineering design	VU22478	Design and prototype components and/or small structures using engineering design	Equivalent
VU21200	Apply fluid mechanic principles in mechanical engineering	VU22479	Apply fluid mechanic principles in mechanical engineering	Equivalent
VU21217	Implement basic principles of materials science to engineering applications	VU22480	Implement basic materials science principles to engineering applications	Equivalent
VU21218	Implement advanced principles of materials science to engineering applications	VU22541	Implement advanced principles of materials science to engineering applications	Equivalent
		VU22481	Apply network concepts and practices to engineering systems	New Unit
		VU22482	Use advanced mathematics for engineering	New Unit
VU21116	Evaluate and interpret structural codes and specifications			Deleted
VU21118	Evaluate and maintain automotive security systems			Deleted
VU21119	Design mechanical access control systems			Deleted
VU21120	Evaluate and maintain security containers			Deleted
VU21121	Analyse, plan and develop mechanical security for buildings			Deleted
VU21122	Produce an advanced engineering design for a reinforced concrete structure	VU22543	Produce an advanced engineering design for a reinforced concrete structure	Equivalent
VU21123	Produce an advanced engineering design for a steel structure	VU22544	Produce an advanced engineering design for a steel structure	Equivalent
VU21124	Implement site investigation Procedures	VU22484	Implement site investigation procedures	Equivalent
VU21125	Apply construction principles to civil engineering works	VU22485	Apply construction principles to civil engineering works	Equivalent

VU21126	Apply principles of materials to civil engineering applications	VU22486	Apply principles of materials testing to civil engineering applications	Equivalent
VU21127	Apply environmental issues to engineering projects	VU22545	Apply environmental solutions to engineering projects	Equivalent
VU21128	Apply principles of mechanics to engineering structures	VU22546	Apply principles of mechanics to engineering structures	Equivalent
VU21129	Apply surveying for civil engineering projects	VU22487	Apply surveying for civil engineering projects	Equivalent
VU21130	Perform measurements and layout tasks on construction sites	VU22488	Perform measurements and layout tasks on construction sites	Equivalent
VU21131	Produce an engineering drainage design of pipes and culverts	VU22547	Produce an engineering drainage design of pipes and culverts	Equivalent
VU21132	Produce an engineering design for a stormwater reticulation scheme	VU22548	Produce an engineering design for a stormwater reticulation scheme	Equivalent
VU21133	Produce an engineering design for a sewerage reticulation scheme	VU22549	Produce an engineering design for a sewerage reticulation scheme	Equivalent
VU21134	Produce an engineering design for a reinforced concrete structure	VU22550	Produce an engineering design for a reinforced concrete structure	Equivalent
VU21135	Produce an engineering design for a steel structure	VU22551	Produce an engineering design for a steel structure	Equivalent
VU21136	Produce reinforced concrete drawings	VU22489	Produce reinforced concrete drawings	Equivalent
VU21137	Produce advanced engineering drawings for a reinforced concrete structure	VU22552	Produce advanced engineering drawings for a reinforced concrete structure	Equivalent
VU21138	Produce structural steel drawings	VU22490	Produce structural steel drawings	Equivalent
VU21139	Produce advanced engineering drawings for a steel structure	VU22553	Produce advanced engineering drawings for a steel structure	Equivalent
VU21140	Produce structural steel shop drawings	VU22491	Produce structural steel shop drawings	Equivalent
VU21141	Produce engineering drawings for a rural road	VU22492	Produce engineering drawings for a rural road	Equivalent
VU21142	Produce drawings to enable urban road construction	VU22493	Produce drawings to enable urban road construction	Equivalent
VU21143	Produce engineering drawings for a stormwater reticulation scheme	VU22494	Produce engineering drawings for a stormwater reticulation scheme	Equivalent
VU21144	Apply surveying computations to engineering problems	VU22554	Apply surveying computations to engineering problems	Equivalent
VU21145	Analyse piping designs	VU22555	Analyse piping designs	Equivalent
VU21146	Design process plant layout	VU22556	Design process plant layout	Equivalent
VU21147	Design piping systems	VU22557	Design piping systems	Equivalent
VU21148	Analyse and design foundations and footings	VU22558	Analyse and design foundations and footings	Equivalent
VU21149	Design a timber structure	VU22559	Design a timber structure	Equivalent
VU21150	Undertake testing of cleanrooms			Deleted
		VU22560	Produce geometric designs for roads	New Unit
		VU22561	Analyse the strength of civil structural elements	New Unit
		VU22562	Apply principles of soil mechanics to civil engineering	New Unit
		VU22471	Utilise Augmented Reality (AR) technology for manufacturing	New Unit

VU21151	Develop procedures for cleanroom operations			Deleted
VU21152	Evaluate and select clean rooms			Deleted
VU21117	Analyse the performance of AC motors	VU22495	Analyse the performance of AC motors	Equivalent
VU21169	Apply transform principles to control problems in engineering			Deleted
VU21170	Implement and maintain control systems for industrial processes	VU21170	Implement and maintain control systems for industrial processes	Equivalent
VU21171	Design and evaluate data acquisition systems			Deleted
VU21172	Apply instrumentation principles to industrial control systems	VU21172	Apply instrumentation principles to industrial control systems	Equivalent
VU21173	Interface control systems to industrial processes and analyse data from SCADA systems	VU21173	Interface control systems to industrial processes and analyse data from SCADA systems	Equivalent
VU21174	Program control systems	VU21174	Program control systems	Equivalent
VU21175	Utilise analog electronics for control applications	VU22496	Utilise analog electronics for control applications	Equivalent
VU21176	Utilise digital electronics for control applications	VU21176	Utilise digital electronics for control applications	Equivalent
VU21270	Implement control processes using PLCs	VU21270	Implement control processes using PLCs	Equivalent
VU21219	Set up mechatronics engineering systems	VU22563	Set up mechatronics engineering systems	Equivalent
VU21220	Interface and program mechatronics engineering systems	VU22498	Interface and program mechatronics engineering systems	Equivalent
VU21232	Program, operate and select a robotics system	VU21232	Program, operate and select a robotics system	Equivalent
VU21233	Plan and manage a robotics system	VU22564	Plan and manage a robotics system	Equivalent
VU21201	Set up fluid power controlled engineering systems	VU22565	Set up fluid power controlled engineering systems	Equivalent
VU21202	Design fluid power controlled engineering systems	VU22566	Design fluid power controlled engineering systems	Equivalent
VU21203	Apply hydraulic principles in Engineering	VU22499	Apply hydraulic principles to achieve an engineering task	Equivalent
VU21204	Apply pneumatic principles in Engineering	VU22500	Apply pneumatic principles to achieve an engineering task	Equivalent
		VU21545	Evaluate proportional and servo controlled fluid power systems	New Unit
		VU21546	Monitor and adjust an integrated fluid power control system	New Unit
		VU21547	Select components for an integrated fluid power design project	New Unit
		VU21548	Install and commission an integrated fluid power system	New Unit
		VU21549	Conduct a feasibility study for an integrated fluid power system	New Unit
		VU21551	Test and monitor fluid power circuits	New Unit
		VU21609	Install and maintain hydraulic/pneumatic systems	New Unit
VU21207	Set up advanced manufacturing systems (AMS)			Deleted



VU21208	Design advanced manufacturing systems (AMS)			Deleted
VU21209	Manage advanced manufacturing systems (AMS)			Deleted
VU21210	Set up manufacturing processes for engineering applications	VU22501	Set up manufacturing processes for engineering applications	Equivalent
VU21211	Design tooling jigs and fixtures for advanced manufacturing	VU22502	Design jigs and fixtures for manufacturing	Equivalent
VU21216	Integrate co-ordinate measuring machines into manufacturing			Deleted
VU21104	Annotate and create assemblies using solid models	VU22497	Annotate and create assemblies using solid models	Equivalent
VU21105	Create and modify surfaces for simple consumer products	VU22503	Create and modify surfaces for simple consumer products	Equivalent
VU21156	Use computer aided drafting systems			Deleted
VU21157	Use advanced 2D & 3D computer aided drafting techniques	VU22542	Use advanced 2D & 3D computer aided drafting (CAD) techniques	Equivalent
VU21159	Apply computer based solid modelling techniques			Deleted
VU21160	Use extended features of CAD	VU22567	Use extended features of computer aided drafting (CAD)	Equivalent
VU21161	Manage CAD systems	VU22568	Manage computer aided drafting (CAD) systems	Equivalent
VU21162	Manage CAD in a business	VU22569	Manage computer aided drafting (CAD) in a business	Equivalent
VU21163	Program a 3D milling machine centre	VU22504	Program a 3D milling machine centre	Equivalent
VU21164	Program 4th axis applications	VU22570	Program 4th axis applications	Equivalent
VU21165	Create advanced programs for CNC machine centres	VU22571	Create advanced programs for CNC machine centres	Equivalent
VU21166	Write and modify basic CNC programs	VU22505	Write and modify basic CNC programs	Equivalent
VU21167	Write advanced CNC programs and operate a vertical machining centre	VU22506	Write advanced CNC programs and operate a vertical machining centre	Equivalent
VU21168	Write advanced CNC programs and operate a multi axis turning centre	VU22507	Write advanced CNC programs and operate a multi axis turning centre	Equivalent
VU21097	Produce engineering components by operating a CNC manufacturing cell	VU22508	Produce engineering components by programming and operating a CNC manufacturing cell	Equivalent
VU21212	Apply computer aided manufacturing (CAM) processes	VU22509	Apply computer aided manufacturing (CAM) processes	Equivalent
VU21213	Apply computer aided manufacturing (CAM) 2D programming	VU22510	Apply computer aided manufacturing (CAM) 2D programming	Equivalent
VU21214	Apply computer aided manufacturing (CAM) lathe programming	VU22511	Apply computer aided manufacturing (CAM) lathe programming	Equivalent
VU21238	Conduct and analyse precision engineering measurements	VU22512	Conduct and analyse precision engineering measurements	Equivalent
VU21205	Apply principles of metrology in manufacturing	VU22513	Apply principles of metrology in manufacturing	Equivalent
VU21206	Apply principles of advanced metrology in manufacturing	VU22572	Apply principles of advanced metrology in manufacturing	Equivalent
VU21215	Program and set up co-ordinate measuring machines (CMM)	VU22573	Program and set up co-ordinate measuring machines (CMM)	Equivalent



		VU22514	Manage inventory and operational controls within the supply chain	New Unit
		VU22515	Manage supply chain forecasting and materials planning	New Unit
		VU22516	Manage supply chain quality	New Unit
		VU22517	Manage and maintain supply chain network communication and relationships	New Unit
		VU22518	Manage global sourcing and supply of domestic supply chains	New Unit
		VU22519	Manage warehouse packaging, materials handling and operational performance	New Unit
		VU22528	Manage and review supply chain continuous improvement and benchmarked performance	New Unit
		VU22529	Perform competitive bidding, contract preparation and contract management tasks	New Unit
VU21244	Apply principles of hydraulics to pipe and channel flow			Deleted
VU21245	Design a water reticulation scheme			Deleted
VU21246	Plan sewerage reticulation systems			Deleted
VU21247	Plan water reticulation systems			Deleted
VU21248	Design pressure sewerage systems			Deleted
VU21249	Design sewerage pumping station systems			Deleted
VU21250	Manage assets in a water utility			Deleted
VU21251	Manage drinking water quality information			Deleted
VU21252	Manage the construction of pipeline systems			Deleted
VU21106	Plan, implement and apply preventative maintenance procedures	VU22530	Plan, implement and apply preventative maintenance procedures	Equivalent
VU21107	Establish and manage maintenance systems	VU22531	Establish and manage maintenance systems	Equivalent
VU21108	Select and apply lubrication principles	VU22532	Select and apply lubrication principles	Equivalent
VU21109	Select and maintain bearing and rotary shaft assemblies	VU22533	Select and maintain bearing and rotary shaft assemblies	Equivalent
VU21111	Perform vibration measurement and control	VU22534	Perform vibration measurement and control	Equivalent
VU21177	Analyse refrigeration systems			Deleted
VU21178	Design a basic single zone duct distribution system			Deleted
VU21179	Determine operational parameters for building HVAC hydronic systems			Deleted
VU21180	Design a commercial refrigeration system			Deleted
VU21181	Optimise the HVAC control systems performance			Deleted
VU21182	Design industrial refrigeration systems			Deleted

VU21183	Design hydronic systems			Deleted
VU21184	Complete a building thermal performance survey			Deleted
VU21185	Determine psychrometric processes and system performance			Deleted
VU21186	Apply energy management principles			Deleted
VU21187	Apply codes and regulations to air conditioning design			Deleted
VU21188	Develop energy management Solutions			Deleted
VU21189	Design commercial and industrial exhaust systems			Deleted
VU21190	Design heating systems			Deleted
VU21191	Commission HVAC/R systems			Deleted
VU21192	Estimate refrigeration heat load			Deleted
VU21193	Apply principles of refrigeration food storage technology			Deleted
VU21194	Design heat exchanger systems			Deleted
VU21195	Analyse and service HVAC/R control systems			Deleted
VU21196	Provide customer service for HVAC control systems			Deleted
VU21197	Service and repair HVAC control systems			Deleted
VU21198	Install HVAC control systems			Deleted
VU21199	Rectify faults in HVAC control systems			Deleted
VU21234	Apply OH&S procedures for large scale solar heating/cooling systems			Deleted
VU21235	Determine the characteristics of large scale solar heating/cooling systems			Deleted
VU21236	Service and repair large scale solar heating/cooling systems			Deleted
VU21237	Provide customer service for large scale solar heating/cooling systems			Deleted
VU21238	Conduct and analyse precision engineering measurements			Deleted
VU21239	Apply safe working practice when operating vacuum systems			Deleted
VU21240	Apply vacuum principles to advanced manufacturing			Deleted
VU21241	Identify & select vacuum components & materials			Deleted
VU21242	Operate vacuum components and systems			Deleted
VU21243	Maintain & repair vacuum systems			Deleted
VU21253	Analyse and select advanced welding processes			Deleted
VU21254	Write and qualify welding procedures for fabrication requirements			Deleted

VU21255	Design welded and fabricated Structures			Deleted
VU21256	Apply destructive & non-destructive weld testing principles			Deleted
VU21257	Implement non-destructive weld testing			Deleted
VU21258	Implement destructive weld testing			Deleted
VU21259	Evaluate and interpret boiler and pressure vessel codes and specifications			Deleted
VU21260	Identify and interpret pipeline fabrication requirements			Deleted
VU21261	Compile a technical report for fabrication			Deleted
VU21262	Design fabricated structures and pressure vessels using non-ferrous metals			Deleted
VU21263	Design fabricated structures and pressure vessels using low and high alloy steels			Deleted
VU21264	Implement OH&S procedures for large wind turbines			Deleted
VU21265	Evaluate large wind turbine operation and safety			Deleted
VU21266	Service and maintain large wind turbines			Deleted
VU21267	Analyse data from monitoring systems for large wind turbines			Deleted
VU21268	Work safely on large wind turbines			Deleted

## Diploma of Engineering Technology

### Employability Skills Summaries

Employability Skill	Industry requirements for this course include the following facets:
<b>Communication</b>	<ul style="list-style-type: none"> <li>Research, organise, analyse and communicate complex information from reference texts, manufacturer's catalogues and industrial magazines, websites, use of phone, email and fax</li> <li>Communicate effectively across a range of communication networks in the workplace</li> <li>Produce, interpret and analyse engineering drawings, charts and graphs</li> <li>Use engineering terminology and language appropriate to the situation and target audience</li> <li>Write technical or non-technical reports that include some level of analysis and/or research</li> </ul>
<b>Teamwork</b>	<ul style="list-style-type: none"> <li>Work alone or as part of a team that may include apprentices, other tradespersons, technicians, engineers and production personnel</li> <li>Provide clear and precise information to team members</li> <li>Delegate and supervise work where appropriate</li> </ul>
<b>Problem-solving</b>	<ul style="list-style-type: none"> <li>Analyse information and data from operations, processes, and test results including determining trends from graphical data</li> <li>Develop solutions and make recommendations to engineering/manufacturing related problems based on analysis of data</li> <li>Apply mathematical techniques and scientific principles to engineering situations</li> </ul>
<b>Initiative and enterprise</b>	<ul style="list-style-type: none"> <li>Apply statistical processes to make recommendations solutions for equipment and process improvements</li> <li>Make modifications to work plans and schedules to overcome unforeseen difficulties or developments</li> <li>Initiate significant modifications to plant and equipment that lead to desired changes in performance</li> </ul>
<b>Planning and organising</b>	<ul style="list-style-type: none"> <li>Organise, sort, categorise and sequence information</li> <li>Select and use planning techniques and tools to plan, sequence and prioritise work operations</li> <li>Prepare, monitor and review work plans, schedules, programs and budgets</li> </ul>
<b>Self-management</b>	<ul style="list-style-type: none"> <li>Carry out work within given timeframe, process and quality constraints</li> <li>Carry out work safely and in accordance with company policy and procedures and legislative requirements</li> <li>Monitor work to ensure compliance with legislation, codes and national standards</li> </ul>

<b>Learning</b>	<ul style="list-style-type: none"> <li>• Maintain knowledge of relevant legislative requirements, codes and standards</li> <li>• Use information from a range of sources to research technical information and data suitable and appropriate for engineering/manufacturing applications</li> <li>• Identify and consult appropriate personnel and technical experts or other reference sources to obtain/verify information</li> </ul>
<b>Technology</b>	<ul style="list-style-type: none"> <li>• Use computing technology to access, input and store information</li> <li>• Apply engineering knowledge and principles</li> <li>• Search computer databases and internet for technical information and data suitable for engineering/manufacturing applications</li> <li>• Inspect engineering/manufacturing plant, equipment and systems for optimum operation and undertake modifications as required</li> </ul>

This table is a summary of employability skills that are typical of this qualification and should not be interpreted as being definitive

## Appendix 3:

### Advanced Diploma of Engineering Technology Employability Skills Summaries

Employability Skill	Industry requirements for this course include the following facets:
<b>Communication</b>	<ul style="list-style-type: none"> <li>• Research, evaluate and report information on systems, techniques, requirements, options and solutions.</li> <li>• Read, interpret and follow information on legislative and regulatory requirements, codes of practice, specifications, design briefs, charts, lists, drawings and other applicable reference documents</li> <li>• Communicate complex ideas through reports, presentations, meetings and one on one communication</li> <li>• Use standard engineering drawing symbols, references, terminology and scientific notation</li> <li>• Consult and advise internal and external clients to ensure clarification of requirements for projects or operations</li> </ul>
<b>Teamwork</b>	<ul style="list-style-type: none"> <li>• Work alone or as part of single and multi-disciplinary teams that includes other para-professionals, professionals, trades and production personnel</li> <li>• Provide clear and precise information to team members</li> <li>• Negotiate and communicate with stakeholders</li> <li>• Delegate and supervise work where appropriate</li> </ul>
<b>Problem-solving</b>	<ul style="list-style-type: none"> <li>• Analyse and evaluate information to determine requirements, strategies and solutions (including benefit/cost analysis)</li> <li>• Apply and manipulate mathematical techniques and scientific principles to engineering situations</li> <li>• Evaluate environmental and sustainability performance of equipment and processes and make recommendations for improvements</li> <li>• Identify and select common engineering materials by their principal properties</li> <li>• Diagnose performance and process problems</li> </ul>
<b>Initiative and enterprise</b>	<ul style="list-style-type: none"> <li>• Apply skills and knowledge in new and different situations and contexts</li> <li>• Use judgement and discretion</li> <li>• Facilitate and capitalise on change and innovation</li> <li>• Generate innovative and creative ideas, approaches and solutions</li> </ul>
<b>Planning and organising</b>	<ul style="list-style-type: none"> <li>• Design and plan documentation for particular applications</li> <li>• Manage work priorities and resources</li> <li>• Prepare, monitor and review work plans, programs and budgets</li> <li>• Identify requirements and manage processes to ensure adequate resourcing, programming, maintenance and training for operations</li> </ul>
<b>Self-management</b>	<ul style="list-style-type: none"> <li>• Manage own time and own processes</li> <li>• Complete tasks in a competent and timely manner</li> <li>• Set personal goals and plans</li> <li>• Gain and use feedback to improve personal performance</li> <li>• Address all legislation, codes and standards related to safety, environmental impact and sustainability issues</li> </ul>

<b>Learning</b>	<ul style="list-style-type: none"> <li>• Undertake research by consulting appropriate personnel and accessing information from a range of sources</li> <li>• Evaluate career options and develop career path strategy</li> <li>• Review and maintain academic development, work experience, ethical practice, indemnity, negotiation, consultation and human relations with respect to the practice of engineering</li> <li>• Mentor others</li> <li>• Identify options for professional development opportunities</li> </ul>
<b>Technology</b>	<ul style="list-style-type: none"> <li>• Apply engineering knowledge and principles</li> <li>• Select and apply engineering techniques and associated technologies, software and hardware</li> <li>• Use technology appropriately to manage work priorities and commitments</li> <li>• Use a CAD program, computer and peripherals</li> </ul>

This table is a summary of employability skills that are typical of this qualification and should not be interpreted as being definitive.



## Appendix 4:

### Diploma of Engineering Technology Skills and Knowledge profile

The Diploma of Engineering Technology provides individuals with the skills and knowledge required to implement and utilise solutions in range of engineering applications requiring substantial theoretical concepts. It has been designed for persons employed in a range of engineering/manufacturing sectors and also those wishing to articulate into a university course of study.

#### **Mechanical Engineering**

##### ***Skills***

- determine material strength requirements
- deal with unexpected situations
- question and clarify information
- follow oral and written instructions
- identify and apply standards and regulations

##### ***Knowledge***

- properties of materials of strength of materials
- statistics and probability techniques
- scientific principles
- mechanical drive systems
- fluid mechanic principles

#### **Civil Engineering**

##### ***Skills***

- consult and communicate with others
- read and follow design references
- prepare documentation
- perform tests
- carry out computations

##### ***Knowledge***

- site investigation procedures
- construction principles for civil engineering
- civil engineering surveying
- materials used in the construction industry
- principles of materials for civil engineering

#### **Automation Systems Engineering**

##### ***Skills***

- read and understand design briefs
- solve problems
- test and commission control system
- read and understand technical data
- select appropriate data acquisition devices

##### ***Knowledge***

- principles to control problems
- maintain control systems
- data acquisition systems
- mechatronics engineering systems
- robotics system

#### **Mechatronic Engineering**

##### ***Skills***

- read and understand design briefs
- test and commission control system
- solve problems
- plan and sequence operations
- perform fault tracing and maintenance

##### ***Knowledge***

- mechatronics engineering systems
- robotics system
- maintain control systems
- mechanical drive systems
- mechanical machines

## **Fluid Power**

### **Skills**

- check for conformance to specification
- plan and sequence operations
- write specifications
- complete documentation
- perform fault tracing and maintenance

### **Knowledge**

- hydraulic principles in engineering
- pneumatic principles in engineering
- integrated fluid power control system
- fluid power systems for mobile plant
- hydraulic and pneumatic fluid power systems

## **Manufacturing Systems**

### **Skills**

- prepare an operating sequence plan
- assess system performance
- select appropriate engineering processes
- identify suitable AMS configuration
- check for conformance to system specifications

### **Knowledge**

- manufacturing processes for engineering applications
- computer aided drafting systems
- jigs and fixtures for advanced manufacturing
- advanced manufacturing systems (AMS)
- precision engineering measurements

## **Engineering Management**

### **Skills**

- maintain documentation
- planning the task
- participating and communicating with others
- coordinating physical and human resources
- principles and practices of 'value adding'

### **Knowledge**

- project management
- procurement processes and options
- leadership skills across an organisation
- risk management
- supply chain quality management

## **Engineering Maintenance Management (EMM)**

### **Skills**

- determine and plan maintenance requirements
- coordinate work with others
- diagnose and rectify faults
- perform routine maintenance checks

### **Knowledge**

- vibration measurement and control
- bearing and rotary shaft assembly maintenance
- basic preventative maintenance techniques
- principles of lubrication selection and application

## Appendix: 5

### Advanced Diploma of Engineering Technology Skills and Knowledge profile

The Advanced Diploma of Engineering Technology provides individuals with the skills and knowledge required to recall and apply engineering and scientific principles in designing in a range of engineering applications. It has been designed for persons employed in a range of engineering/manufacturing sectors and also those wishing to articulate into a university course of study.

#### Mechanical Design Engineering

##### ***Skills***

- preparation of design proposals
- design and develop engineering solutions
- writing technical reports
- solving engineering problems
- preparing analysis documentation

##### ***Knowledge***

- advanced statics principles
- finite element analysis
- mechanical engineering systems
- mechanical machines
- thermal fluid processes
- design process

#### Civil Design Engineering

##### ***Skills***

- conduct an environmental study
- analyse engineering structure
- prepare detail plans for stormwater reticulation
- perform manual surveying computation techniques
- validating line list and piping & instrument diagrams

##### ***Knowledge***

- advanced principles of materials science
- advanced engineering design
- environmental project management
- piping systems
- foundation and footings design

#### Automation Systems Design

##### ***Skills***

- select appropriate data acquisition devices
- read and understand design briefs
- develop downloaded and test programs
- prepare an implementation plan
- design acquisition system

##### ***Knowledge***

- data acquisition systems
- industrial robotic applications
- mechatronics engineering systems
- microcomputer/PLC
- manage a robotics system

#### Mechatronic Engineering Design

##### ***Skills***

- read and understand design briefs
- commission system into operation
- consult and communicate with others

##### ***Knowledge***

- mechatronics engineering systems
- industrial robotic applications
- manage a robotics system

## **Fluid Power Design Engineering**

### ***Skills***

- plan a maintenance task
- maintain fluid power systems
- commission system into operation
- design fluid power controlled engineering system
- consult and communicate with others

## **Integrated Manufacturing Systems**

### ***Skills***

- analyse job requirements
- communicating technical and procedural requirements
- plan and schedule required operations
- troubleshooting system faults and non-conformance
- ensure that component will be produced to specifications

## **Engineering Maintenance Management**

### ***Skills***

- manage a preventative maintenance system
- analyse and plan for risk measures
- develop maintenance goals, policies and procedures
- investigating sustainability implications of maintenance processes
- auditing plant, facilities and services

### ***Knowledge***

- fluid power related technologies
- fluid power controlled engineering systems
- integrated fluid power control systems
- applications for pneumatics and hydraulics
- multiple actuator control circuit

### ***Knowledge***

- rapid tooling applications
- computer integrated manufacturing systems
- rapid manufacturing processes
- advanced programs for CNC machine centres
- advanced metrology in manufacturing

### ***Knowledge***

- maintenance management systems
- risk management procedures
- facilities and service maintenance response systems
- asset categorisation and maintenance scheduling and prioritising
- features of integrated management systems

## Diploma of Engineering Technology

- **Core Units**

Current versions of the units listed below may be found at [training.gov.au](http://training.gov.au)

MEM16006A - Organise and communicate information
MEM16008A - Interact with computing technology
MEM22001A - Perform engineering activities
MEM22002A - Manage self in an engineering environment
MEM23004A - Apply technical mathematics
MEM30007A - Select common engineering materials
MEM30031A - Operate computer-aided design (CAD) system to produce basic drawing elements



## VU22451 - Investigate advanced technology applications in the manufacturing and related industries

**Unit Descriptor** This unit describes the knowledge and skills required to learner to investigate advanced manufacturing technologies that have been recognised as innovative and/or cutting edge and have significantly improved production processes, products and/or services and present the findings.

No licensing, legislative, regulatory or certification requirements apply to this unit of competency at the time of publication.

**Employability Skills** This unit contains employability skills.

**Application of the Unit** This unit applies to a person who is preparing for a career in the engineering, manufacturing or related industries and is required to investigate current and emerging advanced manufacturing technologies

### Element

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

### Performance Criteria

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- |   |  |
|---|--|
| 1 Determine the applications of advanced technologies in manufacturing                    | 1.1 Sources of information on <b>advanced manufacturing technologies</b> in the <b>engineering and manufacturing industries</b> are identified<br>1.2 Real world examples of advanced manufacturing and engineering achievements are located<br>1.3 Impact of advanced manufacturing technology on product and/or service is determined  |
| 2 Investigate an advanced technology and its' impact on a process, product and/or service | 2.1 Application and parameters of the technology being investigated are defined and its' integration with existing production methods are clarified<br>2.2 Design principles of the technology are explored and documented<br>2.3 The value adding dimension of the technology is analysed and evaluated<br>2.4 Impact on workforce capabilities and/or customer demands and market competitiveness are determined<br>2.5 Future developments in the technology and its application are examined |
| 3 Present research on advanced technology   | 3.1 Research material is compiled and the format of the presentation is planned  |



## VU22451 - Investigate advanced technology applications in the manufacturing and related industries

- 3.2 **Presentation** of the investigation is prepared, trialled and amended as required
- 3.3 Research is presented to relevant audience/stakeholder

### Required Knowledge and Skills

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

#### **Required knowledge:**

- current advanced manufacturing technologies which impact on both process and/or products
- advanced manufacturing technologies nomenclature such as Industry 4.0/5.0
- sources of information on the manufacturing, engineering and related industries
- diversity of the manufacturing, engineering and related industries including key sectors and structure
- presentation techniques and resources

#### **Required skills:**

- recognising the application of advanced technologies in the manufacturing and related industries and improvements to a processes, products and services
- undertaking research in an manufacturing environment and using various methods to gather technical information and data
- communicating with technical personnel in an manufacturing environment
- planning and presenting technical information to an audience
- completing a research project in a given timeframe

### Range Statement

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

**Advanced manufacturing technologies** include but are not limited to:

- computer based technologies such as CAD, CAE, CAM, HPC
- rapid prototyping/additive manufacturing
- industry 4.0/5.0
- advanced robotics
- advanced materials/textiles
- design led innovations program
- disruptive additive subtractive manufacturing
- augmented reality (AR) technology
- agile collective problem solving techniques





## VU22451 - Investigate advanced technology applications in the manufacturing and related industries

- control system/s and monitoring devices such as:
  - smart sensors
  - factory automation sensors
  - sensors encodes
  - automation direct sensors
- artificial intelligence, data management
- Building Information Modelling (BIM)
- product lifecycle management

**Engineering and manufacturing sectors** include but are not limited to:

- public transport
- automotive components
- white and brown goods
- shipbuilding and boatbuilding
- plastics, rubber, cabling
- heavy engineering
- electrical/electronics
- aerospace
- bio medical and pharmaceutical
- food and beverage

**Presentation** includes but is not limited to:

- power point show
- photographs
- drawings/sketches/diagrams/graphs/flowcharts
- brochures/pamphlets
- sample products
- written or oral information

### Evidence Guide

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

Assessment must confirm the ability to:

- Research and define at least two examples of advanced manufacturing technology, analyse the principles of each technology including the value add component and provide examples of the application of each. One example is to be process orientated and the other is to be product or service orientated



## **VU22451 - Investigate advanced technology applications in the manufacturing and related industries**

- prepare and provide a detailed presentation of the findings to a relevant audience/stakeholder.
- the above competencies can be demonstrated individually or as part of a small team.

### **Context of and specific resources for assessment**

The candidate will have access to a library, IT equipment and internet, resource materials and references. The candidate will be permitted to refer to any relevant workplace procedures, product and manufacturing specifications, codes, standards, manuals and related documentation.

This unit may be assessed off the job or a combination of both. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a group of learners. The assessment environment should not disadvantage the candidate.

### **Methods of assessment**

The following suggested assessment methods are suitable for this unit:

- research project findings
- presentation of information
- written report/documented evidence
- oral and written questioning



## VU22452 - Use communication network concepts and practices in manufacturing and engineering applications

**Unit Descriptor** This unit describes the skills and knowledge in communication network concepts and practices that are used in manufacturing and engineering applications. Specifically, the unit covers the manner in which data traverses, networks, protocols, networking and communication devices, Internet Protocol (IP) addressing, routing protocols, Virtual Local Area Networks (VLANs), troubleshooting logs and networking monitoring tools.

No licensing or certification requirements apply to this unit at the time of accreditation.

**Employability skills** This unit contains employability skills.

**Application of the Unit** This unit is applicable to individuals working as paraprofessionals in engineering, manufacturing and related industries.

### ELEMENTS

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Define the function and operation of key communication network concepts
2. Demonstrate the function and operation of key communication networking devices

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Types of communication networks*** are defined
- 1.2 Data transmission in a communication network is explored
- 1.3 Physical communication network equipment and cables is identified
- 1.4 Methods, tools and infrastructure used to connect to the internet from a workstation are explored
- 2.1 Physical and logical network representations of a local area network are implemented
- 2.2 Function and operation of network switches are described , and implemented
- 2.3 Function and operation of VLANs are described and implemented
- 2.4 Function and operation of network routers are described, and implemented
- 2.5 Function and role of a computer based interlocking device is described and applied
- 2.6 Function and operation of a firewall is described and applied
- 2.7 Function and operation of a wireless access point (WAP) is described, and implemented.
- 2.8 Operation of a network monitoring tool is described and applied



- |  |     |  |
|--|-----|--|
|  | 2.9 | Function and operation of log files used for troubleshooting is described and applied  |
| 3. Install and set up a basic network                  | 3.1 | Structure of an internetworking operating system (IOS) is defined in order to prepare a communication network device for operation   |
|  | 3.2 | Cabling communication networking devices to a provided network diagram are performed   |
|  | 3.3 | Configuring communication network addresses for a workstation is <del>demonstrated</del> and performed   |
|  | 3.4 | A <b>functional communication network</b> is configured and tested   |
| 4. Establish protocols and models using OSI and TCP/IP | 4.1 | Function and basic operation of <b>key protocols</b> in the Open Systems Interconnect (OSI) and Transmission control Protocol/Internet Protocol (TCP/IP) communication models are configured |
|  | 4.2 | Differences and commonalities between the OSI and TCP/IP models for a communication network are described  |
|  | 4.3 | OSI Layer 1 standards and types of communication channels are described  |
|  | 4.4 | OSI Layer 2 Protocols, standards and addressing (MAC addresses) for both LANs and WANs are described   |
|  | 4.5 | IPv4 and IPv6 addressing schemes are configured  |
|  | 4.6 | Function and operation of <b>OSI Layer 3 Routed and Routing addressing protocols</b> are described   |
|  | 4.7 | Packet encapsulation and de-capsulation concepts are described   |
|  | 4.8 | Function and operation of <b>OSI Layer 4 Protocols</b> are configured  |
|  | 4.9 | Function and operation of <b>OSI Layer 5 to 7 protocols</b> and networking applications are described  |
| 5. Configure IP addressing schemes                     | 5.1 | Sub-netting an IPv4 and IPv6 network is applied  |
|  | 5.2 | Configuring IPv4 and IPv6 communication network addresses for a workstation is performed   |



## REQUIRED SKILLS AND KNOWLEDGE

This describes the essential skills and knowledge and their level required for this unit

### ***Required skills:***

- using basic numeracy skills to perform calculations in binary and hexadecimal number systems
- using base level problem solving skills to implement provided scripts for a switch and a router
- reading and accurately interpreting documents and reports
- installing and configuring a basic network
- configuring protocols, models and IP addressing systems
- operating a personal computer
- identifying network cable types
- interpreting network testing information

### ***Required knowledge***

- OSI layered communication model
- TCP/IP layered communication model
- Media Access Layer (MAC) addresses
- packet encapsulation and decapsulation concepts and operation
- binary number system
- hexadecimal number system
- Transmission Control Protocol (TCP) protocol
- User Datagram Protocol (UDP)
- function and operation of application layer protocols
- VLANs
- network monitoring tools e.g. Wireshark
- log files generated from networking devices e.g. Interlocking device, switches, operating system
- IPV4 addressing and subnetting
- IPV6 addressing and subnetting
- network cabling
- network devices:
  - routers
  - switches
  - computer based interlocking device
  - firewall fundamentals
  - wireless access points
- end to end test commands e.g. Ping, Traceroute
- switch and router IOS commands examples
- emerging network technologies



## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below

### ***Types of communication***

***networks*** include but are not limited to:

- Local Area Network (LAN)
- Wide Area Network (WAN)
- Metropolitan Area Network (MAN)
- Wireless LAN (WLAN)
- Virtual LAN (VLAN)
- Virtual Private Network (VPN)
- signaling network

### ***Functional communication***

***network*** includes but is not limited to:

- workstations
- routers
- switches
- hubs

***Key protocols*** include but are not limited to:

- Address Resolution Protocol (ARP)
- Reverse Address Resolution Protocol (RARP)
- Transmission Control Protocol (TCP)
- User Datagram Protocol (UDP)
- Internet Protocol (IP)
- Internet Control Message Protocol (ICMP)
- File Transfer Protocol (FTP)
- Simple mail Transfer Protocol (SMTP)
- Domain Name System (DNS)
- Internet Group Management Protocol (IGMP)

### ***OSI Layer 3 Routed and Routing addressing***

***protocols*** include but are not limited to:

- Routing Information protocol (RIP)
- Enhanced Interior Gateway Routing Protocol (EIGRP)

### ***OSI Layer 4 Protocols***

include but are not limited to:

- Transmission Control Protocol (TCP)
- User Datagram Protocol (UDP)

### ***OSI Layer 5 to 7 protocols***

include but are not limited to:

- Hypertext Transfer Protocol (HTTP)
- File Transfer Protocol (FTP)
- Trivial File Transfer Protocol (TFTP)
- Simple mail Transfer Protocol (SMTP)
- Domain Name System (DNS)



## EVIDENCE GUIDE

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 section in Section B of the accreditation submission.

### **Critical aspects for assessment and evidence required to assess competency in this unit**

Assessors must be satisfied that the candidate can:

- identify the function and operation of communication key network concepts
- define key features of the TCP/IP and OSI models
- implement and demonstrate the function and operation of key networking devices
- implement and troubleshoot a small communication routed network.

### **Context of and specific resources for assessment**

Evidence should show competency working in a realistic environment and a variety of conditions. The candidate will have access to the network and all computer equipment, materials and documentation required. The candidate will be permitted to refer to any relevant workplace procedures, product and manufacturing specifications, codes, standards, manuals and reference materials.

This unit may be assessed on the job, off the job or a combination of both. Where assessment occurs off the job, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.

### **Method of assessment**

Evidence can be gathered through a variety of ways including:

- observation of processes and procedures;
- oral and/or written questioning on required knowledge and skills;
- testimony from supervisors, colleagues, clients and/or other appropriate persons;
- inspection of the final product or outcome;
- portfolio of documented evidence.

Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.





## Advanced Diploma of Engineering Technology

- **Core Units**

Current versions of the units listed below may be found at [training.gov.au](http://training.gov.au)

MEM22013A - Coordinate engineering projects
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MEM30033A - Use computer-operated design (CAD) to create and display 3-D models
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## Mechanical Engineering/Mechanical Engineering Design

Current versions of the units listed below may be found at [training.gov.au](http://training.gov.au)

CPCCWHS1001 - Work safely in the construction industry
MEM09002B - Interpret technical drawing
MEM13014A - Apply principles of occupational health and safety in the work environment
MEM23005A - Apply statistics and probability techniques to engineering tasks
MEM23006A - Apply fluid and thermodynamics principles in engineering
MEM23007A - Apply calculus to engineering tasks
MEM23008A - Apply advanced algebra and numerical methods to engineering tasks
MEM23063A - Select and test mechanical engineering materials
MEM23109A - Apply engineering mechanics principles
MEM23114A - Evaluate thermodynamic systems and components
MEM234003A - Design machines and ancillary equipment
MEM234004A - Design for engineering-related noise and vibration mitigation
MEM23120A - Select mechanical machine and equipment components
MEM23121A - Analyse loads on frames and mechanisms
MEM23138A – Evaluate suitability of materials for engineering-related applications
MEM24012C - Apply metallurgy principles
MEM30029A - Use workshop equipment and processes to complete an engineering project
MEM30012A – Apply mathematical techniques in a manufacturing engineering or related environment
MSMENV272 - Participate in environmentally sustainable work practices



## VU22453- Handle engineering materials

### Unit Descriptor

This unit of competency describes the knowledge and skills required to safely handle materials in accordance with Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements and enterprise procedures.

It includes using manual handling techniques, operating mechanical handling equipment, handling hazardous materials and emergency procedures.

No licensing or certification requirements apply to this unit at the time of accreditation

### Employability Skills

This unit contains Employability Skills.

### Application of the Unit

This unit is applicable to an individual planning to work as a technicians or paraprofessional in engineering, manufacturing and related industries.

### ELEMENT

Elements describe the essential outcomes of a unit of competency.

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- |                                    |  |
|------------------------------------|--|
| 1. Plan to lift and move materials | 1.1 Lifting and moving requirements are identified and clarified with <b><i>appropriate personnel</i></b> .  |
|                                    | 1.2 <b><i>Resources</i></b> , safety and handling factors are identified and hazard control measures implemented where practicable.  |
|                                    | 1.3 Special handling procedures for <b><i>hazardous materials</i></b> and areas are identified and applied   |
|                                    | 1.4 <b><i>Manual lifting techniques, mechanical aids, tools and material handling equipment</i></b> are selected appropriate to the <b><i>material properties</i></b> , task requirements and safe handling considerations |
|                                    | 1.5 Safety signs, symbols and labels are identified and interpreted correctly  |
| 2. Move/shift materials            | 2.1 <b><i>Manual lifting techniques</i></b> and strategies are correctly applied   |
|                                    | 2.2 Material is lifted, moved and placed/stored safely   |
|                                    | 2.3 Handling equipment is operated and stored safely and correctly, taking account of <b><i>environmental considerations</i></b>   |
|                                    | 2.4 Safe handling practices, procedures and directions are followed  |
| 3. Apply emergency procedures      | 3.1 Emergency procedures are applied in accordance with <b><i>Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements</i></b> and <b><i>enterprise procedures</i></b> if required                |
|                                    | 3.2 Emergency containment/protection procedures relating to specific materials are applied if applicable   |



## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- planning a lifting procedure in a engineering/manufacturing environment
- reading safety signs and symbols in the workplace
- performing manual lifting techniques
- operating mechanical aids and lifting devices normally used in an engineering/manufacturing environment
- storing of mechanical aids and lifting devices
- working and communicating with other work team members
- questioning and clarifying information
- following oral and written instructions from a leading hand/workplace supervisor
- carrying out emergency procedures in the event of a workplace accident

### **Required knowledge:**

- manual lifting techniques
- types and applications mechanical aids and lifting devices
- legislation, acts and national occupational health and safety (NOHSC) guidelines
- dangerous materials labelling
- material safety data sheets (MSDS)
- risk assessment and hazard control
- personal protective equipment and safety devices
- personal responsibilities
- safety signs and symbols

**Appropriate personnel** may include but is not limited to:

- supervisor
- leading hand
- foreman
- trainer/coach
- teacher

**Resources** may include but are not limited to:

- work requests/sheets
- safety signs, symbols and labels
- material safety data sheets (MSDS)
- emergency procedures
- relevant codes
- personal protective equipment



- dedicated tools
- materials and objects for lifting/moving
- mechanical lifting aids
- mechanical lifting devices
- consumables

**Hazardous materials** may include but are not limited to:

- chemicals
- liquids and gases
- toxic and noxious materials

**Manual lifting techniques and strategies** may include but are not limited to:

- strategies include:
  - individual and team lifting
  - dividing load
  - re-packaging
- manual lifting techniques include:
  - lifting
  - carrying
  - lowering
  - pulling
  - pushing
  - storing
  - team lifting
- lifting aids include:
  - blocks
  - wedges
  - ropes
  - containers
  - levers

**Mechanical aids** may include but are not limited to:

- levers and bars
- spreader bars
- slings and dogs
- wedges
- chain blocks
- cranes and hoists

**Tools** may include but are not limited to:

- dedicated tools for attaching/removing mechanical lifting aids and safety equipment e.g. spanners

**Mechanical handling equipment** may include but is not limited to:

- hand trolleys and skates
- wheelbarrows
- hand pallet trucks (not sit on)
- hand carts



- other dedicated devices used for handling materials

**Material properties** may include but are not limited to:

- size
- mass
- shape
- structure
- chemical properties
- any specific property affecting handling operation

**Environmental considerations** may include but are not limited to:

- excessive noise
- proximity to other personnel
- hazardous materials and areas
- workplace layout

**OHS/WHs requirements** may include but are not limited to:

- legislation, acts and National Occupational Health and Safety (NOHS) guidelines
- personal protective equipment
- material safety management systems
- material safety data sheets (MSDS)
- hazardous substances and dangerous goods codes
- local safe operating procedures
- awards provisions
- assessment of risk
- hazard control measures

**Enterprise procedures** may include but are not limited to:

- the use of tools and equipment
- instructions, including job sheets
- labelling and packaging
- material handling and storage
- safety procedures
- emergency procedures
- reporting and communication
- manufacturers' specifications and operational procedures



## EVIDENCE GUIDE

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 section in Section B of the accreditation submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - follow OHS/WHs procedures and practices as specified in the performance criteria
  - plan and safely lift engineering materials using a minimum of two (2) different mechanical aids and/or equipment
  - read and interpret safety signs, symbols and dangerous goods labelling
  - apply risk control measures and emergency procedures

### Context of and specific resources for assessment

- 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/WHs policy and work procedures and instructions
  - access to workplace environment
  - operational access to relevant equipment, tools, materials and consumables
  - access to relevant plans, drawings and/or instructions
  - manufacturer specifications/manuals
    - Evidence should show competency working in realistic environment and a variety of conditions. The candidate will have access to all tools, equipment, materials and documentation required.
    - The candidate will be permitted to refer to any relevant workplace procedures, product and manufacturing specifications, codes, standards, manuals and reference materials.

### Method of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.



- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.





# VU22471 – Utilise Augmented Reality (AR) technology for manufacturing

**Unit Descriptor** The unit describes the skills and knowledge required to prepare to use AR technology for manufacturing.

The unit includes an overview of the technology, the infrastructure requirements, areas of deployment and examines some emerging and available tools and systems that utilise AR technology in manufacturing

No licensing or certification requirements apply to this unit at the time of accreditation

**Employability skills** This unit contains employability skills

**Application of the Unit** This unit is applicable to an individual preparing to work or working as a technician or paraprofessionals in engineering, manufacturing and related industries.

## ELEMENT

Elements describe the essential outcomes of a unit of competency.

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- |   |  |
|---|--|
| 1. Identify Augmented Reality (AR) infrastructure and tool requirements | 1.1 <b><i>AR headsets</i></b> are investigated with the features defined   |
|   | 1.2 <b><i>AR software is classified</i></b> for a particular applications  |
|   | 1.3 <b><i>AR infrastructure requirements</i></b> are determined  |
| 2. Research current AR tools and technologies used in manufacturing     | 2.1 <b><i>Potential areas of use of AR in the manufacturing sector</i></b> are identified and investigated           |
|   | 2.2 <b><i>Established current tools utilising best practise AR technologies</i></b> for manufacturing are identified |
|   | 2.3 Emerging tools utilising AR technologies for manufacturing are identified  |
| 3. Select, implement and use an AR tool for manufacturing               | 3.1 An application of AR technology used in manufacturing is selected  |
|   | 3.2 AR equipment for the selected application is assembled   |
|   | 3.3 Equipment and software for the AR application is installed and connected   |
|   | 3.4 AR software settings for the application are configured  |
|   | 3.5 AR headset for the application is trialed  |
|   | 3.6 Use of the AR tool is demonstrated   |
|   | 3.7 Feedback on the function and operation of the AR equipment, software and application is provided                 |



## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- working in an AR environment in the manufacturing industry
- using computer technology in manufacturing environment
- installing and configuring software for a manufacturing application
- interpreting AR data
- setting parameters on AR tools and equipment and demonstrating application

### **Required knowledge:**

- AR computer simulation packages
- settings and parameters on AR tools and equipment
- applications of AR tools and systems in the manufacturing industry
- current AR tools and practices

## RANGE STATEMENT

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

**AR headsets** includes but are not limited to:

- HTC Vive
- Oculus Rift
- Microsoft Hololens
- Sony SmarteEyeglass
- Epson Moverio BT-200
- Vuzix M100 Smart Glasses
- Recon Jet
- Optivent Ora-1
- Glass Up

**AR software is classified** include but is not limited to:

- individual software packages
- platforms
- systems

**AR infrastructure requirements** includes but are not limited to:

- headsets
- IT networking infrastructure
- workstation/laptop/tablet
- software application



**Potential areas of use of AR in the manufacturing sector**

include but are not limited to:

- assembly processes
- maintenance
- expert support
- quality assurance
- automation
- training

**Established current tools utilising best practise AR technologies** include but not limited to:

- Vital Enterprises AR Tools
- thyssenkrupp AR tools for elevator repairs and maintenance
- AR Training tools
- SlashGear QA AR tools
- Airbus MiRA AR tools
- DAqRI Smart Helmet
- Siemens SimCcentre
- Technomatix

## EVIDENCE GUIDE

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 section in Section B of the accreditation submission.

**Critical aspects for assessment and evidence required to assess competency in this unit**

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- identify Augmented Reality (AR) infrastructure and tool requirements
- provide examples of the current application of AR tools and technologies in manufacturing
- set up and demonstrate the use of an AR tool used in manufacturing.

**Context of and specific resources for assessment**

Assessment will take place in a classroom/training environment where the candidate will have access to augmented reality welding technology, analysis information and programming advice. As well as job specifications drawings and other relevant documentation. The competencies covered by this unit would either be demonstrated by an individual working alone or as part of class group.

- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions



- access to workplace or work real environment and a variety of conditions
- operational access to augmented reality (AR) computer simulated package, tools, materials and consumables
- access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

### **Method of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



# VU22535 - Apply advanced statics principles to engineering problems

## Unit Descriptor

This unit of competency describes the knowledge and skills required to apply advanced static concepts and principles to solve complex engineering problems.

It includes two and three dimensional force analysis and associated diagrams for structures and mechanical componentry.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Prerequisite unit(s)

It is recommended that learners attempting this unit have the required knowledge and skills as described in:

MEM23109A Apply principles of mechanics to engineering problems

MEM23007A Apply calculus to engineering tasks

## Application of the Unit

The unit applies to a person working in an engineering, manufacturing and construction environment where the application of advanced statics can provide solutions to a wide variety of engineering problems.

This unit of competency is intended for courses at Advanced Diploma level or higher.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Determine the extent of advanced statics required for the analysis

2. Apply principles of advanced statics in the analysis or design of a solution

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements*** or a given work area are clarified.
- 1.2 ***Engineering problem*** is determined through requests, design briefs or equivalent and clarified with appropriate personnel.
- 1.3 Expert advice is sought with respect to the engineering problem and in according to ***enterprise procedures***.
- 1.4 ***Resources and equipment*** required are identified, obtained and checked as fit for the purpose.
- 2.1 Industry codes, regulations and technical documentation relevant to the engineering problem are collated and interpreted.
- 2.2 Tables and graphs are used to obtain computational data, where appropriate.



- 2.3 Appropriate assumptions underlying the engineering problem are made and recorded.
    - 2.4 Most appropriate analytical, computational or design methodology is selected and can be justified.
  3. Verify, document and interpret analysis and/or design
    - 3.1 Results of the analysis or design are recorded and documented in accordance with requirements and enterprise procedures.
    - 3.2 Results are graphed and/or charted and interpreted, where appropriate.
    - 3.3 Formal report to present outcomes is prepared according to enterprise procedures, if required.

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- identifying and following relevant OHS/WHS procedures
- interpreting industry codes, regulations and technical documentation
- selecting the most appropriate computational method to analyse and solve the engineering problem
- solving engineering problems involving the analysis of two dimensional force and couple systems
- representing forces and moments as three dimensional Cartesian vectors
- analysing and solving engineering problems involving basic three dimensional applications
- analysing and solving problems involving free body diagrams of two and three dimensional structures and assemblies
- constructing shear force and bending moment diagrams for structures and assemblies subjected to two and three dimensional force systems
- presenting results in graphs, charts and tables to requirements
- working and communicating with others project team members

### **Required knowledge:**

- two dimensional force analysis;
- three dimensional force analysis;
- free body diagrams of two and three dimensional systems;
- shear force, bending moments and torque diagrams for two and three dimensional force systems.



## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHs requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Engineering problem*** may include:

Any engineering task that requires the application of advanced statics in its analysis or design. This includes all two and three dimensional force analysis of structures found in manufacturing and construction engineering applications.

***Enterprise procedures*** may include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- operational procedures

***Resources and equipment*** may include:

- computer access
- scientific calculator
- engineering tables and graphs
- regulations and codes of practices
- reference texts



## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement Occupational Health and Safety workplace procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to apply advanced statics to solve engineering problems on more than one occasion and in different contexts involving two and/or three dimensional force analysis in structures and mechanical componentry.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant equipment, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals
  -

### Methods of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.





- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22536 - Apply advanced dynamics principles to engineering problems

### Unit Descriptor

This unit of competency describes the knowledge and skills required to apply advanced dynamics to solve problems common to all engineering fields.

This includes friction, centrifugal force, balancing, mechanical vibrations, impulse, momentum, impact, systems of bodies in motion, and simple, compound and epicyclic gearing.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Prerequisite unit(s)

It is recommended that learners attempting this unit have the required knowledge and skills as described in:

VU22475 - Apply scientific principles to engineering problems

### Application of the Unit

The unit applies to a person working in an engineering, manufacturing, and construction environment where the application of advanced scientific principles can provide a solution to engineering problems.

This unit of competency is intended for courses at Advanced Diploma level or higher.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Determine the extent of advanced dynamics required for the analysis
2. Apply advanced dynamics in the analysis or design of a solution

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements*** for a given work area are clarified.
- 1.2 ***Engineering problem*** is determined through requests, design briefs or equivalent and clarified with appropriate personnel.
- 1.3 Expert advice is sought with respect to the engineering problem and according to ***enterprise procedures***, where appropriate.
- 1.4 ***Resources and equipment*** required are identified, obtained and checked as fit for the purpose.
- 2.1 Industry codes, regulations and technical documentation relevant to the engineering problem are interpreted and understood.
- 2.2 Tables and graphs are used to obtain computational data, where appropriate.
- 2.3 Appropriate assumptions underlying the engineering problem are made and recorded.



- |    |   |     |   |
|----|---|-----|---|
| 3. | Verify, document and interpret outcomes | 3.1 | Industry codes, regulations and technical documentation relevant to the engineering problem are interpreted and understood. |
|    |   | 3.2 | Results of the analysis or design are recorded and documented in accordance with requirements and enterprise procedures.    |
|    |   | 3.3 | Results are graphed and/or charted and interpreted, where appropriate.  |
|    |   | 3.4 | Formal report to present outcomes is prepared according to enterprise procedures, if required.                              |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- identifying and following relevant OHS/WHS procedures
- interpreting industry codes, regulations and technical documentation
- recognising the underlying dynamic principles to solve engineering problems
- selecting the most appropriate computational method to analyse and solve the mechanical engineering problem
- applying advanced dynamics to engineering problems
- quoting and recording assumptions made in the solution
- presenting results in graphs, charts and tables to requirements
- writing technical reports
- working and communicating with other project team members

### **Required knowledge:**

- friction
- centrifugal force
- balancing
- mechanical vibrations
- impulse, momentum and impact
- systems of bodies in motion
- gearing

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

**OHS/WHS requirements** may include:

- legislation
- protective equipment
- material safety management systems



- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Engineering problem*** may include:

Any engineering problem that requires the application of advanced dynamics in its analysis or design. This includes:

- friction mechanical drives
- centrifugal force
- balancing
- mechanical vibrations
- linear and rotational motion
- momentum
- bodies in motion
- gearing

***Enterprise procedures*** may include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- operational procedures

***Resources and equipment*** may include:

- computer access
- scientific calculator
- engineering tables and graphs
- regulations and codes of practice
- reference texts



## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge, and be capable of applying the competency in new and different situations and contexts within the timeframes typically expected of the discipline, work function and industrial environment.
- Specifically they must be able to:
  - implement Occupational Health and Safety workplace procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to apply advanced dynamics to solve engineering problems on more than one occasion researching from the following areas respectively:
    - friction
    - centrifugal force
    - balancing
    - mechanical vibrations
    - impulse, momentum and impact
    - bodies in motion
    - simple and compound gears
    - epicyclic gears

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant equipment, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals



**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22537 - Apply finite element analysis

### Unit Descriptor

This unit of competency describes the skills and knowledge required to apply finite element analysis to engineering applications using a general purpose finite element analysis software package.

This unit applies especially to the determination of stresses, displacements and natural frequencies.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working in a mechanical/structural/civil engineering enterprise where analysis of machine parts and/or structures is undertaken.

The unit is intended for courses at advanced diploma level or higher.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- |   |                                     |     |   |
|---|-------------------------------------|-----|---|
| 1 | Setup a finite element model        | 1.1 | <b><i>Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements</i></b> for a given work area are clarified, and any impacts on design are identified.            |
|   |                                     | 1.2 | <b><i>Analysis task</i></b> for the engineering part or structure is determined by using documentation, drawings, work requests or discussions with <b><i>appropriate personnel</i></b> . |
|   |                                     | 1.3 | Nodes and elements of part or structure to be analysed are created to determine finite element model.   |
|   |                                     | 1.4 | Finite element model is refined by applying all relevant internal and external parameters and conditions.   |
|   |                                     | 1.5 | Appropriate personnel are consulted to ensure the work is co-ordinated effectively with other involved in the work place.   |
|   |                                     | 1.6 | <b><i>Resources</i></b> and <b><i>equipment</i></b> needed for the task are obtained in accordance with <b><i>enterprise procedures</i></b> and checked for correct operation and safety. |
| 2 | Produce solution or results file(s) | 2.1 | <b><i>Appropriate solver</i></b> for the type of analysis being undertaken is selected.   |
|   |                                     | 2.2 | Solver parameters are adjusted as necessary, to optimise the solution.  |
|   |                                     | 2.3 | Solver is run and solution file is generated.   |



- |     |  |   |     |   |     |   |     |  |
|-----|--|---|-----|---|-----|---|-----|--|
|     | 2.4  | Solver log file is inspected for warnings and errors and corrective action taken.   |     |   |     |   |     |  |
|     | 2.5  | Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.  |     |   |     |   |     |  |
| 3   | Extract and interpret results  | <table border="0"> <tr> <td>3.1</td> <td>Results are extracted from results file and displayed</td> </tr> <tr> <td>3.2</td> <td>Results are verified to required certainty level.</td> </tr> <tr> <td>3.3</td> <td>Results are recorded, analysed and reported to appropriate personnel in accordance with enterprise procedures.</td> </tr> </table> | 3.1 | Results are extracted from results file and displayed | 3.2 | Results are verified to required certainty level. | 3.3 | Results are recorded, analysed and reported to appropriate personnel in accordance with enterprise procedures. |
| 3.1 | Results are extracted from results file and displayed  |   |     |   |     |   |     |  |
| 3.2 | Results are verified to required certainty level.  |   |     |   |     |   |     |  |
| 3.3 | Results are recorded, analysed and reported to appropriate personnel in accordance with enterprise procedures. |   |     |   |     |   |     |  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- identifying and following relevant OHS/WHS procedures
- gathering information relevant to the analysis task
- interpreting and evaluating documentation, specifications and drawings for Finite Element Analysis purposes
- determining the type of analysis required
- using a Finite Element Analysis software, including pre-processor and post processor, if any, effectively
- employing available software features efficiently
- constructing models of engineering part or structure suitable for Finite Element Analysis using appropriate software
- determining and setting parameters and conditions for required type of analysis
- applying boundary conditions to suit type of analysis required, including axisymmetric analysis
- choosing, setting up, and running appropriate solvers such as; linear static, linear buckling, non-linear static, natural frequency steady state heat etc.
- displaying, verifying and interpreting analysis results
- preparing analysis documentation
- working and communicating with others project team members.

### **Required knowledge:**

- finite element analysis
- advanced modelling techniques
- Cartesian, Polar and Spherical coordinate systems
- stress concentration
- dead loads, live loads, wind loads, structural and non-structural mass
- material libraries





- types of beam, plate, and brick elements
- properties of materials; stress, strain, modulus of elasticity, modulus of rigidity, Poisson's ratio, allowable stress
- equivalent stresses based on Von Mises criterion and Tresca criterion
- shear force and bending moment diagrams, bending stress and torsional stress
- heat transfer modes; conduction, convection, and radiation
- thermal stress
- accuracy checking methods including use of strain gauges.

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Analysis task*** includes:

- determination of stresses
- displacements
- natural frequencies

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Resources*** may include:

- computer software (FEA and CAD)
- software reference documentation
- library files
- stationery
- material property standards
- reference books



**Equipment** may include:

- computer with advanced graphics software and computational capability.
- high resolution colour printer/plotter
- digitiser and / scanner

**Enterprise procedures** may include:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- operational procedures

**Appropriate solvers** includes:

- Sparse
- Preconditioned Conjugate Gradient (PCG)
- Incomplete Cholesky Conjugate Gradient (ICCS), frontal

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHs workplace procedures and practices as specified in the performance criteria
  - demonstrate the application of finite element analysis including:
    - modelling a wide range of shapes and structures;
    - choice of element type and control of element shape so as to minimise calculation errors;
    - effective use of library files;
    - selection of efficient modelling techniques including importation of geometry from other software packages;
    - application of appropriate boundary conditions;
    - verification of results;
    - presentation of results, including software generated graphics, in a form useful to others;
    - ability to identify areas of excessive stress and/or deformation and to recommend modifications



**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant equipment, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22472 - Apply electrotechnology principles in an engineering work environment

### Unit Descriptor

This unit of competency describes the knowledge and skills required to select, set-up and use a range of test equipment to measure voltage, current and resistance.

This involves testing for continuity, insulation and identifying commonly used electrical/electronic devices for the supply of power and for the control of machines and plant in an engineering environment

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit would be applied by entry level engineering workers required to apply electrotechnology principles in an engineering work environment.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Use basic electrical principles to plan, conduct, or complete engineering tasks.
2. Determine electrical requirements when planning engineering tasks.
3. Operate electrical equipment and devices to power and control engineering machinery.

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 **Basic electrical units, terms** and symbols are recognised and applied
- 1.2 Basic electrical diagrams are interpreted and the operation of the circuit explained to **appropriate personnel** in the work place
- 1.3 Potential electrical hazards are identified and reported according to **enterprise procedures**
- 2.1 **Appropriate electrical measurement devices** are used to measure basic electrical quantities in **simple DC and AC circuits**
- 2.2 Electrical measurements are interpreted correctly and **sub-units of measurements** are adjusted as required
- 2.3 Calculations are performed to obtain unknown electrical quantities not directly available through measurement
- 3.1 **Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements**, relevant Australian standards, codes of practice, manufacturers specifications, environmental requirements and enterprise procedures are identified and followed



- 3.2 **Electrical equipment and devices** are operated safely and only for the purpose intended according to manufacturers' operating instructions, specifications and any **specific safety requirements**
- 3.3 Electrical equipment and devices are operated that have been safety tested and appropriately tagged
- 3.4 The status of discrete and programmable controllers is assessed and reported correctly
- 3.5 Discrete and programmable controllers are operated correctly to instructions and **enterprise procedures**
- 4. Locate protection device in an electrical circuit and isolate the circuit
  - 4.1 The location of protection devices for electrical circuits and equipment is identified
  - 4.2 Purpose of **protection devices** is known and can be explained
  - 4.3 Subsections of the **electrical distribution** are isolated and made safe

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- recognising and interpreting electrical symbols, diagrams and schematics
- recognising potential electrical hazard in an engineering workshop environment
- operate electrical devices and equipment commonly used in an engineering workshop
- recognising electrical protection devices commonly found in an engineering workshop
- isolating subsection of an electrical circuit in a workshop environment

### **Required knowledge:**

- basic electricity
  - concepts of electromotive force (emf)
  - power dissipation
  - conductors, semi-conductors and insulators
  - direct and alternating current
  - potential dangers of working with electricity
- simple practical circuits
  - terms 'circuit', 'load', 'source', 'short circuit', 'open circuit', and 'overload'
  - circuit operation
  - switches and protection devices
  - Ohm's Law
- series, parallel and series-parallel DC circuits
  - (no more than three resistors)
  - circuit connection



- series, parallel, series-parallel circuit laws
  - measuring resistance, voltage and current
  - calculation of resistance, voltage, current and power
- electrical distribution in buildings and premises
  - single and three phase systems
  - distribution components:
    - mains,
    - sub-mains,
    - final sub-circuits,
    - main switchboards,
    - distribution boards,
    - main switches
    - isolators
  - purpose of :
    - main switchboards,
    - distribution boards
    - power ratings of typical appliances
    - equipment
    - importance of earthing
- electrical/electronic systems:
  - system level functions of power and control devices
  - controllers function and application

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***Basic electrical units and terms*** includes:

- voltage
- current
- resistance
- power
- DC and AC
- conductor
- insulator

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- trainer
- teacher



**Enterprise procedures**

include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**Appropriate electrical measurement devices**

include:

- analog
  - voltmeter,
  - ammeter
  - ohm meter
  - watt meter
- digital:
  - voltmeter,
  - ammeter
  - ohm meter
  - watt meter
- cathode ray oscilloscope

**Simple DC and AC circuits**

include:

- circuits with up to three resistors: in series, in parallel, in series/parallel
- one switch
- one fuse

**Sub-units of measurements**

include:

- conversion between prefixes of:
  - Mega
  - kilo
  - unit
  - milli
  - micro

**OHS/WHS requirements**

may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operating procedures
- award provisions

**Electrical equipment**

**and devices** may include:

- single phase or three phase connected:
  - grinders
  - drills
  - lathes
  - mills
  - planers
  - hand operated power tools
  - extension leads



**Specific safety requirements** may include:

- working safely around machinery
- working safely with tools and equipment
- risk and hazard recognition
- emergency procedures
- awareness of electrical hazards
- follow confined spaces procedures
- first aid

**Protection devices** may include:

- fuses
- limit switches
- proximity switches
- detectors
- sensors
- contactors
- overload devices
- isolators
- push buttons

**Electrical distribution** may include:

- main switch boards
- sub switch boards
- fuse boxes

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- implement OHS/WHs workplace procedures and practices including the use of risk control measures as specified in the performance criteria
- use and interpret electrical devices/equipment to measure voltage, current and resistance and test for continuity and insulation on at least one occasion
- locate and recognise electrical protection devices and isolate an electrical circuit.

**Context of and specific resources for assessment**

- This unit should be assessed as it relates to normal work practice using procedures, information and resources typical of a workplace
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions





- operational access to relevant machines, tools, materials and consumables
- access to relevant plans, drawings and instructions and manufacturer's specifications/manuals.

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22473 - Prepare and document a work plan to fabricate an engineering product or component.

### Unit Descriptor

This unit of competency describes the knowledge and skills required to prepare and document a work plan to fabrication an engineering component or tool.

It includes defining the problem, identifying and reviewing specifications, determining resources, sequencing the production tasks and reviewing the plan against the required outcome.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit applies to an entry level engineering worker required to apply basic job task planning skills in an engineering or manufacturing environment.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

#### 1. Identify task requirements

1.1 Task outcomes and ***task requirements*** are identified and clarified with ***appropriate personnel***

1.2 Relevant ***documentation*** to plan and carry out the task is access and interpreted

1.3 ***Factors affecting performance*** of the task are identified and accounted for where possible

#### 2. Plan to manufacture engineering components

2.1 Steps and activities required to fabricate engineering components are identified, ordered and documented to ensure efficient and effective use of resources and time

2.2 ***Resources needed*** for the task are identified and documented

2.3 ***Enterprise work procedures*** are identified and included in the plan where necessary

2.4 Documented work plan is checked for accuracy against task requirements and specifications

#### 3. Review work plan

3.1 Tasks outcomes are checked against job specifications, task instructions and available resources with appropriate personnel

3.2 Where required work plan is revised to better meet object task requirements and required outcome



## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- communicating including:
  - cooperating in a team
  - verbal reporting
  - questioning and clarifying information
  - following oral and written instructions
  - analysing elements of a task
  - preparing a written work plan
- interpreting sketches and drawings
- planning skills to:
  - identify task requirements, relevant documentation, factors affecting performance and outcomes
  - identify needed resources and appropriate work procedures
  - check plan accuracy against specification
  - compare and revise outcomes against specification and plan

### **Required knowledge:**

- occupational health and safety/workplace health and safety (OHS/WHS)
  - workplace safety procedures
  - risk assessment and hazard control
  - personal protective equipment and safety devices
  - personal responsibilities
- document interpretation
  - work instructions and procedures
  - reference manuals and catalogues

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

**Task requirements** may include:

- problem definition
- identification of and reviewing specifications
- determination of resources, production sequences and schedules

**Appropriate personnel** may include:

- supervisor
- leading hand
- foreman
- work colleagues
- trainer/coach
- teacher



**Documentation** may include:

- task lists
- instructions
- work procedures
- manufacturer manuals
- wiring diagrams and schematics
- technical drawings and sketches
- parts lists
- computer records

**Factors affecting task performance** may include:

- wrong or damaged parts
- unexpected or potential delays
- environmental factors – weather, noise, dust etc.
- hazards
- insufficient or incorrect information
- material shortages

**Resources needed** may include:

- work orders and cutting lists
- specifications and reference documents
- work procedures
- job samples
- tools and equipment
- materials, parts and consumables
- measuring devices
- safety equipment

**Enterprise work procedures** may include:

- instructions, including job sheets
- safety procedures
- emergency procedures
- reporting and communication
- manufacturers' specifications and operational procedures
- quality procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:



**Context of and specific resources for assessment**

- implement OHS/WHs workplace procedures and practices including the use of risk control measures as specified in the performance criteria
- demonstrate the ability to prepare a documented work plan to fabricate an engineering component according to specification and job instructions on at least two occasions.
- This unit should be assessed as it relates to normal work practice using procedures, information and resources typical of a workplace
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant equipment, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals.

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence might include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning should be undertaken in such a manner as is appropriate to the language and literacy levels of the candidate and to the requirements of the unit of competency.



# VU22474 - Apply principles of strength of materials to engineering problems

## Unit Descriptor

This unit of competency describes the knowledge and skills required to assess the strength of materials used in engineering applications

The unit includes an awareness of the impact of stress, strain, deformation, and properties of sections, shear force and testing. No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency would apply to a person working in as a technician or para-professional engineer responsible for undertaking general design work determining the strength of materials.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Identify the requirements for determining material strength

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 **Occupational Health and Safety/Workplace, Health and Safety (OHS/WHS) and environmental requirements** for a given work area are determined.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures in preparation for the work area are followed.
- 1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with **appropriate personnel**.
- 1.4 The **strength of materials task** is determined through request, design briefs or equivalent and clarified with appropriate personnel.
- 1.5 Where appropriate expert advice is sought with respect to the strength of material task and according to **enterprise procedures**.
- 1.6 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.7 **Resources and equipment** needed for the task are obtained in accordance with enterprise procedures and checked for correct operation and safety.



- |    |                                       |  |
|----|---------------------------------------|--|
| 2. | Select the appropriate testing regime | 2.1 Relevant OHS/WHS requirements for carrying out the work are followed.  |
|    |                                       | 2.2 Industry codes, regulations and technical documentation relevant to the strength of materials task are interpreted and understood                        |
|    |                                       | 2.3 Tables and graphs are used to obtain computational data, where appropriate.  |
|    |                                       | 2.4 The appropriate assumptions underlying the strength of materials are made and recorded.  |
|    |                                       | 2.5 Resources required are identified, obtained and checked as fit for the purpose.  |
|    |                                       | 2.6 The most appropriate computational method is selected and justified.   |
| 3. | Undertake materials testing           | 3.1 Relevant OHS/WHS requirements for carrying out the work are followed.  |
|    |                                       | 3.2 Strength of materials test is performed and results recorded.  |
|    |                                       | 3.3 Decisions for dealing with unexpected situations are made based on discussions with appropriate personnel, job specifications and enterprise procedures. |
|    |                                       | 3.4 Methods of dealing with unexpected situations are selected on the basis of safety and specified work outcomes.   |
| 4  | Verify and interpret results          | 4.1 Relevant OHS/WHS requirements for completing the work are followed.  |
|    |                                       | 4.2 Equipment and tools used with this task are maintained and stored in accordance with enterprise procedures.  |
|    |                                       | 4.3 Results are graphed or charted, where appropriate  |
|    |                                       | 4.4 Results are interpreted, verified and discussed with appropriate personnel.  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- determining material strength requirements and selecting the appropriate test regime
- seeking expert advice on test requirements where appropriate
- performing strength tests in accordance with relevant OHS/WHS requirements and workplace procedures
- discussing and dealing with unexpected situations in the testing process
- recording test results in accordance with workplace procedure



**Required knowledge:**

- stress and strain of engineering materials
- centrally loaded connections
  - thin walled pressure vessels
  - properties of plane figures
- simple beams (point and distribute loads)
  - torsional stress
  - thermal stress
- classification of materials
- properties of engineering materials
  - physical properties
  - mechanical properties
  - chemical properties
- materials testing methods of engineering materials:
  - destructive testing and applications
  - Non-Destructive Testing (NDT)
  - corrosion testing
- engineering materials:
  - engineering applications of:
    - ferrous metals
    - non-ferrous metals
    - polymers
- effects of mechanical and thermal processes on the properties of materials

**RANGE STATEMENT**

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

**OHS/WHS requirements** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

**Environmental requirements** may include:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise





**Appropriate personnel** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

**Strength of materials task** may include:

- materials analysis
- materials selection
- physical properties
- chemical analysis
- non-destructive testing (NDT)
- destructive testing
- corrosion testing

**Enterprise procedures** may include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**Resources and equipment** may include:

- general and specialised tools
- appropriate testing and analysis equipment
- reference material, data and tables
- manufacturers' data

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be 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
  - demonstrate the ability to successfully apply strength of materials solutions to common engineering problems on five different occasions.



**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22475 - Apply scientific principles to engineering problems

### Unit Descriptor

This unit of competency describes the knowledge and skills required to apply scientific principles to solve problems common to all engineering fields.

This includes quantities and units, vector and scalar quantities, kinematics dynamics, heat and temperature, constitution of matter and error and uncertainty.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency is applied to engineering, manufacturing and construction environments where the application of scientific principles can provide a solution to standard engineering problems.

Work associated with this unit of competency is carried out at a para-professional level.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Identify the scientific principles embedded in an engineering problem

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS)*** and ***environmental requirements*** for a given work area are determined.
- 1.2 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.3 The ***engineering problem*** is determined through requests, design briefs or equivalent and clarified with appropriate personnel.
- 1.4 Expert advice is sought with respect to the engineering problem and according to ***enterprise procedures***, where appropriate.
- 1.5 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.6 ***Resources and equipment*** needed for the task are obtained in accordance with enterprise procedures and checked for correct operation and safety.



- |   |  |
|---|--|
| 2. Apply scientific principles in the analysis or design of an engineering solution | 2.1 Relevant OHS/WHS requirements for carrying out the work are followed.  |
|   | 2.2 Industry codes, regulations and technical documentation relevant to the engineering problem are interpreted and understood.  |
|   | 2.3 Tables and graphs are used to obtain computational data, where appropriate.  |
|   | 2.4 The appropriate assumptions underlying the engineering problem are made and recorded.  |
|   | 2.5 The most appropriate analytical, computational or design methodology is selected and can be justified.                       |
|   | 2.6 Resources and equipment required are identified, obtained and checked as fit for the purpose.                                |
| 3. Verify, document and interpret outcomes  | 3.1 Relevant OHS/WHS requirements for completing the work are followed.  |
|   | 3.2 The results of the analysis or design are recorded and documented in accordance with requirements and enterprise procedures. |
|   | 3.3 Results are graphed and/or charted and interpreted, where appropriate.   |
|   | 3.4 A formal report to present outcomes is prepared according to enterprise procedures, if required                              |
|   | 3.5 Outcomes of analysis or design are verified and discussed with appropriate personnel.  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- communicating and working with other team members
- reading skills to interpret job instruction, technical documents and OHS/WHS procedures
- clarifying engineering problems
- obtaining resources and materials
- interpreting graphs and charts
- making appropriate assumptions
- recording analysis/design results
- presenting a formal report

### **Required knowledge:**

- basic chemistry
  - elements, compounds, mixtures, states of matter.
  - basic structure of matter, protons, neutrons, electrons.
  - The Bohr Atom.



- The Periodic Table of Elements.
- historical development, trends within the table and variations of electron structure within the table.
- Ionic, covalent and metallic bonding.
- valencies of common ions and radicals.
- molecular and ionic equations.
- Avogadro's Number and the mole concept.
- solubility and precipitation, solution concentration.
  - stoichiometric calculations.
  - oxidation and reduction.
  - definitions, half reactions, balancing redox equations, significance of oxidation and reduction in metallurgy.
- The Gas Laws
  - Boyle's Law, Charles's Law, Combined Gas Law.
  - Ideal gas equation  $PV = nRT$ .
  - Molar volume of a gas.
  - Gay-Lussac's Law, Avogadro's Law.
  - Gas reaction calculations.
- chemical laboratory techniques.
  - correct use of balances, heating devices and measuring devices such as pipettes, burettes and measuring cylinders.
- electromagnetic waves.
  - electromagnetic spectrum, frequency, periodicity, wavelength.
- The SI System of Units.
  - fundamental standards, scientific notation, significant figures.
- linear motion.
  - displacement, velocity and acceleration.
  - equations of linear motion.
  - free falling bodies.
- circular motion.
  - angular displacement, velocity and acceleration.
  - equations of circular motion.
  - relationship between linear and circular motion
- work, energy, power.
  - work and equivalence with energy, power, gravitational potential energy, kinetic energy, other types of energy, energy transformations.
  - work done by a constant force.
  - work done by a variable force.
  - potential energy.
  - kinetic energy.
  - principle of energy transformations.



- work – energy equation.
  - Power
- simple machines
  - mechanical advantage
  - velocity ratio
  - efficiency of a machine
  - law of the machine
  - centrifugal force
  - levers
  - gears, belts and chain drives
  - wheel and axle devices
  - systems of ropes and pulleys
- dynamics of linear motion
  - mass, force and acceleration
  - inertia force
  - acceleration against a resistance
  - acceleration against gravity
  - systems of bodies in motion (rotational and translation)
  - centrifugal force
- momentum
  - momentum
  - principle of conservation of momentum
- heat and temperature
  - kinetic theory
  - phase transition
  - specific heat
  - latent heat
  - temperature scales
  - temperature measurement
- error and uncertainty
  - sources of error
  - treatment of error and uncertainty
  - importance of minimising error
  - calculation of error



## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Enterprise procedures*** may include:

Any engineering task that requires the application of scientific principles in its analysis or design. This includes:

- constitution of matter
- gas laws
- quantities and units
- vector and scalar quantities
- work, energy and power
- simple machines
- kinematics and dynamics
- heat and temperature
- error and uncertainty



**Enterprise procedures** may include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**Resources and equipment** may include:

- computer access
- scientific calculator
- engineering tables and graphs
- regulations and codes of practices
- reference texts

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- implement OHS/WHS workplace procedures and practices including the use of risk control measures as specified in the performance criteria
- demonstrate the ability to successfully apply strength of materials solutions to common engineering problems on five different occasions
- demonstrate the ability to apply scientific principles to solve engineering problems on at least two occasions by researching from each of the following areas respectively:
  - basic chemistry
  - gas laws
  - linear and circular motion
  - work energy and power
  - Simple machines
  - momentum
  - heat and temperature
  - error and uncertainty in measurement

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.





- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals.

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



# VU22476 - Plan for the implementation of mechanical drive systems

## Unit Descriptor

This unit of competency describes the knowledge and skills required to plan for the implementation of mechanical drive systems.

This includes using catalogues and drawing of components including shafts, couplings, belts, chains, gears variable speed drives, brakes, clutches, bearings, winch equipment, reciprocating drives/linear to rotational

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency applies to engineering enterprises engaging in the design and implementation of mechanical components.

Work associated with this unit of competency is carried out at a para-professional level.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Plan a mechanical drive system

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) and environmental requirements*** for a given work area are determined.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 The requirements for the ***mechanical drive system*** are determined from documentation, reports, or clients and from discussions with appropriate personnel.
- 1.5 A draft implementation brief is completed and approved by the appropriate personnel.
- 1.6 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.7 ***Resources and equipment*** needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.



- |   |      |  |
|---|------|--|
| 2. Detail draw a mechanical drive system                      | 2.1  | OHS/WHS requirements for carrying out the work are followed.   |
|   | 2.2  | The mechanical drive system is drawn to specification.   |
|   | 2.3  | Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures. |
|   | 2.4  | Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.                                      |
| 3. Document implementation plan for a mechanical drive system | 3.1  | OHS/WHS requirements for completing the work are followed.   |
|   | 3.2  | Work site is made safe in accordance with established safety procedures.   |
|   | 3.3. | The implementation of a mechanical drive system is documented and the implementation plan is approved by the appropriate personnel.                  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- communicating and working with other team members in an engineering environment
- reading skills to interpret design brief, job instruction, technical documents, plans and OHS/WHS procedures
- preparing an implementation brief
- drawing a mechanical drive system
- completing documentation

### **Required knowledge:**

- mechanical drive components
  - shafting/couplings, keys and keyways, splines, rigid/flexible couplings, couplings selection, fluid coupling
  - gearing
    - gear types, gear manufacture, manual/auto transmission
    -
  - chain drives
    - design/range
    - conveyor chain
  - belt drives
    - different designs, selection criteria, conveying equipment, mechanical variable speed drives, vee belt, chain, ratchet, friction, brake and clutch design principles, design



- bearings
  - o journal bearings, rolling element bearings, lubricant principles
- winch equipment
  - o pulley and rope system
- reciprocating drive/linear to rotational drive
  - o various designs
- drafting mechanical drive systems
  - belt drives
    - o vee, flat, toothed, link, round, centre to centre distance, ratio, belt length
  - chain drives
    - o roller, block, silent, detachable link, chain length
  - gear drives
    - o spur, helical, herring bone, bevel, hypoid, worm and worm wheel, gear terminology
    - o calculations, ratio, centre to centre distance
  - drive shafts
    - o couplings, shafts, assembly
  - reduction box assembly
    - o housing, shafts, gears, bearing, seals, lubrication, mounting,
  - machine drive system bases
    - o mounting holes, centre heights, alignment

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise



***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Mechanical drive system*** may include:

- belt drives
- chain drives
- gear drives
- variable speed drives
- winch equipment,
- reciprocating drives/linear to rotational
- drive shafts
- reduction box assemblies
- machine drive system bases

***Resources and equipment*** may include:

- drafting equipment
  - manual or computer aided
- specifications
- standards
- manuals
- catalogues,
- stationery,
- calculators

***Enterprise procedures*** may include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures



## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- implement OHS/WHS workplace procedures and practices including the use of risk control measures as specified in the performance criteria
- demonstrate the ability to plan the implementation of mechanical drives systems to the specified level on more than one occasion and in different context.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

### Methods of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons



VU22476 - Plan for the implementation of mechanical drive systems

- inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22538 - Design mechanical engineering systems

### Unit Descriptor

This unit of competency describes the knowledge and skills required to design mechanical engineering systems.

This includes use of codes, catalogues and design handbooks to extract information to make appropriate calculations and/or selections.

This is based on skills encompassing project management, client liaison, design options, tender documentation and technical reporting.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at para professional level in an engineering enterprise which engages in the design and implementation of mechanical systems.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Write a specification for a mechanical engineering system

2. Analyse component and assembly design conditions

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements*** for a given work area are determined.
- 1.2 Customer requirements are identified in consultation with customer.
- 1.3 Functional analysis is performed and all variables which will affect the design, including OHS/WHS and ***environmental requirements***, are identified.
- 1.4 Specification document is prepared for client and clarified with ***appropriate personnel***.
- 1.5 Appropriate personnel are consulted to ensure system requirements are accurately identified.
- 2.1 Conditions of operation and ***mechanical variables*** and design parameters are identified.
- 2.2 Load conditions, working stresses and other relevant factors are calculated using formulae appropriate to the task.
- 2.3 Design loads and working stresses are determined using suitable factor of safety selected from codes or reference manuals.





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|   | 2.4 | Suitability of components to carry specified load under specified conditions is determined using appropriate formulae.   |
| 3. Select mechanical components and materials | 3.1 | Components and materials are selected appropriate to design specifications, calculated design loads, working stresses and factor of safety.  |
|   | 3.2 | Standard formulas and standard tabulated data are used to size engineering components.   |
|   | 3.3 | <b>Mechanical components</b> are selected from applicable <b>reference documents</b> to meet the design specification, calculations and to satisfy cost reliability and life requirements. |
| 4. Design mechanical engineering system       | 4.1 | Most suitable design to meet the system requirements is selected using proven design techniques.   |
|   | 4.2 | Linear and geometric tolerances are determined to ensure functionality and design performance.   |
|   | 4.3 | Feasibility of proposed design is determined based on calculations and relevant diagrams/drawings.   |
|   | 4.4 | System design is optimised using relevant calculations.  |
|   | 4.6 | Appropriate personnel are consulted to ensure the design meets customer requirements and safety factors.   |
|   | 4.7 | Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and <b>enterprise procedures</b> .                               |
| 5. Document design                            | 5.1 | <b>Resources and equipment</b> needed for the design task are obtained in accordance with enterprise procedures and checked for correct operation and safety.                              |
|   | 5.2 | Preliminary, general arrangement, design and detail drawings are prepared as required to <b>Australian Standard</b> .  |
|   | 5.3 | Design documentation and reports are prepared with all <b>relevant design information</b> .  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- consulting and communicating with project team members
- identifying and following relevant OHS/WHS procedures
- performing functional analysis
- performing calculations



- selecting components
- carrying out design tasks
- testing design
- preparing and completing documentation

**Required knowledge:**

- design principles and procedures;
  - stress and strain including:
    - tension
    - compression
    - bearing
    - shear
  - fatigue and stress concentration factor including:
  - factor of safety
  - fits and tolerances
  - Australian Standards
  - material specifications
  - drawing requirements
- levers
  - lever designs including:
    - bell crank lever
    - materials used
    - allowable stress
- keys and splines
  - characteristics and merits of types in common use
  - standard proportions of keys
  - shear stress
  - bearing stress
  - length of keys and splines
- couplings
  - types
  - analysis of components
  - stresses including:
    - shear
    - bearing
    - bending
  - standard proportions of flanged couplings and knuckle joints
    - proportion of hub and key



- journal bearings
  - elementary journal bearing design
  - bearing clearance
  - length to diameter ratio
  - bearing pressure
  - position of oil holes and grooves
  - heat generated and dissipated
    - allowable operating temperatures of lubricants
- rolling contact bearings including:
  - bearing types and size
  - combined bearing load
  - axial and radial loads
  - static and dynamic capacity
  - requisite bearing life for different types of machines
  - permissible speeds of operation
- bolted connections including:
  - types
  - standard bolt sizes
  - allowable stresses
  - fabrication of joints
  - modes of failure
  - analysis of eccentrically loaded joints
- welded connections including:
  - practical and design consideration of welded connections
  - allowable stresses on welds
  - design of fillet and butt welds
  - eccentrically loaded joints
  - effect of symmetric and unsymmetrical weld patterns
- helical springs (round wire)
  - types
    - allowable working stresses
  - stiffness
  - wahl correction factor
  - deflection
  - spring rate
  - spring index
  - spring ends
  - typical specifications required for manufacture
  - spring design by nomograms



- translation screws
  - types
  - screw proportions
  - coefficient of friction
  - efficiency
  - conditions for self-locking
  - stresses in screw threads
  - bearing pressures
  - depth of nut
  - column effect
- design documentation
  - document types
  - components and elements of design documents
  - sequence and structure of information
  - use of tables graphs and charts
  - style and language
  - report terminology
- design skills including:
  - manual and/or CAD drawing and drafting
  - AS 1100 parts 1 -10
  - design aids
  - interpreting reference manuals and other documentation
  - mechanical formulae, calculations and measurement within the scope of this unit
  - engineering materials

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager



***Mechanical variables*** may include:

- site engineer
- trainer
- mentor
- teacher
- team member
- loads
- working stresses
- safety factors
- sizes and tolerances

***Mechanical components*** may include:

- bearings
- couplings
- bolted connections
- welded connections
- splines and keyways
- shafts
- springs
- screws
- keys
- levers

***Reference documents*** may include:

- industrial catalogues
- standard proportions
- Australian codes
- manufacturers guidelines
- charts
- computer spread sheets or nomographs
- data sheets
- part number sheets

***Enterprise procedures*** may include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

***Resources and equipment*** may include:

- texts
- codes



- design manuals
- catalogues
- drawing board/machine,
- drafting instruments and/or CAD system with printer/plotter
- design aids

**Australian standard** refers to:

- AS 1100 Parts 1 – 10

**Relevant design information** may include:

- design procedure
- design outcomes
- tasks and processes
- assumptions
- calculations
- source of design formulae
- final sizes
- material and parts selection
- manufacturing recommendations
- detailed sketches and drawings of final design

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement Occupational Health and Safety workplace procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to design mechanical engineering systems on more than one occasion and in different contexts which includes:
    - writing specifications
    - analysing components and assembly design conditions
    - selecting mechanical components and materials
    - designing mechanical engineering systems and
    - documenting mechanical engineering designs.



**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations.
- The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant equipment, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22539 - Design mechanical machines

### Unit Descriptor

This unit of competency describes the knowledge and skills required to design rotating machines, using catalogued and standard machine component parts and assemblies.  
No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at paraprofessional level in an industrial engineering enterprise where mechanical machine design is used to produce goods or services.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

- 1 Interpret design requirements for a rotating machine

2. Select mechanical machine components

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS)*** for a given work area are obtained and understood and impact on design are identified.
- 1.2 Machine design task is determined through requests, work orders or equivalent and clarified with the ***appropriate personnel***.
- 1.3 ***Mechanical variables*** which will affect the design are analysed.
- 1.4 Expert advice is sought with respect to the design task and according to ***enterprise procedures***, where appropriate.
- 2.1 OHS/WHS requirements for carrying out the work are followed.
- 2.2 ***Machine components*** are selected from applicable ***reference documents*** to meet the design specification, calculations and to satisfy cost reliability and life requirements.
- 2.3 Component sizes and tolerances are calculated using standard formulas and standard (tabulated) component data.
- 2.4 Mechanical measurements and calculations are performed and interpreted correctly.





- |                              |   |
|------------------------------|---|
| 3. Design mechanical machine | <p>3.1 OHS/WHS requirements for carrying out the work are followed.</p> <p>3.2 <b>Resources and equipment</b> for the task are obtained in accordance with enterprise procedures and checked for correct operation and safety.</p> <p>3.3 Principles of mechanical drive systems and standard machine design are applied to the design task.</p> <p>3.4 Feasibility of proposed design is determined based on calculations and relevant diagrams/drawings.</p> <p>3.5 Machine design is prepared using relevant calculations.</p> <p>3.6 Machine design is optimised within design parameters, using relevant calculations.</p> <p>3.7 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.</p> |
| 4. Document machine design   | <p>4.1 OHS/WHS requirements for carrying out the work are followed.</p> <p>4.2 Design documentation and reports are prepared with all <b>relevant design information</b>.</p> <p>4.3 Final design specifications are established and agreed on with appropriate personnel.</p> <p>4.4 Alternative design solutions are provided, where required.</p> <p>4.5 Work completion is notified according to enterprise procedures.</p>   |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- consulting and communicating with other team members
- identifying and following relevant OHS/WHS procedures
- performing measurements and calculations
- preparing machine design solutions in response to project brief
- preparing design documentation detailing component specifications

### **Required knowledge:**

- design factors include:
  - basic principles of strength analysis
  - tensile, shear/torsional and bending strength
  - drive shaft materials for given conditions
  - fatigue, shock, stress raisers and endurance
  - stress
    - direct stress
    - shear stress (torsional)
    - bending stress



- combined stress
  - spline and pin sizes and formulae
  - fatigue failure theory
  - factor of safety
  - fits and tolerances
  - Australian Standards
  - material specifications
  - drawing requirements
- shaft types include:
  - circular and non-circular
  - keyed
  - flanged
  - crank webbed
  - hollow
  - pinned shafts
  - shafts with flats
  - splined shafts
  - square and rectangular
  - hollow circular and thin walled
  - keyed and other stress-raised shafts
- calculations and formulae includes:
  - standard formulae to determine loading of shaft systems
  - fatigue figure analysis
  - stress formulae
  - spline and pin formulae
  - formulae to determine standard and irregular shaft sizes
  - force analysis
  - formulae to analyse drive suitability
  - formulae to determine axial and bending forces.
- design documentation includes:
  - document types
  - components and elements of design documents
  - sequence and structure of information
  - use of tables graphs and charts
  - style and language
  - report terminology
- design skills includes:
  - manual and/or CAD drawing and drafting
  - AS 1100 parts 1 -10
  - design aids
  - interpreting reference manuals and other documentation
  - mechanical formulae, calculations and measurement within the scope of this unit
  - engineering materials



## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHs requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Mechanical variables*** may include:

- forces - torque, shear (torsional) stress and bending and combined stress
- fatigue
- thermal
- corrosion
- wear
- mode of application
- life
- materials
- stress raiser
- shock

***Enterprise procedures*** may include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

***Machine components*** includes:

- Drive components, such as:
- shafts
- rigid couplings
- flexible couplings
- gear drives
- vee belts
- chains
- gear drives
- keys
- splines



- pins
- belt drive
- Power:
- electric motors
- speed reducers
- prime movers

**Reference documents** may include:

- industrial catalogues
- standard proportions
- Australian codes
- manufacturers guidelines
- charts
- computer spread sheets or monographs
- data and part number sheets

**Resources and equipment** may include:

- texts
- codes
- design manuals
- catalogues
- drawing board/machine,
- drafting instruments and/or CAD system with printer/plotter
- design aids

**Relevant design information** may include:

- design procedure
- design outcomes
- tasks and processes
- assumptions
- calculations
- source of design formulae
- final sizes
- material and parts selection
- manufacturing recommendations
- detailed sketches and drawings of final design

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement Occupational Health and Safety workplace procedures and practices including the use of risk control measures as specified in the performance criteria



- demonstrate the ability to interpret design requirements for a rotating machine and developing a design solution using catalogued mechanical components and standard machine parts.

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant equipment, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include the demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22477 - Select rotating electrical machines

### Unit Descriptor

This unit of competency describes knowledge and skills required to select setup and test a range of alternating current and direct current rotating machines.

This involves the determination of required characteristics for the application, the selection of appropriate machine type to meet these requirements, the design of circuits to operate and test the machine and the production of drawings and documents to describe its operation.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

The unit of competency applies to engineering, manufacturing and construction environments where the selection of rotating electrical machines is required.

Work associated with this unit of competency is carried out at a para-professional level.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- |  |     |   |
|--|-----|---|
| 1. Select a machine for a particular application | 1.1 | <b><i>Occupational Health and Safety/Workplace Health and Safety (OHS/WHS)</i></b> and <b><i>environmental requirements</i></b> for a given work area are determined                |
|  | 1.2 | Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area  |
|  | 1.3 | Safety hazards that have not previously been identified are documented and risk control measures devised and implemented in consultation with <b><i>appropriate personnel</i></b> . |
|  | 1.4 | Documents describing application requirements are determined and assembled.   |
|  | 1.5 | Characteristics of different machines are considered and mapped against application requirements.   |
|  | 1.6 | <b><i>Resources and equipment</i></b> required for the operation and design of the machine process are assembled and collated.  |
|  | 1.7 | Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.   |
| 2. Setup a machine for operation or testing      | 2.1 | OHS/WHS requirements for carrying out the work are followed.  |
|  | 2.2 | Equipment/machines/plant are checked as being isolated where necessary in strict accordance with OHS/WHS requirements.  |



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|----|---|-----|--|
| 3. | Complete records in relation to machine setup | 2.3 | Worksite is prepared for the operation and/or testing of the machine.  |
|    |   | 2.4 | Calculations are performed to confirm operational/testing selection.   |
|    |   | 2.5 | Equipment is connected and tested to conform to operational design requirements.   |
|    |   | 2.6 | Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and <b>enterprise procedures</b> . |
|    |   | 2.7 | Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.  |
|    |   | 2.8 | Operation and test procedures are undertaken in accordance to requirements and enterprise procedures.  |
|    |   | 3.1 | OHS/WHS requirements for carrying out the work are followed.   |
|    |   | 3.2 | Work site is made safe in accordance with established safety procedures  |
|    |   | 3.3 | Equipment/machines/plant return to storage as per enterprise procedures.   |
|    |   | 3.4 | Drawings/documents are updated to reflect established conditions   |
|    |   | 3.5 | Appropriate personnel are notified of the completion of work and reports and/or completion documents are finalised/commissioned.                             |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- communicating and working with other team members
- reading skills to interpret job instruction, technical documents and OHS/WHS procedures
- performing calculations
- isolating equipment/machines/plant
- making connections and perform tests
- updating documents

### **Required knowledge:**

- rotating machine construction and operating principles
  - construction of rotating machines
  - generated emf and back emf
  - development of torque
  - factors affecting generated voltage and torque



- DC generators
  - circuit diagrams and connections
  - methods of excitation
  - control of output voltage
- DC motors
  - circuit diagrams and connections
  - evaluation of performance of motor
  - effects of load
- three phase motors
  - construction
  - operation principles
    - rotating magnetic fields
    - poles
    - rotors – squirrel cage and wound
    - torque and Rotor : XLrotor relationship
- three-phase synchronous machines
  - operating principles
  - construction features
  - application
- three-phase synchronous machines
  - effects of load changes
  - effects of excitation change
  - load/current characteristics
- testing procedures for rotating machines
  - types of tests conducted
  - testing procedures
  - testing in accordance with Australian standards
  - load characteristics testing

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions





**Appropriate personnel** may include:

- excessive energy and water use
- excessive noise
- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

**Resources and equipment** may include:

- DC motors
- DC generators
- Single phase AC motors
- Three phase induction motors
- Three phase synchronous motors
- Three phase synchronous generators

**Enterprise procedures** may include:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- implement OHS/WHS workplace procedures and practices including the use of risk control measures as specified in the performance criteria
- demonstrate the ability to set up, operate and test rotating machines on at least two occasions and in different contexts.



**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22540 - Generate design solutions

### Unit Descriptor

This unit describes the skills and knowledge required to create sound design solutions in an industry context which are economically viable, environmentally conscious, ergonomically appropriate and equitable for those producing the product as well as the end user.

The unit begins with a general overview of industrial design and the role of the designer and includes the starting point of a design brief, research and analysis of ideas and resources, plus the development of innovative concepts. It also includes a requirement for critical and informed collaboration with others about one's own work.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit will apply to a person working at a professional level and responsible for creating design solutions in an engineering industry context and involves critical and informed collaboration with others.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Identify the scope of design for the industry

2. Define the design problem

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement<sup>1</sup>. Assessment of performance is to be consistent with the evidence guide.

- 1.1 **Research** typical design applications in industry area.
- 1.2 Identify the role of the designer in the industrial setting
- 1.3 Research ***environmental and sustainability issues*** in the industry
- 1.4 Identify ***key issues*** pertinent to the industry
- 1.5 Research ***materials, tools and equipment*** applicable to design in the industry.
- 2.1 Determine ***user/client needs and requirements***
- 2.2 Define the ***design problem***
- 2.3 Clarify ***specifications***, parameters and ***constraints*** of the design problem in consultation with relevant ***stakeholders***



- |  |  |
|--|--|
| <p>3. Undertake research to inform the design solution</p>             | <p>3.1. Collect, evaluate and acknowledge sources of <b>relevant information</b> to assist in solving the design problem</p> <p>3.2 Consider <b>historical, current trends and futures perspectives</b> that might inform the design solution</p> <p>3.3 Identify environmental conditions and consequences pertinent to the design problem</p> <p>3.4 Consider <b>social, economic, ethical and cultural issues</b> pertinent to the design problem</p> <p>3.5 Collate research information to inform development of design solution(s).</p>  |
| <p>4. Communicate and collaborate with others</p>                      | <p>4.1 Develop working relationships with stakeholders and peers in the design process</p> <p>4.2 Inform interested stakeholders of the progress and associated implications of the design process</p> <p>4.3 Obtain <b>input</b> regularly throughout developmental stages to ensure that design process/es and outcomes are continuously improved</p> <p>4.4 Negotiate additional requirements or modifications to the design and undertake any necessary amendments to the designs</p>  |
| <p>5. Formulate a range of <b>approaches</b> to the design problem</p> | <p>5.1 Reflect on and integrate ideas generated from research and consultation</p> <p>5.2 Apply principles of <b>functionality, ergonomics, aesthetics</b> and <b>sustainability</b> to the development of the design options</p> <p>5.3 <b>Document</b> design options in accordance with project requirements</p>  |
| <p>6. Select most appropriate design solution</p>                      | <p>6.1 Identify the social and environmental consequences of design solution</p> <p>6.2 Identify the functional and aesthetic qualities of the design solution</p> <p>6.3 Determine the feasibility, desirability and appropriateness of the proposed design solution in light of original design problem through consultation</p> <p>6.4 Identify advantages and disadvantages of potential design solution</p> <p>6.5 Adjust and refine design solution based on research, reflection and relevant constraints</p> <p>6.6 Document preferred design solution in accordance with project requirements</p> |



## REQUIRED SKILLS AND KNOWLEDGE

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

### Required skills:

- researching skills to inform the design solution
- communicating and literacy skills to collaborate with relevant stakeholders, request advice, receive feedback and work with a range of people about the design requirements and solutions
- numeracy skills to perform calculate take measurements assess sizes, determine costs etc
- engineering design skills to develop solutions in response to a define need
- personal and professional presentation

### – Required Knowledge:

- a wide range of sources of information pertaining to the development of the design
- appropriate communication methods to encourage collaboration about the concept for own work
- the theoretical and philosophical context for design development
- other design practitioners and their development of concepts for own work
- the elements and principles of design and how they may be used in the development of the concept for own work
- copyright, moral rights and intellectual property issues and legislation which assist the development and critical discourse of the concept for own work
- literacy skills sufficient to research and evaluate a wide range of source materials for the development of the concept for own work

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## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

### **Research** includes:

- historical practice, photographs and other records, direct observation from the natural or built environment, technical reports/data, company reports, promotional material

### **Environmental and sustainability**

### **Issues** may include:

- process
- use of renewable resources
- appropriate technology
- waste/by products/emissions
- life cycle analysis
- outcome
- energy efficiency
- environmental consciousness/green design
- conservation of resources
- recycling



**Key issues** may include:

- legal requirements in accordance with Federal, State and Territory legislation, regulation and standards
- intellectual property/patents
- Codes of practice
- social
- economic
- ethical
- cultural
- historical practices

**Materials** include:

- Naturally occurring
- Manufactured
- Composite
- Altering characteristics
- Material combining
- Material compatibility
- Adherents
- Availability: forms, sizes, supply, costs
- Typical uses
- Recent innovations
- Traditional
- Social, environmental and industrial implications: recycling, renewable and non-renewable resources, etc.
- OHS/WHS considerations

**Properties** may include:

- Physical - appearance, density, porosity, moisture content
- Mechanical - strength, stiffness, toughness, ductility, elasticity
- Chemical - oxide or compound, pH, resistance to corrosion/durability
- Thermal - specific heat, expansion, conductivity
- Electrical - conductivity, magnetic effect, galvanic action
- Magnetic - diamagnetic, paramagnetic
- Acoustic - sound transmission, sound reflection
- Optical - colour, light transmission, light reflection
- Macro structure – detail visible to naked eye, eg grain surface cracks

**Tools and equipment** may include:

- hand tools
- power tools
- hydraulic tools
- pneumatic tools
- machinery & plant
- measuring tools
- computer and software



**User/client needs and requirements:**

- describes and specifies the work to be completed
- is determined by commissioning body or organisation (could be supervisor, client, community organisation)
- may be written, diagrammatic, visual, verbal

**Design problem**

includes:

- spontaneous idea
- open brief
- closed brief
- modification of existing product or process or system
- point in an ongoing design process

**Specifications** include:

- purpose
- audience
- medium
- style

**Constraints** may include:

- technical
- financial/budget
- time
- environmental
- appearance

**Stakeholder** may include:

- employer
- customer/client
- consumers
- work colleagues
- other tradespeople
- peer group, mentor, supervisor, other design practitioners

**Relevant information**

may include:

- design standards
- material characteristics and capabilities
- stylistic considerations
- legal, contractual, ethical and copyright considerations
- health and safety
- technological considerations and influences
- work by other practitioners
- discussion and debate about the design with peers/supervisor
- evaluation of options
- problem-solving strategies
- further reflection on concept
- further evaluation of concept against personal affinity with the idea, social conventions and or significance and aesthetic considerations
- innovation, thinking beyond established boundaries or conventions



**Historical perspectives, current trends, futures perspectives** includes:

- materials
- tools & equipment
- procedures/processes
- sustainability
- recyclability

**Social issues** may include:

- workforce
- customers/clients
- relationships with the community

**Economic issues** may include:

- cost of production
- number of items/manufacturing method
- time frames
- budgeting and financing requirements
- transportation
- availability of materials, tools and equipment
- sponsorship
- government policy
- triple bottom line

**Ethical issues** may include:

- impact on community
- workforce
- environment
- customers/clients

**Cultural issues** may include:

- workforce
- customers/clients

**Input** may include:

- electronic
- face to face
- visual and oral presentation, written and visual
- presentation, use of diagrams, charts, electronic –video
- conference, Internet, forum

**Approaches** may include:

- no change
- adjustment to utilise the capabilities of the techniques
- adjustment to design solution





## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - develop the design concept through a process of selecting and critically examining source material and then refining the design concept
  - demonstrate effective collaboration about the design concept which shows a command of relevant references, terminologies and ideas
  - source industry information

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

### Methods of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons



- inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22478 - Design and prototype components and/or small structures using engineering design principles

### Unit Descriptor

This unit of competency describes the knowledge and skills required to design and prototype engineering components or small structures in an engineering context.

This involves preparation of concept proposals, drawings, plans and models.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency is applied to engineering, manufacturing and construction environments where the design and prototype components and/or small structures using engineering design principles.

Work associated with this unit of competency is carried out at a para-professional level.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

- 1 Interpret design brief and prepare concept proposal

- 2 Set up design for model or prototype production

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 The design task is determined through requests, work orders or equivalent and clarified with the **appropriate personnel**.
- 1.2 Alternate design solutions are developed and evaluated in conjunction with the appropriate personnel.
- 1.3 Where appropriate expert advice is sought with respect to the design task and according to **enterprise procedures**.
- 1.4 A **concept proposal**, including evaluation of alternate approaches, codes and regulations, is prepared and reviewed with appropriate personnel.
- 1.5 Final design specifications are established and agreed on with appropriate personnel.
- 2.1 **Resources** required are identified, obtained and checked as fit for purpose.
- 2.2 Relevant codes, regulations and technical documentation relevant to the production process are interpreted and understood.
- 2.3 A work plan is prepared showing the correct sequence of operation.



	2.4	Prototype manufacture is set up by selecting appropriate techniques and tools for the task required.
3	Produce model or prototype	3.1 <b>Occupational Health and Safety/Work Health and Safety (OHS/WH&amp;S) requirements</b> , relevant Australian standards, codes of practice, manufacturers' specifications, <b>environmental requirements</b> and enterprise procedures are identified and adhered to.
	3.2	<b>Specific safety requirements</b> are met throughout the task and can be explained.
	3.3	Work plan is followed during production process.
	3.4	Work output is inspected for compliance with design specifications and requirements.
	3.5	Unexpected situations are dealt with safely and reported to the appropriate personnel.
4.	Clean up work area and maintain equipment	4.1 Work area is cleared of waste, cleaned and secured following enterprise procedures.
	4.2	Equipment is cleaned and inspected for serviceable conditions following enterprise procedures.
	4.4	Machinery and tooling is maintained in accordance with manufacturers' specifications and enterprise procedures.
5.	Review design outcomes	5.1 Any routine and non-routine problems in design and/or prototype production are identified and corrective action suggested
	5.2	Model or prototype is reviewed with the appropriate personnel in terms of the intended use the design
	5.3	Final design is documented and signed off according to enterprise procedures.

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- communicating and working with other team members
- reading skills to interpret design brief, job instruction, technical documents, plans and OHS/WH&S procedures
- setting up and producing a model or prototype according to job requirements
- preparing and reviewing relevant documentation

### **Required knowledge:**

- design fundamentals
  - needs analysis



- design goals
- systematic design procedures
- design specifications
- feasibility
- constraints
- cost
- engineering objectives in design
  - materials
    - metal
      - ferrous
      - non-ferrous
      - non-metal
    - strength
      - rigidity
      - elasticity
    - joints
    - manufacturability
    - assembly
    - safety
  - detail design
    - drawings
    - folding and filing methods
    - parts lists
    - projection
    - lines
    - sectioning
    - dimensioning
    - ISO
    - tolerances and fits
    - surface finish indications
    - measurements
  - prototype production
    - fundamentals
    - manufacturing methods
    - manufacturing materials
    - manufacturing assembly
    - safety issues
  - final design documentation



## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- trainer/coach
- teacher

***Enterprise procedures*** may include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

***Concept proposal*** may include:

- drawings
- reports
- computations
- feasibility studies
- environmental constraints
- costing

***Resources*** may include:

- computer hardware
- computer software
  - word processing
  - spreadsheets
  - data base
  - drafting
- engineering work area
- machining tools
- fabrication equipment
- power tools
- hand tools
- materials

***OHS/WHs requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operating procedures
- awards provisions



**Environmental requirements** may include:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

**Specific safety requirements** may include:

- working safely around machinery
- working safely with tools and equipment
- risk and hazard recognition
- emergency procedures
- awareness of electrical hazards
- follow confined spaces procedures
- first aid

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- implement OHS/WHS workplace procedures and practices including the use of risk control measures as specified in the performance criteria
- demonstrate the ability to successfully apply strength of materials solutions to common engineering problems on five different occasions.

### Context of and specific resources for assessment

- This unit should be assessed as it relates to normal work practice using procedures, information and resources typical of a workplace
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or simulated workplace environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals



**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.





# VU22479 - Apply fluid mechanic principles in mechanical engineering

## Unit Descriptor

This unit of competency describes the knowledge and skills required to apply fluid mechanic principles in mechanical engineering.

This includes the principles and applications of fluids, fluid components, fluid status, fluid flow, fluid power, and forces developed by flow in fluids. To perform calculations to determine changes, forces etc. fluid flow and head loss in pipes and through open channels, to determine operational aspects of a pump in a system and to describe the basic types of fluid machinery.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency applies to industrial engineering enterprises where the application of fluid power is used to produce goods or services.

Work associated with this unit of competency is carried out at a para-professional level.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Determine the application of fluid mechanics to engineering problems

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Work Health and Safety (OHS/WH&S) and environmental requirements*** for a given work area are clarified.
- 1.2 Established OHS/WH&S requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards, which have not previously been identified, are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 Engineering problems are solved using fluid mechanics principles from job instructions and discussions with client and/or appropriate personnel.
- 1.5 Specifications for the solution are drawn up and approved by the appropriate personnel.
- 1.6 Expert advice is sought with respect to the solution and according to ***enterprise procedures***, where appropriate.
- 1.7 ***Resources and equipment*** needed for the task are obtained in accordance with enterprise procedures.



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| 2. Apply fluid mechanic principles to the solution of engineering problems | 2.1 Relevant OHS/WHs requirements for carrying out the work are followed.<br>2.2 Solution options are evaluated and the most appropriate solution is chosen.<br>2.3 Appropriate computations are carried out to ensure that the solution meets specifications.<br>2.4 The <b>fluid mechanic system</b> is sketched to specification.<br>2.5 Potential risks with respect to the application are analysed and management strategies are recommend to appropriate personnel.<br>2.6 Contingency plans are implemented in collaboration with appropriate personnel. |
| 3. Validate and review the solution  | 3.1 Relevant OHS/WHs requirements for completing the work are followed.<br>3.2 The solution is validated and reviewed with the appropriate personnel.<br>3.3. The fluid system is documented and approved by the appropriate personnel.  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- communicating and working with other team members
- reading skills to interpret job instructions, technical documents and OHS/WHs procedures
- carrying out computations using fluid power principles
- solving engineering problems using fluid power principles
- preparing and reviewing relevant documentation

### **Required knowledge:**

- 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
- 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
- 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 - buoyance, flotation, apparent weight and centre of buoyancy
  - 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
- 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
  - forces developed by a fluid flowing in a pipe or duct with changes in direction and/or cross section
- Reynold's Number and flow regime
  - Reynold's Number for fluid flow in a pipe given the flow rate and fluid properties.
  - characteristics of laminar, turbulent and mixed (transition) flow.
  - relationship between Reynold's Number and flow regime.
  - Upper and Lower Critical Reynold's Number.
  - non-circular pipes.
- head loss in pipes and fittings
  - Darcy Equation for head loss in a pipe.
  - determination of the friction factor using both Moody Diagram and formula.
  - head loss through fittings using K factors.
  - head loss through a piping system consisting of a single diameter pipe and a number of fittings.
  - system head curve for a piping system consisting of a single diameter pipe and a number of fittings as well as reservoirs or tanks either vented or under pressure or vacuum.
- pipe networks
  - head loss through parallel and series pipes.
  - reduction of a simple pipe network consisting of a number of parallel or series pipes to an equivalent single pipe system.
- channel flow
  - Chezy and Manning formula for flow rate through an open channel.
  - flow rate given dimensions and inclination.
  - optimum shape of section for both fixed and variable flow rates.
- fluid machinery
  - distinction between the various types of fluid equipment, namely, pumps, compressors, fans, turbines and motors.
  - positive displacement machines - fixed and variable displacement piston types, vane types, gear and gerotor types, flexible impeller, flexible diaphragm screw, peristaltic.



- pumping systems
  - duty point for a rotodynamic pumping system by combining system head curve with pump performance curve.
  - flow, head, power and efficiency at the duty point.
  - energy cost of pumping.
  - causes and effects of cavitation.
  - avoidance of cavitation by attention to inlet system design.
  - influence of fluid temperature and pressure on tendency for cavitation.

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provision

***Environmental requirements*** may include:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- awards provisions

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Enterprise procedures*** may include:

- use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufactures specifications and operational procedures



**Resources and equipment** may include:

- textbooks
- standards
- specifications
- catalogues
- stationery
- calculators

**Fluid mechanic system** may include:

- fluid flow apparatus, for pipes, channels, notches and weirs
- head loss apparatus
- impact of a jet apparatus
- pump and turbine apparatus
- buoyancy tank
- venturi tube

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- implement OHS/WHS workplace procedures and practices including the use of risk control measures as specified in the performance criteria
- demonstrate the ability to successfully apply strength of materials solutions to common engineering problems on five different occasions.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions



- operational access to relevant machines, tools, materials and consumables
- access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include the demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



# VU22480 - Implement basic materials science principles to engineering applications

## Unit Descriptor

This unit of competency describes the knowledge and skills required to apply basic principles of materials science to engineering problems applications.

It involves testing of materials to evaluate the engineering properties of materials and includes the recognition of common materials used in engineering, the classification of materials, the properties of materials and the factors that influence those properties.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency provides the knowledge of materials science to work at para-professional level in an engineering/manufacturing environment.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Prepare for materials testing and evaluation task

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) and environmental requirements*** for a given work area are determined.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 The ***materials testing and evaluation task*** requirements are determined through documentation, job sheets and through discussion with appropriate personnel.
- 1.5 Expert advice is sought with respect to the ***materials science task*** and according to ***enterprise procedures*** where appropriate.
- 1.6 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.7 ***Resources and equipment*** needed for the task are obtained in accordance with enterprise procedures and checked for correct operation and safety.





- |   |     |   |
|---|-----|---|
| 2. Perform materials testing and evaluation task              | 2.1 | OHS/WHs requirements for carrying out the work are followed.  |
|   | 2.2 | Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with appropriate personnel. |
|   | 2.3 | The materials testing and evaluation is undertaken according to enterprise procedures.  |
|   | 2.4 | The most appropriate materials testing and evaluation methodology is chosen for given task.   |
|   | 2.5 | Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.                  |
|   | 2.6 | Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.   |
| 3 Complete and document materials testing and evaluation task | 3.1 | OHS/WHs requirements for completing the work are followed.  |
|   | 3.2 | Documentation associated with materials testing and evaluation task is prepared according to enterprise procedures.   |
|   | 3.3 | Documentation associated with the materials testing and evaluation task is controlled and correct revision levels are assigned.                                       |
|   | 3.4 | The completion of the materials testing and evaluation task is notified and outcomes are discussed with appropriate personnel.  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- communicating and working with other team members
- reading skills to interpret job instruction, technical documents and OHS/WHs procedures
- preparing and performing material tests on provided material samples
- preparing and reviewing relevant documentation

### **Required knowledge:**

- classification of materials:
  - review of material classes
  - metals and non-metals, ferrous and non-ferrous metals
  - thermosetting, thermoplastic and elastomeric polymers
  - composite materials
  - ceramic materials
  - biomaterials
  - advanced materials



- structure of materials:
  - states of matter
  - atomic structure
  - periodic table
  - atomic bonding in solids
  - crystal structures
  - development of grain structures
  - non-crystalline materials
- properties of materials:
  - physical properties
    - electrical conductivity/resistivity
    - specific gravity/density
    - thermal conductivity/ expansion
    - specific heat
    - melting/boiling points
  - mechanical properties
    - strength: yield, tensile, compressive, torsion, flexural  
hardness, impact properties, elasticity, plasticity, ductility, malleability, fatigue, and creep
- stress and strain behaviour of materials:
  - stress: yield, proof, ultimate, breaking strain
  - modulus of elasticity
- tensile testing of materials:
  - tensile testing; behaviour of ductile and brittle materials to tensile forces
- hardness and impact testing:
  - common methods
- chemical properties:
  - corrosion and oxidation of metals and ceramics
  - degradation of polymers
- ferrous metals:
  - plain carbon and alloy carbon steels
  - cast irons
- non-ferrous metals:
  - aluminium, copper, nickel, zinc, titanium, magnesium, and their respective metals alloys
  - refractory metals
- polymers:
  - thermosetting, thermoplastic and elastomeric polymers
  - polymerisation
  - manufacturing processes
  - applications



- ceramic materials:
    - applications of ceramic materials
      - heavy clay products
      - domestic ceramics
      - electrical ceramics
      - abrasives
      - refractories
      - glass, glass ceramics
      - advanced ceramics
      - manufacturing processes pertaining to ceramic materials
  - composite materials:
    - principles
    - laminar, particulate and fibre composites
    - metal and ceramic matrix composites
    - applications
  - effects of mechanical and thermal processes on the properties of materials:
    - hot and cold work
    - grain growth
    - recrystallisation
- joining of metals:
- metallurgical considerations involving the soldering, brazing and welding of metals
  - difficulty in welding high carbon steel
- Non-Destructive Testing of materials:
  - visual
  - X-Ray
  - ultrasonic
  - dye penetrant
  - magnetic particle
  - Eddy current

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

**OHS/WHS requirements** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions



***Environmental requirements***

may include:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Materials testing and evaluation task*** applies to:

- failure analysis
- tensile testing
- impact testing

***Materials science task*** applies to:

- metallographic investigations
- testing of metallic coatings and coating systems
- failure and fracture analysis
- thermal fatigue
- mechanical fatigue
- tensile testing

***Enterprise procedures*** may include:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures



**Resources and equipment** may include:

- appropriate written reference and texts on materials and material strength testing
- tensile testing equipment
- hardness testing equipment
- impact testing equipment
- appropriate heat treatment facilities
- computer workstation with appropriate testing applications software
- universal testing machine

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- implement OHS/WHS workplace procedures and practices including the use of risk control measures as specified in the performance criteria
- demonstrate the ability to successfully apply strength of materials solutions to common engineering problems on five different occasions.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals



**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



# VU22541 - Implement advanced materials science principles to engineering applications

## Unit Descriptor

This unit of competency sets out the knowledge and skills required to apply advanced principles of materials science to engineering problems applications.

This includes the identification and description of structure and properties of materials, metallography, heat treatment processes for metals, strengthening mechanisms, surface engineering and failure mechanisms.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency applies to a person working at para professional level in an engineering environment where a sound knowledge and skills in the science of materials for engineering applications are required

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Determine the requirements for applying advance principles of materials science to an engineering application.

2. Select the appropriate testing regime.

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS)*** for a given work area are clarified.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 ***Materials science task*** is determined through request, design briefs or equivalent and clarified with ***appropriate personnel***.
- 1.4 Expert advice is sought with respect to the materials science task and according to ***enterprise procedures***, where appropriate.
- 1.5 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with appropriate personnel.
- 1.6 ***Resources*** and equipment needed for the task are obtained in accordance with enterprise procedures and checked for correct operation and safety.
- 2.1 OHS/WHS requirements for carrying out the work are followed.
- 2.2 Industry codes, regulations and technical documentation relevant to the materials science task are interpreted and implemented.



- 2.3 Tables and graphs are used to obtain computational data, where appropriate.
  - 2.4 Appropriate assumptions underlying the materials science task are made and recorded.
  - 2.5 Resources required are identified, obtained and checked as fit for the purpose
  - 2.6 Appropriate computational method is selected and justified.
3. Undertake a solution.
  - 3.1 OHS/WHS requirements for carrying out the work are followed.
  - 3.2 Metallographic investigations and/or material testing tasks are performed and results recorded.
  - 3.3 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.
  - 4.2 Results are verified, interpreted and discussed with appropriate personnel.
  - 4.3 Results are graphed or charted, where appropriate.
  - 4.4 Results are recorded, stored and archived according to enterprise procedures.

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- consulting and communicating with others involved with the work tasks
- reading and interpreting technical information such as material data sheets
- interpreting and producing graphs and tables
- performing metallographic investigations and material testing tasks
- performing a range of computations related to material suitability for a specified application
- producing graphs and charts related to material performance

### ***Required knowledge:***

- structure of crystalline materials:
  - crystal structures
  - crystal systems
  - crystallographic planes and directions
  - review of developing microstructures
  - determination of crystal structures
  - structure of non-crystalline solids





- imperfections in crystalline materials:
  - point defects
  - impurities in solids
  - solid solutions
  - linear defects
- microscopic examination:
  - metallography
  - optical microscopy
  - electron microscopy
  - microphotography
- diffusion:
  - mechanisms
  - applications
- dislocations and strengthening mechanisms:
  - definitions and characteristics of dislocations
  - slip
  - plastic deformation of polycrystalline materials
  - strengthening mechanisms in metals
  - strain hardening
- review of recrystallisation and grain growth
- structure and properties of ceramic materials
  - crystal structures
  - types and application of engineering ceramics
    - clay-based ceramics
    - refractories
    - advanced ceramics
    - aluminium oxide
    - silicon carbide
    - silicon nitride
    - zirconia, MG-PSZ
    - sialon
    - glass and glass ceramics
  - heat treatment of glass
    - annealing and tempering
- structure and properties of polymeric materials:
  - molecular structure
  - saturated and unsaturated molecules
  - polymerisation
  - crystalline and non-crystalline polymers
  - mechanical properties of crystalline and non-crystalline polymers
  - melting and glass transition temperatures



- elastomers
  - mechanical properties
  - viscoelasticity
- phase diagrams:
  - phases
  - microstructure
  - equilibrium
  - equilibrium phase diagrams
  - binary isomorphous systems
  - non-equilibrium cooling
  - binary eutectic systems
  - development of microstructure in eutectic alloys
- iron-carbon alloys:
  - phase equilibrium diagram
  - development of microstructures of plain carbon steels
- heat treatment of plain carbon steels:
  - phase transformations
  - isothermal transformation diagrams
  - thermal processing
    - influence of quenching media
    - annealing
    - normalising
    - tempering
    - hardenability
- heat treatment of alloy carbon steels:
  - influence of alloying elements
  - secondary hardening
- heat treatment of aluminium alloys:
  - precipitation hardening
  - solution heat treatment
  - precipitation heat treatment
- surface engineering of metal alloys:
  - diffusion
  - selective processes
  - vapour coating
- composite materials:
  - fibre reinforced materials
  - laminate
  - MMC
  - CMC



- sandwich panel
- strength of materials for fibre composite structures
- failure of materials:
  - fundamentals
  - ductile fracture
  - brittle fracture
  - fracture mechanics
  - impact fracture
  - fatigue
  - creep

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Materials science task*** may include:

- metallographic investigations
- testing of metallic coatings and coating systems
- failure and fracture analysis
  - thermal fatigue
  - mechanical fatigue
- tensile testing

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member



**Enterprise procedures** may include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**Resources** may include:

- appropriate written reference and texts on materials AMS material strength testing
- tensile testing equipment
- hardness testing equipment
- impact testing equipment
- appropriate heat treatment facilities
- computer workstation with appropriate testing applications software

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
- demonstrate the ability to successfully to apply advanced principles of materials science involving data interpretation, metallographic investigations and/or material testing, interpretation and recommendations to an engineering problem on at least two occasions and in different contexts

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.



- access to workplace or work real environment and a variety of conditions
- operational access to relevant testing equipment, tools, materials and consumables
- access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include the demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



# VU22481 - Apply network concepts and practices for engineering systems

## Unit Descriptor

This unit of competency describes the skills and knowledge in network concepts and practices that are deployed in engineering computer systems.

Specifically the unit covers the manner in which data transverses the intranet, the internet including the cloud, networking protocols, devices, IP addressing, routing protocols and building and commissioning a small network.

No licensing or certification requirements apply to this unit at the time of accreditation.

## Employability skills

This unit contains employability skills.

## Pre-requisite

VU22452 Use communication network concepts and practices in manufacturing and engineering applications

## Application of the Unit

This unit is applicable to a person intending to work at paraprofessional level in an engineering/manufacturing environment where computer technology is applied to enhance production processes

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Outline the function and operation of key network concepts
2. Categorise cloud service and deployment models
3. Configure protocols and models using OSI and TCP/IP

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Types of Networks*** are defined
- 1.2 Data transmission in a network are described
- 1.3 Physical networking equipment and cables are identified
- 1.4 Methods, tools and infrastructure used to connect to an intranet or internet from a workstation are defined and demonstrated
- 2.1 ***Components of a cloud service*** are defined
- 2.2 ***Cloud service models*** are identified
- 2.3 ***Cloud deployment models*** are classified
- 2.4 ***Cloud infrastructure*** are defined
- 3.1 Function and basic operation of ***key protocols*** in the Open Systems Interconnect (OSI) and Transmission control Protocol/Internet Protocol (TCP/IP) as they pertain to network communication are configured
- 3.2 Differences and commonalities between the OSI and TCP/IP models are described
- 3.3 OSI Layer 1 standards and infrastructure are described
- 3.4 OSI Layer 2 protocols, standards and addressing (MAC addresses) for both LANs and WANs are described



- 3.5 IPv4 and IPv6 addressing schemes are configured
- 3.6 Function and operation of **OSI Layer 3 Routed and Routing addressing protocols** are described
- 3.7 Data encapsulation and decapsulation concepts are described
- 3.8 Function and operation of **OSI Layer 4 Protocols** and common ports are configured
- 3.9 Function and operation of **OSI Layer 5 to 7 protocols** and networking applications are described
- 4. Identify the function and operation of key networking devices
  - 4.1 Physical and logical network representations of a local area network are described
  - 4.2 Function and operation of network switches are defined
  - 4.3 Function and operation of network routers are described
  - 4.4 Function and operation of a firewall is defined
  - 4.5 Function and operation of a wireless access point (WAP) is defined
- 5. Install and commission a basic network
  - 5.1 Key features and structure of a network operating system (IOS) used to prepare a networking device for operation will be defined and demonstrated
  - 5.2 Cabling networking devices to a provided network diagram is performed
  - 5.3 Provided device configurations are implemented
  - 5.4 Configuring network addresses for a workstation are performed
  - 5.5 **A functional network** are configured
  - 5.6 End to end network **troubleshooting methodologies and commands** are implemented and demonstrated



## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- articulating issues arising to the operation of a network
- base level problem solving skills to implementing provided scripts for a switch and a router
- reading and accurately interpret documents and reports
- operating a personal computer
- interpreting network diagrams
- cabling a network

### **Required knowledge:**

- OSI layered communication model
- TCP/IP layered communication model
- Media Access Layer (MAC) addresses
- binary number system
- hexadecimal number system
- cloud based storage architectures (IaaS, PaaS, SaaS, CaaS, MaaS, XaaS)
- cloud deployment models (public cloud, private cloud, single hosted cloud, multi hosted cloud)
- cloud infrastructure (storage, network and computing)
- Transmission Control Protocol (TCP) protocol
- User Datagram Protocol (UDP)
- function and operation of network layer protocols
- function and operation of application layer protocols
- IPV4 addressing
- IPV6 addressing
- routers, switches, firewall fundamentals & wireless access points
- end to end test commands e.g. Ping, Traceroute

## Range Statement

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below

**Types of Networks** may include :

- Local Area Network (LAN)
- Wide Area Network (WAN)
- Metropolitan Area Network (MAN)
- Wireless LAN (WLAN)
- Virtual LAN (VLAN)
- Virtual Private Network (VPN)

**Components of a cloud service** may include:

- networking
- storage
- computing
- virtualisation





**Cloud service models** may include:

- Infrastructure as a Service (IaaS)
- Platform as a Service (PaaS)
- Software as a Service (SaaS)
- Monitoring as a Service (MaaS)
- Communication as a Service (CaaS)
- Anything as a Service (XaaS)

**Cloud deployment models** may include:

- public cloud
- private cloud
- single hosted cloud
- multihosted cloud

**Cloud infrastructure** may include:

- on demand services
- products
- virtual servers
- virtual PC's
- virtual switches
- storage clusters
- networking

**Key protocols** may include:

- ARP
- RARP
- TCP
- UDP
- IP
- ICMP
- FTP
- SMTP
- DNS
- IGMP

**OSI Layer 3 Routed and Routing addressing protocols** may include:

- RIP
- EIGRP

**OSI Layer 4 Protocols** may include:

- TCP
- UDP



**OSI Layer 5 to 7 protocols**  
may include:

- HTTP
- FTP
- TFTP
- SMTP
- DNS

**Common troubleshooting methodologies and commands** may include:

- bottom up testing
- ping
- traceroute

## EVIDENCE GUIDE

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 section in Section B of the accreditation submission.

**Critical aspects for assessment and evidence required to assess competency in this unit**

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- categorise cloud service and deployment models
- define key features of the protocols and models used for OSI and TCP/IP
- identify the function and operation of key networking devices
- implement a basic network.

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to computer hardware and software, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals



**Method of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22482 - Use advanced mathematics for engineering

<b>Unit Descriptor</b>	<p>This unit describes the knowledge and skills required to apply basic mathematics to engineering studies.</p> <p>This includes numbers, algebra, sequences and series, functional relationship (linear, polynomial, quadratic, exponential, logarithmic and circular), introduction to 2D vectors and introductory to differential and integral calculus of those functions.</p> <p>No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.</p>
<b>Employability Skills</b>	This unit contains Employability Skills.
<b>Application of the Unit</b>	This unit applies to paraprofessionals and technologists required to solve mathematical problems in an engineering/manufacturing or related industry.

### ELEMENT

Elements describe the essential outcomes of a unit of competency.

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- |   |  |
|---|--|
| 1. Identify a need for applying key mathematical concepts | 1.1 Identify a problem requiring application of advanced mathematics.  |
|   | 1.2 Determine data available for analysis.   |
|   | 1.3 Define key mathematical concepts and knowledge appropriate for analysis.                                 |
| 2. Apply mathematical techniques to solve problem         | 2.1 Apply appropriate advanced <b><i>mathematical techniques</i></b> required to solve problem.              |
|   | 2.2 Check answer by appropriate means  |
|   | 2.3 Interpret answer to determine information required by problem definition.                                |
| 3. Develop mathematical outcome/result                    | 3.1 Use <b><i>appropriate data presentations to communicate</i></b> the solutions to relevant stake holders. |
|   | 3.2 Check outcome has addressed problem  |



## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- apply set of numbers and algebraic skills to manipulate and process mathematical information
- identify different types of functions and mathematically analysing their behaviour and apply to solve simple engineering problems
- use the techniques of sequences and series to solve simple mathematical problems
- use the techniques of two dimensional vectors to solve mathematic and applied problems
- apply basic techniques of calculus
- identify and define problems
- collect and analyse data
- report and present data and quantitative information

### **Required knowledge:**

- Numbers:
  - types of numbers & notation(revise)
  - negative numbers
  - radicals and surds
  - introduction to errors
  - matrix (add/subtract/multiply)
- Algebra:
  - expanding and factorising (revise)
  - binomial theorem
  - adding/subtracting/multiplying/dividing algebraic expressions
  - solving quadratic equations (revise)
  - completing the square
- Sequences and Series:
  - arithmetic sequences and series
  - geometric sequences and series
- Functions and relations:
  - set notations and sets of numbers
  - Interval notations
  - domain and range
  - Define function
  - one-to one function
  - function Notations
  - piecewise defined functions
- Linear relations:
  - graphing straight lines (revise)
  - parallel and perpendicular lines
  - Families of straight lines
  - Modelling exercises (applications)



- Quadratic relations:
  - graphing quadratic function
  - quadratic transformations
  - the discriminant
  - solving quadratic in-equations
  - modelling exercise (applications)
- Cubic Polynomials:
  - the language of polynomials
  - the remainder theorem and factor theorem
  - division of polynomial (long division)
  - solving cubic equations
  - graphing cubic polynomials
  - quadratic transformations
  - modelling exercise (applications)
- Other functions and relations:
  - rectangular hyperbolas
  - the truncus
  - the graphs of  $y = \sqrt{x}$
  - the circle
  - inverse function
- Exponential functions and logarithms:
  - graphs of exponential functions
  - solving exponential equations and inequalities
  - logarithm Laws
  - using logarithms to solve exponential equations and inequalities
  - graphs of logarithm functions
  - exponential modelling (applications)
- Circular functions:
  - trigonometric ratios
  - circular measure (radian-degree)
  - unit circle definition
  - symmetric properties (including extra values, complementary relations)
  - pythagorean identity
  - graphs of sine, cosine and tangent functions  $y = a \sin n(x + e) + c$
  - solving trigonometric equations
  - general solution for trig. Function
  - circular modelling (applications)
- Introduction to 2D Vectors:
  - 2D vectors
  - adding and subtracting vectors
  - scalar multiplication
  - resolving vectors
  - magnitude of a vectors
  - unit vectors



- Differentiation:
  - introduction to differentiation
  - the limits
  - differentiation using first principal
  - rules for Differentiation
  - differentiation of  $\{c, x^n, e^{kx}, \log(kx), \text{Trig.}\}$
  - the Inverse rule
  - the chain rule
  - the product rule
  - the Quotient rule
  - second derivatives
  - coordinate geometry applications of differentiation (rate of change, equations of tangents and normal)
  - stationary points
  - optimisation problems
- kinematics applicationsAnti-Differentiation:
  - anti - differentiation of polynomial functions.
  - integration using simple substitutions
  - simple Integration by parts
  - definite Integrals
  - applications – area between curves

## RANGE STATEMENT

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording in the Performance Criteria is detailed below. Add any essential operating conditions that may be present with training and assessment depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts.

***Mathematical techniques***  
may include:

- one or more or any of the techniques listed under 'required knowledge
- a related techniques



**Appropriate data representations to communicate** may include:

- report
- presentation
- verbal communication
- web-based
- electronic or hard copy

## EVIDENCE GUIDE

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.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- identify appropriate mathematical techniques for engineering or related problems
- apply the appropriate technique to the problem
- check answer has addressed problem
- communicate the outcome of the analysis in a suitable way for the stakeholder.

### Context of and specific resources for assessment

This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, then a simulated working environment must be used where the range of conditions reflects realistic workplace situations. The competency covered by this unit would be demonstrated by an individual working alone or as part of a team.

Where applicable, reasonable adjustment must be made to work environments and training situations to accommodate ethnicity, age, gender, demographics and disability.

Access must be provided to appropriate learning and/or assessment support when required. Where applicable, physical resources should include equipment modified for people with disabilities.

### Method of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include demonstration of practical skills and may also include:





- observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## Civil Engineering/Civil Engineering Design

CPPBDN4004 - Set up BIM-capable software and files for building design drafting projects
CPPBDN5013A - Develop and collaborate on building information models for small-scale building design projects
CPCBC4004A - Identify and produce estimated costs for building and construction projects
MEM09002B - Interpret technical drawing
MEM23109A - Apply engineering mechanics principles
MEM30012A - Apply mathematical techniques in a manufacturing engineering or related environment
MSMENV272 - Participate in environmentally sustainable work practices



# VU22543 - Produce an advanced engineering design for a reinforced concrete structure

## Unit Descriptor

This unit of competency sets out the knowledge and skills required to complete an engineering project brief, including the analysis and design of complex flexural reinforced concrete members from first principles, using appropriate design aids. No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency applies to a person working at paraprofessional level in a civil engineering environment where the design of reinforced concrete structures is undertaken.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- |  |   |
|--|---|
| 1. Identify reinforced concrete structure to be designed | <ul style="list-style-type: none"><li>1.1 <b><i>Occupational Health and Safety/Workplace Health and Safety (OHS/WHS)</i></b> and <b><i>environmental requirements</i></b> for a given work area are determined.</li><li>1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.</li><li>1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with <b><i>appropriate personnel</i></b>.</li><li>1.4 The design is identified from documentation, work requests or discussions with appropriate personnel.</li><li>1.5 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.</li><li>1.6 <b><i>Resources and equipment</i></b> needed for the task are obtained in accordance with <b><i>enterprise procedures</i></b> and checked for correct operation and safety.</li></ul> |
| 2. Plan design approach                                  | <ul style="list-style-type: none"><li>2.1 OHS/WHS requirements for carrying out the work are followed.</li><li>2.2 Documentation relating to design project is collected and analysed.</li><li>2.3 Design references and equipment are available to plan the design, to conform to relevant standards or regulations, in accordance with enterprise procedures.</li></ul>   |



- |    |                                       |  |
|----|---------------------------------------|--|
| 3. | Complete the design                   | 3.1 OHS/WHs requirements for carrying out the work are followed.   |
|    |                                       | 3.2 The design is completed to conform to relevant standards or regulations, in accordance with enterprise procedures.                                   |
|    |                                       | 3.3 Design references and equipment are used, according to relevant standards, manufacturer's manuals and enterprise procedures.                         |
|    |                                       | 3.4 Results are recorded, analysed, examined and applied, according to enterprise procedures.  |
|    |                                       | 3.5 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures. |
|    |                                       | 3.6 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.                                      |
| 4  | Compile, document and present results | 4.1 OHS/WHs requirements for completing the work are followed.   |
|    |                                       | 4.2 Design references and equipment are maintained and stored in accordance with enterprise procedures.  |
|    |                                       | 4.3 Results are recorded, analysed and reported to appropriate personnel in accordance with enterprise procedures.                                       |
|    |                                       | 4.4 Results are stored and archived according to enterprise procedures.  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- reading skills to interpret task related documentation, specifications, drawings and OHS/WHs procedures
- obtaining the appropriate resources and equipment to undertake design task
- identifying and applying relevant standards and regulations to undertake design task
- performing appropriate engineering design calculations
- employing available design aids efficiently
- preparing and maintaining records in accordance with specifications and statutory requirements
- communicating and working with others



**Required knowledge:**

- serviceability deem-to-comply conditions for:
  - rectangular beams
  - one-way slabs
  - two-way slabs
- simplified deflection calculation
- design of two-way rectangular slabs
- arrangement of reinforcement
- design of reinforced strip and axially loaded pad footings for:
  - bending
  - bending shear
  - punching shear
- selection of starter bars
- constructability of reinforcement placement
- design of unreinforced footings
- design of loaded short stubby column using:
  - rectangular sections reinforced on two faces
  - rectangular sections reinforced on four faces
  - circular section.

**RANGE STATEMENT**

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions, dust
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand



- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

**Resources and equipment** may include:

- specifications
- manuals
- standards, such as:
  - AS3600 - Concrete Structures
  - AS5100 – Bridge Design
- catalogues
- stationary
- calculators

**Enterprise procedures** may include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit, as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement Occupational Health and Safety workplace procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to complete an engineering project brief including the analysis and design of advanced flexural reinforced concrete members of a concrete structure from first principles, using appropriate design aids on more than one occasion and in different contexts
  - prepare and complete relevant documentation and present reports.



**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals.

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



# VU22544 - Produce an advanced engineering design for a steel structure

## Unit Descriptor

This unit of competency describes the knowledge and skills required to complete an engineering project brief, including the analysis and advanced design of steel structures from first principles, using appropriate design aids.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency applies to a person working at para-professional level in a civil engineering environment and required to prepare the design of steel structures.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

- 1 Identify steel structure to be designed

- 2 Plan design approach

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 **Occupational Health and Safety/Workplace, Health and Safety (OHS/WHS) and environmental requirements** for a given work area are clarified.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work.
- 1.3 Safety hazards, which have not previously been identified, are documented and risk control measures devised and implemented in consultation with **appropriate personnel**.
- 1.4 The design is identified from documentation, work requests or discussions with appropriate personnel.
- 1.5 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.6 **Resources and equipment** needed for the task are obtained in accordance with **enterprise procedures** and checked for correct operation and safety.
- 2.1 OHS/WHS requirements for carrying out the work are incorporated in the design plan.
- 2.2 Documentation relating to design project is collected and analysed.
- 2.3 Design references and equipment are available to complete the design, to conform to relevant standards or regulations, in accordance with enterprise procedures.





- |   |                                       |   |
|---|---------------------------------------|---|
| 3 | Complete the design                   | <p>3.1 OHS/WHS requirements for carrying out the work are followed.</p> <p>3.2 The design is completed to conform to relevant standards or regulations, in accordance with enterprise procedures.</p> <p>3.3 Design references and equipment are used according to relevant standards, manufacturer's manuals and enterprise procedures.</p> <p>3.4 Results are recorded, analysed, examined and applied according to enterprise procedures.</p> <p>3.5 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.</p> <p>3.6 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.</p> |
| 4 | Compile, document and present results | <p>4.1 OHS/WHS requirements for completing the work are followed.</p> <p>4.2 Design references and equipment are maintained and stored in accordance with enterprise procedures.</p> <p>4.3 Results are recorded, analysed and reported to appropriate personnel in accordance with enterprise procedures.</p> <p>4.4 Results are stored and archived according to enterprise procedures.</p>   |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- reading skills to interpret task related documentation, specifications, drawings and OHS/WHS procedures
- obtaining the appropriate resources and equipment to undertake design task
- identifying and applying relevant standards and regulations to undertake design task
- performing appropriate engineering design calculations
- determining design for dead and live loads
- determining wind loads on buildings
- employing available design aids efficiently
- preparing and maintaining records in accordance with specifications and statutory requirements
- communicating and working with other team members



**Required knowledge:**

- relevant Australian or other appropriate standards
- load calculation on steel beams and frames
- safe steel beam load tables
- impact of wind loads on buildings
- pin-jointed steel frames
- biaxial bending stresses calculations
- design considerations for welded plate girders
- combined tension and bending on steel structures
- design considerations for steel purlins and girts

**RANGE STATEMENT**

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include::

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions, dust
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member



**Resources and equipment** may include:

- specifications
- manuals
- standards, such as:
  - AS4100 – Steel Structures
  - AS5100 – Bridge Design
  - AS1170.0:200
  - AS1170.1:200
  - AS1170.2:2002
- catalogues
- stationary
- calculators

**Enterprise procedures** may include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS workplace procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to complete an engineering project brief including the analysis and advanced design of structural steel members in a steel structure from first principles using appropriate design aids on more than one occasion and in different contexts.
  - prepare and complete relevant documentation and present report/s



**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals.

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the engineering design plans
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



# VU22484 - Implement site investigation procedures

## Unit Descriptor

This unit of competency describes the knowledge and skills required to apply site investigation procedures and geological studies in accordance with the relevant Australian standards.

The unit includes practical activities and tests that are common to site investigation, testing and engineering analysis of soils, identifications of major rock and mineral types, setting up, calibrating and operating test equipment and reporting requirements.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency applies to a person working at para-professional level in a civil engineering environment where testing and analysis of materials is undertaken. This may include office, laboratory and fieldwork.

## ELEMENT

Elements describe the essential outcomes of a unit of competency.

Elements describe actions or outcomes that are demonstrable and assessable.

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

1. Identify site location and materials to be tested and analysed

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS)*** and ***environmental requirements*** for a given work area are determined.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 The site location, testing and analysis task are identified from documentation, work requests or discussions with appropriate personnel.
- 1.5 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.6 ***Resources*** and ***equipment*** needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.



- |                                     |  |
|-------------------------------------|--|
| 2. Plan test and analyse            | <p>2.1 OHS/WHs requirements for carrying out the work are followed.</p> <p>2.2 Equipment/machines and procedures are checked as being in accordance with OHS/WHs requirements.</p> <p>2.3 The history of the site and materials to be tested are identified and recorded.</p> <p>2.4 Test equipment is checked for calibration and conforming to Australian Standard.</p> <p>2.5 Materials to be tested are prepared to Australian and/or local standards or regulations in accordance with enterprise procedures.</p>   |
| 3. Conduct test and analyse results | <p>3.1 OHS/WHs requirements for carrying out the work are followed.</p> <p>3.2 Equipment/machines/plant is checked as being isolated in strict accordance with OHS/WHs requirements, where necessary.</p> <p>3.3 Test is conducted to job requirements in accordance with Australian Standards.</p> <p>3.4 Test equipment is operated/used to Australian Standards.</p> <p>3.5 Results are recorded and analysed.</p> <p>3.6 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.</p> <p>3.7 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.</p> |
| 4. Document and report results      | <p>4.1 OHS/WHs requirements for completing the work are followed.</p> <p>4.2 Results are recorded, analysed and reported according to enterprise procedures.</p> <p>4.3 Results are stored and archived according to enterprise procedures.</p>  |



## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- communicating and working with other team members
- reading skills to interpret task related documentation, job instructions, drawings and OHS/WHS procedures
- carrying out on site sampling
- setting up and calibrating sampling testing equipment
- Completing testing procedures according to job requirements
- making computations and recording test results
- preparing a report and other relevant documentation

### **Required knowledge:**

- site investigation:
  - sequence;
    - desktop study
    - site visit
    - risk assessment
    - risk register
    - geotechnical risks; e.g. soft ground, hydrogeology
  - cost;
  - terrain classifications
- geological classifications:
  - geophysical methods;
  - sampling;
  - drilling;
  - collecting.
- field and laboratory testing:
  - unified soil classification system
- geoscience geology:
  - origins of the earth
  - structure of the earth
    - soil mechanics
    - soil types
    - regolith
  - plate tectonics
  - volcanism
  - palaeontology
  - petrology



- minerals, exploration and engineering
  - primary minerals
  - accessory minerals
  - secondary minerals
  - ore-forming minerals
- rocks, mechanics and engineering
  - igneous rocks
  - sedimentary rocks
  - metamorphic rocks
- structural geology and mapping
  - folds
  - faults
  - engineering problems
  - interpretation of maps
- winning of rocks and minerals
  - mines
  - quarries
- quarry products and uses
  - stone
  - gravel
  - sand
  - limestone
  - other
- testing of rock products
  - in-situ testing
  - sampling
  - individual tests
- field work
  - visual impact of operations
  - environmental considerations
  - flow chart of operations
  - quality control
  - products
- characteristics of soils:
  - soil development processes
  - weathering -physical and chemical
  - residual and depositional soils
  - variability within the soil mass
  - soil constituents
  - particles





- size, shape and mineral type
  - cohesive, non-cohesive
  - fine and coarse grained soils
- voids
  - water, salts and air
- organics
- soil behaviour
  - influence of particle size and shape, void size and proportion
  - permeability and capillarity
  - strength of soils
    - cohesive and cohesionless soils
    - role of confinement
- compression and expansion of soils
  - properties of clay minerals
  - consolidation
  - expansive soils
- soil in-situ:
- modes of failure of soils and structures
- superstructure, substructure, footings and foundations
- structures
  - buildings, bridges
  - walls, culverts
  - architectural structures, sign structures
  - tunnels
  - retaining structures
- types of footings
  - spread footings
  - piles; shallow and deep
- shear strength failures
  - slip failures of slopes
  - bearing capacity failures
  - retaining walls
- settlement
  - differential settlements
  - total allowable settlement
  - design criteria
- defects in the soil mass
  - cracks, fissures
  - bedding planes
  - soil structure
  - anisotropy



- effects on permeability, compressibility and shear strength
- permeability of soils
  - rate of permeability
  - permeable soils and seepage
    - anisotropy, aquifers, aquitards
  - permeable soils and lack of drainage
- role of water in soils
  - water table
    - zone of saturation
  - horizontal and sloping
    - hydrological gradients
  - above and below ground surface
    - surface flows and near surface flows
  - aquifers
  - perched water table
  - well points
- conditions
  - static (equilibrium)
  - seepage (climatic effects)
  - artesian
- water as a lubricant
- effective stress
  - positive and negative pore pressures effect of pore pressure on shear strength
- influence of seepage on effective stress
  - soil suction
  - direction of seepage
  - quick conditions
- methods of describing soils:
- grain size
  - sieve and hydrometer analysis
  - grading, packing and maximum density
- influence of fines
  - plasticity, Atterberg Limits
  - shrinkage, plastic and liquid limits
  - plasticity index
- classification of soils
  - classification tests
  - particle size distribution, plasticity
  - visual examination (colour, texture, moisture etc.)
- unified soil classification system, field tests



- voids in soil
  - volume of voids
  - magnitude of potential compressibility
  - size of voids
  - permeability, rate of compressibility
  - void ratio
  - amount of voids in typical materials and effect of density
- water in soil
  - moisture content
  - degree of saturation
  - dry, partially saturated and saturated soil
- density of soil
  - dry, saturated and buoyant densities
  - relation between buoyant and saturated densities
  - maximum dry density and wet density
  - soil particle density
- modification of soil properties:
  - compaction
  - influence on shear strength, compressibility and permeability
  - standard and modified compaction
  - brief outline of rollers and tampers
  - dry density/moisture content curves for:
    - field and laboratory tests
    - different compactive efforts
    - different types of soils
  - optimum moisture content, maximum dry density
  - zero air voids/saturation line
  - field density measurement
    - sand replacement
    - balloon densometer
    - nuclear density meter
  - dry density ratio
- stabilisation
  - drainage-surface, sub-surface drains
  - (interceptor, table and french drains)
    - slopes and retaining walls
  - grading
  - additives-cement, lime
  - geofabrics
- flexible pavements:
  - California Bearing Ratio



- laboratory test
- dynamic cone penetrometer
- surface course, base course, sub-base materials
- CBR, PI, Grading
- traffic load in Equivalent Standard Axles (ESA),
- design life
- use of graph of thickness versus ESA for different
- CBR values
- strength of soils:
  - Coulomb's law, shear strength parameters
  - cohesive and cohesionless soil
  - role of confinement
  - direct shear test
- investigation techniques:
  - drilling
  - sampling
    - disturbed and undisturbed samples
    - test pits
  - in-situ evaluation
    - probes, vanes
    - penetrometers
    - water level, piezometer
- laboratory practical work:
  - particle size distribution
  - Atterberg limits
  - field classification
  - compaction test
  - C.B.R. test
  - direct shear test
  - penetrometer (optional)

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

**OHS/WHs requirements** may include but not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions



**Environmental requirements** may include but not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

**Appropriate personnel** may include but not limited to:

- supervisor
- leading hand
- foreman
- technician
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

**Resources** may include but not limited to:

- appropriate Australian Standards, such as:
  - AS 1141
  - AS 1726
  - AS 1289
- local regulations and codes of practice
- reference texts, tables and graphs
- stationery
- appropriate tools and equipment
- measurement equipment

**Equipment** may include but not limited to:

- site investigation equipment
- soil sampling equipment
- soil testing equipment
- suitable laboratory facilities
- scientific calculator
- personal protective equipment

**Enterprise procedures** may include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:



- implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria and range
- demonstrate practical activities and tests that are common to site investigation, testing and engineering analysis of soils on more than one occasion and in different context. Testing must be done in accordance to the appropriate Australian Standard.
- prepare and complete relevant documentation and present report.

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



# VU22485 - Apply construction principles to civil engineering works

## Unit Descriptor

This unit of competency describes the knowledge and skills required to apply the fundamental principles and concepts associated with planning, estimating and costing to the preparation and interpretation of tender documents, costs estimates and the reporting of actual versus estimated project costs.

This includes the documenting of people, plant, equipment and processes employed in the building and civil construction industry.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency applies to a person working at paraprofessional level in a civil engineering environment where civil engineering design and construction project work is undertaken.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Establish the construction principles of civil engineering projects

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) and environmental requirements*** for a given work area are determined.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 The planning, estimating, costing and construction principles of a civil engineering construction project are identified from tender documentation, work requests or discussions with appropriate personnel.
- 1.5 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.6 ***Resources and equipment*** needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.



- |  |  |
|--|--|
| 2. Develop planning, estimating, costing and construction principles of a civil engineering construction project | <p>2.1 OHS/WHs requirements for carrying out the work are followed.</p> <p>2.2 Construction project material is collected and identified from documents, work requests or discussions with appropriate personnel.</p> <p>2.3 Design references are evaluated to complete the planning, estimating, costing and construction principles of a civil engineering construction project, in accordance with enterprise procedures.</p> <p>2.4 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.</p> <p>2.5 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.</p> |
| 3. Complete planning, estimating, costing and develop construction principles of a civil engineering project     | <p>3.1 OHS/WHs requirements for carrying out the work are followed.</p> <p>3.2 The planning, estimating, costing and construction principles are completed to conform with enterprise procedures.</p> <p>3.3 Design references are used according to manufacturer's manuals and enterprise procedures.</p> <p>3.4 Outcomes are recorded, analysed, examined and applied according to enterprise procedures.</p> <p>3.5 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.</p> <p>3.6 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.</p>                   |
| 4. Compile, document and present results.  | <p>4.1 OHS/WHs requirements for carrying out the work are followed.</p> <p>4.2 Design references are maintained and stored in accordance with enterprise procedures.</p> <p>4.3 Results are recorded, analysed and reported to appropriate personnel in accordance with enterprise procedures.</p> <p>4.4 Results are stored and archived according to enterprise procedures.</p>  |



## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- consulting and communicating with others in the project team
- resolving unexpected situations related to the project
- identifying and follow relevant OHS/WHS procedures
- planning, estimating and costing a civil engineering construction project
- reading and interpreting design references, environmental controls information and relevant building codes and legislation
- prepare documentation relevant to the project

### ***Required knowledge:***

- earthworks:
  - excavations
    - bulk v/s detail
    - rock v/s OTR
  - wet v/s dry conditions
  - equipment selection to perform the particular type of excavation
    - suitability/mode of operation
    - production rate
    - cost of operating
    - safety
  - types of excavations
    - clearing/stripping
    - trenches, pads, footings
    - bulk road cuttings
    - sedimentation basins
    - piers, piling
    - setting out
- pipeworks:
  - types
    - earthware, concrete, steel, cast iron, UPVC
    - advantages v/s disadvantages
  - uses
    - sewerage, stormwater, domestic water supply, conduiting, subsurface drainage
  - bed, joint and laying techniques
  - testing procedures
  - pits and ancillary structures
  - set-out and alignment
    - laser
    - boning rod/profiling

- -stringlines
  - maintenance
- general civil aspects:
  - culvert and bridges - types/uses
  - dams – types
  - tunnelling - methods and tunnel lining
  - caissons
  - breakwaters, quays, docks, locks, weirs
  - construction safety w.r.t. all of the above
  - civil engineering terms and features:
    - formwork, slip form, tilt-up slabs
- steel
  - people and activities involved in the structural steel industry:
  - design, raw steel, ordering shop drawings, fabrication, treatment, delivery and erection.
    - bolting v/s welding
    - uses in buildings, bridgework, coal mining industry etc.
- roads:
  - road elements and components:
    - flexible pavements
    - rigid pavements
    - urban roads
    - cross section
    - drainage
    - Rural roads
    - cross section
    - drainage
    - footpaths
- road and pavement construction:
  - plan stages
    - use of computer software for project management
  - plan stockpiles
  - types of pavement materials
    - granular
    - asphalt
    - concrete
  - select plant
  - earth moving
  - trench excavation
  - compaction
    - methods of compaction
    - correct method of compaction based on site conditions
    - purpose of CBR testing

- concrete:
  - materials and ready mix concrete suppliers.
  - transporting, placing, finishing, curing
- concrete:
  - types
    - plain
    - reinforced
    - prestressed
  - uses
    - bridges
    - buildings
    - roads
    - dams
- quarrying plant :
  - as for excavation plus specialized equipment - pugmills, crushers, conveyors, sand dredging and washing facilities,
  - fixed v/s mobile plant
- quarry layout
- quarry products
  - sand, gravel, clay, shale, crushed rock.

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include but not limited to:

- legislation
- awards provisions

***Environmental requirements*** may include but not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

**Resources and equipment** may include but not limited to:

- specifications
- manuals
- standards
- catalogues
- stationary
- calculators

**Enterprise procedures** may include but not limited to:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHs procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate planning, estimating, costing and developing construction principles of a civil engineering project on more than one occasion and in different contexts.
  - complete relevant documentation and reports in accordance with workplace procedures.

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals.



**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include the demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.
- This unit may be assessed in conjunction with other unit/s that form part of a total job role.

## VU22486 - Apply principles of material testing to civil engineering applications

### Unit Descriptor

This unit of competency describes the knowledge and skills required to undertake practical activities and tests of common construction materials, such as aluminium, brick, timber and concrete and analyse the results.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at paraprofessional level in a civil engineering environment where testing and analysis of materials is undertaken. This may include office, laboratory and fieldwork.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Identify materials to be tested and analysed

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 **Occupational Health and Safety/Workplace Health and Safety (OHS/WHS)** and **environmental requirements** for a given work area are determined.
  - 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area
  - 1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with **appropriate personnel**.
  - 1.4 The testing and analysis task is identified from documentation, work requests or discussions with appropriate personnel.
  - 1.5 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
  - 1.6 **Resources** and **equipment** needed for the task are obtained in accordance with **enterprise procedures** and checked for correct operation and safety.
- 2.1 OHS/WHS requirements for carrying out the work are followed.
  - 2.2 Materials to be tested is prepared to Australian and/or local standards or regulations in accordance with enterprise procedures.



- |                                     |     |  |
|-------------------------------------|-----|--|
|                                     | 2.3 | Test equipment is checked for calibration and conforming to Australian Standard  |
|                                     | 2.4 | If appropriate, the origin of the materials to be tested is identified and recorded.   |
| 3. Conduct test and analyse results | 3.1 | OHS/WHs requirements for carrying out the work are followed.   |
|                                     | 3.2 | Equipment/machines/plant is checked as being isolated where necessary in strict accordance, with OHS/WHs requirements.                               |
|                                     | 3.3 | Tests are conducted to job requirements in accordance with relevant Australian Standards.  |
|                                     | 3.4 | Test equipment is operated/used in accordance with Australian Standards.   |
|                                     | 3.5 | Results are recorded and analysed.   |
|                                     | 3.6 | Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures. |
|                                     | 3.7 | Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.                                      |
| 4 Document and report results       | 4.1 | OHS/WHs requirements for completing the work are followed.   |
|                                     | 4.2 | Results are recorded, analysed and reported according to enterprise procedures.  |
|                                     | 4.3 | Results are stored and archived according to enterprise procedures.  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- consulting and communicate with other team members in a civil engineering environment
- identifying and following relevant OHS/WHs and workplace procedures
- planning and conducting material testing activities
- setting up, calibrating operating testing equipment
- analysing and documenting the result and updating relevant documentation

### **Required knowledge:**

- use of aluminium, bricks, timber, adhesives, plastic and concrete in the construction industry.
- aluminium
  - methods of manufacture.
  - tests to determine the physical properties.

- use of aluminium in construction activities.
- limitations of aluminium in jointing, particularly riveting.
- bricks
- brick manufacturing.
- tests to determine the physical properties of bricks.
- how bricks are used in the construction industry.
- timber
  - method of processing timber.
  - uses of timber in the construction industry.
  - the physical properties of timber including likely defects.
  - suitable tests.
  - methods of jointing timber including bolting and nailing.
- adhesives
  - examples of the uses of adhesives.
  - properties and use of six synthetic adhesives.
  - tests on given adhesives including classification and most suitable use.
- plastics
  - manufacture and use of plastics.
  - how plastics can be moulded.
  - test to determine the tensile strength.
- concrete:
  - concrete ingredients, hydration, setting, strength.
  - reinforced concrete - steel bars, wires, tendons.
- cement:
  - cement ingredients and their production, mineral content and properties.
  - heat of hydration, setting time, strength development, shrinkage.
  - resistance to aggressive agents - porosity, acid, sulphates, seawater, frost, heat.
  - types of cement.
- aggregates:
  - importance of aggregates.
  - properties - rock type, artificial aggregates, grading, shape and texture, bond, strength, resistance to wear, specific gravity, porosity.
  - deleterious substances - organic matter, surface coatings, salt, unsound particles, alkali/aggregate reaction.
  - aggregate crushing test.
- water:
  - quality - portable, pH range, salt content, silt.
  - effect of quality on-setting, strength, corrosion.
- steel:
  - types of bars, fabric.
  - tempcore bars - bending, joining.
  - galvanised bars, prestressing tendons and wire.



- bond.
- admixtures:
  - behaviour, application, effect, air-entraining, set-accelerating, set-retarding, water-reducing, super-plasticisers, expanding, permeability – reducing
- Pozzolans:
  - effects on-porosity, workability, strength.
  - types: fly-ash, others.
- concrete tests:
  - moisture content of sand.
  - slump test.
  - make and crush cylinders on given mix.
  - design concrete
- properties of plastic concrete:
  - workability.
  - factors affecting workability:
    - w/c ratio,
    - water content,
    - % air-entrainment,
    - aggregate grading,
    - aggregate/cement ratio
- superplasticisers.
- measuring workability:
  - Slump test and its usefulness on site.
  - Effects of time and temperature on workability.
  - Segregation:
  - types, effects of aggregate grading.
- bleeding:
  - bleeding, causes, remedies.
- properties of Hardened Concrete:
  - tensile strength, compressive strength, w/c ratio, age, bonding of reinforcement, curing time and temperature, cement type, water quality, aggregate type, density, porosity, admixtures
- elasticity, shrinkage:
  - stress/strain, drying shrinkage, effects of aggregate, admixtures, curing and storage, shrinkage induced cracks, external moisture effects, carbonation shrinkage
- creep:
  - creep, relaxation of stress, creep recovery.
- factors influencing creep:
  - volume of cement paste, aggregates, strength of concrete, type of cement, admixtures, humidity.
  - relation between creep and time:
  - effects of creep - deflection of beams/slabs, stress redistribution, loss of prestress.
- durability of concrete:

- durability of concrete, requirements of AS3600, corrosion of reinforcement, abrasion, freeze/thaw
- corrosion:
  - mechanics of corrosion:
  - corrosion of concrete and prevention, quality of concrete, cement type, cover
- cracks:
  - corrosion of steel and prevention, special steels,
  - coating steel, eg. epoxy and galvanising, corrosion inhibitors in concrete,
  - cathodic protection.
- abrasion:
  - abrasion, factors affecting abrasion - strength, aggregates,
  - surface finish, curing, AS3600.
- freeze/thaw:
  - factors affecting frost action - moisture content, w/c ration, entrained air, AS3600.
  - other factors: alkali/aggregate reaction, seawater, acids, sulphates.
- transporting concrete:
  - delay:
  - affect on stiffening, effect on slump.
  - drying out:
  - humidity, mix, cover.
  - segregation:
  - cohesive mix, methods of avoiding segregation
  - methods of transporting:
  - ready-mix trucks, concrete pumps
  - pumping concrete:
  - types of pumps and performance, properties of concrete for easy pumping, pumping procedures.
- placing:
  - placing of formwork and reinforcement, avoiding segregation,
  - methods of handling for good practice, deep lift placing,
  - cold weather placing, hot weather placing,
  - placing concrete under water, shotcrete, placement of mass concrete.
- compacting:
  - objectives and importance of compacting, methods of compacting.
  - immersion vibrators, external vibrators, surface vibrators, vibrating tables.
  - effects of vibrators on mix design.
  - effects of prolonged vibration and revibration.
- curing concrete:
  - importance of curing.
  - methods and effects of curing.
  - water or damp cover:
  - ponding, sprinkling, damp covers.

- impermeable mediums:
- waterproof material, shuttering, curing compounds
- accelerated curing:
- low pressure steam curing, high pressure steam curing (autoclaving),
- infra-red curing, electrical curing.
- problems:
- plastic shrinkage cracks, effects on hydration, loss of strength,
- abrasion resistance, effects of delayed curing
- surface finishing:
  - untreated concrete surfaces.
  - shuttering types.
  - tooled surface finishes.
  - exposed aggregate finishes.
  - miscellaneous methods.
  - abrasion resisting finishes.
- special concretes:
  - concrete for water-retaining structures.
  - AS3735 requirements.
  - light weight concrete.
  - high density concrete.
  - fibre and glass reinforced concrete.
  - roller compacter concrete (RCC).

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHs requirements*** may include but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may

- supervisor

include:

- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

**Resources** such as:

- appropriate Australian Standards
- local regulations and codes of practice
- reference texts, tables and graphs
- stationery
- appropriate tools
- measurement equipment

**Equipment** including:

- materials testing equipment
- concrete testing equipment
- suitable laboratory facilities
- universal tester
- scientific calculator
- personal protective equipment

**Enterprise procedures** may include but are not limited to:

- the use of tools and equipment.
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### **Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to undertake practical activities and tests of common construction materials, such as aluminium, brick, timber and concrete and analyse and document the results on more than one occasion and in different context.

Testing must be done in accordance to the appropriate Australian Standard

- complete relevant documentation and report in accordance with workplace procedures.

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.
- This unit may be assessed in conjunction with other unit/s that form part of a total job role.

## VU22545 - Apply environmental solutions to civil engineering projects

### Unit Descriptor

This unit of competency describes the knowledge and skills required to undertake an environmental study as part of a civil engineering project.

The unit includes the potential impact of the environment on a civil engineering project, preparation for and undertaking an environmental study and selecting and integrating an appropriate solution.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working in a civil engineering office as a para professional where environmental considerations form an integral part of a civil engineering project solution.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

#### 1. Identify environmental impact

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WH&S) and environmental requirements*** for a given work area are determined.
- 1.2 Established OHS/WH&S requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 The ***environmental impact*** of an engineering project is identified from documentation, work requests or discussions with ***appropriate personnel***.
- 1.4 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.5 ***Resources and equipment*** needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.

#### 2. Select appropriate environmental solution

- 2.1 OHS/WH&S requirements for carrying out the work are followed.
- 2.2 An environmental study is conducted with respect to a civil engineering project taking into account all legal and regulatory requirements.



- |                                     |     |  |
|-------------------------------------|-----|--|
|                                     | 2.3 | The environmental study is analysed and the optimum environmental outcome selected.  |
|                                     | 2.4 | Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures. |
| 3. Integrate environmental solution | 3.1 | OHS/WHS requirements for carrying out the work are followed.   |
|                                     | 3.2 | Environmental solution is incorporated into engineering project in discussion with appropriate personnel and according to enterprise procedures.     |
|                                     | 3.3 | Appropriate environmental permits and/or approvals are obtained, if required.  |
|                                     | 3.4 | An environmental monitoring plan for the engineering project is drawn up.  |
|                                     | 3.5 | Completion of work task is documented and reported to appropriate personnel.   |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- consulting and communicate with other team members in a civil engineering office
- identifying and following relevant OHS/WHS and workplace procedures
- preparing for and conducting an environmental study
- analysing the results and determining solution
- preparing and updating relevant documentation

### **Required knowledge:**

- environment of the earth:
  - atmosphere
  - hydrosphere
  - lithosphere
  - climate
  - ecosystems
- engineering within the environment:
  - roads
  - towns and cities
  - dam building
  - communication
  - power generation and distribution
  - water distribution
  - sanitation/sewerage
  - industrial centres
  - railways
  - mining

- quarrying
- environment degradation:
  - air pollution
  - water pollution
  - land abuse
  - agriculture
  - soil erosion
  - deforestation
  - land fill
  - land contamination
  - salinity
  - soil stability
  - waste disposal
  - resources
  - aesthetics
  - visual impact
  - noise
  - offensive odour
  - social disruption
- environment control:
  - standards
  - measurement
  - monitoring
  - evaluation and remedial measures
- environment restoration:
  - reclamation of an environment
  - revegetation of an environment
  - restoration of an environment
  - rehabilitation of an environment
  - contaminated site management
  - general construction site management
  - soil conservation
  - soil salinity
- environment case study:
  - select an environment issue
  - carry out an investigation
  - monitor the situation
  - compile data
  - provide viable engineering solutions



## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include but not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include but not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise
- dust control

***Environmental impact*** may include but not limited to:

- output emissions
  - air borne
  - water borne
- soil contamination
- erosion
- salinity
- noise
- light
- smell
- visual
- pests and noxious weeds

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- qualified specialist consultant
- site engineer
- trainer
- mentor
- teacher
- team member

***Resources and equipment*** may include but not limited to:

- specifications



- manuals
- standards
- catalogues
- stationary
- calculators
- computer work station

**Enterprise procedures** may include but not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### **Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - undertake an environmental study on more than one occasion and in different contexts, analyse the results and recommend an environmental solution
  - prepare and complete relevant documentation and present report.

### **Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals.

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include the demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

# VU22546 - Apply principles of mechanics to engineering structures

## Unit Descriptor

This unit of competency describes the knowledge and skills required to perform analyses concerned with the mechanical properties of materials as they relate to problems of strength and stability of mechanical structures.

This includes the calculation of different kinds of loading on structural elements.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency applies to a person working at para professional level in a structural/civil engineering environment where analysis of structures is undertaken.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

1. Establish mechanical properties of materials for engineering structures

- 1.1 **Occupational Health and Safety/Workplace Health and Safety (OHS/WHS)** and **environmental requirements** for a given work area are determined.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with **appropriate personnel**.
- 1.4 The mechanical properties of materials are identified from documentation, work requests or discussions with appropriate personnel.
- 1.5 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.6 **Resources and equipment** needed for the task are obtained in accordance with **enterprise procedures** and checked for correct operation and safety.

2. Plan approach to analyse the properties of materials

- 2.1 OHS/WHS requirements for carrying out the work are followed.
- 2.2 Documentation relating to the material properties is collected and analysed.



- |    |  |   |
|----|--|---|
|    | 2.3                                    | Design references are available to complete the analysis, to conform to Australian standards, manufacturer's manuals, in accordance with enterprise procedures. |
|    | 2.4                                    | Decisions for dealing with unexpected situations are made from discussions with appropriate personnel and enterprise procedures.                                |
| 3. | Complete the analysis                  |   |
|    | 3.1                                    | OHS/WHS requirements for completing the work are followed.  |
|    | 3.2                                    | The analysis is completed to conform with relevant Australian standards, manufacturers manuals, in accordance with enterprise procedures.                       |
|    | 3.3                                    | Design references are used according to relevant Australian standards, manufacturer's manuals and enterprise procedures.  |
|    | 3.4                                    | Results are recorded, analysed, examined and applied according to enterprise procedures.  |
|    | 3.5                                    | Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.            |
|    | 3.6                                    | Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.   |
| 4  | Compile, document and present results. |   |
|    | 4.1                                    | OHS/WHS requirements for carrying out the work are followed.  |
|    | 4.2                                    | Design references are maintained and stored in accordance with enterprise procedures.   |
|    | 4.3                                    | Results are recorded, analysed and reported to appropriate personnel in accordance with enterprise procedures.  |
|    | 4.4                                    | Results are stored and archived according to enterprise procedures.   |

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- communicating and consulting with other team members
- identifying and following relevant OHS/WHS and workplace procedures
- reading skills to and interpret technical documentation and work related instructions
- preparing a plan of action for an analysis task
- analysing problems related to the strength and stability of engineering structures
- updating/preparing relevant records and workplace documents

**Required knowledge:**

- load analysis:
  - relationship between dead load and live load
  - the significance of wind load and the factors affecting wind load
  - the variation of load due to liquid pressure with wind load
  - the common terms used in the Standard
  - calculation of dead load using the values of density given in the Standard
  - selection of appropriate value of live load from the Standard
  - combined effect of dead load and live load on a structural element
  - definition of different terms in the Standard (e.g. terrain category, basic wind speed etc)
  - effects of internal pressure and external pressure
  - calculation of wind load using the simplified procedure
  - consideration of worse possible case
  - variation of pressure due to fluid
  - resultant force and the line of action of the resultant moment created
  - modes of failure
- properties of materials
  - stress and strain:
    - normal stress and strain
    - modulus of elasticity
    - deformation
    - Poisson's Ratio
    - shear stress and strain
    - modulus of rigidity
    - yield stress, ultimate stress, proportional limit
    - factor of safety
  - allowable stress
- centrally loaded connections:
  - bolted connections
  - shear, tensile and bearing stresses
  - centrally loaded welded connections
  - fillet and butt welds
  - modes of weld failure
  - size and length of welds
  - punching of plates
- thin walled pressure vessels:
  - define thin wall
  - longitudinal stress
  - hoop stress
- properties of plane figures:
  - first moment of area
  - second moment of area

- simple beams (point and distributed loads):
  - shear force diagrams
  - bending moment diagrams
  - bending stress
  - deflection by formula
- torsional stress:
  - torque diagrams
  - angle of twist
  - torsional shear stress
- thermal stress:
  - coefficient of linear expansion
  - thermal stresses in single members
- advanced properties of materials:
  - stress and strain:
    - axial stresses in members in series and parallel
    - axial stresses in members of two materials
    - thermal stresses in members in series and parallel
    - thermal stresses in bi-metal members
- strain energy:
  - strain energy
  - resilience
  - impact loads
- bending and shear in beams:
  - further SF and BM diagrams
  - axial bending stress in beams
  - curvature and bending moment
  - shear stress in beams
  - shear stress formula
  - distribution of shear stress over section
  - shear flow
- combined stresses:
  - combined axial and bending stress
  - combined axial and pressure stress
  - combined bending and torsional stress
  - combined bending and shear stress
  - principle stress
  - Mohr's Circle
- buckling of columns:
  - effective length of columns
  - slenderness ratio
  - failure criteria
- beam deflection:

- Macaulay's method
- moment area method

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include, but are not limited to:

- legislation
- awards provisions

***Environmental requirements*** may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Resources and equipment*** may include, but are not limited to:

- specifications
- manuals
- standards such as;
  - AS1170-1989 Part 1
  - AS1170-1989 Part 2
- catalogues
- stationary
- calculators

***Enterprise procedures*** such as:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures



## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS and workplace procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to perform analyses concerned with the mechanical properties of materials on more than one occasion and in different context. Analyses must be done in accordance to the appropriate Australian Standard and manufactures' manuals
  - prepare and complete relevant documentation and present report

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals.

### Methods of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.

- Where performance is not directly observed and/or is required to be demonstrated over a period of time and/or in a number of locations, any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.
- This unit may be assessed in conjunction with other unit/s that form part of a total job role.

## VU22487 - Apply surveying for civil engineering projects

### Unit Descriptor

This unit of competency describes the knowledge and skills required to design and establish survey control for engineering and construction purposes.

This includes the measurement and calculation of survey data, drawing of sketch plans, collection and processing of topographical data for detail mapping and related computational skills.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at para professional level in an engineering/civil engineering environment where measurement and set out of engineering works is undertaken. This competency includes both desk and fieldwork.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

1. Identify survey to be undertaken

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) and environmental requirements*** for a given work area are determined.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 The survey and analysis task is identified from documentation, work requests or discussions with appropriate personnel.
- 1.5 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.6 ***Resources and equipment*** needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.



- |                                       |  |
|---------------------------------------|--|
| 2. Plan survey                        | 2.1 OHS/WHS requirements for carrying out the work are followed.   |
|                                       | 2.2 Documentation relating to existing survey features is collected and analysed.  |
|                                       | 2.3 <b>Surveying equipment</b> is checked for calibration and conforming to Australian Standard  |
|                                       | 2.4 Reconnaissance of construction/engineering sites is performed to local standards or regulations in accordance with enterprise procedures.            |
|                                       | 2.5 Survey risk management procedures are established and discussed with appropriate personnel.  |
| 3. Conduct survey and analyse results | 3.1 OHS/WHS requirements for carrying out the work are followed.   |
|                                       | 3.2 Survey control is conducted to job requirements in accordance with enterprise procedures.  |
|                                       | 3.3 Survey equipment is operated/used according to manufacturers' manuals and enterprise procedures.   |
|                                       | 3.4 Results are recorded, analysed and computations are applied according to enterprise procedures.  |
|                                       | 3.5 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures. |
|                                       | 3.6 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.                                      |
| 4 Document, and report results        | 4.1 OHS/WHS requirements for completing the work are followed.   |
|                                       | 4.2 Equipment and tools used in survey are maintained and stored in accordance with enterprise procedures.   |
|                                       | 4.3 Results are recorded, analysed and reported to appropriate personnel according to enterprise procedures.   |
|                                       | 4.4 Results are stored and archived according to enterprise procedures.  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- communicating and working with other team members
- reading skills to interpret task related documentation, job instructions, drawings and OHS/WHS procedures
- carrying out site reconnaissance in preparation for the surveying task
- operating surveying equipment and performing the survey
- making computations and recording the results
- preparing a report and completing other relevant documentation

### ***Required knowledge:***

- theodolite - basic operation, testing and maintenance
  - use of theodolite for measuring and setting out horizontal and vertical angles.
  - closed theodolite traverse using both Face left and face right to obtain mean angles
  - use of theodolite to set a known bearing and set out horizontal angles to an accuracy of  $\pm 20''$
- three dimensional survey control using total stations (or theodolite and EDM)
  - setting up instruments and reflectors
  - testing of total station/reflector combinations for distance index error
  - input distance index correction and scale factor correction for atmospheric conditions
  - descriptive data, directions, distances and height of equipment above ground marks
  - coordinates of control marks
- radiations in three dimensions using total stations and/or theodolite and EDM/Data recorder
  - descriptive data, directions, distances and height of equipment to features requiring precise connection to the control network
  - generating coordinates of features radiated from the control points
  - transforming network coordinates to match known coordinates of radiated points
- mapping of engineering/construction sites using total stations and/or theodolite and EDM/Data recorder
  - computing coordinates, bearings and lengths of features requiring precise location for subsequent engineering design
  - plotting point, line and area features
  - interpreting and plotting contours
  - annotating maps with text to enhance interpretation
- computing co-ordinates and bearings and distances as related to grids and general set out works for construction works and building site set out
  - the angular relationship between different bearings (whole circle ) and determine bearings from angles and fixed lines
  - calculating the bearing and distance between two sets of co-ordinates (North and East)

- calculating the co-ordinates of a point given the bearing and distance from a point with known co-ordinates.
- determining offsets from a co-ordinated point given the bearing and distance from a point with known co-ordinates
- setting out for construction works using theodolite and tapes
  - calculating the information necessary to set out a structure, or part thereof, using a site plan with positions fixed by a mixture of bearings and distances (radiations), offsets and co-ordinates
  - setting out a building structure from radiations and/or X,Y,Z co-ordinates
  - setting out circular curve using theodolite from deflection angles and/or chord
  - setting out a road reserve
  - setting out a portal frame factory.

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include but not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include but not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include but not limited to:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

**Resources and Equipment** may include but not limited to:

- appropriate Australian Standards
- local regulations and codes of practice
- reference texts, tables and graphs
- stationery
- appropriate tools,
- measurement equipment
- basic surveying equipment
- consumables
- maps
- markers
- paint
- personal protective equipment

**Enterprise procedures** may include but not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**Survey equipment** may include but not limited to:

- levels
- theodolite
- data collector and software
- GPS equipment
- lasers
- compass
- measuring wheels
- tripods
- poles
- construction calculator
- CAD/survey software
- field tools

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- implement OHS/WHs procedures and practices including the use of risk control measures as specified in the performance criteria
- demonstrate the ability to design and establish survey control for engineering and construction purposes. This includes the measurement of and calculation of survey data, drawing of sketch plans, collection and processing of topographical data for detail mapping and related computational skills on more than one occasion and in different contexts
- prepare and complete relevant documentation and present report/s.

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant survey equipment, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals.

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.



- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.
- This unit may be assessed in conjunction with other unit/s that form part of a total job role.

# VU22488 - Perform measurements and layout tasks on construction sites

## Unit Descriptor

This unit of competency sets out the knowledge and skills required to perform basic measurement and layout tasks on construction sites, including the use of levels and distance measuring techniques.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency applies to a person working as a para professional in a structural/civil engineering environment where measurement and set out of engineering works is undertaken. This competency includes both desk and fieldwork.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

1. Identify survey to be undertaken

- 1.1 **Occupational Health and Safety/Workplace health and Safety (OHS/WH&S)** and **environmental requirements** for a given work area are determined.
- 1.2 Established **OHS/WH&S requirements** and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with **appropriate personnel**.
- 1.4 The survey and analysis task is identified from documentation, work requests or discussions with appropriate personnel.
- 1.5 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.6 **Resources** and **equipment** needed for the task are obtained in accordance with **enterprise procedures** and checked for correct operation and safety.

2. Plan survey

- 2.1 OHS/WH&S requirements for carrying out the work are followed.
- 2.2 Documentation relating to existing survey features is collected and analysed.



- |    |     |  |
|----|-----|--|
|    | 2.3 | Surveying equipment is checked for calibration and conforming to relevant Australian Standard  |
|    | 2.4 | Reconnaissance of construction / engineering sites is performed to local standards or regulations in accordance with enterprise procedures.          |
|    | 2.5 | Survey risk management procedures are established and discussed with appropriate personnel.  |
| 3. |     | Conduct survey and analyse results   |
|    | 3.1 | OHS/WHS requirements for carrying out the work are followed.   |
|    | 3.2 | Survey control is conducted to job requirements in accordance with enterprise procedures.  |
|    | 3.3 | Survey equipment is operated/used according to manufacturer's manuals and enterprise procedures.   |
|    | 3.4 | Results are recorded, analysed and computations are applied according to enterprise procedures.  |
|    | 3.5 | Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures. |
|    | 3.6 | Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.                                      |
| 4. |     | Document, and report results   |
|    | 4.1 | OHS/WHS requirements for completing the work are followed.   |
|    | 4.2 | Equipment and tools used in survey are maintained and stored in accordance with enterprise procedures.   |
|    | 4.3 | Results are recorded, analysed and reported to appropriate personnel according to enterprise procedures.   |
|    | 4.4 | Results are stored and archived according to enterprise procedures.  |
|    | 4.5 | Work completion is notified to appropriate personnel according to enterprise procedures.   |

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- consulting and communicating with others
- identifying and following relevant OHS/WHS procedures
- reading and understanding documentation and work requests
- planning survey activity
- carrying out construction / engineering site reconnaissance
- checking surveying equipment



- performing surveying measurements
- preparing surveying and related documentation
- constructing longitudinal/cross sections and determine associated grades and levels in typical drainage and pipeline situations
- construction site levelling and detail survey using automatic level stadia tacheometry (application limited to small sites)
- producing a scaled and orientated sketch of engineering site annotated with features

**Required knowledge:**

- surveying fundamentals including:
  - a measurement reference system and measurable quantities
  - co-ordinate and orientation reference systems
  - surveying applications to engineering projects
  - graphical and mathematical relationship between measurements and coordinate systems
  - requirements for survey control and topographic mapping for engineering projects : including
    - location, density & longevity of control monuments
    - detail necessary for engineering design
    - setting out for construction
    - deformation & movement monitoring
- reconnaissance of construction/engineering sites including:
  - locate important features
  - field sketch terrain and cultural features
  - approximately locate proposed works on a site
  - place survey control monuments
  - reconnaissance surveys by
    - compass, clinometer & pace traverse
    - single frequency GPS
  - graphically adjust reconnaissance traverses
  - produce a scaled and orientated sketch of engineering site annotated with form lines and features
- detail measurement on a construction/engineering site including:
  - measured horizontal distances by tape and plumb bob to an accuracy of +/- 5mm in 20 metres
  - determined horizontal distance from slope distances and vertical angle
  - magnetic directions
  - the relative position of points and features by offset and radiation
  - producing sketches with measured dimensions of buildings and other cultural and natural features
  - annotating sketches to identify features and their attributes using standard surveying symbols

- Third Order Levelling - Two Peg Test:
  - test and adjust automatic levels if maladjustment exceeds 5mm in 30metres
- 'Rise and Fall' method including:
  - differential levelling in closed traverses, calculate reduced levels using Rise and Fall method of level reduction to an accuracy of  $\pm 12\text{mm} \sqrt{k}$  where  $k$  = total traverse length
  - determination of reduced levels of features and survey control monuments
  - calculation of clearances under overhangs/bridges using an inverted staff
  - use of automatic and electronic levels, laser planes and hydrostatic methods to obtain reduced levels of features on engineering sites
- Height of Collimation. - Grid Contouring and Volumes including:
  - how to set out a grid and level it, using H.O.C. method
  - preparation of a contour plan from grid spot levels to a specified accuracy and stated contour interval
  - production of a cross section through a contour plan showing cut and fills
  - determination of the volume of a solid, the surface of which has been levelled and contoured

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

**Resources** may include, but are not limited to:

- appropriate Australian Standards
- local regulations and codes of practice
- reference texts, tables and graphs
- stationery
- appropriate tools,
- measurement equipment

**Equipment** including:

- basic surveying equipment
- level
- CAD / survey software
- scientific calculator
- personal protective equipment

**Enterprise procedures** such as:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to design and establish survey control for engineering and construction purposes. This includes the measurement of and calculation of survey data, drawing of sketch plans, and setting out of works and related computational skills, on more than one occasion and in different contexts.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an

individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.

- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant survey and measuring equipment, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

#### **Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## VU22547 - Produce an engineering design for drainage pipes and culverts

### Unit Descriptor

This unit of competency describes the knowledge and skills required to apply principles of design for a minor culvert for a rural road using appropriate drainage standards.

This includes the application of basic concepts in engineering hydrology to estimate flood flow magnitude and basic culvert and drainage design practices.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at paraprofessional level in a civil engineering environment where the design of roads using drainage pipes and culverts is undertaken. The unit includes both desk and fieldwork.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

#### 1. Identify drainage design requirements

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements*** and ***environmental requirements*** for a given work area are obtained and interpreted.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 Design requirements are identified from documentation, work requests or discussions with appropriate personnel.
- 1.5 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the workplace.
- 1.6 ***Resources and equipment*** needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.





- |  |   |
|--|---|
| 2. Plan design approach                  | <p>2.1 OHS/WHs requirements for carrying out the work are incorporated in the design plan.</p> <p>2.2 On site reconnaissance to gather surveying data, measurements, photographs and other required information for the design project is completed.</p> <p>2.3 Design references and equipment are available to complete the design, to conform to relevant Australian and/or local standards or regulations, in accordance with enterprise procedures.</p> <p>2.4 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.</p> <p>2.5 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.</p> |
| 3. Complete the design                   | <p>3.1 OHS/WHs requirements for carrying out the work are followed.</p> <p>3.2 Design is completed to conform to relevant Australian and/or local standards or regulations, in accordance with enterprise procedures.</p> <p>3.3 Design references and equipment are used according to relevant Australian standards, manufacturers' manuals and enterprise procedures.</p> <p>3.4 Design is reviewed with appropriate personnel and amended as required to provide the optimum solution.</p>   |
| 4. Compile, document and present results | <p>4.1 Design references and equipment are maintained and stored in accordance with enterprise procedures.</p> <p>4.2 Results are recorded, analysed and reported to appropriate personnel in accordance with enterprise procedures.</p> <p>4.3 Results are stored and archived according to enterprise procedures.</p>   |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- communicating and working with other team members
- reading skills to interpret task related documentation, relevant data, job instructions, drawings and OHS/WHs procedures
- carrying on site reconnaissance to gather surveying data, measurements, photographs and other required information in preparation for the culvert design and drainage task
- making computations and recording the results

- assembling gathered information and data and preparing a culvert and drainage design solution
- reviewing design in consultation with others and finalising the proposal
- completing required workplace documentation

**Required knowledge:**

- hydrological cycle:
  - historic rainfall data
  - flood records
  - availability of data
- meteorology:
  - elements
  - meteorology measuring gauge results to be recorded and graphed, over the period of duration of the module
- rain gauging:
  - types of rainfall
  - types of rain gauge
  - networks
  - data adjustment
  - mass curve and hydrograph
  - intensity
- rain gauging results recorded and graphed over the period of duration of the module
- stream flow:
  - factors affecting run-off
  - stream flow components
  - stream flow monitoring equipment
  - flood hydrograph
  - use of flood hydrograph software
  - stage discharge
- stream gauging practical project requiring:
  - suitable site selection with easy determination of stream cross section
  - monitoring equipment
  - work could be completed in liaison with the local authority
- flood estimation:
  - factors affecting (rainfall, catchment)
  - peak flow
  - run-off hydrograph
  - flood routing
  - flood frequency analysis
  - design flood selection
- hydraulic structures:

- retarding basin
- channel flow regulation (irrigation)
- reservoir storage
- erosion control (systems)
- data collection:
  - recognise the terminology associated with drainage design
- development of a logical plan of action in approaching design task
- the information required to undertake design:
  - topographic and base maps, cadastral plans, subdivision plans
  - aerial photographs
  - flood flow, flood level data rainfall data
  - rainfall intensity/ frequency/ duration curves
  - rainfall coefficients
  - drainage design charts, pipes, channels and pits
  - data related to runoff, soil types, geology, stream
  - pattern, vegetation, land use
  - existing drainage lines, outfalls, channels, water-courses, existing drainage locations and levels
  - location and levels of other services
  - state the sources for the design data
- major and minor floods:
  - average recurrence interval
  - review the Water Cycle
  - Identify factors increasing and decreasing run-off
  - Show relationship between flood magnitude
  - storm event ranking, frequency and Average Recurrence Interval
  - definition of minor, major, rare and extreme floods
  - level of public protection afforded by minor and major flood control design
  - designers responsibility to compromise between ultimate flood protection and economy
  - A.R.I. appropriate to the design task
- control measures for floods of greater magnitude:
  - roadway reserves, floodways in footways and reserves
  - retention, detention and retardation techniques
- rational method for design of peak discharge:
  - theory of method based on completely impervious catchment and continuity of flow
  - (Rainfall in = Discharge out)
  - state rational method formula and define terms
  - direct relationship between discharge area
  - Coefficient of Runoff and Equivalent Area
  - formula in terms of above for litres and cubic metres/second
  - relationship between intensity, frequency and duration

- peak discharge occurs when design storm duration equals time of flow from most remote point
- time of Concentration and relation to Design Intensity
- calculation of design discharge from single use catchment given the area, runoff coefficient and time of concentration
  - intensity/ frequency/ duration for design A.R.I
- weighted coefficient of runoff for a multi-use catchment
- the design discharge from multi-use catchment given areas, coefficient and time of concentration
  - equivalent areas making up the catchment area can be summed to give total area weighted coefficient
- coefficient of run off based on percentage of impervious area
- rural catchment areas:
  - state data required for design
  - the topographic plan - ridges, valleys, watercourses
  - properties of contours
  - e catchment boundaries along ridge lines
  - Trace boundary from outlet to ridge line by crossing contours at right angles
  - the catchment area by planimeter, scale and calculation, counting grade squares
  - stream flow lengths, overland flow lengths
  - time of concentration - various methods
  - overland flow time design charts with limits
  - stream time using approximate velocities
  - tortuosity factor to measure length
  - average weighted stream slope
  - stream velocity design chart using weighted slope
  - time as distance/velocity plus overland time
  - time of concentration with Bransby-Williams formula
  - appropriate value for  $t_0$
  - state characteristics affecting runoff coefficient relief, retention, infiltration, cover, intensity
  - estimation of values from site data
  - use of Turner's tables to determine runoff coefficient
  - use of Rural Catchment Runoff Coefficient design chart
  - coefficient  $C_{10}$
  - application of frequency factor obtain  $C_y$
  - comparison of results and selection of appropriate values
- calculation of design discharge:
  - selection of appropriate recurrence interval
  - determination of intensity from adopted  $t_c$
  - calculation of discharge using adopted  $C_r$  and area
  - comparison with streamflow flood records if available

- culvert design:
  - design data - roadway and stream at site
  - determination of depth and velocity of discharge flow in natural waterway
  - derivation of tailwater depth
  - selection of culvert slope compatible with site conditions
  - determination of culvert length through embankment
  - setting of allowable headwater depth - U/S water level
  - establishment of freeboard requirement
  - trial culvert type and cover requirements
  - critical depth of flow
  - use of the Drainage Design Manual (D.D.M.) procedure and design charts to establish maximum headwater level
  - headwater level, cover, outlet velocity for acceptability
  - modification of culvert trail size and recompute as required
  - design data in a form suitable for transfer to working drawings refer Culvert Design Sheet (D.D.M.)
- urban runoff and flow:
  - rational method
  - partial area effect
  - circumstances when partial area has an effect
  - two values: rational method - full areas, part area
  - time of concentration for various land uses
  - kinematic wave formulation for overland flow
  - variation with intensity, A.R.I
  - use of overload flow chart (D.D.M.)
- determination of flow time in gutters or channels (D.D.M. chart)
  - minimum times for design
  - roof to gutter time
- determination of time of entry:
  - overland (roof) time plus channel time to inlet
  - calculation of full area and part area coefficients
  - coefficient of runoff for project
  - determination of full area and part area coefficients for all internal and external land uses contributing to development outlet
- pipe and pipe layout
  - location of road drainage lines
- pit locations:
  - entry pits at upstream side of intersections, low pits, tangent points
  - determination of entry pit spacing based on flow spread and inlet capacity, lot discharge

- use of design charts and calculation establish entry pits locations. Calculate runoff entry and bypass
- selection of economical route for road drainage to outlet
- use of high side of road, avoid easements
- location of junction pits at direction change, at maximum spacing
- review and adjustment of road drainage network
- locate easement drainage:
  - identification of blocks not served by road drainage
  - location of easement pits and inlets
  - economical route to road drains
  - minimum pipe sizes to be used in easements, road reserves and beneath pavements
  - determination of minimum cover required
  - determination of pipe lengths
- catchment areas:
  - catchment areas contributing to each outlet pipe from pits in the network
  - division of catchment areas into sub areas based on land use
  - identification of sub areas entering gutter inlets
  - recording areas, coefficient of runoff for each sub area
  - calculation of equivalent areas for each sub area
  - sum equivalent areas entering each outlet pipe
- time of concentration:
  - use of roof and gutter time for house lots
  - use of overland and gutter time for grassed and paved areas
  - use of longest time for full area flow
  - use of impervious entry time for part area flow (minimum 5 minutes)
  - estimation of time in pipe to downstream pit (nearest: ½ minute)
  - sum time downstream from pit to pit
  - adopting longest time at junctions part area and full area
  - in Victoria part area design will predominate
- calculate peak discharge:
  - use of rational method to calculate part area and full area discharge at each pit
  - part area produces peak discharge in Victoria
  - note that pipe travel time may be amended later when pipe velocities are determined requiring adjustment to discharge
  - calculation of maximum flood discharge at critical points
  - determining gap flow - overflow at critical points
  - consideration of overflow path at intersections, court bowls
  - Pit Water Level and Hydraulic Grade Lines
  - transfer of discharge data to design sheet
- pipe design:
  - adoption of minimum freeboard at pits

- insertion of pit design kerb levels in design sheet
- calculation of maximum pit water level at each pit
- Bernoulli equation
- definition of hydraulic grade line at level of water surface.
- pressure line = total energy
- velocity head
- show that H.G.L. is highest allowable obvert level for full pipe flow, pipe located at or beneath H.G.L
- review of pipeline shock losses.
  - determination of head loss coefficients for pits in network use D.D.M. charts
  - adoption of suitable method.
  - trial pipe size, calculate velocity as  $Q/A$
  - calculation of water level at downstream pit as U/S
  - W.L. - Head loss at pit - Head loss in pipe

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHs requirements*** may include but not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include but not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include but not limited to:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

**Resources and equipment** may include but not limited to:

- specifications
- appropriate manuals
- standards
- catalogues
- stationary
- calculators

**Enterprise procedures** may include but not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to demonstrate the ability to:
  - implement OHS/WHs procedures and practices including the use of risk control measures as specified in the performance criteria and range
  - carry out an on-site reconnaissance and gather required data and information for a proposed culvert and drainage system on more than one occasion and in different context
  - design a culvert drainage system solution to meet a specific requirement on more than one occasion and in different contexts

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or simulated work facility and off site environments
  - access to relevant tools, equipment, materials and consumables



- access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final design solutions or outcomes
  - portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## VU22548 - Produce an engineering design for a stormwater reticulation scheme

### Unit Descriptor

This unit of competency describes the knowledge and skills required to apply principles of design for a stormwater reticulation scheme using appropriate design standards.

The unit includes conducting an on-site reconnaissance, data collection and analysis, application of hydrology principles, use of relevant charts from drainage design manual and other design aids.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at paraprofessional level in a civil engineering environment responsible for the development of stormwater reticulation design solutions.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

1. Identify stormwater reticulation scheme to be designed

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements and environmental requirements*** for a given work area are obtained and interpreted.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 Design requirements are identified from documentation, work requests or discussions with appropriate personnel.
- 1.5 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.6 ***Resources*** and ***equipment*** needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.



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| 2. Plan design approach                 | 2.1 OHS/WHs requirements for carrying out the work are followed.<br>2.2 On site reconnaissance to gather surveying data, measurements, photographs and other required information for the design project is carried out.<br>2.3 Design references are consulted and required documentation is gathered to complete the design task in accordance with enterprise procedures.<br>2.4 Design and drafting system (CAD) is set up according to operating procedure<br>2.5 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.<br>2.6 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes. |
| 3. Complete the design                  | 3.1 OHS/WHs requirements for carrying out the work are followed.<br>3.2 Design solution is prepared to conform to relevant standards and regulations in accordance with enterprise procedures.<br>3.3 Unexpected situations are deal with in accordance with work plan and discussions with appropriate personnel.<br>3.4 Completed design is reviewed with appropriate personnel and amended as required to provide optimum solution.   |
| 4. Compile, document and present design | 4.1 Design solution is presented and discussed with appropriate personnel<br>4.2 Design references and equipment are maintained and stored in accordance with enterprise procedures.<br>4.3 Work completion is notified to appropriate personnel and required documentation completed accordance with workplace procedures.  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- communicating and working with other team members
- reading skills to interpret task related documentation, relevant data, job instructions, drawings and OHS/WHs procedures
- carrying on site reconnaissance to obtain surveying data, take measurements and photographs and gather other required information in preparation for stormwater reticulation scheme
- making computations and recording the results

- assembling gathered information and data and preparing a design solution
- setting up and using design aids
- reviewing design in consultation with others and finalising the proposal
- completing required workplace documentation

**Required knowledge:**

- data collection relevant to stormwater reticulation scheme:
- urban runoff and flow:
  - revise rational method
  - partial area effect
  - circumstances when partial area has an effect
  - kinematic wave formulation for overland flow
  - variation with intensity, A.R.I
- time of entry:
  - overland (roof) time plus channel time to inlet
  - generalise coefficient of runoff for project
- pipe and pipe layout
- pit locations
- catchment areas
- time of concentration
- design aids:
  - use of computer methods
  - use of commercial software and programs
  - commercial drainage design and analysis programs to design small urban stormwater reticulation scheme

**RANGE STATEMENT**

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use

- excessive noise

**Appropriate personnel** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

**Resources** may include but are not limited to:

- appropriate Australian Standards
- local regulations and codes of practice
- reference texts, tables and graphs
- stationery
- measurement equipment

**Equipment** may include but is not limited to:

- CAD/survey software
- scientific calculator
- personal protective equipment

**Enterprise procedures** such as:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to demonstrate the ability to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria and range

- carry out an on-site reconnaissance and gather required data and information for a proposed stormwater reticulation scheme on more than one occasion and in different context
- design a stormwater reticulation scheme on more than one occasion and in different contexts.

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or simulated work facility and off site environments
  - access to relevant design aids and equipment, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final design solutions or outcomes
  - portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, workplace supervisors or other appropriate persons.

# VU22549 - Produce an engineering design for a sewerage reticulation scheme

## Unit Descriptor

This unit of competency sets out the knowledge and skills required to apply principles of design for an engineering sewerage reticulation scheme using appropriate design standards.

The units includes conducting an on-site reconnaissance, data collection and analysis, application of hydrology principles, sewerage reticulation design procedures and use of relevant charts from drainage design manual.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency applies to a person working at paraprofessional level in a civil engineering environment responsible for the development sewerage reticulation design solutions.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

1. Identify sewerage reticulation scheme to be designed

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements*** and ***environmental requirements*** for a given work area are determined
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 Design is identified from documentation, job brief or discussions with appropriate personnel.
- 1.5 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.6 ***Resources and equipment*** needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.



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| 2. Plan design approach                  | <p>2.1 OHS/WHs requirements for carrying out the work are followed.</p> <p>2.2 On site reconnaissance to gather surveying data, measurements, photographs and other required information for the design project is carried out.</p> <p>2.3 Design references are consulted and required documentation is gathered to complete the design task in accordance with enterprise procedures.</p> <p>2.4 Design and drafting system (CAD) is set up according to operating procedure.</p> <p>2.5 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.</p> <p>2.6 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.</p> |
| 3. Complete the design                   | <p>3.1 OHS/WHs requirements for carrying out the work are followed.</p> <p>3.2 Design solution is prepared to conform to relevant standards and regulations in accordance with enterprise procedures.</p> <p>3.3 Unexpected situations are deal with in accordance with work plan and discussions with appropriate personnel.</p> <p>3.4 Completed design is reviewed with appropriate personnel and amended as required to provide optimum solution.</p>  |
| 4. Compile, document and present results | <p>4.1 Design solution is presented and discussed with appropriate personnel.</p> <p>4.2 Design references and equipment are maintained and stored in accordance with enterprise procedures.</p> <p>4.3 Work completion is notified to appropriate personnel and required documentation completed accordance with workplace procedures</p>   |

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- communicating and working with other team members
- reading skills to interpret task related documentation, relevant data, job instructions, drawings and OHS/WHs procedures
- carrying on site reconnaissance to obtain relevant data, such as survey measurements and site photographs and other required information in preparation for sewerage reticulation scheme



- making computations and recording the results
- assembling gathered information and data and preparing a design solution
- setting up and using design aids
- reviewing design in consultation with others and finalising the proposal
- completing required workplace documentation

***Required knowledge:***

- instrumentalities:
  - list of Authorities including agencies
  - sewerage reticulation
  - sewerage treatment
  - roles, jurisdiction and statutory powers of the above
- job brief:
  - data required for design and specification
  - topographic detail
  - soil conditions
  - underground services
  - easements
  - obstructions
- horizontal alignment:
  - standard practice and factors affecting location of sewers
  - along streets/rear of properties
  - along easements
  - other services
  - curved sewers
  - access
- sewerage authority drawings:
  - existing mains
  - existing sewerage pipes
  - standard symbols for all features
- vertical alignment:
  - allotment categories
  - allotment controls
  - area to be controlled
  - control surface level
  - minimum depths
  - minimum grades
  - boundary trap

- fixing of vertical alignment:
  - minimum depth and clearance from other services
  - fixture controls
  - property branch sewers
  - IL of end fitting
  - access chambers, inspection shafts, pipeline ends
  - final invert levels, grades surface levels, chainages, type of pipes
- working drawings.
  - plan and longitudinal sections.
  - use of standard symbols.
- testing:
  - initial test (air test)
  - acceptance test
  - visual inspection
  - exfiltration test
  - maintenance tests
  - TV inspection
  - infiltration
- septic tanks.
  - principles of treatment methods
  - components of a septic tank
  - design according to the Septic Tank Code
- package plants.
  - role of the package treatment plant
  - permanent facility
  - temporary element in a larger scheme
  - principle of operation
  - commercial availability
  - sizes v. community population
- small treatment plants.
  - the need for treatment
  - function of the elements
  - design for 500 people
  - loading rates
  - disinfection
  - sludge disposal
  - location/security
  - sketch of layout

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include but not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include but not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Resources and equipment*** may include but not limited to:

- specifications
- appropriate manuals
- standards
- catalogues
- stationary
- calculators

***Enterprise procedures*** may include but not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

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The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to demonstrate the ability to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - carry out an on-site reconnaissance and gather required data and information for a proposed sewerage reticulation scheme
  - apply principles of design for an engineering sewerage reticulation scheme in accordance appropriate design standards and design brief on at least one occasion.

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or simulated work facility and off site environments
  - access to relevant design aids and equipment, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons

- inspection of the final design solutions or outcomes
  - portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, workplace supervisors or other appropriate persons.

# VU22550 - Produce an engineering design for a reinforced concrete structure

## Unit Descriptor

This unit of competency describes the knowledge and skills required to produce a design for a flexural reinforced concrete structure consistent with requirements of a project brief.

The unit includes the design principles of flexural reinforced concrete members such as suspended slabs, beams, columns and footings as well as using appropriate design aids.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency applies to a person working at paraprofessional level in a civil engineering environment where design of reinforced concrete structures is undertaken.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

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|--|--|
| 1. Identify reinforced concrete structure to be designed | <div>1.1 <b><i>Occupational Health and Safety/Workplace Health and Safety (OHS/WH&amp;S) requirements</i></b> and <b><i>environmental requirements</i></b> for a given work area are determined.</div> <div>1.2 Established OHS/WH&amp;S requirements and risk control measures and procedures are followed in preparation of the work area.</div> <div>1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with <b><i>appropriate personnel</i></b>.</div> <div>1.4 Design requirements for the <b><i>reinforced concrete structure</i></b> are identified from the design brief</div> <div>1.5 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.</div> <div>1.6 <b><i>Resources and equipment</i></b> needed for the design are obtained in accordance with <b><i>enterprise procedures</i></b>.</div> |
| 2. Plan design approach                                  | <div>2.1 Documentation relating to design project is collected and analysed.</div> <div>2.2 Design brief is reviewed and discuss with relevant personnel</div>   |



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|--|-----|--|
|  | 2.3 | <b><i>Design references and equipment</i></b> are available to plan the design, to conform to relevant Australian and/or local standards or regulations, in accordance with enterprise procedures. |
| 3. Complete the design                   | 3.1 | OHS/WHs requirements for carrying out the work are followed.   |
|  | 3.2 | The design is completed to conform to relevant Australian and/or local standards or regulations, in accordance with enterprise procedures.   |
|  | 3.3 | Design references and equipment are used according to relevant Australian standards, manufacturer's manuals and enterprise procedures.   |
|  | 3.4 | Results are recorded, analysed, examined and applied according to enterprise procedures.   |
|  | 3.5 | Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.   |
|  | 3.6 | Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.  |
| 4. Compile, document and present results | 4.1 | Design references and equipment are maintained and stored in accordance with enterprise procedures.  |
|  | 4.2 | Results are recorded, analysed, documented and presented to appropriate personnel in accordance with enterprise procedures.  |
|  | 4.3 | Results are stored and archived according to enterprise procedures.  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- consulting and communicating with other team members involved in the design project
- identifying and following relevant OH&S procedures
- reading and interpreting a design brief and related documentation
- using design reference material
- preparing a design project plan
- producing a design for a reinforced concrete structure that meets the requirements of design brief and relevant Australian standards
- preparing and updating design documentation

### ***Required knowledge:***

- loads
- moments
- shear forces
- ultimate strength theory for bending using rectangular stress block
- moment capacity
- rectangular beam design from first principles
  - durability, exposure classifications and minimum concrete cover
- design aids for rectangular beam design
- strength equations:
  - for doubly reinforced beams,
  - for T-beams and L-beams
- T-beams and L-beams.
- length for tension and compression reinforcement
- reinforcement:
  - hooks and cogs
  - curtailment of reinforcement
  - arrangement of reinforcement
- shear:
  - shear equations
  - design of shear reinforcement
- shear reinforcement and appropriate design aids

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHs requirements*** may include but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand



- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

**Reinforced concrete structure**  
including:

- suspended slabs
- beams
- columns
- footings

**Resources and equipment** such  
as:

- specifications
- manuals
- standards
- catalogues
- stationary
- calculators

**Enterprise procedures** may  
include but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**Design references and  
equipment**

- specifications
- manuals
- standards
- CAD / design aid software
- tables / graphs / charts

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for  
assessment and evidence  
required to demonstrate  
competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHs procedures and practices including the use of risk control measures as specified in the performance criteria and range

**Context of and specific resources for assessment**

- demonstrate the ability to design flexural reinforced concrete structure using appropriate design aids which complies to a brief, relevant Australian standards and building codes on more than one occasion and in different contexts.
- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - Access to workplace or work real environment and a variety of conditions
  - Operational access to relevant design equipment, tools, materials and consumables
  - Access to relevant Australian Standards, plans, drawings and instructions and manufacturer's specifications/manuals.

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

# VU22551 - Produce an engineering design for a steel structure

## Unit Descriptor

This unit of competency describes the knowledge and skills required to complete an engineering project including the analysis and design of simple steel structures from first principles using appropriate design aids.

The unit includes a ranges of relevant engineering calculations and design principles for a range of steel structure components

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency applies to a person working at paraprofessional level in a civil engineering environment where design of steel structures is undertaken.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

1. Identify steel structure to be designed

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements and environmental requirements*** for a given work area are determined.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 Design requirements for the ***steel structure*** are identified from the design brief.
- 1.5 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.6 ***Resources*** and equipment needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.

2. Plan design approach

- 2.1 Design project documentation is collected and analysed.
- 2.2 Design references and equipment are set up to complete the design, in accordance to relevant Australian standards regulations and enterprise procedures.



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|  | 2.3 | Decisions for dealing with unexpected situations are made from discussion with appropriate personnel, job specifications and enterprise procedures.        |
| 3. Complete the design                   | 3.1 | The steel structure design is completed to conform to relevant Australian and/or local standards or regulations, in accordance with enterprise procedures. |
|  | 3.2 | Design references and equipment are used according to relevant Australian standards, manufacturer's manuals and enterprise procedures.                     |
|  | 3.3 | Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.  |
|  | 3.4 | Completed design is reviewed against job specifications with appropriate personnel and amended as required to provide optimum solution                     |
| 4. Compile, document and present results | 4.1 | Final design is presented and discussed with appropriate personnel   |
|  | 4.2 | Design references and equipment are maintained and stored in accordance with enterprise procedures.  |
|  | 4.3 | Results are stored and archived according to enterprise procedures.  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- consulting and communicate with others
- identifying and following relevant OHS/WHS procedures
- calculating:
  - loads on beams and frames
  - geometric properties of beam sections
  - effective lengths of beams
  - effective lengths of columns with and without lateral restraints
  - stresses caused by biaxial bending in a beam
  - effective lengths of members in pin-jointed frames
- designing:
  - column for concentric load or eccentric load
  - bolted, welded and flange plate connections
  - base plate for a simple connection or for a moment connection
  - structural members subjected to tensile forces
  - members in pin jointed frames using safe load tables
  - welded plate girder
  - load bearing stiffeners



- structural member in combined tension and bending
- checking for local web crushing and buckling

**Required knowledge:**

- loads on structures:
  - AS 1170 Part 1 to determine design dead and live loads
  - loads on beams, where loads are transmitted through panel areas
  - loads on frames where loads are transmitted through panel areas
  - wind loads on buildings as per AS 1170 Part 2
- beams (plated):
  - geometric properties of (plated) beam sections
  - plated beam bending, shear and deflection
- column design:
  - effective lengths of columns with and without lateral restraints
    - concentric load
    - eccentric load
- connections:
  - bolted connection for concentric load
  - welded connection for concentric and eccentric loads
  - flange plate connections using continuous and intermittent welds
- column base plates:
  - base plate for a simple connection
  - base plate for a moment connection
- biaxial bending:
  - stresses caused by biaxial bending in a beam
- tension members:
  - structural members subjected to tensile forces
- pin Jointed frames:
  - effective lengths of members in pin-jointed frames
  - members in pin jointed frames using safe load tables
- welded plate girders:
  - welded plate girder
  - local web crushing and buckling
  - load bearing stiffeners
- combined tension and bending:
  - structural member in combined tension and bending
- purlins and girts:
  - purlins and girts using cold-formed steel sections in:
    - single span
    - continuous span

**RANGE STATEMENT**

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include but not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include but not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include but not limited to:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Steel structure*** may include but not limited to:

- beams and columns
- base plates
- bolted, welded and flange plate connections
- welded plate girders
- stiffeners
- pin jointed frames
- purlins and girts

***Resources*** may include but not limited to:

- specifications
- manuals
- standards
- catalogues
- stationary
- calculators

***Enterprise procedures*** may include but not limited to:

- the use of tools and equipment

- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### **Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria and range statement.
  - demonstrate the ability to design a steel structure in accordance to job specifications and relevant Australian standards on more than one occasion and in different contexts.

### **Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant design aids and equipment, tools, materials and consumables
  - access to relevant Australian Standards, plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include the demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22489 - Produce reinforced concrete drawings

### Unit Descriptor

This unit of competency sets out the knowledge and skills required to produce typical drawings for the detailing of reinforced concrete components of a building, in accordance with standard practice in AS1100.501 and AS3600.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at paraprofessional level in a civil engineering environment where technical drawings of reinforced concrete elements of a building are prepared.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Identify reinforced concrete components to be drawn

2. Plan drafting approach

3. Complete the drawings

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational, Health and Safety/Workplace, Health and Safety (OHS/WHS) requirements*** for a given work area are obtained and followed.
- 1.2 Drawings, relevant documentation and work requests are identified and discussed with ***appropriate personnel***.
- 1.3 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved with the project and on the work site.
- 1.4 ***Resources and drafting equipment*** needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.
- 2.1 Project specifications and related documentation are analysed and discussed with appropriate personnel.
- 2.2 Drafting equipment is set up to complete the drawings, in accordance with enterprise procedures manufacturer's requirements.
- 3.1 Drawings of concrete reinforced components are completed in accordance with relevant drafting and concrete structures Australian Standards, building regulations and enterprise procedures.
- 3.2 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.



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|                                       | 3.3 | Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes. |
|                                       | 3.4 | Drawings are reviewed against job specifications with appropriate personnel and amended as required.            |
| 4. Present and archive final drawings | 4.1 | Drafting references and CAD equipment are maintained and stored in accordance with enterprise procedures.       |
|                                       | 4.2 | Drawings are presented to appropriate personnel and signed off in accordance with enterprise procedures.        |
|                                       | 4.3 | Drawings are stored and archived according to enterprise procedures.  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- consulting and communicating with project personnel
- identifying and following relevant OHS/WHS requirements and procedures
- reading and interpreting building codes and Australian Standards 1100.501
- drafting concrete outlines using elevation, sectional views and details
- applying labelling and dimensioning of reinforcement components
- producing completed technical drawings
- using appropriate system of bar marking to identify reinforcement
- displaying bars and fabric
- preparing bar schedules and calculating steel quantities
- extracting data from AS3600 Concrete Structures Code
- determining splice and anchorage lengths
- drawing details of various types of construction and expansion joints used in reinforced concrete structures
- preparing and updating related documents

### **Required knowledge:**

- AS3600 Concrete Structures Code, AS2807.1 Residential Reinforced Concrete Code, CIA Reinforced Concrete Detailing Manual and current local practice in placement of reinforcement:
  - pad footings
  - slabs on ground
  - columns
  - simply supported beams
  - walls
- drawing conventions for concrete outline using plans, sections, views and details for:
  - footing types

- floor slab systems
- beams
- columns
- walls, penetrations and openings
- expansion and contraction joints
- labelling and dimensioning requirements of reinforcement:
  - main
  - distribution
  - shear
- drawing conventions for:
  - bar types and shapes
  - hooks
  - cogs
  - bends
- systems of bar marking to identify reinforcement
- display of bars and fabric with reference to:
  - other reinforcement
  - other elements of the structure
  - requirements of appropriate cover
- bar schedules and calculation of steel quantities:
  - item numbering systems
  - colour tagging system
  - bar sizes/grade
  - quantities
  - dimensions
  - shape
  - tonnage
- AS3600 Concrete Structures Code to determine splice and anchorage lengths for various conditions.

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

**OHS/WHS requirements** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

**Appropriate personnel** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

**Resources and drafting equipment** may include, but are not limited to:

- manual drafting equipment:
- computer aided drafting (CAD) equipment
- specifications
- manuals
- standards
- stationary
- calculators

**Enterprise procedures** may include, but are not limited to:

- the use of resources and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria and range statement
  - demonstrate the ability to produce drawings of reinforced concrete components in accordance with appropriate drafting conventions and Australian Standards on more than one occasion and in different contexts.

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant Australian Standards, plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## VU22552 - Produce advanced engineering drawings for a reinforced concrete structure

<b>Unit Descriptor</b>	<p>This unit of competency describes the knowledge and skills required to produce advanced reinforced concrete drawings, in accordance with required practices and conventions as outlined in AS1100.501 and AS3600.</p> <p>No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.</p>
<b>Employability Skills</b>	<p>This unit contains employability skills.</p>
<b>Application of the Unit</b>	<p>This unit of competency applies to a person working at paraprofessional level in a civil engineering environment where drawing of advanced reinforced concrete structures is prepared.</p>

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- |   |   |
|---|---|
| 1. Identify reinforced concrete structure to be drawn | <p>1.1 <b><i>Occupational Health and Safety/ Workplace Health and Safety (OHS/WHS) requirements</i></b> for a given work area are determined.</p> <p>1.2 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with <b><i>appropriate personnel</i></b>.</p> <p>1.3 Drawings are identified from documentation, work requests or discussions with appropriate personnel.</p> <p>1.4 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.</p> <p>1.5 <b><i>Resources and drafting equipment</i></b> needed for the task are obtained in accordance with <b><i>enterprise procedures</i></b> and checked for correct operation and safety.</p> |
| 2. Plan drafting approach                             | <p>2.1 Project specifications and related documentation are analysed and discussed with other project personnel.</p> <p>2.3 Design references are assembled and drafting equipment is set up in accordance with manufacturer's requirements and enterprise procedures.</p>  |



- |                                       |  |
|---------------------------------------|--|
| 3. Complete the drawings              | 3.1 Drawings of concrete reinforced components are completed to conform with relevant Australian Standards building regulations and enterprise procedures. |
|                                       | 3.2 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.   |
|                                       | 3.3 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.  |
|                                       | 3.4 Drawings are reviewed against job specifications with appropriate personnel and amended as required.   |
| 4. Present and archive final drawings | 4.1 Drafting references and drafting equipment are maintained and stored in accordance with enterprise procedures  |
|                                       | 4.2 Drawings are presented to appropriate personnel and signed off in accordance with enterprise procedures.   |
|                                       | 4.3 Drawings are stored and archived according to enterprise procedures.   |

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- consulting and communicating with other project personnel
- identifying and following relevant OHS/WHS requirements and procedures
- reading and interpreting building codes and Australian Standard 1100.50
- drafting concrete outlines using elevations and sectional views
- applying labelling and dimensioning conventions for reinforced concrete components
- specify requirements
- preparing bar schedules and calculating steel quantities
- applying the appropriate design criteria and in line with AS 3600
- preparing and updating related documents

### ***Required knowledge:***

- AS 3600 and CIA Reinforced Concrete Detailing Manual in the placement of reinforcement to:
  - pile caps
  - suspended slabs, continuous and simply supported
  - continuous beams
  - retaining walls
- concrete outlines using plans, sections, elevations and details for:
  - footings
  - suspended slabs
  - beams

- columns
- stairs
- retaining walls
- labelling and dimensioning conventions for reinforcement:
  - main
  - secondary
  - distribution
  - shear
  - temperature
  - nominal
- drawing symbols of:
  - bar types and shapes
  - hooks
  - cogs
  - bends
- display of bars and fabric with reference to:
  - other reinforcement
  - other elements of the structure
- appropriate cover
- bar marking to identify reinforcement
- AS 3600 to determine:
  - splice lengths
  - anchorage lengths
- construction requirements:
  - AS 3600

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer



- trainer
- mentor
- teacher
- team member

**Resources and drafting equipment** may include, but are not limited to:

- manual drafting equipment
- computer aided (CAD)
- specifications
- manuals
- standards
- catalogues
- stationary
- calculators

**Enterprise procedures** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, plans and drawings.
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHs procedures and practices including the use of risk control measures as specified in the performance criteria and range statement
  - demonstrate the ability to produce advanced structural reinforced concrete drawings in line with appropriate drafting conventions and Australian Standards on more than one occasion and in different contexts.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.

- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant Australian Standards, plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## VU22490 - Produce structural steel drawings

### Unit Descriptor

This unit of competency describes the knowledge and skills required to produce drawings for structural steel elements, in accordance with accepted practice and Australian Standards.

The unit includes interpreting and applying relevant sections of the Australian Standard, and Australian Institute of Steel Construction (AISC) handbook, making calculations, setting up drafting equipment and preparing the drawing/s in line with job specifications.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at paraprofessional level in a civil engineering environment where technical drawings of structural steel elements are prepared.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Identify structural steel elements to be drawn

2. Plan drafting approach

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements and environmental requirements*** for a given work area are determined.
- 1.2 Drawings, relevant documentation, work requests are identified and discussed with ***appropriate personnel***.
- 1.3 Appropriate project personnel are consulted to ensure the work is co-ordinated effectively with others at the work site.
- 1.4 ***Resources and drafting equipment*** needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.
- 2.1 Project specifications and related documentation are analysed and discussed with appropriate personnel.
- 2.2 Relevant sections of the ASIC handbook are analysed and applied and calculations preformed as required.
- 2.3 Design references and drafting equipment are set up to complete the drawings in accordance with enterprise procedures and manufacturer's requirements.



- |                                       |  |
|---------------------------------------|--|
| 3. Complete the drawings              | 3.1 Drafting references and equipment are used according to manufacturer's manuals and enterprise procedures.<br>3.2 Drawings of structural steel elements are completed to conform to relevant Australian standards, ASIC handbook, building regulations and enterprise procedures.<br>3.3 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel and in reference to job specifications and enterprise procedures.<br>3.4 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.<br>3.5 Final drawings are reviewed with appropriate personnel against job specifications and amended as required. |
| 4. Compile, present and store results | 4.1 Drafting references and equipment are maintained and stored in accordance with enterprise procedures.<br>4.3 Drawings are presented to appropriate personnel in accordance with enterprise procedures.<br>4.4 Drawings are stored and archived according to enterprise procedures.   |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- consulting and communicating with other project personnel
- identifying and following relevant OHS/WHS procedures
- reading and interpreting AS4100, ASIC Handbook, relevant building codes
- specify requirements
- performing calculations to determine span, channel and beam sizes etc.
- producing technical structural drawings in accordance to AS 1100 using manual or computer aided drafting equipment
- preparing and updating supporting documentation

### **Required knowledge:**

- steel sections handbooks in the identification of steel members and derivation of dimensions:
  - universal beams
  - taper flange beams
  - universal columns
  - channels (parallel and taper flange)
  - angles (equal and unequal)

- relevant data from Steel Structures Code AS4100
- relevant data from AISC Standardised Structural Steel Connections Handbook:
  - basic parameters
  - geometrical details
  - standard connections
- structural steel line diagrams:
  - plans
  - sections
  - views
- basic design information to correctly draw, label and dimension structural steel connections employing:
  - details
  - sections
  - views
- relevant:
  - symbols
  - terminology
  - linework
  - lettering
- detailing:
  - base plates
  - column/bearer and beam/bearer joints
  - trusses
  - gusset plates
  - girts, purlins and bracing
- application of:
  - centre of gravity lines
  - gauge lines
  - edge distances
  - bolt pitches
  - hole sizes
- detailing weld types and requirements for field and site welding:
  - fillet welds
  - butt welds
- specifications of appropriate protective coatings:
  - organic
  - inorganic
  - galvanised
- member lengths
- member marker system

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Resources and drafting equipment*** may include but are not limited to:

- manual drafting equipment
- computer aided drafting (CAD) equipment
- specifications
- manuals
- standards
- catalogues
- stationary
- calculators

***Enterprise procedures*** may include but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, plans and drawings.
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHs procedures and practices including the use of risk control measures as specified in the performance criteria and range statement
  - demonstrate the ability to produce drawings of structural steel elements in accordance with standard drafting conventions and relevant Australian standards on more than one occasion and in different contexts.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant Australian Standards, plans, drawings and instructions and manufacturer's specifications/manuals

### Methods of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.

- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



# VU22553 - Produce advanced engineering drawings for a steel structure

## Unit Descriptor

This unit of competency describes the knowledge and skills required to complete typical structural steel drawings in accordance with accepted practice as outlined in AS1100.501. The unit includes interpreting and applying relevant sections of AS4100 and Australian Institute of Steel Construction (AISC) Handbook, performing calculations and preparing dimensioned detailed structural drawings of steel members in accordance with job specifications. No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency applies to a person working at paraprofessional level in a civil engineering environment where drawings of steel structures are prepared.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

1. Identify steel structure to be drawn

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements*** for a given work area are determined.
- 1.2 Drawings, relevant documentation and work requests are identified and discussed with ***appropriate personnel***.
- 1.3 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.4 ***Resources and equipment*** needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.

2. Plan drafting approach

- 2.1 Project specifications and related documentation required for the drawings are collected and analysed.
- 2.2 Relevant sections of the AISC handbook and AS4001 are analysed and calculations performed as required.
- 2.3 Drafting references and equipment are set up available to complete the design and detailed drawings in accordance with enterprise procedures and manufacturer's requirements.



- |                                       |   |
|---------------------------------------|---|
| 3. Complete the drawings              | <p>3.1 Drafting references and equipment are used according to manufacturer's manuals and enterprise procedures.</p> <p>3.2 Drawings of steel structural and individual components are completed to conform with Australian drafting and steel structure standards, AISC Handbook requirements and relevant building codes.</p> <p>3.3 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.</p> <p>3.4 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.</p> <p>3.5 Final drawings are reviewed with appropriated personnel and against job specifications and amended as required.</p> |
| 4. Present and archive final drawings | <p>4.1 Drafting references and equipment are maintained and stored in accordance with enterprise procedures.</p> <p>4.2 Drawings are presented and to appropriate personnel accordance with enterprise procedures.</p> <p>4.3 Drawings are stored and archived according to enterprise procedures.</p>  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- consulting and communicating with other project personnel
- identifying and following relevant OHS/WHS procedures
- using steel section tables
- applying relevant data from AS 4100
- performing calculations to determine span, beam sizes, spacing, footing plates etc.
- extracting relevant information and data from the AISC Handbook
- producing structural steel drawing which include:
  - plans, sections, elevations and details
  - use symbols, terminology, line-work and lettering
  - data and dimensioning
  - weld types
  - protective coating specifications
  - construction requirements as per AS 4100

**Required knowledge:**

- section tables:
  - universal beams
  - universal columns
  - parallel flange channels
  - taper flange channels
  - equal angles
  - unequal angles
  - rolled hollow sections
- data from AS 4100 and design capacity tables for structural steel in the selection and specification of bolts and welds
- structural steel members using plans, sections, elevations and details for:
  - braced frames
  - portal frames
  - trusses
- design data for:
  - tension members
  - compression members
  - beams
  - shear connections
  - moment connections
- drawing standards for:
  - symbols
  - terminology
  - linework
  - lettering
- detailing of:
  - structural steel members
  - connections
  - base plates
  - bracing
- dimensioning:
  - centre of gravity lines
  - gauge lines
  - edge distances
  - bolt pitches
  - hole sizes
- weld types
  - fillet welds
  - butt welds
- protective coatings:
  - organic

- inorganic
- galvanised
- construction requirements:
  - as per AS4100

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Resources and equipment*** may include, but are not limited to:

- drafting equipment
  - manual
  - computer aided
- specifications
- manuals
- standards
- catalogues
- stationary
- calculators

***Enterprise procedures*** may include but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHs procedures and practices as specified in the performance criteria
  - demonstrate the ability to produce detailed structural steel drawings in accordance with AS 1100.501 and AS4100 and AISC Handbook on more than one occasion and in different contexts.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to manual or computer aided drafting equipment, references and consumables
  - access to relevant Australian Standards, AISC handbook, plans, drawings and instructions and manufacturer's specifications/manuals

### Methods of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.

- Where performance is not directly observed any evidence should be authenticated by appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## VU22491 - Produce structural steel shop drawings

### Unit Descriptor

This unit of competency describes the knowledge and skills required to produce structural steel shop drawings dealing with welded and bolted joint connections, in accordance with accepted practice as outlined in AS4100 and Australian Institute of Steel Construction (AISC) manuals.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at paraprofessional level in a civil engineering environment where shop drawings of structural steel elements are prepared.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Identify structural steel elements to be drawn for fabrication

2. Plan drafting approach

3. Complete the drawings

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements*** for a given work area are determined.
- 1.2 Drawings relevant documentation and work requests are identified and discussed with ***appropriate personnel***.
- 1.3 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.4 ***Resources and equipment*** needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.
- 2.1 Project specifications and related documentation required for the shop drawings are collected and analysed.
- 2.2 Relevant sections of the AISC handbook and AS4100 are analysed and calculations preformed as required.
- 2.3 Design references and equipment are set up to complete the shop drawings in accordance with enterprise procedures and manufacturer's requirements.
- 3.1 Drafting references and equipment are used according to manufacturer's manuals and enterprise procedures.
- 3.2 Steel shop drawings are completed to conform to Australian drafting and steel structure standards, AISC handbook requirements and enterprise procedures.



- |    |                                    |  |
|----|------------------------------------|--|
|    | 3.3                                | Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures. |
|    | 3.4                                | Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.                                      |
|    | 3.5                                | Final drawings are reviewed with appropriate personnel and against job specifications and amended as required.                                       |
| 4. | Present and archive final drawings | 4.1 Drafting references and equipment are maintained and stored in accordance with enterprise procedures.  |
|    | 4.2                                | Drawings are presented and discussed with appropriate personnel in accordance with enterprise procedures.  |
|    | 4.3                                | Drawings are stored and archived according to enterprise procedures.   |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- consulting and communicating with other project personnel
- identifying and following relevant OHS/WHS procedures
- interpreting and using relevant data from the AISC Handbook and AS4100
- performing calculations to determine span, beam sizes, spacing, footing plates etc..
- produce drawings which comply with AS1100 drafting standard
- storing and archiving drawings

### **Required knowledge:**

- AISC handbook:
  - steel members
  - dimensions
- steel sections:
  - universal beam
  - universal column
  - parallel flange channel
  - taper flange channel
  - equal angle
  - unequal angle
  - flat bar and plate
- drawing standards:
  - hole size
  - hole pitch
  - gauge lines
  - edge distance



- structural and high strength bolts:
  - structural and high strength bolts, washers and tightening procedures
- basic weld symbols:
  - butt and fillet welds
  - terminology
- standard connections:
  - bolted
  - welded
  - beam to column
  - beam to beam
- column and beam splices
- members:
  - centroid
  - cutting

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHs requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Resources and equipment*** may include, but are not limited to:

- drafting equipment
  - manual
  - computer aided (CAD)
- specifications
- manuals
- standards
- stationary
- calculators

**Enterprise procedures** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to produce structural steel shop drawings in accordance with AS1100.501 and AS4100 and AISC handbook on more than one occasion and in different contexts.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to manual or computer aided drafting equipment, materials and consumables
  - access to relevant Australian Standards, plans, drawings and instructions and manufacturer's specifications/manuals

### Methods of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures

- oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## VU22492 - Produce engineering drawings for a rural road

### Unit Descriptor

This unit of competency describes the knowledge and skills required to complete typical road drawings required in the geometrical layout of rural roads to comply with the requirements of AS1100.401.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at paraprofessional level in a civil engineering environment where drawings of urban and rural roads are prepared.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Identify rural road project to be drawn

2. Plan drafting approach

3. Complete the drawings

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements and environmental requirements*** for a given work area are determined.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Existing drawings, relevant documentation and work requests sought and discussed with ***appropriate personnel***.
- 1.4 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.5 ***Resources and equipment*** needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.
- 2.1 Project specifications and related documentation required for the drawing project are collected and analysed.
- 2.2 Design references and equipment are set up to complete the drawings in accordance with enterprise procedures and manufacturer's requirements.
- 3.1 Drafting references and equipment are used according to manufacturer's manuals and enterprise procedures.
- 3.2 Earthworks volumes are calculated and a mass/haulage diagram is plotted.



- 3.3 Drawings are completed to conform to relevant Australian standard, relevant regulations, in accordance with enterprise procedures.
  - 3.4 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.
  - 3.5 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.
  - 3.6 Final drawings are reviewed with appropriate personnel and against job specifications and amended as required
- 4. Present and archive final drawings
  - 4.1 Drafting references and equipment are maintained and stored in accordance with enterprise procedures
  - 4.2 Drawings are presented and discussed with appropriate personnel in accordance with enterprise procedures.
  - 4.3 Drawings are stored and archived according to enterprise procedures.

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- consulting and communicating with other project personnel
- identifying and following relevant OHS/WHS procedures
- preparing drawings including:
  - plotting from a given survey data
  - using relevant drawing symbols
  - plotting horizontal alignment
  - plotting and tabulating information on longitudinal sections
  - plotting and tabulating information on cross sections
  - calculating earthworks volumes
  - plotting a mass/haulage diagram

### ***Required knowledge:***

- survey data:
  - survey traverse - by coordinates where appropriate
  - contours
  - topographical detail - fences, power lines, trees, vegetation, buildings etc
  - cadastral information - property boundaries, county, parish, lot Nos, etc
  - bench marks
  - reference and offset pegs

- drawing symbols and standards:
  - symbols - fences, culverts, water courses, underground services etc
  - terminology
  - linework
  - lettering
  - bearings
  - north point
  - chainages/stations
  - point of intersection
  - deflection angle
  - tangent length
  - ARC length
  - shift
  - curve details
  - transitions
  - culverts
  - road reserve
  - intersections/turnouts
- longitudinal section information:
  - datum
  - grades
  - vertical intersection points
  - vertical curves
  - natural surface levels
  - finished surface levels
  - cut and fill data
  - culvert details
- cross sections:
  - natural surface
  - finished surface
  - crossfall
  - pavement/shoulder
  - table drains
  - batters
  - culverts
  - chainages
- earthworks volumes
- mass/haulage diagram

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Resources and equipment*** may include, but are not limited to:

- drafting equipment:
  - manual or computer aided (CAD)
- specifications
- manuals
- standards
- catalogues
- stationary
- calculators

***Enterprise procedures*** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication

- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to produce drawings for the geometrical layout of typical rural roads in accordance with the requirements of AS1100.401 and job specifications on more than one occasion and in different contexts.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to manual or computer aided drafting equipment, relevant references and consumables
    - access to relevant Australian Standards, plans, drawings and instructions and manufacturer's specifications/manuals

### Methods of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills



- testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## VU22493 - Produce drawings to enable urban road construction

### Unit Descriptor

This unit of competency describes the knowledge and skills required to complete typical road drawings required in the construction of urban roads to comply with the requirements of AS 1100.401

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at paraprofessional level in a civil engineering environment where drawings of urban roads are prepared.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Identify urban road project to be drawn

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- |  |   |
|--|---|
| 1. Identify urban road project to be drawn | <ol style="list-style-type: none"><li>1.1 <b><i>Occupational Health and Safety, Workplace Health and Safety (OHS/WHS) requirements and environmental requirements</i></b> for a given work area are determined.</li><li>1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.</li><li>1.3 Existing drawings, relevant documentation, work requests are sought and discussed with <b><i>appropriate personnel</i></b>.</li><li>1.4 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.</li><li>1.5 <b><i>Resources and equipment</i></b> needed for the task are obtained in accordance with <b><i>enterprise procedures</i></b> and checked for correct operation and safety.</li></ol> |
| 2. Plan drafting approach                  | <ol style="list-style-type: none"><li>2.1 Project specifications and related documentation required for the drawing project is collected and analysed.</li><li>2.2 Design references and equipment are set up to complete the drawings in accordance with enterprise procedures and manufacturer's requirements.</li></ol>  |
| 3. Complete the drawings                   | <ol style="list-style-type: none"><li>3.1 Drafting references and equipment are used according to manufacturer's manuals and enterprise procedures.</li><li>3.2 Earthworks volumes are calculated and a mass/haulage diagram is plotted.</li></ol>  |



- 3.3 Drawings are completed to conform to Australian standard AS1100.401 relevant regulations and in accordance with enterprise procedures.
    - 3.4 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.
    - 3.5 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.
    - 3.6 Final drawings are reviewed with appropriate personnel and against job specifications and amended as required.
  4. Present and archive final drawings
    - 4.1 Drafting references and equipment are maintained and stored in accordance with enterprise procedures.
    - 4.2 Drawings are presented and discussed with appropriate personnel in accordance with enterprise procedures.
    - 4.3 Drawings are stored and archived according to enterprise procedures.

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- consulting and communicating with others project personnel
- identifying and following relevant OHS/WHS procedures
- preparing drawings including:
  - interpreting and plotting from survey data
  - plotting horizontal alignment
  - plotting and tabulating longitudinal section information
  - plotting and tabulating cross section information
  - drawing intersections using plans, sections and details

### ***Required knowledge:***

- survey data:
  - survey traverse - by co-ordinates
  - contours
  - topographical detail - fences, power lines, trees, vegetation, buildings etc
  - cadastral information - property boundaries, county, parish, lot numbers, etc
  - bench marks
  - reference pegs/offset pegs
- horizontal alignment:
  - features and services

- service relocations
- offsets/levels/kerb and channels
- pavement contours
- stormwater drainage
- property access
- ramped kerb crossings
- footpaths/driveways
- medians and traffic islands
- intersections
- channelisation
- auxiliary lanes
- roundabouts
- line markings
- road furniture
- signs
- signalisation
- street lighting
- longitudinal section information:
  - datum
  - grades
  - vertical intersection points
  - vertical curves
  - natural surface levels
  - finished surface levels
  - cut and fill data
  - cross drainage details
- cross section information:
  - natural surface
  - finished surface
  - crossfall
  - pavement boxes
  - batters
  - property boundaries
  - footpaths
  - kerb and channel
  - median/traffic islands
  - surfaces – asphalt, bitumen
  - road furniture
  - services
  - chainage
  - datum

- intersection drawings:
  - offsets/levels
  - kerb and channels
  - medians
  - traffic islands
  - roundabouts
  - pavement contours
  - pavement markings

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Resources and equipment*** may include, but are not limited to:

- drafting equipment
  - manual or computer aided (CAD)
- specifications
- manuals

- standards
- catalogues
- stationary
- calculators
- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**Enterprise procedures** may include, but are not limited to:

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHs procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to produce urban road project drawings in accordance with the requirements of AS1100.401 and job specifications on more than one occasion and in different contexts.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to manual or computed aided drafting equipment and consumables
  - access to relevant Australian Standards, plans, drawings and instructions and manufacturer's specifications/manuals.

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## VU22494 - Produce engineering drawings for a stormwater reticulation scheme

### Unit Descriptor

This unit of competency sets out the knowledge and skills required to complete engineering drawings for a stormwater reticulation scheme, in accordance with AS1100.401 and relevant drainage standards.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at paraprofessional level in a civil engineering environment where stormwater reticulation drawings are prepared.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

1. Identify stormwater reticulation scheme to be drawn

- 1.1 ***Occupational Health and Safety /Workplace Health and Safety (OHS/WHS) requirements and environmental requirements*** for a given work area are determined.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Existing drawings, relevant documentation and work requests are sought and discussed with ***appropriate personnel***.
- 1.4 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.5 ***Resources and equipment*** needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.

2. Plan drafting approach

- 2.1 Project specifications and related documentation required for the drawing project is collected and analysed.
- 2.3 Design references and equipment are set up to complete the drawings in accordance to the manufacturer's manuals and enterprise procedures.





- |                                 |  |
|---------------------------------|--|
| 3. Complete the drawings        | 3.1 Drafting references and equipment are used according to manufacturer's manuals and enterprise procedures.  |
|                                 | 3.2 Survey data is analysed and required calculations are performed  |
|                                 | 3.3 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures. |
|                                 | 3.4 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.                                      |
|                                 | 3.5 Drawings are completed to conform with AS1100.401, State and local council regulations and in accordance with enterprise procedures.                 |
|                                 | 3.6 Final drawings are reviewed with appropriate personnel against job specifications and amended as required.   |
| 4. Present and archive drawings | 4.1 Drawings are presented and discussed with appropriate personnel in accordance with enterprise procedures   |
|                                 | 4.2 Drafting references and equipment are maintained and stored in accordance with enterprise procedures.  |
|                                 | 4.4 Drawings are stored and archived according to enterprise procedures.   |

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- consulting and communicating with others project personnel
- identifying and following relevant OHS/WHS procedures
- preparing detail plans for stormwater reticulation including:
  - interpret and plot from given survey data
  - use symbols, terminology, line-work and lettering
  - prepare a pit information and schedule

### ***Required knowledge:***

- topographical details - property boundaries, road formation, existing services etc
- labelling
- alignment dimensioning
- pit types and locations
- longitudinal sections for stormwater reticulation
  - natural surface levels
  - pipeline invert levels
  - pit information

- details of pits, kerb and channel
- pit schedule numbering system and invert levels
- pit type and dimensions

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Resources and equipment*** may include, but are not limited to:

- drafting equipment
  - manual or computer aided (CAD)
- specifications
- manuals
- standards
- catalogues
- stationary
- calculators

**Enterprise procedures** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturer's specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### **Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to produce drawings for a stormwater reticulation scheme in accordance with AS 1100.401 and job specifications on more than one occasion and in different contexts.

### **Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to manual or computer aided drafting equipment manufacturer's manuals and consumables
  - access to relevant plans, drawings, job instructions topographical information, survey data and any other relevant information required for the production of the drawings.

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## VU22554 - Apply surveying computations to civil engineering projects

### Unit Descriptor

This unit of competency describes the knowledge and skills required to apply computational concepts and methods that are common to civil engineering and surveying projects. This includes the conversion of survey measurements and data into surveying and mapping coordinates and computational set out data to facilitate the construction of an engineering project. This does not include the use of calculus.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at paraprofessional level in a civil engineering environment where surveying data mapping and computations are undertaken for the completion of engineering project work. This may include both office and fieldwork for the gathering of relevant data.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Identify surveying computational requirements

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety. Workplace Health and Safety (OHS/WHS) requirements*** and ***environmental requirements*** for a given work area are determined.
- 1.2 Surveying ***computational task*** is determined through work requests, design briefs, documentation or equivalent and clarified with the ***appropriate personnel***.
- 1.3 Expert advice is sought with respect to the surveying computational task and according to ***enterprise procedures***, where appropriate.
- 1.4 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others
- 1.5 ***Resources and equipment*** needed for the task are obtained in accordance with enterprise procedures.



- |  |   |
|--|---|
| 2. Select appropriate surveying computational method | <p>2.1 OHS/WHS requirements for carrying out the work are followed.</p> <p>2.2 Industry codes, regulations and technical documentation relevant to the surveying computational task are interpreted and understood.</p> <p>2.3 Tables and graphs, surveying plans or equivalent where appropriate are used to obtain surveying computational data.</p> <p>2.4 Appropriate assumptions underlying the surveying computational task are made and recorded.</p> <p>2.5 Resources required are identified, obtained and checked as fit for purpose.</p> <p>2.6 Most appropriate computational method is selected and justified.</p> |
| 3. Use scientific calculator                         | <p>3.1 Arithmetic operations are performed, including decimals and fractions for a given application or circumstance.</p> <p>3.2 All calculator functions can be used in computational sequences.</p> <p>3.3 <b>Features of a scientific calculator</b> are utilised to efficiently perform computations.</p>   |
| 4. Perform surveying computation                     | <p>4.1 OHS/WHS requirements for carrying out the work are followed.</p> <p>4.2 Computations are performed and results recorded according to enterprise procedures.</p> <p>4.3 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.</p> <p>4.4 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.</p>   |
| 5. Verify and interpret results                      | <p>5.1 Results are validated and discussed with appropriate personnel.</p> <p>5.2 Results are graphed, tabled or sketched charted in accordance with enterprise procedures, where appropriate.</p> <p>5.3 Work completion notification is conveyed to appropriate personnel in accordance to enterprise procedures.</p>   |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- consulting and communicating with others project personnel
- identifying and following relevant OHS/WHs procedures
- reading and interpreting job instructions
- inputting survey data
- using tables, graphs and surveying plans
- performing manual surveying computation techniques
- using a scientific calculator
- verifying and documenting calculation results

### **Required knowledge:**

- surveying computation (manual techniques):
  - horizontal angles from observed directions
  - horizontal angular misclosures and compute bearings
  - vertical angles from vertical circle reading
  - distances for meteorological effects
  - slope distance and vertical angle to horizontal distance and vertical component
  - height difference from vertical component, height of instrument and height of target
  - horizontal distances and bearings to Eastings and Northings, closed traverse computations, isolation of most likely source of gross errors and adjustment of traverses
- coordinate geometry operations on personal computers:
  - known or given coordinated points
  - data from previous surveys e.g. cadastral plans /architectural plans
  - coordinated transformations on data sets with common points
  - coordinate file merging
  - coordinate geometry operations which generate new points by:
    - traverses and radiations
    - intersections of direction and/or distance combinations
    - fitting circles using various criteria
    - creating parallel entities
  - traverse data and adjustment
  - out data tabulation
    - coordinated points
    - points regularly spaced along lines
    - points regularly spaced along circular curves
- area operations on personal computers:
  - areas of polygons
  - areas of figures with circular curves
  - polygons to achieve a specified area by:
    - rotation of a line
    - parallel movement of a line

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

### ***OHS/WHS requirements***

may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operating procedures
- awards provisions

### ***Environmental***

***requirements*** may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

### ***Computational tasks***

including:

- arithmetic
- algebra
- geometry
- co-ordinate geometry
- matrices
- quadratic functions
- exponential and logarithmic functions
- trigonometric functions
- charts and graphs

### ***Appropriate personnel***

may include:

- supervisor
- colleague
- foreman
- team leader
- supervising engineer
- teacher

### ***Enterprise procedures***

may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures



**Resources and equipment** may include, but are not limited to:

- computer access
- scientific calculator
- engineering tables and graphs
- regulations and codes of practices

**Features of a scientific calculator** including:

- arithmetic functions
- trigonometric functions
- inverse trigonometric functions
- exponentials and logarithmic functions
- reciprocals
- scientific number representation
- engineering number representation
- rectangular to polar conversions

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHs procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to apply mathematical concepts to engineering problems and verify results in familiar and unfamiliar situations and in different contexts.

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to computing hardware and software scientific calculator, relevant charts, graphs and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

### Methods of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## VU22555 - Analyse piping designs

### Unit Descriptor

This unit of competency describes the knowledge and skills required to analyse piping designs with respect to equipment, materials, and fittings to meet design specifications, safety and economic parameters for a specific installation.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

The unit of competency applied to a person working at paraprofessional level in a processing engineering and manufacturing environment which is responsible for the design, manufacture and installation of piping systems.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1 Determine industry requirements and standards

- 1.1 ***Occupational Health and Safety/Workplace health and Safety (OHS/WHS) requirements*** and ***environmental requirements*** for a given work area are determined.
- 1.2 Established OHS/WHS requirements and ***risk control*** measures and procedures applicable for a given work area are followed.
- 1.3 Safety hazards are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 ***Industry procedures, codes and applicable standards*** for a given piping design are determined from site information and design specifications.
- 1.5 Appropriate personnel are consulted to ensure that work is co-ordinated effectively with others.
- 1.6 ***Resources*** for the analysis task are obtained in accordance with ***enterprise procedures***.

- 2 Analyse process flow, materials, performance and usage

- 2.1 OHS/WHS requirements for carrying out the work are followed.
- 2.2 Process flows are analysed to prepare for producing piping & instrument diagrams (P&ID) and line lists.
- 2.3 ***Project codes and regulations*** relevant to the job are confirmed.
- 2.4 Decisions on dealing with unexpected situations are based on discussions with appropriate personnel and reference design specifications and enterprise procedures.



- |   |  |   |
|---|--|---|
| 3 | Select equipment and determine piping configurations | 3.1 OHS/WHS requirements for carrying out the work are followed.  |
|   |  | 3.2 Piping specifications and appropriate materials are matched to plant requirements.                                      |
|   |  | 3.3 Appropriate fittings and valves are determined from piping specifications.  |
|   |  | 3.4 Appropriate <b><i>fabrication and welding methods</i></b> are selected.   |
| 4 | Confirm analysis and selections                      | 4.1 OHS/WHS requirements for completing the work are followed.  |
|   |  | 4.2 Piping analysis and equipment selection is confirmed in discussions with appropriate personnel.                         |
|   |  | 4.3 Structural properties of the weld and joint design are checked and confirmed in discussions with appropriate personnel. |
|   |  | 4.4 The analysis and selection is documented and approved according to enterprise procedures.                               |

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- identifying and following relevant OHS/WHS procedures
- applying freehand technical sketching techniques
- appropriately deploying equipment and components
- applying piping standards and codes
- creating and validating line list and piping & instrument diagrams
- selecting appropriate parameters for standard equipment including :
  - pumps
  - exchangers
  - vessels
  - fired heaters
  - compressors
  - valves
- selecting appropriate standard piping and joint configurations applicable to:
  - pumps
  - exchangers
  - vessels
  - fired heaters
  - compressors
  - racks
  - underground
  - utilities and fire protection

- expansion provisions
- valves
- welding
- matching piping specifications to plant requirements
- selecting material for plant requirements
- using CAD software efficiently including materials data
- communicating and working effectively with other project team members

**Required knowledge:**

- technical standards and codes of practice
- scope of regulatory requirements
- impact of HAZOP and environmental studies including:
  - hygiene
  - HAZMAT material selection
  - weather effects
  - geo-mechanical effects
- process flow diagram (PFD)
- engineering flow diagram (EFD)
- chemistry of process

**RANGE STATEMENT**

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions, dust
- excessive energy and water use
- excessive noise

***Risk control*** including:

- plant layout concepts
- HAZOP
- constructability
- associations to other disciplines

- greenfield and brownfield sites
- equipment spacing

**Appropriate personnel** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- designer
- trainer
- mentor
- teacher
- team member

**Industry procedures, codes and applicable standards** such as:

- Australian and international standards
- classes of design & construction
- standard piping components and configurations
- statutory requirements

**Resources** may include, but are not limited to:

- design briefs and project specifications
- manufacturers catalogues and specifications
- regulations and legislative constraints on target plant area
- suitable CAD and data management software
- company standards
- workstation either networked or stand alone

**Enterprise procedures** may include, but are not limited to:

- use of tools and equipment
- project instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- company operational procedures

**Projects codes and regulations** including:

- material selection
- valve data sheets
- P&ID industry standards
- P&ID standard symbols
- plant areas in plot plans
- pipe class and service summary

**Fabrication and welding methods** including:

- butt
- full penetration
- partial penetration
- fillet
- plug
- processes
- procedures, qualification and registration
- heat treatment (pre, post and interpass)
- non-destructive testing (NDT)
- weld preparation

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHs procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the analysis of piping design on more than one occasion and in different contexts which includes:
    - preparation of P&ID and line lists;
    - application of technical standards or codes of practice;
    - analysis and consequent design adjustments of material and equipment configurations within a given set of parameters using CAD systems.

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to computing hardware and software and consumables

- access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22556 - Design process plant layout

### Unit Descriptor

This unit of competency describes the knowledge and skills required to identify the individual units of plant and design a plot plan as part of an engineering team. To draft and specify a design to meet predetermined safety parameters and for a specific location.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Prerequisite unit

VU22555- Analyse piping designs

### Application of the Unit

The unit of competency applies to a person working at paraprofessional level in a civil engineering environment which includes design and structural engineering services.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

- 1 Determine plant environment and constraints for plot plan

- 2 Establish location for units of plant and process flow

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements*** and ***environmental requirements*** for a given work area are clarified.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards are documented and ***design risk parameters*** devised and implemented in consultation with ***appropriate personnel***.
- 1.4 ***Environmental effects*** which will influence optimisation of the plant layout are identified.
- 1.5 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others.
- 1.6 ***Resources*** for the design task are obtained in accordance with ***enterprise procedures***.
- 2.1 OHS/WHS requirements for carrying out the work are followed.
- 2.2 ***Plant design basis*** and ***plant requirements*** are identified.
- 2.3 Pipe arrangements are determined from ***standard configurations*** for equipment.



- |   |                                       |  |
|---|---------------------------------------|--|
|   | 2.4                                   | Decisions on dealing with unexpected situations are based on discussions with appropriate personnel and reference design specifications and enterprise procedures.   |
| 3 | Draft plot plan and specifications    | 3.1 OHS/WHS requirements for carrying out the work are followed.<br>3.2 Ensure project <b><i>drafting procedures</i></b> are in place including <b><i>entire facility</i></b> .<br>3.3 <b><i>Plot plan</i></b> prepared to enterprise specification and regulatory requirements. |
| 4 | Finalise plot plan and specifications | 4.1 Documentation is confirmed ready for enterprise signoff in discussion with appropriate personnel.<br>4.2 Hazards and operational process (HAZOP) study is checked to ensure piping design is compliant.<br>4.3 Parameters for design risk assessment are satisfied.          |

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- identifying and following relevant OHS/WHS procedures
- appropriately deploying of individual units within the facility and equipment from HAZOP studies, legislative requirements, environmental constraints and regulations;
- applying standards and codes of practice relevant to plant and piping design
- creating and using plot drawings which include:
  - line list
  - site layouts
  - Process Flow Diagrams (PFD) & Engineering Flow Diagram's (EFD)
  - piping specifications
  - Piping & Instrument Diagrams P&ID
- complying with enterprise standards including use of:
  - CAD
  - piping materials data in CAD packages
  - QA plans in project teams work
  - peer, inter-discipline and self-reviews in QA processes

### ***Required knowledge:***

- technical standards or codes of practice called up by regulation
- standard piping configurations for equipment
- scope of regulatory requirements
- impact of HAZOP and environmental studies to final design
  - hygiene and cleaning
  - material specifications
  - weather effects
- geo-mechanical effects

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions
- company standards

***Environmental requirements*** may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions, dust
- excessive energy and water use
- excessive noise

***Design risk parameters*** including:

- company standards and risk mitigation strategies
- HAZOP requirements

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- designer
- trainer
- mentor
- teacher
- team member

***Environmental effects*** such as:

- geophysical effects
  - wind loads
  - earthquake
- geographical constraints
  - topography
  - strata
- environmental constraints

**Resources** may include, but are not limited to:

- design briefs and project specifications
- manufacturers catalogues and specifications
- geographical surveys
- environmental impact studies
- regulations and legislative constraints on target plant area
- predictive weather and geological stability data
- suitable CAD and data management software
- company standards
- computer workstation

**Enterprise procedures** may include, but are not limited to:

- the use of tools and equipment
- project instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- company operational procedures

**Plant design basis** including:

- design risk assessment
- equipment spacing
- constructability
- maintenance
- future expansion
- infrastructure
- maintenance and operability
- containment including statutory requirements & dangerous goods
- economic considerations
- flow of systems
- separation of equipment including statutory requirements
- space for other disciplines such as underground piping, foundations, electrical and instruments.
- constructability
- piping flexibility

**Plant requirements** may include, but are not limited to:

- Piping & Instrument Diagrams (P&ID)
- Process Flow Diagrams (PFD)
- Engineering Flow Diagram's (EFD) as required
- apply codes, ie API, ASME/ANSI, ASTM, DIN, Aus Std's, as specified
- statutory requirements & plant registration
- support steelwork design loads

**Standard configurations**  
including:

Configuring connections between units of plant and/or equipment require consideration for manufacturers specification and company standards relating to but not exclusively:

- pumps
- exchangers
- valves
- horizontal and vertical vessels
- fired heaters
- compressors
- pipe dimensions and materials
- pipe rack
- underground Piping
- utilities and fire protection
- expansion provisions
- access for operational and emergency purposes including alternative means of escape

**Drafting procedures** may include:

- document traceability
- statutory requirements
- peer, inter-discipline reviews
- drafting checking and engineering checking

**Entire facility** may include:

- geography of site
- boundaries and spatial information
- individual units
- equipment location
- earthworks and associated containment structures
- the piping
- access routes

**Plot plan** may include but is not limited to:

- equipment lists
- equipment location requirements
- individual units within the facility
- pipe racks and Structural supports
- containment structures
- P&ID, PFD's
- line lists

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - design a process plant layout on more than one occasion and in different contexts which includes:
    - preparation of input data files for P&ID, PFD's, EFD's, line lists, Plot Plans, and CAD modelling;
    - application of knowledge of technical standards or codes of practice called up by regulation;
    - design and consequent design adjustments of plant and equipment configurations within a given set of geophysical parameters, configurations within a given set of parameters using CAD systems.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to computing aided drafting hardware and software, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

### Methods of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills

- testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## VU22557 - Design piping systems

### Unit Descriptor

This unit of competency describes the knowledge and skills required to design a piping systems that takes into account environmental hazards, safety parameters, process flow, pipe stresses as well as relevant standards and regulations for a specific piping arrangement.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Prerequisite unit

VU22555 - Analyse piping designs

### Application of the Unit

The unit of competency applies to a person working at paraprofessional level in a civil engineering environment. As a member of a project team, the person is responsible for the design of piping systems to meet job specifications for particular requirements.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1 Use environmental factors to determine pipe design basis

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements and environmental requirements*** for a given work area are clarified.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards are documented and ***design risk parameters*** devised and implemented in consultation with ***appropriate personnel***.
- 1.4 Known geophysical effects and subsequent impact are incorporated within design risk parameters, in consultation with appropriate personnel.
- 1.5 ***Piping design parameters*** are identified for the specific application.
- 1.6 Appropriate personnel are consulted to ensure that work is co-ordinated effectively with others.
- 1.7 ***Resources*** for the design task are obtained in accordance with ***enterprise procedures***.





- |   |                           |  |
|---|---------------------------|--|
| 2 | Specify pipe requirements | 2.1 Material for identified plant requirements using designated project <b><i>piping specifications</i></b> is selected.<br>2.2 Pipe arrangement from <b><i>plant layout requirements</i></b> is determined.<br>2.3 Decisions on dealing with unexpected situations are based on discussions with appropriate personnel and reference design specifications and enterprise procedures.   |
| 3 | Finalise pipe design      | 3.1 <b><i>Project execution procedures</i></b> are confirmed as fit for the purpose.<br>3.2 <b><i>Fully dimensioned isometric drawings</i></b> using data sets are prepared.<br>3.3 Material is determined from piping specifications.<br>3.4 <b><i>Stress and supports</i></b> are specified and confirmed with stress engineer.<br>3.5 Sketches for input into stress analysis modelling programs for example Project Design Management System (PDMS), Project Design System (PDS) are prepared. |

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- identifying and following relevant OHS/WHs procedures;
- using standard piping fittings appropriately
- utilising manufacturer's specifications within piping design drawings and Hazard and operability process (HAZOP) studies;
- applying standards and codes within design drawings;
- creating of Material Take Off sketches (MTO's);
- preparing input data files for 3D CAD (PDMS & PDS) and other systems.

### ***Required knowledge:***

- technical standards and codes of practice
- scope of regulatory requirements (if applicable)
- impact of HAZOP to final design
  - hygiene
  - materials selection
- materials data in 3D CAD packages
- QA plans in project teams
- peer, inter-discipline and self - reviews in QA processes
- welding processes, and their application in piping design

- materials specification
  - finishing processes, post field fabrication
  - corrosion
  - wear resistance
  - chemicals
  - non-destructive testing (NDT)
  - service fluids
- stress analysis and consequent design adjustments
  - supports
  - nozzle loads
  - environmental loads
  - thermal impact on materials performance
- correct selection of standard equipment and piping configurations with reference to:
  - pumps
  - exchangers
  - vessels
  - fired heaters
  - compressors
  - racks
  - undergrounding
  - utilities and fire protection
  - expansion provisions
- valves

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions
- company standards

***Environmental requirements*** may include::

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions, dust
- excessive energy and water use
- excessive noise

**Design risk parameters** may include:

- company standards and risk mitigation strategies
- HAZOP requirements
- HAZMAT requirements

**Appropriate personnel** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- designer
- trainer
- mentor
- teacher
- team member

**Piping design parameters** may include:

- identify Piping & Instrument Diagrams(P&ID), & Process Flow Diagrams (PFD) required
- use of applicable codes: and Australian Standard's and statutory requirements
- chemical, corrosion and wear and impact resistance requirements
- classes of design and construction, including statutory requirements
- pipe sizing as specified by P&ID's and Line List
- support steelwork design loads
- piping loads on steelwork including hydrostatic test loads

**Resources** may include:

- design briefs and project specifications
- manufacturers catalogues and specifications
- suitable CAD, modelling and data management software
- company standards

**Enterprise procedures** may include:

- the use of tools and equipment
- project instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- company operational procedures

**Piping specifications** may include:

- line lists
- codes
- pipe dimensions
- temperature/pressure ratings
- wall thickness, incorporating design factors

- material specification
- economic considerations
- service fluids
- surface finish
- operating environment
- Material Take Off (MTO) sketches
- bulk MTO from P&ID and plot plan

**Plant layout requirements** may include:

- specified equipment
- specified piping requirements and connections
- underground piping
- utilities and fire protection
- expansion provisions

**Project execution procedures** including:

- document traceability
- statutory requirements
- peer, inter-discipline reviews are complete
- drafting checking vs engineering checking is complete

**Fully dimensioned Isometric drawings** may include:

- supports
- field welds
- material list
- enterprise specification, analysis and regulatory requirements.

**Stress and supports** may include:

- input data files for stress analysis
- support types
- stress nomographs
- selection
- stress isometrics

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria

- design a piping system on more than one occasion and in different contexts which includes:
  - utilising manufacture specifications for components, within design drawings
  - preparing of drawings using PDMS & PDS
  - applying appropriate technical standards and codes of practice

### **Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to computer hardware and software, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

### **Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

# VU22558 - Analyse and design foundations and footings

## Unit Descriptor

This unit of competency describes the knowledge and skills required to analyse the requirements and design the foundations and footings of a substantial engineering structure in accordance to a project brief.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

The unit of competency applies to a person working at paraprofessional level in a civil engineering environment. As a member of a project team, the person is responsible for the design of elements of infrastructure such as buildings or other civil construction projects.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

- 1 Determine footings to be designed

- 2 Plan design approach

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements*** and ***environmental requirements*** for a given work area are clarified.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 The design is determined from documentation, work requests or discussions with appropriate personnel.
- 1.5 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.6 ***Resources and equipment*** needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.
- 2.1 OHS/WHS requirements for carrying out the work are followed.
- 2.2 Documentation relating to design project is collected and analysed.
- 2.3 Design references and drafting equipment are set up to develop the design in accordance with enterprise procedures.



- |   |                                       |   |
|---|---------------------------------------|---|
| 3 | Complete the design                   | 3.1 Design references and equipment are used according to manufacturer's manuals and enterprise procedures.<br>3.2 Calculation are performed to determine foundations and footing requirements<br>3.3 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.<br>3.4 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.<br>3.5 The design is completed to conform with relevant Australian standard, regulations and building codes<br>3.6 Design outcomes are analysed and examined with appropriate personnel and against project design brief and amended as required. |
| 4 | Compile, document and present results | 4.1 Design references and equipment are maintained and stored in accordance with enterprise procedures.<br>4.2 Results are recorded, analysed and reported to appropriate personnel in accordance with enterprise procedures.<br>4.3 Final designs are stored and archived according to enterprise procedures.  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- identifying and following relevant OHS/WHS procedures
- selecting appropriate footing type for a given applications
- designing foundations and footings, for a given applications including:
  - gravity retaining walls
  - unsupported excavation trenching to Australian standards and regulatory requirements
  - calculating stresses in soil and settlements
  - selecting correct pile type(s)
  - determining appropriate underpinning
  - designing a cantilever sheet piling wall
  - preparing sketches and drawings of foundation and footings
- communicating verbally and in writing effectively
- working and communicating effectively with other team members

**Required knowledge:**

- footings and foundation types
- AS2870 'Residential Slabs and Footings'
- principles of soil dynamics
- water table, slopes and rocks
- stresses in soil mass
- cantilevers and gravity retaining walls
- pile types
- underpinning
- excavation trenching

**RANGE STATEMENT**

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions, dust
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member



**Resources and equipment** may include, but are not limited to:

- specifications
- suitable CAD and data management software
- manuals
- standards
- catalogues
- stationery
- calculators

**Enterprise procedures** may include but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHs procedures and practices including the use of risk control measures as specified in the performance criteria
  - complete an engineering project brief including the analysis and design of foundations and footings for a building structure using appropriate design aids on more than one occasion and in different contexts. Design must conform to relevant Australian standard, regulations and building codes.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions

- operational access to suitable CAD and data management software, material and consumables
- access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

# VU22559 - Design timber structures

## Unit Descriptor

This unit of competency describes the knowledge and skills required to analyse the requirements from a project brief and design a timber structure using appropriate design aids.  
No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

The unit of competency applies to a person working at paraprofessional level in a civil engineering environment. As a member of a project team, the person is responsible for the design of timber buildings and other civil construction projects.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1 Identify timber structure to be designed

- 1.1 ***Occupational Health and Safety/Workplace health and Safety (OHS/WH&S) requirements and environmental requirements*** for a given work area are determined.
- 1.2 Established OHS/WH&S requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 The design is identified from documentation, work requests or discussions with appropriate personnel.
- 1.5 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.6 ***Resources*** and design equipment needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.

- 2 Plan design approach

- 2.1 OHS/WH&S requirements for carrying out the work are incorporated into the design plan.
- 2.2 Documentation relating to design project is collected and analysed.
- 2.3 Design references and equipment are set up in accordance with enterprise procedures.



- |   |                                   |     |  |
|---|-----------------------------------|-----|--|
| 3 | Complete the design               | 3.1 | Design references and equipment are used according to manufacturer's manuals and enterprise procedures.  |
|   |                                   | 3.2 | Calculations are performed to determine loads and stresses to determine beams columns and connection requirements                                    |
|   |                                   | 3.3 | Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures. |
|   |                                   | 3.4 | Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.                                      |
|   |                                   | 3.5 | The design is completed to conform with relevant Australian standard, regulations and building codes   |
|   |                                   | 3.6 | Design outcomes are analysed and examined with appropriate personnel and against project design brief and amended as required.                       |
| 4 | Present and archive final designs | 4.1 | Design references and equipment are maintained and stored in accordance with enterprise procedures.  |
|   |                                   | 4.2 | Results are recorded, analysed and reported to appropriate personnel, in accordance with enterprise procedures.                                      |
|   |                                   | 4.3 | Designs are stored and archived according to enterprise procedures.  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- identifying and following relevant OHS/WHS procedures
- recognising types of construction timber
- selecting timber appropriate for design
- interpreting and applying Australian Standard AS1170
- calculating loads and stresses
- preparing a timber structure design which meets the requirements of a project brief
- working and communicating effectively with others team members

### **Required knowledge:**

- design principles and types for timber structure
- timber classifications and specifications
- Australian standard AS1720
- commercial timber sizes
- loads on structures

- design of:
  - beams
  - columns
  - connections
- tension members

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHs requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions, dust
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Resources*** may include, but are not limited to:

- specifications
- suitable CAD and data management software
- manuals
- standards
- catalogues
- stationery
- calculators

**Enterprise procedures** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### **Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - design a timber structure in response to a design brief using appropriate design aids in accordance to Australian standard, regulation and relevant building codes on more than one occasion and in different contexts.

### **Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to suitable CAD and data management software, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## VU22560 – Produce geometric designs for roads

### Unit Descriptor

This unit of competency describes the knowledge and skills required to produce geometric designs of both rural and urban roads in accordance with the relevant parts of Austroads - Guide to Road Design. The unit includes the application of the design features of intersection, horizontal and vertical alignment of roadway centrelines, super elevation and sight distance requirements and environmental considerations.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working as part of a project team at para-professional level in a civil engineering environment where design of rural and urban roads is undertaken.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

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|--|--|
| 1. Identify roadway requirements to be designed  | 1.1 Established Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements and risk control measures and procedures are followed in preparation of the work area. |
|  | 1.2 Design brief and relevant documentation sought and examined  |
|  | 1.3 <b><i>Appropriate personnel</i></b> are consulted to ensure the work is co-ordinated effectively with others involved at the project.  |
|  | 1.4 <b><i>Resources and equipment</i></b> needed for the task are obtained in accordance with <b><i>enterprise procedures</i></b> .  |
| 2. Design and calculate the combined horizontal and vertical alignment of a roadway centreline | 2.1 Tabulated data is extracted and typical cross section plan is developed.   |
|  | 2.2 Data required to detail the combined horizontal and vertical alignment of the road centreline is calculated.   |
|  | 2.3 Data required to detail the left/right pavement edge levels is calculated.   |





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|---|-----|--|
|   | 2.4 | Data required to detail the left/right shoulder point levels is calculated.  |
|   | 2.5 | Data is recorded in table form and applied to the design.  |
| 3. Develop superelevation requirements  | 3.1 | Position/s of the superelevations determined.  |
|   | 3.2 | Lengths of superelevations are determined.   |
|   | 3.3 | Maximum, minimum and relative grade of the superelevations are calculated  |
|   | 3.4 | Curve and adverse cross fall requirements are calculated.  |
|   | 3.5 | Overland water flows and underground drainage systems are developed and added to the design  |
| 4 Implement sight distance requirements | 4.1 | Stopping sight distances requirements are calculated.  |
|   | 4.2 | Approach and overtaking and other related sight distances are calculated.  |
|   | 4.3 | Data is recorded in table form and applied to the design.  |
| 5 Design intersections                  | 5.1 | Traffic volumes and traffic analysis data is utilised to determine intersection type and configuration.  |
|   | 5.2 | Turning templates are applied and functional layout is developed for the intersection.   |
|   | 5.3 | Intersection sight distances criteria are applied.   |
|   | 5.4 | Data required to horizontally and vertically define the intersection is calculated.  |
|   | 5.5 | Pavements are correctly contoured.   |
|   | 5.6 | Design and specifications are detailed on required road design drawings.   |
| 6. Determine environment considerations | 6.1 | Nature strip and landscaping requirements are established.   |
|   | 6.2 | Appropriate noise attenuation systems for the environment are determined.  |
|   | 6.3 | Requirements for public transport operations and other road user needs such as cyclist lanes and pedestrians crossings, walkways and special needs are determined. |
|   | 6.4 | Roadside and pavement drainage requirements are determined.  |
|   | 6.5 | Type and placement of safety barriers is determined.   |



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|---|--|
| 7. Complete and present final design drawings, specifications and design report | 7.1 Design drawings and specifications are completed.  |
|   | 7.2 Design report is prepared highlighting the key features of the design as well as any areas where specific design criteria within the brief could not be achieved |
|   | 7.3 Design is reviewed against project brief and in conjunction with appropriate personnel and amendments completed if required.                                     |
|   | 7.4 Final design drawings, specifications and report are sign off by appropriate person/s and archive according to enterprise procedure.                             |

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- interpreting and evaluating documentation, specifications and drawings
- obtaining the appropriate resources and equipment to undertake design task
- using and applying relevant road design guidelines, standards and regulations
- performing appropriate road design calculations
- operating CADD and data management software efficiently
- preparing and maintaining records in accordance with specifications and statutory requirements
- working and communicating with other project team members

### ***Required knowledge:***

- introduction:
  - objectives of geometric design
  - road safety including safe system principles
  - critical factors influencing design, design parameters including traffic volumes, composition and level of service
  - Normal Design Domain (NDD) / Extended Design Domain (EDD) including Context Sensitive Design (CSD)
  - design speed and operating speed including speed parameters and 85<sup>th</sup> percentile speed (Operating Speed)
  - alignment controls
- environmental considerations, including landscape and urban design and noise considerations cross section:
  - road classifications
  - traffic lane widths and road crossfalls
  - consideration for on road public transport
  - provision for other road users, cyclists (on road cycling lanes), pedestrians (footpaths)
  - medians
  - shoulders

- verge
- batters
- nature strips (urban environment)
- roadside drainage consideration, including subsurface drainage (pavement drainage)
- clear zones
- safety barriers (overview)
- sight distance:
  - driver eye height, driver reaction time. Longitudinal deceleration
    - stopping sight distance (including trucks)
    - approach sight distance
    - overtaking sight distance
    - other sight distance
  - consideration of sight distance in both the horizontal and vertical aspect
- horizontal alignments:
  - design controls
  - design procedure
  - tangents, including deflection angles that do not require curves
  - circular curves
  - types of horizontal curves
    - compound curves
    - broken back curves
    - reverse curves
    - transition curves
- superelevation:
  - design procedure
  - linear method
  - maximum and minimum superelevation
  - length of superelevation
  - rate of rotation
  - relative grade
  - superelevation development lengths
  - positioning of superelevation with and without transitions
  - curve with adverse crossfalls
- aquaplaning:
- vertical alignment:
  - design controls
  - design procedure
  - vertical design controls
  - maximum and minimum grades
  - vertical curves
    - crest curves
    - sag curves
    - sight distance criteria
    - minimum length of curves
    - maximum grade change without vertical curves
- coordination of horizontal and vertical alignments
- earthworks considerations:
  - geotechnical considerations
  - material types
  - earthworks balance
  - extraction of quantities



- intersections:
  - overview of intersection types
  - intersection safety and safe system approach
  - design vehicles, design and checking vehicles, turn movements
  - sight distance requirements
    - Approach Sight Distance (ASD)
    - Safe Intersection Sight Distance (SISD)
    - Minimum Gap Sight Distance (MGSD)
  - auxiliary lanes
    - deceleration lanes
    - acceleration lanes
  - medians and median openings
  - rural and urban intersection treatments

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***Appropriate personnel*** may include:

- supervising/design engineer
- traffic engineer
- structural engineer
- surveyors
- technicians
- landscape/urban designer
- team leader
- team members

***Resources and equipment*** may include, but are not limited to:

- design brief
- suitable CAD and data management software
- reference manuals e.g. Austroads - Guide to Road Design and VicRoads Supplements
- Australian standards
- specifications and catalogues
- calculators

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - develop at least one geometric urban road design and a least one geometric rural road design to meet the requirements of a design brief, relevant parts of the Austroads Guide and VicRoads Supplements.

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to suitable CADD system and data management software materials and consumables
  - access to relevant plans, drawings, instructions, manuals and specifications

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## VU22561 – Analyse the strength of civil structural elements

### Unit Descriptor

This unit of competency describes the knowledge and skills required to determine and calculate different kinds of loadings and actions on structural elements. The unit also includes analysis of beam and column structures involving calculation of such features as support reactions, shear and bending moments.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Pre-requisite

MEM23019A - Apply engineering mechanics principles

### Application of the Unit

This unit of competency applies to a person working at paraprofessional level in a civil engineering environment where analysis of the strength of civil structures is undertaken.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1 Determine industry requirements and standards

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WH&S) requirements*** and ***environmental requirements*** for a given work area are clarified.
- 1.2 Established OHS/WH&S requirements and risk control measures and procedures applicable for a given work area are followed.
- 1.3 Safety hazards are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 Industry procedures, codes and applicable standards are determined from site information and design specifications.
- 1.5 Appropriate personnel are consulted to ensure that work is co-ordinated effectively with others.
- 1.6 ***Resources*** for the analysis task are obtained in accordance with ***enterprise procedures***.



2 Plan analysis approach	<p>2.1 OHS/WHS requirements for carrying out the work are followed.</p> <p>2.2 Documentation relating to analysis project is collected for reviewed.</p> <p>2.3 References and Australian standards for the project are consulted to complete the structural analysis.</p>
3 Complete the analysis	<p>3.1 Calculations are performed to determine the structural integrity of the civil structural design elements.</p> <p>3.2 Analysis is completed as determined by relevant Australian standard.</p> <p>3.3 Results are recorded, analysed, examined and applied according to enterprise procedures.</p> <p>3.4 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.</p> <p>3.5 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.</p>
4 Confirm analysis and computations	<p>4.1 Structural analysis and computations for the civil structural design are checked and confirmed with appropriate personnel.</p> <p>4.2 The analysis is documented and approved according to enterprise procedures.</p>

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- consulting and communicating with others project team members
- identifying and following relevant OHS/WHS procedures
- planning an structural analysis activity
- reviewing and applying appropriate sections of the relevant Australian Standard
- performing necessary calculations
- preparing and updating documentation

### **Required knowledge:**

- use of relevant Australian standards:
  - permanent and imposed actions
  - load combinations
  - wind actions

- overview and simplified applications
- loading due to fluid pressure and failure modes
- in plane:
  - bending of beams
  - shear of beams
  - bending moment
  - deflection of beams
- compression members:
  - over view of buckling failure
  - Euler's Equation,
  - effective lengths
  - failure modes
- action of members within a frame structure
- fixed and continuous beams:
  - behaviour and analysis
- slope deflection equations and its application
- moment distribution method and its application
- introduction to computer analysis software
  - overview and simple applications
- analysis the strength of structural elements

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHs requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions, dust
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman



- manager
- site engineer
- trainer
- mentor
- teacher
- team member

**Resources** may include, but are not limited to:

- specifications
- manuals
- standards
- catalogues
- stationery
- calculators

**Enterprise procedures** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - analyse the strength of the elements of a civil structure on more than one occasion and in different contexts in accordance to the appropriate Australian Standard.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an

individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.

- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant equipment, materials and consumables
  - access to relevant plans, drawings and job instructions and references.

#### **Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## VU22562 – Apply principles of soil mechanics to civil engineering

### Unit Descriptor

This unit of competency describes the skills and knowledge required to take representative soil samples and carry out standard tests to evaluate and classify soils in accordance to relevant Australian standards and guidelines

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Pre-requisite

MEM23004A – Apply technical mathematics

### Application of the Unit

This unit of competency applies to a person working at paraprofessional level in a civil engineering environment where sampling and classification of soils by standard testing procedures are performed.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

- 1 Identify soils to be tested and analysed

- 2 Plan tests and analyse a range of soils

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements*** and ***environmental requirements*** for a given work area are obtained and followed.
- 1.2 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented.
- 1.3 Relevant documentation, and work requests are discussed with ***appropriate personnel*** and co-ordinated effectively with others involved at the work site.
- 1.4 ***Resources*** needed for the task are obtained in accordance with ***enterprise procedures***
- 2.1 Required tests are confirmed against job instructions
- 2.2 Representative soil/s sample/s are collected and prepared for testing in accordance Australian standards and enterprise procedures.
- 2.3 Testing equipment is checked for calibration and conformance to relevant Australian standard
- 2.4 If appropriate, the origin of the soils to be tested is identified and recorded.



- |   |                                  |  |
|---|----------------------------------|--|
| 3 | Conduct test and analyse results | <p>3.1 OHS/WHS requirements for operating testing equipment are followed.</p> <p>3.2 Tests are conducted according to job requirements relevant Australian standard, guidelines and enterprise procedures.</p> <p>3.3 Tests equipment is operated in accordance with manufacturer's requirements.</p> <p>3.4 Results are recorded and analysed and discussed with appropriate personnel.</p> <p>3.5 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.</p> <p>3.7 Test results analysed and soil samples classified in accordance with Australian standard, guidelines and enterprise procedures</p> |
| 4 | Document and report results      | <p>4.1 Test results are recorded, and reported according to enterprise procedures.</p> <p>4.2 Results are stored and archived according to enterprise procedures.</p>  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- consulting and communicating with other project team personnel
- identifying and following relevant OHS/WHS procedures
- planning soil testing activities
- taking representative soil samples
- setting up and calibrating testing equipment
- operate test equipment and performing tests
- analysing test results and classifying soils in accordance relevant Australian standard
- preparing and reporting test results

### ***Required knowledge:***

- origin and the process of soil formations
- soil parameters and classification of soil
  - soil particle density test
  - Atterberg limits test
  - sieve analysis test
- mass volume relationship of soil

- properties of soil
  - compaction test
  - shear strength test
  - permeability test
  - California bearing ratio (CBR) test
- consolidation of fine grained soils
- soil stabilisation and related parameters

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHs requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions, dust
- excessive energy and water use

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Resources*** may include, but are not limited to:

- soil sampling equipment
- soil testing equipment
- specifications
- manuals
- standards

- catalogues
- stationery
- calculators

**Enterprise procedures** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### **Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - Implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to :
    - take representative soil samples
    - carried out a range of practical soil testing activities
    - analyse test results and classify a range of common soil in accordance to the appropriate Australian standard, guidelines and enterprise procedures.

### **Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.

- access to workplace or work real environment and a variety of conditions
- operational access to soil sampling and testing equipment, materials and consumables
- access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

# Automation Systems Engineering/Automation Systems Design

## Control Systems

Current versions of the units listed below may be found at [training.gov.au](http://training.gov.au)

MEM10004B - Enter and change programmable controller operational parameters
MEM10005B - Commission programmable controller programs
MEM23003A - Operate and program computers and/or controllers in engineering situations
MEM23111A - Select electrical equipment and components for engineering applications
MEM23112A - Investigate electrical and electronic controllers in engineering applications
MEM23116A - Evaluate programmable logic controller and related control system component applications
MEM23117A - Evaluate microcontroller applications
MEM234010A - Design microcontroller applications
MEM234011A - Design programmable logic controller applications
MEM30027A - Prepare basic programs for programmable logic controllers





## VU22495 - Analyse the performance of AC motors

### Unit Descriptor

This unit of competency describes the knowledge and skills required to access the operational environment for the appropriate selection of an AC motor and starting system. The unit includes the analysis of the performance of common single phase and three phase AC motors including starting and braking, acceleration/deceleration, timing and cyclic loading. No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Prerequisite unit(s)

It is recommended that learners attempting this unit have the required knowledge and skills as described in:

VU22472 Apply electrotechnology principles in an engineering work environment

### Application of the Unit

The unit of competency applies to a person working at para professional level in an engineering, manufacturing or construction environments where AC motors are in used for a range of purposes.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

- 1 Determine the application requirements for an AC motor

- 2 Analyse, test and determine the operational environment for an AC motor

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 **Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements** for a given work area are clarified.
- 1.2 **AC motor** requirements are determined from documentation, work requests or discussions with **appropriate personnel**.
- 1.3 Analysis and/or testing of AC motor is planned and documented.
- 1.4 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.5 **Resources and equipment** needed for the task are obtained in accordance with enterprise procedures and checked for correct and safe operation.
- 2.1 Equipment/motors/plant is checked as being isolated where necessary in strict accordance with OHS/WHS requirements.
- 2.2 AC motor is tested following prepared test plans and in accordance with relevant standards, if appropriate.



- |   |   |  |
|---|---|--|
|   | 2.3   | Appropriate computations are undertaken to determine operational parameters as required.   |
|   | 2.4   | Acceleration time of a given motor/load combination is estimated, if required  |
|   | 2.5   | Rating of AC motor subjected to cyclic loading is estimated, if required.  |
|   | 2.6   | Unexpected situations in relation to this task are dealt with in discussion with appropriate personnel and enterprise procedures.  |
| 3 | Recommend a suitable AC motor for selection | 3.1 Outcomes of the analysis and test are recorded and documented according to enterprise procedures.<br>3.2 Recommendations based on outcomes are made and justified in accordance with enterprise procedures.<br>3.3 Equipment used for testing is maintained and stored in accordance with enterprise procedures.<br>3.4 Documented outcomes are filed, stored and archived in accordance with enterprise procedures. |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- identifying and following relevant OHS/WHS procedures
- selecting the appropriate test equipment and tests for a given AC motor
- drawing up a test plans for testing of AC motors
- compiling with relevant testing procedures and standards
- carrying out the required tests efficiently
- carrying out any required calculation in relation to AC motor testing
- communicating technical and procedural requirements with other appropriate personnel
- dealing effectively with unexpected situations that may occur during the planning and testing process

### **Required knowledge:**

- three phase induction motors:
  - operating principles
  - equivalent circuits
  - construction
  - starting and braking
- three phase synchronous motors:
  - operating principles
  - equivalent circuits
  - construction
  - starting and breaking
  - power factor correction
- single phase motors:
  - induction
  - shaded pole
  - reluctance

hysteresis  
universal

- acceleration and deceleration times
- cyclic loading

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHs requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***AC motor*** including:

- induction motors:  
three phase  
single phase
- three phase synchronous motors
- single phase shaded pole motors
- single phase reluctance motors
- single phase hysteresis motors
- single phase universal motors

***Resources and equipment*** may include, but are not limited to:

- computer access
- scientific calculator
- engineering tables and graphs
- regulations and codes of practice
- reference texts

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to assess an operational environment and select an appropriate AC motor to meet the performance requirements on two occasions.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant testing equipment, tools, and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals.

### Methods of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## VU21170 - Implement and maintain control systems for industrial processes

### Unit Descriptor

This unit of competency sets out the knowledge and skills required to implement and maintain control systems for industrial processes in engineering. It includes the configuration and installation of a range of analog and digital electronic devices for controlling processes through the application of stored programs.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency sets out the knowledge and skills required to configure, install, diagnose, fault-find and commission control systems for a range of industrial processes in engineering.

Work associated with this unit of competency is carried out at a para-professional level.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Determine control system requirements
2. Configure and install control system components and software

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements and environmental requirements*** for implementing and commissioning a control system are identified.
- 1.2 Interfacing and programming requirements are established through requests, work orders or equivalent and clarified with the ***appropriate personnel***.
- 1.3 Control system components are selected from applicable documents to meet the design specification and calculations and to satisfy cost, reliability and life requirements.
- 1.4 Expert advice is sought with respect to control system configuration and according to ***enterprise procedures***, where appropriate.
- 2.1 OHS/WHS requirements for carrying out the work are followed.
- 2.2 Industry codes, regulations and technical data relevant to control systems are interpreted and understood.
- 2.3 Control system parameters, tables and graphs are used to obtain computational data where appropriate.



- 2.4 Sensors and actuators, including analog transducers and hardware signal conditioning devices are connected to computer interface.
    - 2.5 Signal conditioning and actuator driver cards and hardware sequencing devices are integrated as required.
    - 2.6 **Resources and equipment** required are identified, obtained and checked as fit for purpose.
    - 2.7 Signal paths are tested and confirmed using testing equipment appropriate to the task.
  3. Commission and maintain control system
    - 3.1 OHS/WHS requirements for carrying out the work are followed.
    - 3.2 Work area and equipment are made safe in accordance with established safety procedures.
    - 3.3 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.
    - 3.4 Control system is tested and commissioned using computer automation and appropriate testing equipment as required.
    - 3.5 Compliance of control system is checked and confirmed against operational specification.
    - 3.6 Fine-tuning, including program editing is performed as necessary.
    - 3.7 Individual and multiple faults are diagnosed within given time constraints using appropriate problem solving techniques.
    - 3.8 Faults are rectified using appropriate testing equipment and techniques.
    - 3.9 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
  4. Verify and document control system
    - 4.1 OHS/WHS requirements for carrying out the work are followed.
    - 4.2 Results are verified and discussed with appropriate personnel.
    - 4.3 Results are graphed or charted where appropriate.

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- consulting and communicating with others  
identifying and following relevant OHS/WHS procedures
- reading and understanding technical data
- using control system parameters, tables and graphs
- connecting sensors and actuators to a computer interface
- integrating signal conditioning and actuator driver cards and hardware sequencing devices
- testing signal paths
- testing and commissioning control system
- carrying out compliance tests
- fine-tuning performed
- diagnosing individual and multiple faults
- rectifying faults
- verifying and document results

### ***Required knowledge:***

- operating modes of BJT, FET and MOSFET devices:
  - cut – off
  - saturation
  - amplification (analogue)
- relay characteristics:
  - types
  - ratings
- relationships of operating modes to industrial control circuits and modules:
  - On/Off state resistance
  - current sinking and sourcing
  - PNP type
  - NPN type
  - analogue
- voltage level shifting circuits and their applications:
  - High to Low voltage
  - Low to High voltage
  - TTL and CMOS interfacing
- the 4-20mA current loop:
  - range and span of operation
  - applications with TT industrial control module
  - 4-20mA transmitter/Receiver IC's

- specialty interfacing IC's:
  - Opto-coupler IC's
  - RS232 transmitter/receiver IC's
  - high current driver IC's
- Control systems and terminology:
  - closed and open loop control
  - control system block diagram
  - control modes
  - programming an industrial PID controller
- final correcting devices:
  - electromechanical relays
  - solid state relays
  - servo motors
  - stepper motors
- industrial timers:
  - revision of electronic
  - configuration of industrial timer modules
  - programming of industrial timer modules
- data acquisition:
  - ADCs and DACs
  - electrical noise, earth loops and shielding instrumentation amplifiers
  - cabling requirements
  - voltage and current standards
  - asynchronous and synchronous data transfer telemetry
- computer control:
  - revision of programmable controllers
  - survey of programmable controller advanced functions and systems
  - computer (XT/AT) familiarisation
  - digital I/O boards
  - analog I/O boards
  - high level languages
  - data acquisition software
  - data loggers
- robotic control:
  - robotic classifications and configurations
  - methods of actuation and motion
  - programming robotic systems
  - robotic sensors
  - industrial applications and safety
  - robotic safety



- PID Control:
  - control algorithm
  - proportional control
  - integral control
  - derivative control
- writing the program for closed loop control:
  - ON-OFF control
  - PID control
- tuning a PID control loop:
  - choosing the proportional constant
  - choosing the integral constant
  - choosing the derivative constant
- digital Control:
  - sampling rates
    - minimum sampling rates, Nyquist criterion
    - factors that affect the sampling rate
    - measuring the sampling rate

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

### ***OHS/WHs requirements***

may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

### ***Environmental***

***requirements*** may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

### ***Appropriate personnel***

may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor

- teacher
- team member

**Enterprise procedures** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**Resources and equipment** may include, but are not limited to:

- signal conditioning & actuator driver cards
- analog transducers
- hardware sequencing device
- computer interface cards
- sensors and actuators
- solid state controller (PID)
- controller hardware
- power sources
- cabling and connectors
- equipment, parts and components
- PC controller and software
- Programmable Logic Controller
- microcontroller
- microprocessor
- hand and power tools
- drawing and reference documents
- testing and measuring equipment

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be 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
  - demonstrate the ability to implement and maintain control systems for industrial processes in engineering on more than one occasion and in different contexts.
  - verify and document control systems

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OH&S policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documentary evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## VU21172- Apply instrumentation principles to industrial control systems

### Unit Descriptor

This unit of competency sets out the knowledge and skills required to apply instrumentation principles to industrial control systems. This includes selecting, installing, maintaining, monitor and calibrating instrumentation, sensors and transducers within an industrial control system.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency is relevant to an engineering process control environment where instrumentation is used to control a variety of variables that form part of the process to a set of given specifications.

Work associated with this unit of competency is carried out at a para-professional level.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable

1. Prepare application of instrumentation task

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements and environmental requirements*** for a given work area are determined.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 ***Instrumentation task*** requirements are determined from documentation, work requests or discussions with appropriate personnel.
- 1.5 Appropriate instrumentation solution is selected from documentation, work requests or discussions with appropriate personnel to fit task requirement, if required.
- 1.6 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.



- |   |     |  |
|---|-----|--|
|   | 1.7 | <b>Resources</b> and <b>equipment</b> to carry out instrumentation task are obtained in accordance with <b>enterprise procedures</b> and checked for correct operation and safety. |
| 2. Carry out instrumentation task             | 2.1 | OHS/WHS requirements for carrying out the work are followed.   |
|   | 2.2 | Equipment/machines/plant are checked as being isolated where necessary in strict accordance with OHS/WHS requirements.   |
|   | 2.3 | Instrumentation task is carried out in accordance with requirements to specifications and according to enterprise procedures.  |
|   | 2.4 | Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.                               |
|   | 2.5 | Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.  |
| 3. Complete and document instrumentation task | 3.1 | OHS/WHS requirements for carrying out the work are followed.   |
|   | 3.2 | Work site is made safe in accordance with established safety procedures  |
|   | 3.3 | Instrumentation work is tested for correct operation within given specifications and enterprise procedures.  |
|   | 3.4 | Instrumentation task is documented and completion reported to appropriate personnel.   |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required Skills:**

- consult and communicate with others
- identify and follow relevant OHS/WHS procedures
- read and understand documentation
- perform instrumentation tasks
- carry out operational tests
- verify results
- prepare documentation and submit reports

**Required Knowledge:**

- process control systems
  - principles of control
  - control variables
  - process control systems (examples)
  - control system topologies
  - multivariable schemes
  - on-off control, multi-step, PID control
  - lag
  - inherent regulation
  - communication links
  - transducers
  - sensors
  - valves
  - signal types
- measurement of control variables
  - temperature
  - pressure
  - flow
  - level
  - density
- detection of control variables
  - temperature
  - pressure
  - chemical
  - level
  - density
- protection and safety
  - lightning and surge
  - static
  - standards and codes of practice
- instrumentation field practice
  - maintenance
  - hazardous atmospheres
  - personal safety
  - wiring
  - enclosures and barriers
  - mounting
  - tubing and piping
  - calibration
  - documentation

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

### ***OHS/WHs requirements***

may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

### ***Environmental***

***requirements*** such as:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

### ***Appropriate personnel***

may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Instrumentation task*** may include, but is not limited to:

- in relation to instrumentation, transducers and sensors
- selection
- installation
- maintenance
- monitoring
- troubleshooting
- calibration

***Resources*** may include, but are not limited to:

- engineering drawings
- documentation
- manufacturers' specifications
- standards
- test and calibration reports
- assorted wires and cables

- tubing and piping
- barriers and enclosures
- mounts
- spares and consumables

**Equipment** may include, but is not limited to:

- hand and power tools
- test instrumentation
- calibration equipment
- range of instruments, transducers and sensors
- data readout equipment

**Enterprise procedures** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the criteria, including required skills and knowledge. Specifically they must be 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
  - demonstrate application of instrumentation principles to industrial control systems by selecting, installing, maintaining, monitoring and calibrating instrumentation, sensors and transducers on more than one occasion and in different contexts.
  - complete and document instrumentation tasks

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - Access to workplace or work real environment and a variety of conditions





- Operational access to relevant machines, tools, materials and consumables
- Access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documentary evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## VU21173 - Interface control systems to industrial processes and analyse data from SCADA systems

<b>Unit Descriptor</b>	This unit of competency sets out the knowledge and skills required to interface control equipment to computers using supervisory control and data acquisition (SCADA) systems. No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.
<b>Employability Skills</b>	This unit contains employability skills.
<b>Application of the Unit</b>	This unit of competency applies to the use of SCADA software to program hardware such as PLCs or commercial hardware modules to control manufacturing processes. Work associated with this unit of competency is carried out at a para-professional level.

### ELEMENT

Elements describe the essential outcomes of a unit of competency.  
Elements describe actions or outcomes that are demonstrable and assessable.

1. Plan for the application of a SCADA system

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WH&S) requirements and environmental requirements*** for a given work area are determined.
- 1.2 Established OHS/WH&S requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 SCADA system requirements are determined from documentation, design briefs, job sheets or discussions with appropriate personnel.
- 1.4 Process parameters and associated information relevant to the SCADA system implementation are identified and analysed.
- 1.5 Optimum implementation option is chosen and checked against requirements.
- 1.6 ***Appropriate personnel*** are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.7 ***Resources and equipment*** needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety



- |    |  |  |
|----|--|--|
| 2. | Configure a SCADA system for an industrial process             | 2.1 OHS/WHS requirements for carrying out the work are followed.<br>2.2 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with appropriate personnel.<br>2.3 Development software is used to configure SCADA system including graphical editor, data base configuration tool, scripting language and Application Program Interface (API).<br>2.4 Configured SCADA system is tested for functionality ensuring that equipment/machines/plant are checked as being isolated where necessary in strict accordance with OH&S requirements.<br>2.5 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures. |
| 3. | Use SCADA system to monitor and control and industrial process | 3.1 OHS/WHS requirements for carrying out the work are followed.<br>3.2 SCADA information is monitored, analysed and evaluated in accordance with enterprise procedures.<br>3.3 Inefficient uses of SCADA system are identified and rectified.<br>3.4 SCADA system is interrogated to obtain current, historical or predicted information if required.<br>3.5 Support is provided to others in the use of the SCADA system in accordance with enterprise procedures.<br>3.6 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes and in consultation with appropriate personnel.   |
| 4. | Document and maintain SCADA system                             | 4.1 OHS/WHS requirements for carrying out the work are followed.<br>4.2 A library of <b>SCADA objects and templates</b> is maintained and updated according to enterprise procedures if required.<br>4.3 Operating and response instructions for SCADA system are documented, maintained and updated and approved by appropriate personnel.  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- consult and communicate with others
- identify and follow relevant OHS/WHs procedures
- use graphical design aids
- acquire data
- analyse data
- interpret alarm logging
- compile and manage a database
- use SCADA programming software
- set up hardware and software
- implement a SCADA system within a process environment
- present a report
  - produce reports for different groups involved in the process
  - categorise information required to produce individual reports
  - analyse data fields to produce reports using word-processing packages

### ***Required knowledge:***

- SCADA systems
  - applications
    - uses in industry
    - commercial packages (e.g. LabView, Citect, Procon, Wizcon, Control View, Siemens, etc.)
    - comparison of applications in industry
  - hardware requirements
  - PLC interface requirements
  - networking requirements
- graphical design
  - basic concepts (review)
  - balance of layout
  - analysis of data required for mimic diagrams
  - uses of a suitable software package
- data analysis
  - conversion of raw data
  - manipulation of complex data within the SCADA software
  - trending
  - graphical representation
- alarm logging
  - selected limits and specification for alarm logging
  - corrective action for alarm status

- database
  - variables, limits and specifications
- programming language
  - function within the SCADA software
  - type and method of program language used to automate tasks within the software package
- SCADA systems within a process environment
  - limitations of SCADA systems (i.e. physical and environmental limitations)
  - applications for SCADA systems
  - networking used for SCADA systems
  - types
  - main frame networking
  - factory networking
  - advantages/disadvantages of different networking systems
- PC set up
  - operating systems (e.g. UNIX, LINUX, Windows, DOS, Solaris, etc.)
  - terminology
  - advantages/disadvantages
  - PC operating environment (e.g. noise immunity, temperature, vibration, dirt, etc.)
  - PC hardware
  - Networking requirements
  - Data storage medium
  - Security access (e.g. user passwords, firewalls, etc.)
- data acquisition
  - hardware requirements
  - serial port: RS232, RS422, RS485
  - USB
  - parallel printer port
  - PCI BUS
  - modem
  - network cards
  - commercial systems (e.g. LabView, HP)
  - software requirements
  - drivers
  - specialist programs
  - OLE and DLE

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

**OHS/WHS requirements** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems

- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements***

may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Resources and equipment*** may include, but are not limited to:

- computer software
- software reference documentation
- internet access
- network access
- relevant standards
- computer (minimum pentium 3)
- variety of input devices
- variety of output devices
- printer
- SCADA system
  - training package
  - software package
- appropriate computer hardware
- variety of input devices
- variety of output devices
- printer
- SCADA system
  - training package
  - software package

**Enterprise procedures** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**SCADA objects and templates**

- PLCs
- devices
- subsystems
- scripts and sequences
- interactive displays
- alarms
- library
- report generator

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be 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
  - demonstrate the ability to successfully interface control systems and industrial hardware devices on more than one occasion and in different contexts.
  - document and maintain SCADA system

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:

- OHS/WHS policy and work procedures and instructions.
- access to workplace or work real environment and a variety of conditions
- operational access to relevant machines, tools, materials and consumables
- access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documentary evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU21174 - Program control systems

<b>Unit Descriptor</b>	<p>This unit of competency sets out the knowledge and skills required to program an industrial control system.</p> <p>No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.</p>
<b>Employability Skills</b>	This unit contains employability skills.
<b>Application of the Unit</b>	<p>This unit of competency the use of the use control systems to control manufacturing processes.</p> <p>Work associated with this unit of competency is carried out at a para-professional level.</p>

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

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|--|--|
| 1. Plan for implementing a control system. | <p>1.1 <b><i>Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements</i></b> and <b><i>environmental requirements</i></b> for a given work area are determined.</p> <p>1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.</p> <p>1.3 The control system requirements are determined from documentation, design briefs, job sheets or discussions with appropriate personnel.</p> <p>1.4 Measurements and data required are identified and appropriate control system components are selected.</p> <p>1.5 Implementation of the control system is analysed, the optimum implementation solution chosen and checked against requirements.</p> <p>1.6 <b><i>Resources and equipment</i></b> needed for the task are obtained in accordance with <b><i>enterprise procedures</i></b> and checked for correct operation and safety.</p> <p>1.7 <b><i>Appropriate personnel</i></b> are consulted to ensure the work is co-ordinated effectively with others involved at the work site.</p> |
| 2. Program and test control system         | <p>2.1 OHS/WHS requirements for carrying out the work are followed.</p> <p>2.2 Appropriate dimensional computations are performed to suit the application.</p>   |



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|----|--|--|
|    | 2.3  | Control program is developed for given environment using design and manufacturers' specifications.   |
|    | 2.4  | Efficient software interfaces are created between programmable device(s) and peripheral devices.   |
|    | 2.5  | The control system is tested for functionality and against specification and faults is rectified, if required.                                       |
|    | 2.6  | Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures. |
| 3. | Commission and document the control system |  |
|    | 3.1  | OHS/WHS requirements for completing the work are followed.   |
|    | 3.2  | Equipment and machinery is checked as being isolated where necessary during commissioning process.   |
|    | 3.3  | Control system is tested 'live' and all appropriate safety precautions are taken according to enterprise procedures.                                 |
|    | 3.4  | The control system is documented and documentation is stored in accordance with enterprise procedures.   |
|    | 3.5  | Work completion is notified to appropriate personnel according to enterprise procedures.   |

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- consult and communicate with others
- identify and follow relevant OHS/WHS procedures
- read and understand design briefs
- identify input/output devices
- navigate appropriate software

- perform dimensional computations
- create efficient software interfaces between programmable device(s) and peripheral devices
- develop a control program
- test control system functionality against specification
- identify safety concerns
- test control system 'live' and adhere to all appropriate safety precautions
- rectify faults
- verify and document results

**Required knowledge:**

- input/output devices
  - types of input/output devices
  - limitations of input/output devices (e.g. speed/range)
  - linearization methods
  - commercial examples
  - means of connection (e.g. network, PCI, serial, USB, etc.)
- control system software
  - control language
    - history
    - advantages/disadvantages
  - types of control languages
    - *C*
    - *Ladder*
    - *Grafset*
    - *Linux*
    - commercial packages (e.g. LabView, Citec, Procon)
  - PC to PLC interfaces
  - control structure
    - sequential
    - repetition
    - selection
  - software debugging
  - fault finding techniques (i.e. troubleshooting)
- dimensional calculations
  - mathematical functions
  - 7 SI fundamental units
  - gas quantities (gauge or absolute, etc.)
  - order of magnitude
  - dimensions

- scientific and engineering notations (correct SI unit prefixes)
- measurement and control terminology
  - range, accuracy, linearity, hysteresis, repeatability, offset
  - bias, sensitivity, drift, noise, electrical calibration, smart instruments, traceability, shielding, grounding, temperature compensation, intrinsic safety, barriers, current loop, HART, IP65, NEMA4, gain
  - turndown, lag, lead, deadline, first order system, second order system, overdamped, underdamped, natural frequency, marginal, stability, rise time, overshoot, decay ratio, dynamic gain, proportional band, relay action, reset action, PID action, pre-filtering
  - ratio, cascade, master, slave, local/remote, manual/auto, wind-up, bumpless transfer, tracking, self-tuning, adaptive control, closed loop, open loop, feedback, feed-forward, set-point, servo, regulator, performance, quarter decay, stability
- safety concerns
  - software reliability
  - noise immunity

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

### ***OHS/WHS requirements***

may include but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

### ***Environmental***

***requirements*** may include but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

### ***Resources and***

***equipment*** may include but are not limited to:

- computer software
- software reference documentation
- internet access
- network access
- relevant standards
- appropriate computer work station

- programmable devices
- variety of input devices
- variety of output devices
- printer

**Enterprise procedures** may include but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**Appropriate personnel** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge, and to be capable of applying the competency in new and different situations and contexts within the timeframes typically expected of the discipline, work function and industrial environment.
- Specifically they must be 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
  - demonstrate the ability to successfully implement control systems on more than one occasion and in different contexts.
  - commission and document the control system

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work,



then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.

- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

#### **Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documentary evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## VU22496 - Utilise analog electronics for control applications

### Unit Descriptor

This unit of competency describes the knowledge and skills required to utilise analog electronics for applications requiring simple control of engineering and manufacturing processes. This unit is confined to simple linear electronic control systems. The application of complex circuit analysis or component level fault finding is beyond the scope of this unit. No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

The unit applies to a person working at para professional level in an engineering or manufacturing environment where analog electronics is used to control a wide variety of processes.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

- 1 Prepare application of analog electronics to control task

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements*** for a given work area are determined.
- 1.2 Safety hazards are identified and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.3 Analog control task requirements are determined from documentation, work requests or discussions with appropriate personnel.
- 1.4 Appropriate analog test plan and control solution is selected from documentation, work requests or discussions with appropriate personnel to fit task requirement.
- 1.5 ***Resources*** and ***equipment*** needed for the task requirement are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.
- 2 Carry out digital control task
  - 2.1 Equipment/machines/plant is checked as being isolated where necessary, in accordance with OHS/WHS requirements.
  - 2.2 Analog control testing for functionality is carried out in accordance with test plan and enterprise procedures.
  - 2.3 Any analog control circuit malfunctions are corrected and the system restored to normal operation condition.



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|---|--|--|
| 3 | Complete and document digital control task | 2.4 Unexpected situations are discussed with other work team personnel and solutions are selected on the basis of safety and specified work outcomes.<br><br>3.1 Control applications are tested for correct operation within given specifications and enterprise procedures.<br><br>3.2 Isolated equipment is reconnected and work site is made safe in accordance with established safety procedures.<br><br>3.3 Analog control task is documented and completion reported to appropriate personnel. |
|---|--|--|

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- identifying and following relevant OHS/WHS procedures risk control measures
- safely handle electronic components
- determining operation of analog controllers from diagrams and tables
- drawing up test plans for analog controllers
- selecting appropriate test methods and equipment
- testing analog controllers for functionality
- troubleshooting analog control circuits
- restoring analog control system operation
- communicating technical requirements and working with other team members.

### **Required knowledge:**

- DC and AC electrical/electronic circuits
- signals, waveforms and analog electrical/electronic concepts
- passive components and their application in industrial control
- typical protection devices
- electromagnetic devices:
  - chokes, inductors, transformers
  - solenoids and relays
  - motors – AC, DC, stepper
- active electronic devices:
  - transistors
  - integrated circuits
- switching electronic devices:
  - transistor
  - SCR/triac
- pulse width control
- control subsystems:



- power supply unit (PSU), linear and switch-mode
- instrumentation/control amplifier
- motor controller
- clock oscillator
- sensors and transducers
- interfacing devices and circuits.

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHs requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Resources*** may include, but are not limited to:

- manufacturer's specifications and documentation
- circuit diagrams
- reference texts and tables
- appropriate safety equipment
- computer work station with appropriate software/hardware
- consumables such as connectors, cable, electronic components, transducers and actuators

***Equipment*** may include, but is not limited to:

- multimeters
- dual trace oscilloscope and probes
- tachometer
- appropriate hand tools
- various types of leads, connectors and probes

**Enterprise procedures** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHs procedures and practices including the use of risk control measures, as specified in the performance criteria
  - interpret and follow work instructions and develop a analog controlled functionality test plan
  - select appropriate test equipment and carry out testing of simple analog controllers for functionality on more than one occasion and in different contexts.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used, where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant test equipment, charts and graphics and consumables
  - access to work instructions and other relevant documentation.

### Methods of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures

- oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## VU21176 - Utilise digital electronics for control applications

### Unit Descriptor

This unit of competency sets out the knowledge and skills required to utilize digital electronics for applications requiring simple control of engineering and manufacturing processes. This unit is confined to hardwired digital control systems and/or basic programmable control logic only. The application of complex digital control and processing theory is not required.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

The unit of competency applies to engineering and manufacturing environments where digital electronics is used to control a wide variety of processes.

Work associated with this unit of competency is carried out at a para-professional level.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

- 1 Prepare application of digital electronics to control task

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WH&S) requirements and environmental requirements*** for a given work area are determined..
- 1.2 Established OHS/WH&S requirements and risk control measures and procedures are followed in preparation of the work.
- 1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 Digital control task requirements are determined from documentation, work requests or discussions with appropriate personnel.
- 1.5 Appropriate instrumentation solution is selected from documentation, work requests or discussions with appropriate personnel to fit task requirement, if required.
- 1.6 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.7 ***Resources and equipment*** to carry out digital control task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.



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| 2 | Carry out digital control task             | 2.1 OHS/WHS requirements for carrying out the work are followed.   |
|   |  | 2.2 Equipment/machines/plant are checked as being isolated, where necessary, in strict accordance with OHS/WHS requirements.                             |
|   |  | 2.3 Digital control task is carried out in accordance with requirements to specifications and according to enterprise procedures.                        |
|   |  | 2.4 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures. |
|   |  | 2.5 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.                                      |
| 3 | Complete and document digital control task | 3.1 OHS/WHS requirements for carrying out the work are followed.   |
|   |  | 3.2 Work site is made safe in accordance with established safety procedures.   |
|   |  | 3.3 Digital control work is tested for correct operation within given specifications and enterprise procedures.  |
|   |  | 3.4 Digital control task is documented and completion reported to appropriate personnel.   |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required Skills:**

- identifying and following relevant OHS/WHS procedures;
- interpreting and evaluating documentation, specifications, manufacturers' manuals and drawings;
- testing digital controllers for functionality;
- applying safe component handling techniques;
- determining operation of digital controllers from diagrams and tables;
- interpreting and applying testing protocols;
- drawing up test plans;
- interfacing digital controller hardware;
- troubleshooting digital circuits;
- selecting appropriate test methods and equipment;
- undertaking required tests efficiently;
- working in teams;
- communicating technical requirements

**Required Knowledge:**

- fundamental digital concepts;
- logic functions and operators;
- binary arithmetic;
- number systems;
- Boolean algebra
- electronic implementation of logic functions and operators;
- combinational digital circuits;
- sequential digital circuits;
- digital troubleshooting;
- interfacing;
- memory;
- reconfigurable hardware;
- programming hardware

**RANGE STATEMENT**

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHs requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions, dust
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

**Resources** may include, but are not limited to:

- manufacturer's specifications and documentation
- circuit diagrams
- reference texts and tables
- appropriate safety equipment
- computer work station with appropriate software/hardware to program programmable logic
- consumables such as connectors, cables, appropriate integrated circuits, electronic components, transducers and actuators

**Equipment** may include, but is not limited to:

- multimeters
- logic probes
- oscilloscope
- appropriate hand tools
- various types of leads, connectors and probes

**Enterprise procedures** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge, and be capable of applying the competency in new and different situations and contexts within the timeframes typically expected of the discipline, work function and industrial environment.
- Specifically they must be 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
  - demonstrate the ability to utilise simple digital controllers on more than one occasion and in different contexts.

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OH&S policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documentary evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU21270- Implement control processes using PLCs

### Unit Descriptor

This unit of competency sets out the knowledge and skills required to program Programmable Logic Controllers (PLCs) within an industrial setting.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to the use of PLCs to control manufacturing processes.

Work associated with this unit of competency is carried out at a para-professional level.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

#### 1. Plan PLC application

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements*** and ***environmental requirements*** for a given work area are determined.

1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.

1.3 PLC application is determined from documentation, job sheets or discussions with ***appropriate personnel***.

1.4 Measurements and data required are identified and appropriate control system components selected.

1.5 ***Resources and equipment*** needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.

1.6 Implementation of the control system is analysed and optimum approach selected, planned for and checked against requirements

1.7 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.

#### 2. Design PLC program outline

2.1 OHS/WHS requirements for carrying out the work are followed.

2.2 Ladder control circuits or logical flow of the application are drawn, if required.

2.3 Ladder control circuits are converted to ladder logic, if required.



3.	Program PLC for the application	3.1	OHS/WHs requirements for carrying out the work are followed.
		3.2	PLC is programmed according to manufacturers' specifications and job requirements.
		3.3	Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.
		3.4	Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.
4.	Test and document PLC program	4.1	OHS/WHs requirements for completing the work are followed.
		4.2	The PLC program is function tested and its operation verified.
		4.3	Equipment and machinery is checked as being isolated where necessary during testing process.
		4.4	Work site is made safe in accordance with established safety procedures.
		4.5	PLC program and function test is documented according to enterprise procedures.
		4.6	Work completion is notified to appropriate personnel according to enterprise procedures.

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- consult and communicate with others
- identify and follow relevant OH&S procedures
- produce logic flow diagram
- write, test and debug PLC program code
- modify program online
- locate hardware and software faults
- document program

### **Required knowledge:**

- programmable controller
  - input rack
  - output rack
  - central Processor Unit (CPU)
  - power supply
  - special units (e.g. motor control, A/D, D/A)
  - programmer

- control Logic
  - relay logic circuit (revision)
    - series circuits
    - parallel circuits
    - combination of series and parallel
    - interlocking
  - programmable logic
    - ON state instruction
    - series equivalent circuits
    - parallel equivalent circuits
    - combination series/parallel
    - OFF state instruction
  - control relay logic conversion
    - relay to logic programmable logic
    - programmable logic to relay logic
- fail safe
  - identifying need for fail safe
  - programming fail safe
  - hardware fail safe
- program editors
  - grafcet
  - statement list
  - ladder
  - graphical
- memory devices
  - terminology (RAM, ROM, EPROM, etc)
  - volatile, non-volatile, static
  - dynamic
  - I/O image registers
  - applications program
  - scratchpad area
  - timer/counter preset/acc registers
  - data tables
- advanced logic concepts
  - word logic operations
    - merge (word AND)
    - mask (word OR)
    - complement (word complement)
- counters & timers
  - timing diagrams
  - edge sensitive (leading and trailing)
  - level sensitive

- interpreting timing diagrams
- software timing functions
  - delay on timer (DOE)
  - delay off timer (DDE)
  - interval timer
- time related software functions
  - one shot
  - time base generators
  - time clock
- advanced control instructions
  - general operations
    - master control function
    - subroutine function
    - input differentiation function
    - temporary relay function
    - bistable control function
    - sequencer control function
    - drum controller function
    - conditional branch function
    - labels and rung comments
  - math operations
    - addition, subtraction, division, multiplication, square, compare
    - conversions BIN to BCD to BIN
    - matrix, arithmetic shift left and right
  - block operations
    - block – move, compare, set, reset
    - word transfer
  - bit operations
    - carry – set, reset
    - shift left and right
    - rotate left and right
- hardware fault location
  - importance of documentation
  - field I/O devices and wiring
  - CPU diagnostic indicators
  - I/O module cards and status indicators
  - watch dog timer
- software fault location and rectification
  - programming console as diagnostic tool
  - override/force functions (safety considerations)
  - diagnostic/error code registers

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHs requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Resources and equipment*** may include, but are not limited to:

- computer software
- software reference documentation
- internet access
- network access
- relevant standards
- suitable computer work station
- PLCs
- variety of input devices
- variety of output devices
- printer
- PLC interface units

**Enterprise procedures** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### **Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be 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
  - demonstrate the ability to successfully program PLCs within an industrial setting on more than one occasion and in different contexts.
  - test and document PLC programs

### **Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documentary evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## **Mechatronics Engineering Design**

Current versions of the units listed below may be found at **[training.gov.au](http://training.gov.au)**

MEM23064A - Select and test mechatronic engineering materials
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## VU22563 - Set up mechatronics engineering systems

### Unit Descriptor

This unit of competency describes the knowledge and skills required to plan and construct a mechatronics engineering system and interface it with a standard industrial programmable controller for a complete operating system.

It includes all wiring and programming to achieve automation together with commissioning and troubleshooting requirements.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at para professional level in an industrial engineering or manufacturing enterprise where mechatronics is applied to form part of the production of goods or services.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Identify principal mechatronics applications within the manufacturing and engineering industry

2. Plan the implementation of a mechatronics system

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements*** for a given work area are determined and specific applications can be given.
- 1.2 Principal mechatronics applications in manufacturing and engineering are identified, as required.
- 1.3 Principles and features of mechatronics are provided, as required.
- 1.4 Advantages and disadvantages of mechatronics for given manufacturing applications are identified.
- 2.1 Relevant OHS/WHS requirements for carrying out the work are incorporated into the plan.
- 2.2 ***Specifications, installation and set-up requirements*** are determined from enterprise documentation and discussion with ***appropriate personnel***.
- 2.3 Stages and activities required for implementation are identified and documented according to ***enterprise procedures***.
- 2.4 ***Resources, components and equipment*** needed for the installation are selected and sourced according to design specification and enterprise procedures.
- 2.5 Mechatronics principles and associated calculations are applied as required to plan the installation.



- |  |     |   |
|--|-----|---|
|  | 2.6 | Procedures for the operation of mechatronics system are developed.  |
|  | 2.7 | Plan is reviewed to improve outcomes and overcome possible problems.  |
| 3. Construct mechatronics systems                | 3.1 | Relevant OHS/WHS requirements for carrying out the work are followed.   |
|  | 3.2 | Resources, components and equipment are obtained and coordinated in accordance with enterprise procedures.                              |
|  | 3.3 | Component set-up and location is checked to ensure conformance to specifications.   |
|  | 3.4 | Implementation activities are managed/coordinated in accordance with implementation plan and enterprise procedures.                     |
|  | 3.5 | Machines and equipment are set up/configured to meet specifications.  |
|  | 3.6 | Unexpected situations are resolved with appropriate personnel and with reference to applicable documentation and enterprise procedures. |
| 4. Program system controllers                    | 4.1 | Relevant OHS/WHS requirements for carrying out the work are followed.   |
|  | 4.2 | Sensors and actuators are interfaced to PLC and checked for correct operation.  |
|  | 4.3 | Logic sequence for the integrated system is prepared, indicating all actions and decision points.                                       |
|  | 4.4 | Programming requirements are analysed and documented.   |
|  | 4.5 | Program is constructed in accordance with manufacturer guidelines and enterprise procedures.  |
|  | 4.6 | Program is downloaded and tested for conformance with operational specifications.   |
| 5. Commission mechatronics system                | 5.1 | Relevant OHS/WHS requirements for carrying out the work are followed.   |
|  | 5.2 | Compliance of system is checked against operational specification.  |
|  | 5.3 | Faults are diagnosed and rectified using appropriate testing equipment and techniques.  |
|  | 5.4 | Final adjustments to components and control systems, including program editing are performed as necessary.                              |
| 6. Monitor implementation of mechatronics system | 6.1 | Relevant OHS/WHS requirements for carrying out the work are followed.   |
|  | 6.2 | Implementation results are compared against the expected outcomes and performance differences identified.                               |

- 6.3 Adjustments are made to improve outcomes, where required.
- 6.4 Procedures are documented to reflect the change
- 6.5 Changes are audited at agreed period/cycle and actions taken to correct any deviations.
- 6.6 Documentation is completed and work completion notified according to enterprise procedures.

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- consulting and communicating with other team member involved with the project
- identifying and following relevant OHS/WHs procedures
- developing a plan for mechatronics system implementation
- setting up and configuring machines and equipment to meet specific requirements
- commissioning a mechatronics system
- diagnosing and rectifying faults in a mechatronics system

### ***Required knowledge:***

- digital sensors
  - optical
  - capacitive
  - inductive & magnetic
  - electromagnetic
- actuation (non-proportional)
  - mechanical actuators
  - electrical actuators
  - energisers & accumulators
  - linkages & transmissions
- cabling and connectors
  - cable types, colour codes, specification
  - shielding requirements
  - connector systems & terminations
- signal conditioning
  - use of switching transistors
  - resistor & capacitor calculations
  - simple DC amplification
  - buffers & operational amplifiers
- logic analysis

- broad description of task
  - flow charts
  - detailed step analysis
- programming
  - input/output designators
  - latching
  - timers & counters
  - special functions
  - illegal functions
  - program structure
- commissioning
  - mechanical adjustment
  - pre-commissioning tests
  - housekeeping precautions
  - accumulated energy safety awareness
  - desirable start sequence
- troubleshooting
  - problem solving techniques
  - during commissioning
  - under time pressure
- sourcing components
  - buy/manufacture split
  - selecting supply source
  - manufacturing in-house items
- planning
  - manual or computer techniques
  - select progress display type
  - continued progress monitoring
  - Project construction
  - assemble base or foundation
  - preliminary layout
  - complete sub-assemblies
  - full assembly
  - check for functionality
  - finishing
- feedback
  - for design correction
  - for component supplier

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Specifications, installation and set-up requirements*** may include, but are not limited to:

- system design and features
- layout
- space
- components
- operational capabilities
- mechanical, electrical and other environmental performance requirements
- materials
- cost/budget/economy
- required/available resources
- timeframe
- specific customer requirements
- hazards and risks
- enterprise requirements
- quality standards
- any other project limitations

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Enterprise procedures*** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets,, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**Resources, components and equipment** may include, but are not limited to:

- sensors and actuators
- programmable logic controllers
- electrical and fluid power sources
- cabling and connectors
- equipment, parts and components
- high profile desktop PC's with Turbo CAD or similar
- plotter and printer
- machine shop equipment
- hand and power tools
- drawings and reference documents

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to plan and construct a mechatronics engineering system and interface it with a standard industrial programmable controller for a complete operating system.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, equipment, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals.

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## VU22498 - Interface and program mechatronics engineering systems

### Unit Descriptor

This unit of competency describes the knowledge and skills required to interface and program mechatronics systems with solid-state hardware sequencing devices and personal computer interfacing. This includes building a dedicated solid-state hardware controller for selected sequencing operations.

The unit also includes the skills and knowledge required to add analog inputs and analog output using a PC interface to assist in computing dependent output/input conditions.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at para professional level in an engineering or manufacturing enterprise where mechatronics are applied to form part of the production of goods and/or services.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Determine requirements for mechatronics system

2. Construct and test computer interface

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements*** and ***environmental requirements*** for installation and commissioning are identified.
- 1.2 Interfacing and programming requirements are established through requests, work orders or equivalent and clarified with the ***appropriate personnel***.
- 1.3 Variables which will affect the design are identified and analysed.
- 1.4 ***Components*** are selected from applicable ***reference documents*** to meet the design specification, calculations and to satisfy cost reliability and life requirements.
- 1.5 Expert advice is sought with respect to the design task and according to ***enterprise procedures***, where appropriate
- 2.1 OHS/WHS requirements for carrying out the work are followed.
- 2.2 Sensors and actuators, including analog transducers and hardware signal conditioning devices, are connected to computer interface.





- 2.3 Calculations are performed using standard formulas and standard (tabulated) component data.
- 2.4 Signal conditioning and actuator driver cards and hardware sequencing devices are integrated, as required.
- 2.5 **Resources and equipment** are obtained in accordance with enterprise procedures and checked for correct operation and safety.
- 2.6 Signal paths are tested and confirmed using testing equipment appropriate to the task.
3. Develop and test system program
  - 3.1 OHS/WHs requirements for carrying out the work are followed.
  - 3.2 Logic sequence for the integrated system is analysed and all actions and decision points identified.
  - 3.3 Detailed operational flow chart is constructed indicating all operator actions, input signals, output action, interlocks, and safety/emergency requirements.
  - 3.4 Detailed step analysis of the program requirements for the operational task is prepared.
  - 3.5 Required program is constructed using suitable language and software relevant to the selected controller.
  - 3.6 Program is tested as far as practicable on the de-energised system for compliance with expected operation.
  - 3.7 Decisions for dealing with unexpected situations are made in discussion with appropriate personnel and in reference to job specifications and enterprise procedures.
4. Commission mechatronics system
  - 4.1 OHS/WHs requirements for carrying out the work are followed.
  - 4.2 Work area and equipment are made safe in accordance with established safety procedures.
  - 4.3 System is commissioned and tested using computer automation and appropriate testing equipment as required.
  - 4.4 Compliance of system is checked and confirmed against operational specification.
  - 4.5 Fine tuning, including program editing, is performed as necessary for range, zero offset, and gain for the analog system.
  - 4.6 Individual and multiple faults are diagnosed within given time constraints and using appropriate problem solving techniques.

- |                                     |     |   |
|-------------------------------------|-----|---|
|                                     | 4.7 | Faults are rectified using appropriate testing equipment and techniques.  |
|                                     | 4.8 | Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site. |
| 5. Monitor implementation of system | 5.1 | OHS/WHs requirements for carrying out the work are followed.  |
|                                     | 5.2 | Implementation results are compared against the expected outcomes and performance differences identified.                 |
|                                     | 5.3 | Adjustments are made to improve outcomes, where required.   |
|                                     | 5.4 | Procedures are documented to reflect the change.  |
|                                     | 5.5 | Changes are audited at agreed period/cycle and actions taken to correct any deviations.                                   |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- consulting and communicating with others working on the project team
- identifying and following relevant OHS/WHs procedures
- connecting sensors and actuators to computer interface
- analysing logic sequence for the integrated system
- constructing and completing flow charts
- performing calculations and running program tests
- testing and commissioning a mechatronics system
- diagnosing and rectifying system faults
- performing monitoring checks, tests and adjustments of the system

### **Required knowledge:**

- logic analysis
  - broad description of task
  - flow charts
  - detailed step analysis
  - type of analog change
- interfacing
  - use of transistors
  - resistor and capacitor calculations
  - buffers & operational amplifiers
  - port address design
  - data direction & buffering

- latching signal generation
- opto-isolation
- amplification for actuator operation
- -driver output configuration
- latching signal generation
- analog signal handling (input/output)
- specific hardware analog conditioners
- programming
  - selection of language
  - input/output addressing
  - input retention(latch)
  - timing & counting
  - program structure
  - analog and arithmetic operations
  - PID functions
- commissioning
  - mechanical adjustment
  - set up analog ranges
  - pre-commissioning tests
  - housekeeping precautions
  - accumulated energy safety awareness
  - desirable start sequence
- troubleshooting
  - problem solving techniques
  - during commissioning
  - under time pressure
- communication
  - PC to PC
  - PC to other controller/s
- solid state controller
  - schematic design of controller
  - component rationalisation
  - PCB layout
  - controller construction
  - EPROM programming
  - commission & troubleshoot

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

**OHS/WHS requirements** may include, but are not limited to:

- legislation
- protective equipment

- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements***

may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Components*** may include, but are not limited to:

- signal conditioning and actuator driver cards
- analog transducers
- hardware sequencing device
- computer interface cards
- sensors and actuators
- solid state controller

***Reference documents*** such as:

- industrial catalogues
- manufacturers guidelines
- charts and graphs
- computer spread sheets
- data sheets
- part number sheets

***Enterprise procedures*** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**Resources and equipment** may include, but are not limited to:

- sensors and actuators
- controller hardware
- power sources
- cabling and connectors
- equipment, parts and components
- PC controller and software
- hand and power tools
- drawings and reference documents
- testing and measuring equipment

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to interface and program a mechatronics system with solid-state hardware sequencing devices and personal computer interfacing on more than one occasion and in different contexts. At least two (2) analog inputs and one (1) analog output using a PC interface to assist in computing dependant output/input conditions is required.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations.  
The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, hardware /software equipment, materials and consumables

- access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## Robotics

Current versions of the units listed below may be found at **[training.gov.au](http://training.gov.au)**

MEM23126A - Evaluate industrial robotic applications
MEM234014A - Design a robotic system



## VU21232- Program, operate and select a robotics system

### Unit Descriptor

This unit of competency sets out the knowledge and skills required to program; operate and select a robotics system. This includes identification, installation and maintenance procedures, program simulated industrial applications, CAD techniques to program robots off-line and to download programs to robots.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a manufacturing enterprise where industrial robots are used as part of the production process.

Work associated with this unit of competency is carried out at a para-professional level.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Determine robot requirements

2. Install robot

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements and environmental requirements*** for a given work area are clarified..
- 1.2 Robot selection criteria are established with ***appropriate personnel***.
- 1.3 Robot ***features, specifications and system requirements*** are determined in accordance with selection criteria.
- 1.4 ***Safety features*** and risk control measures for robot and operating environment are established, in consultation with appropriate personnel.
- 1.5 Manufacturer's operating procedures and engineering drawings are interpreted to define robot function and tool path geometry.
- 2.1 OHS/WHS requirements for carrying out the work are followed.
- 2.2 Schedule for robot installation and commissioning is prepared.
- 2.3 Robot installation is coordinated with appropriate personnel.





- 2.4 **Resources and equipment** needed for the task are obtained in accordance with **enterprise procedures** and checked for correct operation and safety.
- 2.5 Unexpected situations are resolved with appropriate personnel, and in accordance with enterprise procedures.
- 2.6 Sensors are interfaced to robot, in accordance with established procedures.
- 2.7 Robot is programmed to interact with peripherals.
- 3. Program robot
  - 3.1 OHS/WHs requirements for carrying out the work are followed.
  - 3.2 Programming requirements are identified.
  - 3.3 Program plan is developed, in accordance with established procedures..
  - 3.4 **Programming method** is selected, as required.
  - 3.5 Coordinates are calculated for tool path or robot functions.
  - 3.6 Program is written in required language and in accordance with standard operating procedures.
  - 3.7 Safety features are incorporated in robot program.
  - 3.8 Operation sheet is prepared, in accordance with established procedures..
- 4. Trial robot
  - 4.1 OHS/WHs requirements for carrying out and completing the work are followed.
  - 4.2 Work site is made safe in accordance with established safety procedures.
  - 4.3 Robot and computer equipment are prepared for program trial.
  - 4.4 Program is trialled by operating robot in manual mode in conjunction with operator as appropriate.
  - 4.5 Program performance is verified against required specifications and with appropriate technical experts or other technical reference sources.
  - 4.6 Program is edited if necessary to adjust operation as required.
  - 4.7 Results are documented and work completion notified according to enterprise procedures.

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- consulting and communicating with others
- identifying and following relevant OHS/WHs procedures
- reading and understanding manufacturer's operating procedures and engineering drawings
- installing robot and robot peripherals
- selecting appropriate programming language and program a robot
- carrying out program trials
- verifying programmed robot performance
- creating and update documentation

### ***Required knowledge:***

- robot selection criteria and procedures
  - classification and application of industrial robots
  - features and components/mechanisms of robots
  - end effectors and applications
  - robot movements
  - drive systems
  - robot specifications, incl. capabilities, operating conditions, limitations
  - pre-selection planning
  - criteria in selecting a robot
- robot Installation
  - pre-installation planning
  - installation
  - layout
  - system documentation
  - safety factors esp to AS2939 -1987
- interfacing
  - interfacing with the robot controller
  - external memory
  - sensor
  - other peripherals
  - program control of interfacing
- robot sensors
  - type of sensors
  - sensor interfacing and compatibility
  - sensor programming
- trouble-shooting and diagnostic
  - control system
  - diagnostic function

- trouble-shooting and fault isolation
- procedures
- maintenance
  - preventative maintenance
  - maintenance scheduling
  - maintenance procedures
- programming robots
  - methods and procedures, incl. manual, walkthrough, leadthrough, off line, optical/vision or sensor systems
  - industrial and special applications e.g. palletising, machine interfacing
  - input/output signals
  - synchronisation
  - sub-routines
  - robots in FMS

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHs requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Features, specifications and system requirements*** may include, but are not limited to:

- components
- capabilities
- speed
- reach
- load carrying capacity
- accuracy/repeatability
- classification
- polar coordinate
- cylindrical coordinate
- Cartesian coordinate

- jointed elbow
- SCARA
- movements
- base
- shoulder
- elbow
- pitch
- roll
- yaw
- applications
- required operating conditions
- limitations
- justification
- safety features

**Safety features** including:

- AS2939 – 1987 – Industrial Robot Safety – Safe Design and Usage
- physical design
- enclosures
- layout
- programming
- sensing
- personnel

**Resources and equipment** may include, but are not limited to:

- sensors
  - micro-switches
  - limit switches
  - proximity switches

**Enterprise procedures** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**Programming method** may include, but are not limited to:

- manual
- walkthrough
- leadthrough
- offline
- optical/vision or sensor systems

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to program, operate and select a robotics system on more than one occasion and in different contexts.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

### Methods of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documentary evidence.

- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## VU22564 - Plan and manage a robotics system

### Unit Descriptor

This unit of competency describes the knowledge and skills required to select, install and commission robots for industrial application.

The unit includes planning and selecting the components, installation of the system, programming and interfacing with the controller, troubleshooting and diagnostic testing.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at para professional level in an engineering/manufacturing enterprise where industrial robots are being installed, commissioned and managed as part of the production process.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Determine robot system requirements

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements and environmental requirements*** for a given work area are clarified.
  - 1.2 Robot system requirements and parameters are established from discussions with ***appropriate personnel***, job specifications and relevant enterprise documentation.
  - 1.3 ***Functional specifications and other factors*** affecting the selection of robot system are identified.
  - 1.4 System options and alternatives are identified and evaluated with appropriate personnel.
  - 1.5 Most appropriate robot system is selected based on relevant scientific principles, production requirements, functional specifications/factors and discussions with appropriate personnel.
  - 1.6 Appropriate calculations and assumptions are used to enable methods, processes & construction techniques choices.
2. Plan robot system installation
  - 2.1 OHS/WHS requirements for carrying out the work are followed.
  - 2.2 Plan for implementation of the robot system is prepared, based on identified system requirements.



- 2.3 Installation and set-up requirements to establish system equipment within given environment are established and incorporated into plan.
- 2.4 **Resources and equipment** needed for the installation are obtained and coordinated in accordance with **enterprise procedures**.
- 2.5 Plan is reviewed to improve outcomes and overcome possible problems.
- 3. Install robot system
  - 3.1 OHS/WHS requirements for installation work are identified, including isolation requirements.
  - 3.2 Resources and equipment for system installation are obtained and checked for conformance to specification.
  - 3.3 Installation activities are managed/coordinated in accordance with implementation plan and enterprise procedures.
  - 3.4 Machines and equipment are set up/configured to meet specifications.
  - 3.5 Adjustments to robot components, peripherals and control systems are performed as necessary.
  - 3.6 Unexpected situations are resolved from discussions with appropriate personnel and reference to applicable documentation and enterprise procedures.
- 4. Perform on line programming of robot systems
  - 4.1 OHS/WHS requirements for carrying out the work are followed.
  - 4.2 On line programming requirements are identified.
  - 4.3 Program plan is developed.
  - 4.4 **Programming method** is selected, in accordance with established procedures.
  - 4.5 Coordinates are calculated for tool path or robot functions.
  - 4.6 Program is written in required language and in accordance with standard operating procedures.
  - 4.7 Safety features are incorporated in robot program.
  - 4.8 Operation sheet is prepared, in accordance with established procedures.
- 5. Perform off line programming (OLP) of robot systems
  - 5.1 OHS/WHS requirements for carrying out the work are followed.
  - 5.2 Suitability for off line programming is identified, with regard to robot type and kinematics as well as technical and economic considerations of OLP.
  - 5.3 CAD model of the work cell is produced.
  - 5.4 Robot-work interaction is simulated on CAD-system.
  - 5.5 OLP program is developed and verified on CAD-system.





- 5.6 OLP is downloaded in the robot controller.
- 5.7 OLP verification and calibration procedures are undertaken to ensure the OLP meets the robot-work interaction requirements.
- 6. Manage robot system
  - 6.1 Operational procedures and functional requirements of robot system are identified and clarified with appropriate personnel.
  - 6.2 Proven planning, control and organising techniques are applied to effectively manage the robot system and environment.
  - 6.3 OHS/WHS and industrial relations issues for all staff operating in a robot system environment are identified and managed.
  - 6.4 Staff training and development needs are identified and training initiated according to enterprise procedures.
  - 6.5 Robot system maintenance is scheduled in accordance with enterprise requirements, maintenance systems and manufacturer recommendations.

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- consulting and communicating with other team member involved in the robotics system installation
- identifying and following OHS/WHS procedures related to the task
- performing calculations to determine coordinates for tool path and robotic functions
- preparing an implementation plan for the installation and commissioning of robotics system
- setting up and configuring machines and equipment
- making component and system adjustments
- developing, verifying and downloading program for a robotic system
- preparing maintenance schedule for a robotic system

### ***Required knowledge:***

- robot selection criteria and procedures
  - classification and application of industrial robots
  - features and components/mechanisms of robots
  - end effectors and applications
  - robot movements
  - drive systems
  - robot specifications, incl. capabilities, operating conditions, limitations
  - technical and economic considerations of OLP
  - pre-selection planning



- criteria in selecting a robot
  - robot Installation
    - pre-installation planning
    - installation
    - layout
    - system documentation
    - safety factors esp to AS2939 -1987
  - interfacing
    - interfacing with the robot controller
    - external memory
    - sensor
    - other peripherals
    - program control of interfacing
  - robot sensors
    - type of sensors
    - sensor interfacing and compatibility
    - sensor programming
  - trouble-shooting and diagnostic
    - control system
    - diagnostic function
    - trouble-shooting and fault isolation
    - procedures
  - maintenance
    - preventative maintenance
    - maintenance scheduling
    - maintenance procedures
  - programming robots
    - on line methods and procedures, incl. manual, walkthrough, lead through, off line, optical/vision or sensor systems
    - industrial and special applications eg palletising, machine interfacing
    - input/output signals
    - synchronisation
    - sub-routines
    - robots in FMS
  - CAD/OLP
    - commercial software for 3D-modelling
    - part/component 3D-graphical representation in CAD format
    - robot and robot movement modelling
    - robot geometries and kinematic data from software libraries and robot supplier/manufacturer data
    - work points, motion type, path representation on computer model
    - OLP verification in CAD-format
    - post-processors for transfer of CAD-based OLP into robot-language format
- 



- verification of OLP in robot controller
- calibration of OLP to compensate for robot repeatability, component variations and part positioning tolerances
- OHS/WHS and human resources management
  - OHS/WHS issues relating to robot systems
  - risk identification and control
  - industrial relations issues
  - staff training within the scope of this unit

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include, but are not limited to:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- technical experts/specialists
- trainer
- mentor
- teacher
- team member

***Functional specifications and other factors*** may include:

- project limitations
- required application/end use

- location
- design, operation or system requirements
- safety requirements
- space
- utilities
- quantities/economies of scale
- enterprise requirements
- costs/budget/economy
- equipment integration
- total quality management considerations
- competitive manufacturing practices

**Resources and equipment** may include, but are not limited to:

- appropriate hand and power tools
- test and measuring equipment
- programming station or computer system
- appropriate connecting cables
- manufacturers' manuals and specifications
- consumables

**Enterprise procedures** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**Programming method** includes:

- manual
- walkthrough
- lead through
- offline
- optical/vision or sensor systems
- 

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge.

- Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to select, install and commission robots for industrial application. This includes:
    - installing robot and peripherals;
    - performing on line and off line programming; and
    - implementing an operational a robot system

#### **Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, robotic hardware/software equipment, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

#### **Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

## Fluid Power/Fluid Power Design Engineering

Current versions of the units listed below may be found at [training.gov.au](http://training.gov.au)

MEM09213A - Produce schematic drawings for hydraulic and pneumatic fluid power systems
MEM12023A - Perform engineering measurements
MEM18001C - Use hand tools
MEM18002B - Use power tools/hand held operations
MEM18052B - Maintain fluid power systems for mobile plant
MEM18055B - Dismantle, replace and assemble engineering components
MEM30010A - Set up basic hydraulic circuits
MEM30011A - Set up basic pneumatic circuits
MEM23115A - Evaluate fluid power systems
MEM234032A - Manage fluid power related technologies in an enterprise



# VU22565 - Set up fluid power controlled engineering systems

## Unit Descriptor

This unit of competency describes the knowledge and skills required to plan, set up and implement a fluid power controlled system.

The unit also includes testing and fault finding as well as the maintenance and repair of single and multi-actuator fluid power circuits.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency applies to a person working at para professional level in an industrial engineering/manufacturing enterprise where the application of fluid power is used to produce goods or services.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Plan implementation of a fluid powered controlled system

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements and environmental requirements*** for a given work area are determined
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are incorporated into the implementation plan.
- 1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 Requirements for implementing or maintaining a ***fluid power system*** are determined from documentation, reports, or clients and from discussions with appropriate personnel.
- 1.5 Fluid power system implementation or maintenance task is planned taking operational requirements into consideration and, if appropriate, documented.
- 1.6 Implementation or maintenance work is scheduled and operational consequences communicated to the appropriate personnel.
- 1.7 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.8 ***Resources and equipment*** needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.



- |   |     |   |
|---|-----|---|
| 2. Implement and maintain a fluid power controlled system | 2.1 | Relevant OHS/WHs requirements for carrying out the work are followed.   |
|   | 2.2 | Equipment/machines/plant is checked as being isolated where necessary in strict accordance with OH&S requirements.              |
|   | 2.3 | Implementation or maintenance task is carried out according to prepared work plan.  |
|   | 2.4 | Implementation/maintenance personnel are coordinated to perform the task in an efficient manner, if appropriate.                |
|   | 2.5 | Fluid power system is tested for functionality and, if required, faults are corrected in accordance with enterprise procedures. |
|   | 2.6 | Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.                 |
| 3. Conduct final testing and complete documentation       | 3.1 | Relevant OHS/WHs requirements for completing the work are followed.   |
|   | 3.2 | Work site is made safe in accordance with established safety procedures.  |
|   | 3.3 | Implementation or maintenance of the fluid power system is completed, and machinery/equipment is checked for correct operation. |
|   | 3.4 | Fluid power system implementation and maintenance task is documented and the appropriate personnel notified.                    |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- consulting and communicating with other team members
- identifying and following relevant OHS/WHs procedures
- planning and implementing a fluid power systems
- performing tests, correcting faults and commissioning a fluid power systems
- establishing a maintenance schedule for the system and completing documentation

### **Required knowledge:**

- fluid power system concepts
  - hydraulic and pneumatic
  - industrial fluids
- electrical principles and components for fluid power systems
  - counters
  - electro/pneumatic/hydraulic circuit drawings



- cascade/stepper circuits
- ladder diagrams
- system controllers
- electro/pneumatic/hydraulic circuits
- fault finding methods
- system controllers (PLC)
  - purpose
  - functions
  - timers
  - counters
  - input and output devices
  - programming
  - testing
  - debugging
  - commissioning
  - modifications
  - documentation
- linear Actuators
  - types (hydraulic and pneumatic)
  - methods of mounting linear actuators
  - regenerative operation of hydraulic, double-acting cylinders
  - calculations related to linear actuators
  - output force and speed
  - forces generated by cushioning
  - rod buckling and safe loads
  - recognition and drawing of standard symbols
  - observation and analysis of performance of linear actuators in laboratory circuits
- control valves (hydraulic and pneumatic)
  - directional controls (industrial and mobile)
  - common operators used
  - centre position flow paths
  - check valves
  - pressure controls
  - comparison of simple and balanced-piston relief valves
  - comparison of pilot operated check valves, counterbalance valves and over-centre valves as controls for vertical cylinder loads
  - flow controls
  - comparison of flow control in pneumatics and hydraulics
  - factors determining the flowrate of a liquid through an orifice
  - speed control due to metering
  - Selection of metering method for over-running or resistive loads
  - calculation
  - recognition and drawing of standard symbols for control valves

- drawing and analysis of typical circuits containing control valves
- observation and analysis of performance of valves in laboratory circuits
- circuit design and analysis (single linear actuator)
  - factors determining circuit type
  - variable or constant stroke velocities
  - total stroke and force application length
  - dwell times under load and between cycles
  - type of load
  - magnitudes of load and speed
  - control method required
  - control of vertical loads
  - calculation
  - pressures required
  - flowrates to and from actuator
  - power losses
  - forces delivered
  - flow line sizes
  - drawing and analysis
  - setting up and operating circuits
- hydraulic pumps
  - function
  - types (fixed and variable displacement)
  - gear, vane, piston
  - selection criteria
  - control method, pressure, flow, efficiency, life
  - calculations
  - power (mechanical and hydraulic)
  - displacement
  - speed
  - efficiency
- filters
  - function
  - contamination (forms/sources)
  - beta rating and efficiency
  - ISO 4406 solid contamination code
  - component contamination tolerance rating
  - element types
  - inlet
  - pressure
  - return
  - accessories
  - positioning in circuits

- air compressors
  - function
  - reciprocating and rotary designs
  - single and two stage operation
  - capacity control
  - Standard Reference Atmospheric Conditions (SRAC)
  - calculations of compressor capacity
  - safety
- receivers and aftercoolers
  - function
  - safety regulations, inspection and testing
  - air receiver ancillary equipment
  - circuit diagram
  - calculations
  - receiver size
  - SRAC volume
- rotary actuators (hydraulic and pneumatic)
  - function
  - types (fixed and variable displacement)
  - calculations
  - displacement
  - speed
  - flow
  - torque
  - power
  - efficiency
- accumulators
  - types
  - gas operated, piston and bladder
  - applications
  - auxiliary power source
  - emergency power source
  - leakage compensation
  - shock suppression
  - calculations
  - size accumulators using the isothermal and adiabatic gas laws
  - draw typical circuits for each application
  - safety requirements
  - fluid pressure release
  - pressure limiting
  - flow control
- hydrostatic transmissions

- function
- circuits
- open and closed
- single and bi-directional
- series and parallel connection
- ancillary equipment
- output characteristics (pump/motor)
  - fixed/fixed
  - fixed/variable
  - variable/fixed
  - variable/variable
- calculations
  - torque
  - speed
  - efficiency
- pneumatic circuit design
  - circuit interpretation
  - cascade circuit design
  - safety circuits
  - emergency stop
  - automatic retract
  - laboratory verification of circuit design
- hydraulic circuit design
  - circuit interpretation
  - design and draw circuits for:
    - single actuators
    - multiple actuators
  - perform calculations to:
    - size components and ancillary equipment
    - determine efficiency
  - select components from manufacturers data sheets

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

**OHS/WHS requirements** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements***

may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Fluid power system*** may include, but is not limited to:

- pneumatic systems
- hydraulic systems
- actuators
- transducers
- control valves
- pneumatic
- hydraulic
- hydraulic pumps
- filters
- air compressors
- hydrostatic transmissions

***Resources and equipment*** may include, but are not limited to:

- plant data
- log sheets
- production schedules
- operational and performance records
- maintenance schedules
- manufacturers' instructions, specifications and services manuals
- appropriate consumables and spare parts
- lubricants
- maintenance computer software
- appropriate hand and power tools
- test equipment

- measuring and aligning equipment
- computer equipment
- personal protective equipment

**Enterprise procedures** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### **Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to plan, implement and set up a fluid power controlled system in line with job requirements as well as conduct tests and correct faults on more than one occasion and in different contexts.

### **Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant testing equipment, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

# VU22566 - Design fluid power controlled engineering systems

## Unit Descriptor

This unit of competency describes the knowledge and skills required to design, construct and commission fluid power controlled engineering systems.

This includes a selection of components, component testing and troubleshooting, mechanical calculations, construction and commissioning of project models.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency applies to a person working at para professional level in an industrial engineering/manufacturing enterprise where the application of fluid power is used to produce goods or services.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Write a specification for a fluid power controlled engineering system

2. Select fluid power components

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 **Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements** and **environmental requirements** for a given work area are determined.
- 1.2 **System requirements** are identified in consultation with client.
- 1.3 Range of variables which will impact on the design are identified.
- 1.4 Specification document is prepared and clarified with **appropriate personnel**.
- 1.5 Appropriate personnel are consulted to ensure system requirements are accurately identified.
- 2.1 OHS/WHS requirements for carrying out the work are followed.
- 2.2 **Mechanical variables** integral to the design are calculated.
- 2.3 **Fluid power components** and design parameters are selected from applicable **reference documents** to meet the design specification, system calculations and to satisfy cost reliability and life requirements.
- 2.4 Actuator sizes, pressures, flow rates, and powers for the system are calculated and selected based on the system specification and the design parameters.
- 2.5 Control requirements for system are determined to meet **calculated control parameters**.





- |   |  |
|---|--|
| 3. Design fluid power controlled engineering system     | <p>3.1 Suitable design to meet the system requirements is developed.</p> <p>3.2 Feasibility of proposed design is determined based on calculation summary and relevant diagrams.</p> <p>3.3 System design is optimized using relevant calculations, to reduce flows, pressures and powers.</p> <p>3.4 Appropriate methods of handling heat loss are selected based calculated heat loss under the worst load conditions.</p> <p>3.5 Appropriate filtration system is selected, based on environmental and system requirements.</p> <p>3.6 Line sizes in the system are determined based on calculated pressures and line velocities.</p> <p>3.7 Design documentation and report are prepared with all <b>relevant design information</b>.</p>  |
| 4. Construct fluid power controlled engineering system  | <p>4.1 Schedule for installation and commissioning is prepared.</p> <p>4.2 System or working model is constructed according to the system design documentation.</p> <p>4.3 System and control components are obtained and checked for correct operation.</p> <p>4.4 <b>Tools, equipment and other resources</b> needed for the construction task are obtained in accordance with <b>enterprise procedures</b> and checked for correct operation and safety.</p> <p>4.5 Installation is coordinated with appropriate personnel.</p> <p>4.6 Unexpected situations are resolved with appropriate personnel, and in accordance with enterprise procedures.</p> <p>4.7 OHS/WHs requirements, relevant Australian Standards, codes of practice, manufacturers' specifications, environmental requirements and enterprise procedures are identified and followed.</p> |
| 5. Commission fluid power controlled engineering system | <p>5.1 Pre-start requirements are performed according to manufacturer documentation and system requirements.</p> <p>5.2 System is started, run and set to operating pressures and flows, observing all applicable safety requirements.</p> <p>5.3 System is tested using appropriate instruments and methods.</p> <p>5.4 Causes of failure are identified (if any) and problems rectified in consultation with appropriate persons.</p> <p>5.5 Preventative maintenance requirements are identified.</p> <p>5.6 Commissioning documentation is completed and work completion notified according to enterprise procedures.</p>  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- consulting and communicating with other team members involved in the project
- identifying and following relevant OHS/WHs procedures
- writing specifications for a system that meets client requirements
- designing fluid power controlled engineering system
- selecting components and constructing a fluid power controlled system
- testing and bringing system into operation
- establishing preventive maintenance requirements and completing documentation

### ***Required knowledge:***

- component selection
  - cylinders - hydraulic and pneumatic
  - hydraulic motors
  - air motors
  - hydraulic directional control valves
  - pneumatic DCV
  - pressure controls
  - characteristics of pressure controls
  - mounting types
  - pump
  - air compressors
  - air receivers
  - reservoir
  - filtration
- line size
  - Bernoulli
  - Reynolds number
  - Moody diagram
  - friction factor
  - line velocity
  - pipe fittings
- specifications
  - final product
  - machine Needs
  - safety
  - type of control
  - life and reliability
  - reliability

- available services available
- environment
- dust
- Chemical
- flammable liquids
- flammable gases or vapours
- standards
  - o AS3900
  - o AS standards in fluid power
  - o local standards
  - o DLI, OH & S
- mechanical calculations
  - components of forces
  - acceleration and deceleration
  - friction
  - winch drives
  - vehicle drives
  - rolling resistance
  - gear, chain and belt drives
- design philosophy
  - pressure selection
  - quality of components
  - lubrication or non-lubricated pneumatics
  - maintenance
  - cost
  - circuit diagram
- initial design factors
  - pressure, force, area
  - area, speed, flow rate
  - pressure, flow rate, power
  - air consumption
- comparison of methods
  - high - low
  - regenerative
  - accumulator
  - single pump
  - multi pump
  - kicker cylinder
- optimising design
  - reduce flows, pressures and powers
  - change the design parameters
  - change times

- compromise
- control requirements
  - position
  - force and torque
  - speed
  - acceleration/deceleration
  - constant power
  - decompression
  - documentation
    - solenoid charts
    - PLC logic statements
- flow controls
  - mounting methods
  - servo valve design and selection
- testing
  - instrumentation
  - methods
  - components
  - causes of failure
  - rectification
- commissioning
  - initial settings
  - bleed out air
  - flushing
  - starting procedures
  - setting pressures and flows
  - preventative maintenance

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions

- excessive energy and water use
- excessive noise

**System requirements** may include, but are not limited to:

- cost
- life of machine
- safety
- type of control
- proposed location

**Appropriate personnel** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

**Mechanical variables** may include, but are not limited to:

- acceleration and deceleration
- friction
- components of forces and moments of forces
- ratios and efficiencies of mechanical drives
- actuator forces, torques and speeds

**Fluid power components** may include, but are not limited to:

- control valves
- manifolds
- electro-hydraulic controls
- fluid conductors
- pumps and reservoirs
- motors
- cylinders, actuators and switches
- sensors
- filters, regulators and lubricators
- fluid conductors
- fittings
- grippers
- compressors, pumps & accumulators

**Reference documents** may include, but are not limited to:

- manufacturers catalogues
- charts
- computer spread sheets or nomographs
- data sheets
- performance curves
- part number sheets

**Calculated control parameters** may include, but are not limited to:

- natural frequency
- response time
- accuracy and loop gain

**Relevant design information** may include, but is not limited to:

- sequence of operations
- flow chart of the process
- sketch of the general arrangement of the equipment used
- materials and parts
- calculation summaries
- schematic circuit diagrams
- project construction schedule

**Tools, equipment and other resources** may include, but are not limited to:

- hand tools
- power tools
- measuring equipment
- test equipment
- spare parts
- consumables
- drawings & specifications
- data sheets
- testing procedures

**Enterprise procedures** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets,, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHs procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to design, construct and commission a fluid power controlled engineering system on more than one occasion and in different contexts. This includes:
    - designing the system
    - selecting components
    - installing and commission the system.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant fluid controlled system components, testing equipment, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals.

### Methods of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include the demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.

- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



# VU22499 - Apply hydraulic principles to achieve an engineering task

## Unit Descriptor

This unit of competency describes the knowledge and skills required to apply hydraulic principles to achieve an engineering task.

The unit includes selecting system components, construction of the hydraulic system and machine control circuitry, system operation, testing, fault finding and routine maintenance requirements.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency applies to a person working at para professional level in an industrial engineering or manufacturing enterprise where the application of hydraulic principles forms part of production goods or services.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Apply hydraulic principles to plan, conduct, or complete an engineering task

2. Determine hydraulic requirements when planning engineering task

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHs) requirements and environmental requirements*** for a given work area are determined.
- 1.2 Applications of hydraulics to engineering activities are provided
- 1.3 Hydraulic units, terms and symbols are recognised and applied correctly.
- 1.4 Hydraulic circuit diagrams are interpreted and the operation of the circuit explained to ***appropriate personnel***.
- 1.5 Concept/principles of hydraulic transmission and circuit design are applied as appropriate to the given engineering task.
- 1.6 Potential hydraulic hazards are identified and reported according to ***enterprise procedures***.
- 1.7 Safety and risk control measures are applied when working with hydraulics.
- 2.1 OHS/WHs requirements for carrying out the work are followed.
- 2.2 Hydraulic circuits, transmission systems and operating parameters are developed and constructed for the given engineering task.



- 2.3 **Hydraulic transmission, fluid conveying and control components** are selected from manufacturers' catalogues and other relevant documentations to suit the operating parameters of the system.
  - 2.4 Hydraulic requirements for the engineering task are confirmed as required with appropriate personnel.
  - 2.5 Required **resources and equipment** are obtained in accordance with enterprise procedures and checked for correct operation.
  - 2.6 Appropriate measurement devices are used to measure hydraulic pressure and flow.
  - 2.7 Hydraulic measurements and calculations are performed and interpreted correctly.
  - 2.8 Unexpected situations are resolved with appropriate personnel, and in accordance with enterprise procedures.
3. Install, operate and test hydraulic equipment and devices
  - 3.1 OHS/WHs requirements, codes of practice, manufacturer's specifications, environmental requirements and enterprise procedures are identified and applied.
  - 3.2 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
  - 3.3 Hydraulic equipment is installed and set up to operate for the purpose intended and in according to manufacturers' operating instructions.
  - 3.4 Testing and fault tracing on hydraulic and electro-hydraulic components and systems is performed in a safe manner.
  - 3.5 Preventative maintenance requirements are identified and a routine maintenance plan is prepared
  - 3.6 Work completion notified in according to enterprise procedures

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- consulting and communicating with other team members involved in the task
- identifying and following relevant OHS/WHs procedures
- interpreting circuit diagrams
- constructing hydraulic circuits and transmission systems
- performing hydraulic pressure and flow measurements and related calculations
- operating hydraulic equipment and devices



- performing testing and fault tracing on hydraulic and electro hydraulic equipment

**Required knowledge:**

- components
  - control valves
    - direction
    - pressure
    - flow
    - actuators
    - cylinders
  - manifolds
  - electro-hydraulic controls
  - fluid conductors
  - pumps and reservoirs
  - motors
- hydrostatic transmission
  - circuits
  - concepts
  - output characteristics(pump/motor)
- hydraulic circuitry
  - machine control circuits
  - symbol identification
  - circuit interpretation
  - operating parameters
- servicing
  - routine maintenance requirements
  - testing and fault tracing

**RANGE STATEMENT**

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements***

may include but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental***

***requirements*** may include but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise



**Appropriate personnel**  
may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

**Enterprise procedures**  
may include but are not  
limited to:

- the use of tools and equipment
- instructions, including job sheets,, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures
- work completion procedures

**Hydraulic transmission,  
fluid conveying and  
control components**  
including:

- control valves
- direction
- pressure
- flow
- actuators
- cylinders
- manifolds
- electro-hydraulic controls
- fluid conductors
- pumps and reservoirs
- motors

**Resources and  
equipment** may include  
but are not limited to:

- tools and equipment
- testing equipment
- measurement devices
- components and parts
- circuit diagrams and other reference documents



## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to apply hydraulic principles by planning, constructing and testing a hydraulic system and machine control circuitry to achieve an engineering task on more than one occasion.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations.
- The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant equipment, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

### Methods of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.



- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22500- Apply pneumatic principles to achieve an engineering task

### Unit Descriptor

This unit of competency describes the knowledge and skills required to apply pneumatic principles to achieve an engineering task.

The unit includes planning, construction, testing and maintenance of pneumatic system and machine control circuitry.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at paraprofessional level in an industrial engineering or manufacturing enterprise where the application of pneumatics technology forms part of production of goods or services.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Apply pneumatic principles to plan, conduct or complete engineering tasks

2. Determine pneumatic requirements when planning engineering task

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements and environmental requirements*** for a given work area are determined.
  - 1.2 Applications of pneumatics to engineering activities are provided as required
  - 1.3 Pneumatic units, terms and symbols are recognised and used correctly.
  - 1.4 Pneumatic circuit diagrams are interpreted and the operation of the circuit explained to ***appropriate personnel*** in the work place.
  - 1.5 Concept/principles of pneumatics and circuit design are applied as appropriate to the given engineering task.
  - 1.6 Potential pneumatic hazards are identified and reported according to ***enterprise procedures***.
  - 1.7 Safety and risk control measures are applied when working with pneumatics.
- 
- 2.1 OHS/WHS requirements for carrying out the work are followed.
  - 2.2 Pneumatic circuits and operating parameters are developed and constructed for the given engineering task.



- 2.3 **Pneumatic plant, fluid conveying and control components** are selected from manufacturer catalogues and other relevant documentations to suit the operating parameters of the system.
    - 2.4 Pneumatic requirements for the engineering task are confirmed as required with appropriate personnel.
    - 2.5 **Resources and equipment** needed for the task are obtained in accordance with enterprise procedures and checked for correct operation and safety.
    - 2.6 Appropriate measurement devices are used to measure pneumatic pressure and flow.
    - 2.7 Pneumatic measurements and calculations are performed and interpreted correctly.
    - 2.8 Unexpected situations are resolved with appropriate personnel, and in accordance with enterprise procedures.
  3. Operate and test pneumatic equipment and devices
    - 3.1 OHS/WHS requirements, relevant Australian Standards, codes of practice, manufacturers' specifications, environmental requirements and enterprise procedures are identified and adhered to.
    - 3.2 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
    - 3.3 Pneumatic equipment is installed and set up to operate safely for the purpose intended according to manufacturers' operating instructions.
    - 3.4 Testing and fault tracing on pneumatic components and systems is performed in a safe manner.
    - 3.5 Preventative maintenance requirements are identified and a routine maintenance plan is prepared.
    - 3.6 Work completion notification is carried out in accordance to enterprise procedure.

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required Skills:**

- consulting and communicating with other team members involved in the task
- identifying and following relevant OHS/WHS procedures
- interpreting pneumatic circuit diagrams
- reading and interpreting pneumatic equipment and components manufacturers' catalogues
- using measuring devices and performing calculations
- installing testing, fault tracing and operating pneumatic equipment
- performing routine maintenance pneumatic system and machine control circuitry.





**Required Knowledge:**

- pneumatic circuitry/plant
  - applications of pneumatics to engineering
  - cascade/stepper circuit design
  - machine control circuits
    - interpretation
    - construction
    - design
  - safety circuits
    - two hand start
    - guard interlock
    - workpiece location
    - emergency stop
- special machines/equipment
  - integral machine circuits
    - drill/feed
    - rotary indexing table
    - strip feeder
  - production aids
    - air collets
    - air pallets
    - tactile devices
    - grippers
    - vacuum heads
  - surface preparation
    - shot blasting
    - spray painting
- system analysis
  - circuitry
    - layout
    - numbering
    - alphabetic designation
    - cascade/stepper circuitry
    - specified and actual air data
    - usage
    - pressure drop
    - loss/leakage
    - flow rates
- circuit documentation
  - motion diagrams
    - displacement-step
    - displacement-time



- control
- written forms
  - tabular listing
  - sequence chart
  - function chart
- fluid logic componentry
  - elements
  - sequencers
  - sensors
- fluid logic circuitry
  - development
  - interpretation
  - construction
- design concepts
  - machine concept
  - control system concept
  - numerical systems
  - numerical codes
  - design process
  - control equation synthesis
  - signal flow
  - equation minimization
- maintenance and servicing
  - maintenance requirements
    - preventative
    - overhaul
  - testing and fault tracing
  - maintenance documents
- safety
  - hazards
  - risk control measures
  - treatment aids
  - machine safe operation
  - personal protective equipment and safety devices



## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHs requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include, but are not limited to:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Enterprise procedures*** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

***Pneumatic transmission, fluid conveying and control components*** may include, but are not limited to:

- cylinders, actuators and switches
- control valves
- solenoid
- pneumatic
- mechanical
- automatic
- sensors



- filters, regulators and lubricators
- fluid conductors
- fittings
- grippers
- compressors, pumps and accumulators/reservoirs

**Resources and equipment** may include' but are not limited to:

- tools and equipment
- testing equipment
- measurement devices
- components and parts
- circuit diagrams and other reference documents

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### **Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to apply pneumatic principles by planning, constructing and testing a pneumatic system and machine control circuitry to achieve an engineering task on two occasions.

### **Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant components, equipment, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals



**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU21545 - Evaluate proportional and servo controlled fluid power systems

**Unit Descriptor** This unit provides the knowledge and skills to enable participants to design and draw/construct electro-proportional and servo control circuit diagrams.

Participants will prepare, construct and evaluate electro-proportional and servo circuit capabilities against given system specifications and performance guidelines.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

**Employability Skills** This unit contains Employability Skills.

**Application of the Unit** This unit would be applied by those involved in the optimisation and performance evaluation of electro-proportional and servo control systems. It involves the interpretation, capability assessment, and review of a design brief, the confirmation of functional schematics, documentation and supporting calculations. The preparation and evaluation of industry-based, test rigs or simulation bench electro-fluid power control circuit and systems, their componentry and their dynamic application under load conditions in accordance with recognised industry best practice.

It is suitable for fluid power system and automation designers and maintenance personnel, and those advancing engineering or related qualifications and careers.

**Pre- Requisites**

MEM23006A	Apply fluid and thermodynamics principles in engineering
VU21546	Monitor and adjust an integrated fluid power control system
VU21547	Select components for an integrated fluid power design project
VU21548	Install and commission an integrated fluid power system
VU21270	Implement control processes using PLC's

### Element

Elements describe the essential outcomes of a unit of competency

### Performance Criteria

Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide

- |  |  |
|--|--|
| 1. Establish a requirements and performance brief. | 1.1 All health, safety and workplace practices for the evaluation task are mapped and tested against recognised industry best practice and codes of practice, prior to commencing the evaluation |
|--|--|



- 1.2 The evaluation briefs for the proportional and servo controlled **fluid power systems** are obtained and analysed
- 1.3 The functional requirements and dynamic characteristics for the effective operation of proportional and servo controlled fluid power systems are determined.
- 1.4 The proportional and servo controlled fluid power systems evaluation brief and specified outcomes are confirmed with the client.
2. Prepare and test a production system test facility or simulation test rig.
  - 2.1 A functional schematic diagram is produced showing system flow, key electro-fluid power components and control logic circuit overview.
  - 2.2 A **time-displacement diagram** of the system functions is tested and confirmed
  - 2.3 A **control logic diagram** for the system is tested and confirmed
  - 2.4 Specifications of all electro-fluid power components are determined and or confirmed by calculation, reference to manufacturer's data sheets and use of charts and graphs.
  - 2.5 The **ramp time** for both linear and rotary actuator circuits is calculated and the envisaged dynamic characteristics of the system are recorded.
  - 2.6 The maximum flow rates for linear and rotary actuator circuits are calculated for **accelerating and decelerating loads** and an appropriate **proportional servo valve** or valve spool option is selected
  - 2.7 The pressure in linear actuator circuits is calculated using established procedures and consideration for both decompression and pressure intensification rates and safety margins
  - 2.8 An electro-fluid power control production system test facility or a simulation of the circuit and control system is **dynamically tested** and evaluated and the systems functionality, characteristics and performance data are logged against specifications
  - 2.9 All required components for the electro-fluid power control and system circuit are identified, sourced and supporting test data recorded and stored
3. Develop an evaluation response plan and preparation for rectification
  - 3.1 Electro-fluid power control circuit and system performance outcomes are data logged, recorded in accordance with guidelines and all variances to specification/s are identified.



- 3.2 **Root cause analysis** of individual variances to specification are conducted using **relevant personnel**, methodologies and recorded data
- 3.3 A recommendations strategy for rectification, recommissioning and re-evaluating the electro-fluid power control and system circuit to specification is produced by relevant personnel
4. Report findings and recommendations
  - 4.1 All revised documentation and specifications arising from the evaluation testing of the electro-fluid power production system test facility; or a simulation of the control circuit and system are recorded
  - 4.2 A final evaluation report is prepared including all findings and recommendations arising from the root cause analysis process and the outcomes against specifications
  - 4.3 Relevant personnel are briefed to support the revised control circuit and system modifications
  - 4.4

## Required Skills and Knowledge

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

### **Required skills:**

- analysing electric/electronic circuits in relation to PLCs
- identifying dangers associated with proportional and servo fluid power circuits
- analysing system functional requirements
- interpreting, designing, drawing and constructing suitable electric and fluid power circuit diagrams
- utilising proportional and servo valves in fluid power circuits
- utilising proportional valves for open and closed loop pump control
- utilising data logging and supporting software
- calculating PID control optimisation

### **Required knowledge:**

- dangers associated with fluid power circuits, especially with regard to electro fluid power control and systems
- proportional and servo control for logic element technology applications
- electro-proportional control hydrostatic-transmission characteristics and dynamics
- standard symbols for fluid power circuits, including:
  - pneumatic circuits
  - hydraulic circuits
  - PLC circuits
- types of proportional valves, including pressure, flow and directional-control valves
- electronic controls, including:
  - proportional solenoids
  - position sensors - Linear variable displacement transducers (LVDT)
  - valve amplifiers – principles, features and set points





- design considerations, such as:
  - open loop versus close loop characteristics
  - proportional and servo spool options, characteristics, valve power limits and pressure ratios
  - proportional and servo - travel function, flow function, pressure function
  - velocity erosion and proportional and servo valve filtration
  - load compensation
  - acceleration and deceleration forces
  - natural frequency of system
  - calculation of flow rate and pressure drop
  - Nyquist stability calculations
  - natural frequency
  - frequency response
  - proportional and servo control systems within accumulator circuits
  - hysteresis
  - reversal error
  - response sensitivity
  - pressure compensation
  - bode diagram – amplitude frequency relationship and phase frequency relationship
  - proportional and servo control for logic element technology applications
  - comparison pump-motor control characteristics of closed loop hydro-static transmissions
  - angular velocity and angular position
  - decompression, regeneration and pressure intensification in proportional and servo valve fluid power systems
  - thermal considerations within proportional and servo control fluid power systems
  - noise abatement and evaluation

## Range Statement

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording in the Performance Criteria is detailed below. Add any essential operating conditions that may be present with training and assessment depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts.

- Fluid power system*** refers to:
- a system that has a pump driven by a prime mover (such as an electric motor or IC engine) that converts mechanical energy into fluid energy.
  - fluid flow is used to actuate various devices, such as cylinders or motors
- Time-displacement diagram*** means:
- volume of fluid that is moved by a hydraulic pump in one cycle
- Control logic diagram*** refers to:
- diagrams that are specialized schematics commonly used to document industrial control logic systems. They are called "ladder" diagrams because they resemble a ladder, with two vertical rails (supply power) and as many "rungs" (horizontal lines) as there are control circuits to represent



<b>Ramp time</b> refers to:	<ul style="list-style-type: none"> <li>the time taken for a motor or a hydraulic pump to reach its maximum output</li> </ul>
<b>Accelerating and decelerating loads</b> refers to:	<ul style="list-style-type: none"> <li>the change in condition encountered by both the fluid and the structural components within the fluid power circuit as a load is accelerated then decelerated</li> </ul>
<b>Proportional Servo valve</b> includes:	<ul style="list-style-type: none"> <li>pressure valves</li> <li>flow valves</li> <li>directional-control valves</li> </ul>
<b>Dynamically tested</b> refers to:	<ul style="list-style-type: none"> <li>the testing and evaluation process is conducted with the fluid power system under full load and operational conditions</li> </ul>
<b>Root cause analysis</b> refers to:	<ul style="list-style-type: none"> <li>the standardised methodology of breaking a problem down to its smallest parts to identify the cause of a problem</li> </ul>
<b>Relevant personnel</b> may include:	<ul style="list-style-type: none"> <li>Sales engineers</li> <li>Applications engineers</li> <li>Production personnel</li> <li>Service management</li> <li>Maintenance personnel</li> <li>Customers</li> <li>Technicians</li> </ul>

## Evidence Guide

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

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - identify dangers associated with electro-fluid power control circuits and systems
  - design and calculate electro-proportional and servo valve control circuits and their supporting systems
  - determine the dynamic functional requirements of electro-fluid power control circuits and systems
  - safely and effectively evaluate electro-proportional and servo valve fluid power control circuits and systems against specifications
  - incorporate proportional valves and servo valves in both open loop and closed loop fluid power systems, including hydro-static transmissions



**Context of and specific resources for assessment**

- prepare and present detailed and concise technical reports
- be able to interpret variances in complex electro-proportional and servo valve control circuits and systems
- relate effectively to customer requests
- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Method of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documentary evidence.
- Where performance is not directly any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



# VU21546 - Monitor and adjust an integrated fluid power control system

**Unit Descriptor** This unit provides the knowledge and skills to enable participants to monitor instrumentation and transducers within an integrated fluid power control system involving detection, measurement and adjustment of control process variables.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

**Employability Skills** This unit contains Employability Skills.

**Application of the Unit** This unit would be applied by those involved in monitoring and adjusting elements of an integrated fluid power process control system. It involves identifying, selecting, and adjusting a range of hardware items including instrumentation, transducers, sensors, control valves and the communication sub-system. It is suitable for people working as fluid power technicians or system designers, draftspersons and maintenance personnel, and those pursuing careers and qualifications in engineering or related disciplines.

**Pre- Requisites**

MEM23006A Apply fluid and thermodynamics principles in engineering

VU21270 Implement control processes using PLC's

VU21547 Select components for an integrated fluid power design project

## Element

Elements describe the essential outcomes of a unit of competency

## Performance Criteria

Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide

- |  |   |
|--|---|
| <p>1. Identify the elements of a process control system</p>        | <p>1.1 The function of the <b><i>process control</i></b>, monitored <b><i>process variables</i></b> and <b><i>instrumentation</i></b> are identified</p> <p>1.2 <b><i>Communication links</i></b> and protocols for the workplace are identified</p> <p>1.3 Types of <b><i>signal</i></b> within the control system are determined</p> <p>1.4 System infrastructure is inspected and static, and dynamic tests are completed to ensure capacity of the system to sustain calculated performance-characteristics</p> |
| <p>2. Select appropriate means of control function measurement</p> | <p>2.1 The accuracy of measurement is determined and the nature and range of error specified.</p> <p>2.2 Closed-loop control optimisation calculations are completed to confirm control dynamics against specifications</p> <p>2.3 Recommendations are prepared to optimise integrated fluid power process control system performance</p>   |



- |   |  |
|---|--|
| 3. Monitor and adjust the control process | 3.1 Readings, measurements and data logging are performed to ascertain the limits of accuracy of the instrumentation and control system employed.<br>3.2 <b>Calculations</b> involving measured process control variables are performed to determine performance.<br>3.3 Adjustments to hardware items are made to restore the system to be within calibration limits.<br>3.4 Status reports are completed and presented to relevant parties |
| 4. Report results                         | 4.1 Findings and recommendations are stored in the relevant project data base<br>4.2 Outcomes and recommendations are built into project team briefings<br>4.3 Existing process control project documentation, standard operating procedures (SOP's) and bill of materials (BOM's) are updated   |

## Required Skills and Knowledge

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

### **Required Skills:**

- identifying process control variables, systems, topologies and multivariable systems
- using instrumentation to detect and measure control variables
- setting up and adjusting transducers, sensors and valves
- identifying and adjusting on-off control, multi-step and proportional integrative and derivative (PID) characteristics
- identifying and monitoring communication signals (analog, digital and pneumatic), links and protocols
- demonstrating the application of correct safety and protection procedures
- testing and replacement of closed-loop driver card

### **Required Knowledge:**

- control variable definitions, quantities and units:  
i.e.
  - temperature
  - pressure
  - flow
  - level
  - density
- control variable detection
- use of instrumentation
- control variable measurement



- process control systems
  - variables, systems, topologies, multivariable systems
  - transducers, sensors, valves
  - on-off control, multi-step, Proportional Integrative and Differential (PID)
  - communication signals (analog, digital and pneumatic), links and protocols
  - closed-loop driver card specifications, applications and installation
- protection and Safety
  - lightning and surge protection
  - static damage
  - minimisation of induced EMFs
  - piping and instrumentation Drawings
  - IEC and ISO standards of protection
  - IEC and NEMA enclosure standards

## Range Statement

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording in the Performance Criteria is detailed below. Add any essential operating conditions that may be present with training and assessment depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts.

***Process control*** may include:

- continuous processes such as oil refining, paper manufacturing, chemical production, energy plants etc

***Process variables*** may include:

- temperature, pressure, flow, chemical properties, level, density etc

***Instrumentation*** may include, but is not limited to:

- instruments for measuring
  - temperature
  - pressure
  - flow
  - chemicals
  - level
  - density

***Communication links*** such as:

- SAP
- SCADA
- Ethernet/IP
- Distributive Control Systems
- Wireless
- PLC's
- GPS
- CANBUS

***Signal*** may include:

- pneumatic
- digital
- analog



**Calculations** may include:

- unit conversion
- integrated system harmonics
- calculation of (not inclusive)
  - ppm
  - Reynolds number
  - pressure elevation and suppression
  - relative gas density
  - energy conservation and efficiencies
  - loop dynamics (open versus closed) etc

## Evidence Guide

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

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- To be considered competent in this unit the candidate must provide evidence that they can achieve all of the elements of competency to the level specified by the associated performance criteria by using the required skills and knowledge. Specifically they must provide evidence that they can:
  - identify dangers and hazards associated with making measurements and adjustments to process control system variables
  - select and apply an integrated fluid power closed-loop process control system to project specifications
  - calculate an integrated fluid power process control systems dynamic performance profile against project specifications
  - complete a data logging profile for an integrated fluid power process control system
  - identify control variables
  - select and use correct instrumentation
  - set up and adjust control system hardware

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions
  - access to workplace or work real environment and a variety of conditions



- operational access to relevant machines, tools, materials and consumables
- access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Method of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documentary evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.





## VU21547 - Select components for an integrated fluid power design project

**Unit Descriptor** This unit provides the knowledge and skills to enable participants to correctly select components for the design, modification and performance improvement of integrated fluid power systems.

The unit requires the calculations, the sizing and the selection of components to meet design specifications.

The components must be compatible with the integrated control system selected.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

**Employability Skills** This unit contains Employability Skills.

**Prerequisites** MEM23006A Apply fluid and thermodynamic principles in engineering

VU21546 Monitor and adjust an integrated fluid power control system

**Application of the Unit** This unit would be applied by those involved in designing and modifying integrated fluid power systems. It involves the application of both system design and reverse engineering concepts.

It is suitable for people working as fluid power technicians or system designers, draftspersons, maintenance personnel and those pursuing careers and qualifications in engineering or related disciplines.

### Element

Elements describe the essential outcomes of a unit of competency

### Performance Criteria

Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement.<sup>1</sup> Assessment of performance is to be consistent with the evidence guide

- |  |  |
|--|--|
| <p>1. Select hydraulic and pneumatic components</p>                            | <p>1.1 Suitable hydraulic and pneumatic components are chosen from manufacturer's catalogues using <b>relevant data</b></p> <p>1.2 The selection of the hydraulic and pneumatic components is verified to meet the system specifications and requirements</p> <p>1.3 Components are selected in accordance with <b>specific criteria</b></p> |
| <p>2. Address servo valve or proportional valve applications in the system</p> | <p>2.1 The <b>parameters</b> for the proportional and servo valves in the system are calculated</p> <p>2.2 Servo and proportional valves are chosen from manufacturer's catalogues based on data sheets, performance curves and part number sheets</p>   |



- 2.3 The selection of servo and proportional valve is verified to meet the system specifications and requirements
3. Determine the heat losses in the hydraulic system
  - 3.1 The **heat load** in the hydraulic system is calculated
  - 3.2 Methods for handling the heat load are investigated
  - 3.3 Changes are made to the hydraulic system, as required, to reduce the heat load and to optimise energy conservation
  - 3.4 The calculation of heat exchanger capacity, heat exchanger type and model, and its location within the circuit is specified
  - 3.5 Environmental and system requirements that affect filtration selection are identified
  - 3.6 The location and type of reservoir necessary to meet the system requirements are confirmed and documented
  - 3.7 The needs of the reservoir and its related components are calculated and selected based on the system specifications
4. Determine the variables affecting pressure drops
  - 4.1 A **range of data** is used to determine the variables affecting pressure drops in valves, lines and fittings
  - 4.2 Suitable line velocities are selected on the basis of mitigating the effects of pressure drop variables
  - 4.3 Line sizes are calculated for all actuators on the basis of line velocity, fluid type and densities, taking into account both pump and return flows
5. Confirm that the system reliability meets specification
  - 5.1 System reliability is calculated based on manufacturer's information, system application and environmental variables
  - 5.2 Recommendations are prepare to enable system reliability to meet design specifications
  - 5.3 The system is modified, as required, to ensure that the reliability factor is met
6. Optimise the system to improve performance and/or reduce costs
  - 6.1 System problems are identified where the design is cumbersome, expensive, inefficient and potentially unreliable
  - 6.2 The system is improved by changing the design characteristics, if required
  - 6.3 The optimum design is documented in accordance with enterprise/client requirements and industry best practice



## Required Skills and Knowledge

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

### **Required skills:**

- writing specifications for fluid power systems
- calculating various parameters from the system specifications
- reading circuit diagrams and manufacturer's catalogues
- analysing relevant data in order to make an appropriate selection of components
- optimising the fluid power system
- solving problems , in terms of modifying system design to reduce heat loads etc
- selecting suitable components for optimising the system performance
- maintaining good customer relations

### **Required knowledge:**

- relevant Occupational Health and Safety requirements
- specifications for fluid power systems
- calculations associated with the various parameters of a fluid power system
- design philosophy
- optimisation techniques for integrated fluid power systems
- Bernoulli's formula
- Moody diagram
- energy conservation
- Proportional Integrative and Differential Servo/Proportional valve calculations
- All Gas Law's

## Range Statement

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording in the Performance Criteria is detailed below. Add any essential operating conditions that may be present with training and assessment depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts.

**Relevant data** may include:

- Data sheets
- Performance curves
- Nomographs
- Pressure drop curves
- Flow rate curves
- Part number sheets

**Specific criteria** includes:

- Client system performance specifications
- Specified system control parameters
- Application based environmental factors

**Parameters** may include:

- Natural frequency
- Response time
- Accuracy



**Heat load** refers to:

- Loop gain
- Heating of hydraulic fluid operation is caused by inefficiencies.
- Inefficiencies result in losses of input power, which are converted to heat.
- If the total input power lost to heat is greater than the heat dissipated, the hydraulic system will eventually overheat

**Range of data** may refer to:

- Bernoulli's formula
- Moody diagram
- Pressure drop formula
- Line velocities
- Line sizes
- Pump flow

## Evidence Guide:

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

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- To be considered competent in this unit the candidate must provide evidence that they can achieve all of the elements of competency to the level specified by the associated performance criteria by using the required skills and knowledge. Specifically they must provide evidence that they can:
  - write specifications for fluid power systems
  - perform calculations of servo and proportional valve parameters from the specifications
  - minimise heat load problems in hydraulic systems
  - calculate pressure drops and flow rates in fluid power systems
  - select appropriate components for the fluid power system using manufacturer's catalogues
  - optimise the fluid power system performance

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions



- access to workplace or work real environment and a variety of conditions
- operational access to relevant machines, tools, materials and consumables
- access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Method of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documentary evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



# VU21548 - Install and commission an integrated fluid power system

## Unit Descriptor

This unit of competency sets out the knowledge and skills required to install and commission integrated fluid power systems. This includes working safely; applying knowledge and interpreting technical data to perform installation, commissioning, optimisation, testing, and repair/replacement of integrated fluid power systems and/or sub assembly-systems.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains Employability Skills.

## Application of the Unit

The unit would be applied to those involved in agricultural/forestry/civil/mechanical engineering, mining and extractive industries, manufacturing or processing environments. This equipment requires installation, commissioning and optimisation, maintenance, testing and/or replacement within integrated fluid power systems.

It is suitable for people working as fluid power technicians or system designers, draftspersons and maintenance personnel, and those pursuing careers and qualifications in engineering or related disciplines.

## Pre-Requisites

MEM23006A Apply fluid and thermodynamics principles in engineering

VU21270 Implement control processes using PLC's

VU21547 Select components for an integrated fluid power design project

## ELEMENT

Elements describe the essential outcomes of a unit of competency.

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1 Prepare to install and commission an integrated fluid power system.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements and environmental requirements*** for a given work area are determined.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation for the work area.
- 1.3 Safety hazards, which have not previously been identified, are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 The requirements for installation, commissioning or replacement, are determined from ***relevant data***.



- |   |   |  |
|---|---|--|
|   | 1.5   | Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved on the work site.  |
|   | 1.6   | Tools, <b>equipment</b> , data logging instruments, needed to install commission and/or replace fluid power components and sub assembly-systems are obtained in accordance with <b>enterprise procedures</b> . |
|   | 1.7   | All tools, equipment, data logging instruments are checked for correct operation and safety prior to use.  |
|   | 1.8   | Integrated fluid power systems, sub assembly-systems and components are identified, confirmed against project documentation and BOM's and installed.   |
| 2 | Install commission and optimise fluid power systems.                    |  |
|   | 2.1   | OHS/WHS requirements for carrying out the work are followed.   |
|   | 2.2   | Circuits/machines/plant is checked as being isolated where necessary in strict accordance with OH&S requirements and enterprise procedures.  |
|   | 2.3   | Installation, commissioning, or component replacement is performed to meet pre-determined criteria and design specifications   |
|   | 2.4   | Data logging and supporting test equipment are installed to enable the integrated fluid power system to be pre-commissioned and initialised for commissioning.   |
|   | 2.5   | Optimisation methods are applied to integrated fluid power installations using data logging and the measurement of operating parameters; referring to the system operational design specifications.            |
|   | 2.6   | Decisions for dealing with unexpected situations are made with reference to appropriate personnel, project specifications and performance requirements.  |
|   | 2.7   | Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.  |
|   | 2.8   | Fluid power system and component installation/commissioning and optimising/testing/replacement activities are carried out efficiently without unnecessary waste.   |
| 3 | Complete and report installation and maintenance of fluid power system. |  |
|   | 3.1   | OHS/WHS requirements for completing the work are followed.   |
|   | 3.2   | Work site is made safe in accordance with established safety procedures and returned to normal operating conditions.   |
|   | 3.3   | Fluid power system maintenance/testing/replacement is documented in accordance with <b>enterprise procedures</b> .   |



- 3.4 Appropriate personnel are notified, in accordance with enterprise procedures, that the fluid power system installation/maintenance/testing/replacement is complete.

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- reading specification statements, diagrams and information
- determining and estimating operating parameters
- using tools, equipment and testing devices
- selection and application of data logging equipment and related software: as examples – pressure, flow, velocity, temperature, vibration, noise and viscosity
- making measurements on operational and non-operational components to determine if replacement is required
- applying logical inspection and testing methods
- selecting appropriate replacement components
- performing fluid power component/system replacement and restoring system to operational standard
- carrying out installation/maintenance/testing/replacement
- constructing control circuits from diagrams
- locating and correcting faults without damage or loss of system integrity
- establishing and maintaining a safe work environment
- communicating technical requirement to others
- working with others
- client liaison
- adapting to changes in work
- control system integration options and their application

### ***Required knowledge:***

- hydraulic and pneumatic laws and principles
- safe and effective commissioning and optimisation procedures
- integrated fluid power system component relationships and functionalities
- operation and application of hydraulic, pneumatic and electro components and systems
- interpretation of manufacturers equipment specifications
- integrated fluid power circuits
- analog and digital control
- closed-loop control theory and practices
- instrumentation methods





- report writing and presentation techniques
- component parts catalogue interpretation
- product/component performance specification and graphs interpretation

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording in the Performance Criteria is detailed below. Add any essential operating conditions that may be present with training and assessment depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts

### ***OHS/WHS requirements***

include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

### ***Environmental requirements***

include:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions, dust
- excessive energy and water use
- excessive noise

### ***Appropriate personnel*** may

include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

### ***Relevant data*** may include:

- reports
- data logging findings
- relevant documentation
- discussion with appropriate personnel



**Equipment** may include:

- hand and power tools
- test equipment and instruments
- data logging equipment and related software
- electrical/electronic variable speed drives and controllers
- logic elements sub-assembly's
- fluid power system diagnostic tools
- removal/installation tools and equipment
- equipment manuals and documentation
- hydraulic, pneumatic and electro components, circuits and systems
- consumables
- PLC's, SCADA and Distributive Control Systems (DCS)
- proportional element control
- integral element control
- derivative element control

**Enterprise procedures** may include:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- operational procedures
- project management capabilities

## EVIDENCE GUIDE

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 section in Section B of the accreditation submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- To be considered competent in this unit the candidate must provide evidence that they can achieve all of the elements of competency to the level specified by the associated performance criteria by using the required skills and knowledge.
- Specifically they must provide evidence that they can:
  - identify dangers and hazards associated with electro-fluid power systems
  - apply risk assessment and risk mitigation tools for the installation and commissioning of electro-fluid power systems
  - interpret specifications and bill of materials (BOM's)



- install and replace hydraulic, pneumatic and electro components in accordance with specifications and set guidelines
- operate and commission an integrated fluid power system control circuit
- establish procedures to install and commission both open-loop and closed-loop integrated fluid power systems
- apply problem solving and fault identification strategies during the installation and commissioning task
- select and apply data-logging equipment and related software in accordance with specifications, set guidelines and safe work practices
- document and report installation and commissioning task outcomes against specifications and set guidelines
- effectively inform all relevant personnel of installation and commissioning outcomes
- manage installation and commissioning site environmental practices to recognised site and industry standards
- restore the system and work site to operational standard

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions
  - access to a real or simulated workplace environment
  - electro-fluid power circuits and specifications
  - equipment and tools to complete the tasks



## Method of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documentary evidence.
- Where performance is not directly any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU21549 - Conduct a feasibility study for an integrated fluid power system

**Unit Descriptor** This unit provides the knowledge and skills to enable participants to produce a feasibility study for an integrated fluid power system using a combination of hydraulic, pneumatic and PLC/electrical/electronic principles and system design concepts.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

**Employability Skills** This unit contains Employability Skills.

**Prerequisites**

- MEM23006A Apply fluid and thermodynamics principles in engineering
- VU21546 Monitor and adjust an integrated fluid power control system
- VU21547 Select components for an integrated fluid power design project
- VU21548 Install and commission an integrated fluid power system
- VU21270 Implement control processes using PLCs

**Application of the Unit** This unit would be applied by those involved in investigating the feasibility of an integrated fluid power system for a particular application. It involves the application of system design concepts.

It is suitable for fluid power system and automation designers and maintenance personnel, and those advancing engineering or related qualifications and careers.

### Element

Elements describe the essential outcomes of a unit of competency

1. Develop a specification for an integrated fluid power system

### Performance Criteria

Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide

- 1.1 ***Customer requirements*** are determined and considered when designing the integrated fluid power system.
- 1.2 The mechanical variables which must be considered in the design are identified.
- 1.3 The actuator forces and torques are calculated over the whole speed range from the customer specification, taking into account the ***variables***
- 1.4 The plant specifications are documented in accordance with established procedures



- |  |   |
|--|---|
|  | 1.5 The details of the final product affecting the system design are confirmed with customer requirements   |
| 2. Select the design parameters to suit the customer requirements                            | 2.1 Integrated fluid power catalogues are referred to, to select component and sub-assembly options the quality of components required for the integrated fluid power system            |
|  | 2.2 Working pressures are determined in relation to specified system dynamics to enable the design to meet the reliability and life requirements and cost related factors of the system |
| 3. Determine the actuators required, based on the system specification and design parameters | 3.1 The <b>actuators</b> sizes are calculated using forces or torques and working pressures   |
|  | 3.2 Actuators are selected where there is high speed, low force/low torque or low speed, high force/high torque during the cycle  |
|  | 3.3 The actuators are selected using standard sizes from manufacturer's catalogues  |
|  | 3.4 The maximum working pressure is re-calculated for each actuator selected  |
|  | 3.5 Flow rates are calculated based on actuator sizes and speeds  |
|  | 3.6 The power required to supply the flows and pressures for the system is calculated to meet the specified cycle time  |
| 4. Determine the type of system that best suits the pressures and flows of the design        | 4.1 Flows, power levels, size of components and circuit requirements are compared using different design methods  |
|  | 4.2 The most suitable design method is selected to meet the system requirements   |
| 5. Optimise the system to reduce flows, pressures and power                                  | 5.1 Pressure, flows, energy conservation and energy consumption are calculated for different cycle times and methods of operation   |
|  | 5.2 Changes are made to the design parameters, cycle times or methods of operation, as required   |
|  | 5.3 The most suitable parameters are selected to optimise the system design   |
| 6. Determine the control requirements for the system   | 6.1 The preliminary operational parameters determining the control requirements for the system are identified   |
|  | 6.2 The <b>control circuit</b> needs are confirmed in accordance with the structural requirements, performance design characteristics and environmental factors for the system          |



- 6.3 The control circuit inputs and outputs required for the system are identified, concept tested and confirmed
- 6.4 An input/output chart is drawn to confirm the system's functionality
- 6.5 Logic statements are written that will allow the control circuit programme to be documented
7. Summarise the system design
  - 7.1 Step/time and flow/time diagrams are produced and confirmed for the system against specifications
  - 7.2 All **calculations** are documented in accordance with established procedures
  - 7.3 A component list is established in the project data base and a supporting bill of materials (BOMs) is prepared.
  - 7.4 The feasibility of the design in meeting the specification and design parameters is confirmed against customer requirements
  - 7.5 A feasibility report is prepared and submitted to the customer

## Required Skills and Knowledge

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

### **Required skills:**

- writing specifications for integrated fluid power systems
- determining customer requirements for integrated fluid power systems
- calculating various parameters from the system specifications
- identifying risks associated with the integrated fluid power system
- selecting design parameters and systems to suit the user
- charting summaries of calculations for the integrated fluid power system
- optimising the integrated fluid power system
- determining control requirements for the integrated fluid power system
- documenting the integrated fluid power system design

### **Required knowledge:**

- relevant OHS/WHS requirements
- specifications for integrated fluid power systems
- dangers associated with integrated fluid power systems
- instrumentation, control and data logging support equipment



- calculations associated with the mechanical parameters of a integrated fluid power system
- design philosophy
- closed loop control principles
- comparison methods such as:
  - high-low
  - regenerative
  - accumulator
  - single pump
  - multi pump
  - kicker cylinder
- optimising techniques for integrated fluid power systems
- control requirements for integrated fluid power system
- instrumentation, control and data logging support equipment

## Range Statement

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording in the Performance Criteria is detailed below. Add any essential operating conditions that may be present with training and assessment depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts.

### ***Customer requirements***

may include:

- Cost
- Life of the machine
- Safety
- Type of control
- Proposed location of the system
- On line system reliability
- Design for maintainability

### ***Variables*** may include:

- Acceleration
- Deceleration
- Proportional element control
- Integral element control
- Derivative element control
- Open-loop versus closed-loop control parameters
- Energy conservation and waste minimisation
- Components of forces
- Moments of forces
- Ratios and efficiencies of mechanical drives





**Actuators** refers to:

- Linear actuators (cylinders)
- Rotary actuators (motors)
- Semi rotary actuators

**Control Circuit** refers to:

- Programmable logic controller (PLC)
- SAP
- SCADA
- Ethernet/IP
- Distributive Control Systems
- Wireless
- GPS
- CANBUS

**Calculations** may involve:

- Forces
- Times
- Strokes
- Pressures
- Flow rates
- Actuator sizes

## Evidence Guide:

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

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- To be considered competent in this unit the candidate must provide evidence that they can achieve all of the elements of competency to the level specified by the associated performance criteria by using the required skills and knowledge.
- Specifically they must provide evidence that they can:
  - Determine the customer requirements for a integrated fluid power system
  - Apply a philosophy of integrated fluid power system design that meets customer, industry standards, environmental and efficiency guidelines
  - Justify feasibility study design recommendations
  - Write specifications for the integrated fluid power system
  - Perform calculations of all machine parameters from the specifications
  - Select appropriate components for the integrated fluid power system from manufacturer's catalogues
  - Optimise the integrated fluid power system output



- Liaise with relevant industry personnel and customers
- Produce a feasibility study in accordance with client specifications and recognised industry best practice

**Context of and specific resources for assessment**

- Assessment should be conducted in a real or simulated workplace environment
- Where assessment occurs in a simulated environment the equipment, tools and processes used should reflect the workplace, as much as possible
- The resources required for assessment include:
  - Access to a real or simulated workplace environment
  - Integrated fluid power system specifications
  - Equipment and tools to complete the tasks
  - Safe and effective workplace procedures

**Method of assessment**

- Assessment must include the demonstration of practical skills and may also include:
  - Verbal/written questions
  - Design and drawing projects
  - Calculation tests



## VU21551 - Test and monitor fluid power circuits

<b>Unit Descriptor</b>	<p>This unit of competency sets out the knowledge and skills required to apply fluid power principles in engineering settings. This includes working safely, applying knowledge of fluids to the operation and testing of fluid power components, interpreting fluid system circuit diagrams and monitoring flow in fluid power circuits.</p> <p>No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.</p>
<b>Employability Skills</b>	This unit contains employability skills,
<b>Application of the Unit</b>	<p>The unit applies to engineering, manufacturing or processing environments where fluid circuits are used.</p> <p>It is recommended that participants have skills and knowledge in reading drawings/diagrams and dismantling/assembling mechanical components.</p>

### ELEMENT

Elements describe the essential outcomes of a unit of competency.

- 1 Prepare to test and monitor fluid power circuits.

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***OHS/WHS requirements*** and ***environmental requirements*** for a given work area are determined.
- 1.2 Established OH&S requirements and risk control measures and procedures in preparation for the work area are followed.
- 1.3 Safety hazards, which have not previously been identified, are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 The need for testing and monitoring fluid components and systems is determined from reports and other documentation and from discussion with appropriate personnel.
- 1.5 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved on the work site.
- 1.6 Tools, ***equipment*** and testing devices needed to test and monitor fluid components and systems are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.



- |   |  |
|---|--|
| 2 Test and monitor fluid power circuits.                            | <p>2.1 OHS/WHs requirements for carrying out the work are followed.</p> <p>2.2 The need to test or measure live is determined in strict accordance with OHS/WHs requirements and when necessary conducted within established safety procedures.</p> <p>2.3 Circuits/machines/plant are checked as being isolated where necessary in strict accordance with OHS/WHs requirements and enterprise procedures.</p> <p>2.4 Testing and monitoring fluid power circuits is performed to meet determined circuit performance criteria.</p> <p>2.5 Testing and monitoring is applied to fluid power installations by employing tests and measurements of operating parameters referenced to system operational requirements.</p> <p>2.6 The requirement for testing and monitoring is identified and appropriately competent persons are engaged to perform the testing and monitoring where it is outside the scope of the fluid power system.</p> <p>2.7 Fluid power safety/ protection systems are identified.</p> <p>2.8 Testing and monitoring is performed and system is restored to specified requirements.</p> <p>2.9 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel and job specifications and requirements.</p> <p>2.10 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.</p> <p>2.11 Testing and monitoring activities are carried out efficiently without unnecessary waste of materials or damage to apparatus and the surrounding environment or services and using sustainable energy practices.</p> |
| 3 Complete and report testing and monitoring of fluid power system. | <p>3.1 OHS/WHs requirements for completing the work are followed.</p> <p>3.2 Work site is made safe in accordance with established safety procedures.</p> <p>3.3 Fluid power circuit testing and monitoring is documented in accordance with enterprise procedures.</p> <p>3.4 Appropriate personnel are notified, in accordance with enterprise procedures, that the testing and monitoring is complete.</p>  |



## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- reading specification statements, diagrams and information
- determining and estimating operating parameters
- using tools, equipment and testing devices
- making measurements on operational and non-operational components
- applying logical inspection and testing methods
- carrying out testing and monitoring without damage or loss of system integrity
- establishing and maintaining a safe work environment
- communicating technical requirement to others
- working with others
- adapting to changes in work

### ***Required knowledge:***

- basic properties of fluids
- fluid power components
- fluid statics
- fluid flow
- fluid forces and fluid power
- fluid circuits
- fluid circuit instruments

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording in the Performance Criteria is detailed below. Add any essential operating conditions that may be present with training and assessment depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts

***OHS/WHS requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions



**Environmental requirements**  
such as:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions, dust
- excessive energy and water use
- excessive noise

**Appropriate personnel** may  
include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

**Enterprise procedures** such as:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- operational procedures

**Equipment** including:

- hand and power tools
- fluid power components and systems
- fluid power circuit testing and monitoring hardware/software tools and instruments
- equipment manuals and documentation
- consumables

## EVIDENCE GUIDE

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 section in Section B of the accreditation submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors should gather a range of evidence that is valid, sufficient, current and authentic. Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the criteria.



- In particular this shall incorporate evidence that shows a candidate is able to:
  - implement OHS/WHs procedures and practices including the use of risk control measures as specified in the performance criteria and range;
  - demonstrate essential knowledge and skills as described in this unit;
  - demonstrate a representative body of performance criteria within a timeframe typically expected of the discipline, work function and industrial environment;
  - demonstrate the application of fluid power principles to testing and monitoring circuits on more than one occasion and in different contexts;
- The demonstration of competence must show:
  - logical testing/monitoring methods
  - system restoration procedures
  - documentation of testing/monitoring

#### **Context of and specific resources for assessment**

- Evidence should show competency working in a realistic environment and a variety of conditions.
- The candidate will have access to all tools, equipment, materials and documentation required. The candidate will be permitted to refer to any relevant workplace procedures, product and manufacturing specifications, codes, standards, manuals and reference materials.
- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.

#### **Method of assessment**

- Assessment must include the demonstration of practical skills and may also include::
  - observation of processes and procedures;
  - oral and/or written questioning on required knowledge and skills;
  - testimony from supervisors, colleagues, clients and/or other appropriate persons;
  - inspection of the final product or outcome;
  - portfolio of documentary evidence



- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.
- Assessment should reinforce the integration of the Key Competencies.





## VU21609 - Install and maintain hydraulic/pneumatic systems

### Unit Descriptor

This unit of competency sets out the knowledge and skills required to install and maintain hydraulic and pneumatic systems. This includes working safely; applying knowledge and interpreting technical data to perform maintenance, testing, installation and repair/replacement of hydraulic and pneumatic systems.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills,

### Application of the Unit

The unit applies to engineering, manufacturing or processing environments where hydraulic and pneumatic systems are used and where this equipment requires installation, maintenance, testing and/or replacement.

It is recommended that participants have skills and knowledge in reading drawings/diagrams and dismantling/assembling mechanical components.

## ELEMENT

Elements describe the essential outcomes of a unit of competency.

- 1 Prepare to install and maintain hydraulic and pneumatic systems.

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***OHS/WHS requirements*** and ***environmental requirements*** for a given work area are determined.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures in preparation for the work area are followed.
- 1.3 Safety hazards, which have not previously been identified, are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 The need for installation, maintenance or replacement is determined from reports and other documentation and from discussion with appropriate personnel.
- 1.5 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved on the work site.
- 1.6 Tools, ***equipment*** and testing devices needed to install, maintain or replace hydraulic and pneumatic systems and components are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.



- |   |   |      |  |
|---|---|------|--|
| 2 | Install and maintain hydraulic and pneumatic systems. | 2.1  | OHS/WHS requirements for carrying out the work are followed.   |
|   |   | 2.2  | The need to test or measure live is determined in strict accordance with OHS/WHS requirements and when necessary conducted within established safety procedures.   |
|   |   | 2.3  | Circuits/machines/plant are checked as being isolated where necessary in strict accordance with OHS/WHS requirements and enterprise procedures.  |
|   |   | 2.4  | Installation or replacement is performed to meet determined hydraulic and pneumatic system performance criteria.   |
|   |   | 2.5  | Maintenance methods are applied to hydraulic and pneumatic installations by employing tests and measurements of operating parameters referenced to system operational requirements.  |
|   |   | 2.6  | The requirement for installation or replacement is identified and appropriately competent persons are engaged to perform the installation or replacement where it is outside the scope of the hydraulic and pneumatic system.  |
|   |   | 2.7  | Hydraulic and pneumatic systems and components are identified and installed.   |
|   |   | 2.8  | Installed hydraulic and pneumatic systems and components are tested to verify operation is as intended and system is restored to specified requirements.   |
|   |   | 2.9  | Decisions for dealing with unexpected situations are made from discussions with appropriate personnel and job specifications and requirements.   |
|   |   | 2.10 | Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.  |
|   |   | 2.11 | Hydraulic and pneumatic system and component installation/maintenance/testing/replacement activities are carried out efficiently without unnecessary waste of materials or damage to apparatus and the surrounding environment or services and using sustainable energy practices. |



- |   |   |     |   |
|---|---|-----|---|
| 3 | Complete and report installation and maintenance of induction motors. | 3.1 | OH&S requirements for completing the work are followed.   |
|   |   | 3.2 | Work site is made safe in accordance with established safety procedures.  |
|   |   | 3.3 | Hydraulic and pneumatic system installation/maintenance/testing/replacement is documented in accordance with enterprise procedures.   |
|   |   | 3.4 | Appropriate personnel are notified, in accordance with enterprise procedures, that the hydraulic and pneumatic system installation/maintenance/testing/replacement is complete. |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- reading specification statements, diagrams and information
- determining and estimating operating parameters
- using tools, equipment and testing devices
- making measurements on operational and non-operational components to determine if replacement is required
- applying logical inspection and testing methods
- selecting appropriate replacement components
- performing hydraulic and pneumatic component/system replacement and restoring system to operational standard
- carrying out installation/maintenance/testing/replacement
- constructing circuits from control diagrams
- locating and correcting faults
- without damage or loss of system integrity
- establishing and maintaining a safe work environment
- communicating technical requirement to others
- working with others
- adapting to changes in work

### **Required knowledge:**

- hydraulic and pneumatic laws and principles
- operation and application of hydraulic and pneumatic components and systems
- interpretation of manufacturer's equipment specifications
- fluid power circuits
- analog and digital control
- fluid instrumentation



## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording in the Performance Criteria is detailed below. Add any essential operating conditions that may be present with training and assessment depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts.

***OHS/WHS requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** such as:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions, dust
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Equipment*** including:

- hand and power tools
- test equipment and instruments
- hydraulic and pneumatic system diagnostic tools
- removal/installation tools and equipment
- equipment manuals and documentation
- hydraulic and pneumatic components, circuits and systems
- consumables



**Enterprise procedures** for example:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- operational procedures

## EVIDENCE GUIDE

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 section in Section B of the accreditation submission.

### **Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors should gather a range of evidence that is valid, sufficient, current and authentic. Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the criteria.
- In particular this shall incorporate evidence that shows a candidate is able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria and range;
  - demonstrate essential knowledge and skills as described in this unit;
  - demonstrate a representative body of performance criteria within a timeframe typically expected of the discipline, work function and industrial environment;
  - demonstrate the application of hydraulic and pneumatic system installation maintenance methods on more than one occasion and in different contexts;
- The demonstration of competence must show:
  - logical inspection/testing methods
  - system restoration procedures
  - documentation of installation/maintenance



### Context of and specific resources for assessment

- Evidence should show competency working in a realistic environment and a variety of conditions.
- The candidate will have access to all tools, equipment, materials and documentation required. The candidate will be permitted to refer to any relevant workplace procedures, product and manufacturing specifications, codes, standards, manuals and reference materials.
- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.

### Method of assessment

- Assessment must include the demonstration of practical skills and may also include::
- observation of processes and procedures;
- oral and/or written questioning on required knowledge and skills;
- testimony from supervisors, colleagues, clients and/or other appropriate persons;
- inspection of the final product or outcome;
- a portfolio of documentary evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.
- Assessment should reinforce the integration of the Key Competencies.



# Manufacturing Systems/Integrated Manufacturing Systems

## Production

Current versions of the units listed below can found at [training.gov.au](http://training.gov.au)

MEM30014A - Apply basic just in time systems to the reduction of waste
MEM23122A - Evaluate computer integrated manufacturing systems
MEM23123A - Evaluate manufacturing processes
MEM23131A - Evaluate rapid prototyping applications
MEM23132A - Evaluate rapid manufacturing processes
MEM23133A - Evaluate rapid tooling applications
MEM23134A - Evaluate jigs and fixtures



# VU22501 - Set up manufacturing processes for engineering applications

## Unit Descriptor

This unit describes the skills and knowledge required to select and implement manufacturing processes for specific engineering applications. The principal processes include metal forming operations, fabrication, powder metallurgy, machine tools and computer numerical controlled (CNC) equipment. No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

The unit of competency applies to a person working at para professional level in an engineering and/or manufacturing environment where a number of manufacturing processes are used.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

1. Determine principal processes within the manufacturing industry

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements and environmental requirements*** for a given work area are clarified.
- 1.3 Principal ***engineering processes*** and their applications are identified.
- 1.4 Key features of the selected engineering processes are identified.
- 1.5 Advantages and disadvantages of selected engineering processes for given manufacturing applications are confirmed.

2. Select process for a specified manufacturing applications

- 2.1 ***Manufacturing outcomes and requirements*** are identified and clarified with ***appropriate personnel***.
- 2.2 ***Functional specifications and other factors*** affecting the selection of engineering processes are identified.
- 2.3 Suitable engineering process is selected based on manufacturing requirements, functional specifications/factors and discussions with appropriate personnel.
- 2.4 Calculations and assumptions are made to facilitate the installation of the machinery and equipment.





3. Implement and commission selected process
  - 3.1 OHS/WHS requirements for carrying out the work are followed.
  - 3.2 Stages and activities required for engineering process are identified and documented according to **enterprise procedures**.
  - 3.3 Manufacturing requirements of TQM, JIT and competitive (lean manufacturing) environments are applied, if required.
  - 3.4 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved.
  - 3.5 Resources and equipment for the process are identified and sourced.
  - 3.6 Resources and equipment for the process are installed, set up and trialled for functionality
  - 3.7 Process is commissioned in accordance with enterprise procedures

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- assessing a range of manufacturing processes
- selecting a manufacturing process for a specific engineering application
- taking measurements and performing calculations to determine process installation requirements
- setting up, trialling and commissioning a manufacturing process
- communicating and coordinating the setting up of the manufacturing process with other relevant personnel

### **Required knowledge:**

- planning
  - sequencing operations
  - identifying factors influencing process selection
  - materials and process preparation
  - properties and characteristics of materials and consumables
  - identifying and clarifying application requirements
  - identifying specifications and required resources
  - reviewing and revising outcomes against task objectives and requirements
- communication
  - researching and interpreting information and specifications
  - categorising manufacturing methods
  - developing enterprise procedures
  - calculations relating to engineering processes within the scope of this unit



- accessing and using information sources using a variety of methods
- use of equipment suppliers' printed data and websites
- accessing and using alternative information sources
- documenting of methods, processes & construction techniques and manufacturing requirements
- engineering processes
  - principal engineering processes
  - applications, features and principles of engineering processes
  - advantages and disadvantages of engineering processes
  - processes include:
    - forming
    - casting
    - sand
    - die
    - shell
    - continuous
    - investment
    - permanent mould
    - forging
    - drop
    - press
    - rolling
    - drawing
    - extrusion
    - direct
    - indirect
    - Impact
    - press-working
    - basic types of presser
    - blanking
    - piercing
    - bending
    - deep drawing
    - powder metallurgy
    - powders
    - forming methods
    - sintering
    - hot pressing
    - finishing
    - economics
    - automatic lathes
    - copying



- single spindle turret
  - multi-spindle
  - sliding head (Swiss)
  - plug-board
  - economics
  - grinding
  - surface
  - horizontal and vertical spindle
  - reciprocating and rotating table
  - cylindrical
  - centreless
  - external
  - internal
  - CNC machines
  - principles of control
  - machines and axes
  - turning machines
  - machining centres
  - applications to manufacturing cells and FMS
- engineering process selection:
  - scientific principles relevant to engineering processes
  - applying scientific principles in the choice of methods, processes & construction techniques
  - the provision for particular materials properties in the choice of methods, processes & construction techniques
  - factors affecting process selection
  - the suitability of application to particular continuous, mass, batch, jobbing shop, sequential or cellular manufacture and assembly
  - identifying and considering materials properties in the choice of methods, processes & construction techniques
  - regulations, standard procedures and MSDS specifications
  - manufacturing requirements
- manufacturing processes:
  - selecting methods, processes and construction techniques suitable for continuous, mass, batch or jobbing shop production, work cell or sequential manufacture and assembly
  - applications suitable for a range of materials handling techniques
  - principles of TQM, JIT and Competitive (lean manufacturing)
  - requirements of TQM, JIT and Competitive (lean manufacturing) environments
  - calculations and assumptions for processes & construction techniques choices
  - materials handling processes and procedures



- OHS/WHS requirements:
  - legislation
  - protective equipment
  - material safety management systems
  - hazardous substances and dangerous goods code
  - local safe operation procedures
  - awards provisions
- environmental considerations:
  - liquid waste
  - solid waste
  - gas, fume, vapour, smoke emissions, including fugitive emissions
  - excessive energy and water use
  - excessive noise

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- Awards provisions

***Environmental requirements*** may include but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Engineering processes*** may include but are not limited to:

- processes, methods and construction techniques related to:
  - forming
  - casting
  - forging
  - extrusion
  - press-working
  - powder metallurgy
  - automatic lathes
  - grinding
  - CNC machinery



**Manufacturing outcomes and requirements** may include but are not limited to:

- continuous, mass, batch jobbing or prototype production
- sequential or cellular manufacture and assembly
- utilising JIT, TQM (QA + QC + Quality Improvement) and competitive (lean) manufacturing principles

**Appropriate personnel** may include but are not limited to:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

**Functional specifications and other factors** may include but are not limited to:

- product design and features
- chemical, electrical, thermal and other environmental performance requirements
- elastic and/or plastic mechanical performance and manufacturability requirements
- materials
- pre/post and complimentary processing requirements
- manufacturing requirements
- suitability of application to manufacturing methods
- quantities/economies of scale
- cost/budget/economy
- required/available resources
- specific customer requirements
- hazards and risks
- enterprise requirements
- quality standards
- any other project limitations



**Enterprise procedures** may include but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### **Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHs procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to select and set up a principal manufacturing process for a specified application on more than one occasion and in different contexts.

### **Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals



**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include the demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22502 - Design jigs and fixtures for manufacturing

### Unit Descriptor

This unit describes the skills and knowledge required to design jigs and fixtures for machining, fabrication, assembly and welding of manufactured products.

The unit includes assessment of need, design considerations, selection of materials, design drawings and development of the final product.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at para professional level in an engineering design and development or manufacturing environment.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Determine the requirements for the design of a jig and a fixture

2. Develop the design of a jig and a fixture

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/ Workplace Health and Safety (OHS/WHS)*** requirements for carrying out the work are clarified.
- 1.2 ***Functional design specifications*** for ***a jig and a fixture*** are identified and clarified with ***appropriate personnel***.
- 1.3 ***Other factors*** affecting the design process are identified and clarified with appropriate personnel.
- 1.4 Resources and equipment needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation.
- 2.1 OHS/WHS requirements for carrying out the work are incorporated into the design.
- 2.2 Fundamental engineering principles of an effective a jig and a fixture design are identified and applied.
- 2.3 Steps and activities required to produce the design are analysed and planned.
- 2.4 Design is developed based on relevant engineering principles, material selection, manufacturing requirements, functional specifications/factors and discussions with appropriate personnel.
- 2.5 Preliminary design layout is prepared and assessed against specifications.
- 2.6 ***Design drawing/s*** is produced and documented according enterprise procedures and AS1100.





- |   |   |
|---|---|
| 3. Finalise design of a jig and a fixture | 3.1 Design drawing is finalised checked for conformance with AS1100 and reviewed with appropriate personnel.<br>3.2 Any required design modifications are identified<br>3.3 Modified design drawing is produced and confirmed with appropriate personnel.<br>3.4 Final design drawing is checked, signed off and documented by appropriate personnel. |
|---|---|

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- assessing and determining design requirements/application for a jig and a fixture
- consulting and communicating with other relevant persons regarding design need and relevant considerations
- developing a design for a jig and a fixture to meet a specified manufacturing requirement
- producing and finalising design drawing/s which conform with AS1100

### ***Required knowledge:***

- planning
  - sequencing activities and operations
  - identifying factors influencing design selection and development
  - identifying and clarifying application requirements
  - identifying design specifications and required resources
  - analysing and planning steps and activities required to produce designs
  - reviewing and revising outcomes against task objectives and requirements
- communication
  - researching and interpreting information and specifications
  - categorising work holding methods
  - calculations relating to work holding device design
  - accessing technical data and related information using a variety of methods
  - documenting/reporting technical information and data
- jigs and fixture types/features
  - applications, features and principles of tooling for advanced automated manufacturing:
    - work holding and manipulation fixtures,
    - part feeding and orientation devices, clamp design and clamping methods
  - advantages and disadvantages of different jigs and fixing methods
  - features, function and differences between types of jigs and fixtures



- jigs and fixture selection/design
  - fundamental principles of effective jig and fixture design
  - applying engineering principles in the choice of jig and fixture design
  - functional and non-functional factors for design selection
  - regulations, standard procedures and MSDS specifications
  - considerations when making jigs and fixtures
  - calculations and assumptions for design
  - alternatives to manufacturing jigs or fixtures
- drawing and drafting
  - producing drawings to Australian Standards (AS 1100) using manual and electronic methods
- OHS/WHS requirements
  - OHS/WHS considerations relating to tooling design
  - legislation and codes of practice
  - OHS/WHS and hazard identification and control principles
  - material safety management systems

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Functional design specifications*** may include:

- principles of location
- support methods
- principles of clamping
- clamps used in automated manufacture
- swarf control
- construction methods
- component analysis
- load/unload accessibility
- process considerations on jig or fixture design
- manufacturing accuracy for the jig or fixture
- jig or fixture identification codes, handling and storage
- use of standard components

***A jig and a fixture*** may include:

- work holding and manipulation fixtures
- part feeding and supply systems
- clamp design and clamping methods



**Appropriate personnel** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

**Other factors** may include:

- quantities/economies of scale
- cost/budget/economy
- required/available resources
- specific customer requirements
- hazards and risks
- enterprise requirements
- quality standards
- any other project limitations

**Enterprise procedures** may include:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**Design drawing/s** may include:

- detailed orthographic drawing/s to Australian Standards (AS 1100)
- isometric or other three dimensional views
- assembly drawing

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria. Specifically they must be able to:
  - implement OHS/WHs procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to develop a design for a jig and a fixture for specific manufacturing applications and produce a documented design drawing of each which conforms with AS1100.



### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to drafting machines or CAD facilities, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

### Methods of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## CAD (Drafting)

Current versions of the units listed below can found at [training.gov.au](http://training.gov.au)

MEM09009C - Create 2D drawings using computer aided design system
MEM09010C - Create 3D models using computer aided design system
MEM09011B - Apply basic engineering design concepts
MEM09022A - Create 2D code files using computer aided manufacturing system
MEM09023A - Create 3D code files using computer aided manufacturing system
MEM09155A - Prepare mechanical models for computer-aided engineering
MEM09156A - Prepare mechatronic models for computer-aided engineering (CAE)
MEM09157A - Perform mechanical engineering design drafting
MEM09158A - Perform mechatronics engineering design drafting
MEM30033A – Use computer aided design (CAD) to create and display 3D models



## VU22330 – Select and interpret drawings and prepare three dimensional (3D) sketches and drawings

**Unit Descriptor** This unit of competency describes the knowledge and skills required to select and interpret drawings to plan and complete an engineering task.

The unit also includes the knowledge and skills required to prepare three dimensional (3D) sketches and drawings of simple engineering components for communication requirements.

No licensing, legislative, regulatory or certification requirements apply to this unit of competency at the time of publication.

**Employability Skills** This unit contains Employability Skills.

**Application of the Unit** This unit would be applied by entry level engineering workers required to undertake a range of basic engineering sketches and drawings using traditional drawing and drafting skills.

### ELEMENT

Elements describe the essential outcomes of a unit of competency

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

1. Identify and select correct sketches or drawings to plan and complete engineering tasks.
  - 1.1 Required sketches or drawings are obtained from documentation, files systems or local sources in accordance with ***enterprise procedures***.
  - 1.2 ***Sketches and drawings*** are checked for containing all necessary information related to job requirements.
  - 1.3 Notes, drawing versions and dates for sketches or drawings are assessed as current and appropriate.
  - 1.4 Communications with others involved in the work is maintained to ensure efficient progress and completion of tasks and that safety is maintained at all times.
2. Employ sketch or drawing details to plan and complete engineering tasks.
  - 2.1 Components are identified from sketches and drawings.
  - 2.2 Views and projections are interpreted to reconstruct a three dimensional (3D) image of components, assemblies and structures.
  - 2.3 ***Drawing symbols***, dimensions and tolerances are interpreted and applied to the work task.
  - 2.4 Materials requirements for work tasks are obtained from sketches and drawings.
  - 2.5 Insufficient sketch/drawing details are identified and reported to the ***appropriate personnel*** in accordance with enterprise procedures.



## VU22330 – Select and interpret drawings and prepare three dimensional (3D) sketches and drawings

- |   |   |
|---|---|
| 3. Prepare sketches or drawings to plan and complete engineering tasks. | 3.1 Objects are sketched and/or drawn for clear communications of requirements and in accordance with Australian drawing standards. |
|   | 3.2 Sketches and drawings are prepared to present the required information with minimal complexity.                                 |
|   | 3.3 Dimension and notes are added to fully describe requirements in accordance with enterprise procedures.                          |
|   | 3.4 Completed sketches and drawings are checked for compliance with requirements and reviewed with the appropriate personnel.       |

### REQUIRED SKILLS AND KNOWLEDGE

#### Required skills:

- reading, interpreting and communicating information from engineering drawings and sketches
- applying sketching skills to produce detail drawing in 3rd angle orthogonal and isometric projection

#### Required knowledge:

- types and functions of technical drawings
- engineering drawing conventions and symbols
- drafting methods for preparing original drawings
- drawing standards and conventions (e.g. AS1100)

### RANGE STATEMENT

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold/italicised wording in the Performance Criteria is detailed below.

- |  |  |
|--|--|
| <b><i>Enterprise procedures</i></b><br>may include but not limited to: | <ul style="list-style-type: none"><li>• the use of tools and equipment</li><li>• instructions, including job sheets, cutting lists, plans, drawings and designs</li><li>• reporting and communication</li><li>• manufacturers' specifications and operational procedures</li></ul> |
|--|--|

- |  |  |
|--|--|
| <b><i>Sketches and drawings</i></b><br>may include but not limited to: | <ul style="list-style-type: none"><li>• free hand</li><li>• manual drafting in one, two or three projections</li><li>• to scale or not-to-scale</li><li>• for selecting, preparing, or assembling components or products</li></ul> |
|--|--|



## VU22330 – Select and interpret drawings and prepare three dimensional (3D) sketches and drawings

- Drawing symbols** may include but not limited to:
- lines types
    - outlines (visible/hidden)
    - dimensioning lines
    - centre lines
  - electrical
  - engineering:
    - mechanical
    - fabrication

- Appropriate personnel** may include but not limited to:
- supervisor
  - leading hand
  - foreman
  - trainer/coach
  - teacher

### EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

To be considered competent in this unit assessors must be satisfied the candidate can demonstrate the achievement of all of the elements of the competency to the level defined by the associated performance criteria

Specifically they must be able to demonstrate the ability to:

- read and interpret views and projections of an engineering component drawing to reconstruct a three dimensional image
- prepare a scaled three dimensional sketch or drawing of a simple engineering component.

**Context of and specific resources for assessment**

Evidence should show competency working in a realistic environment and a variety of conditions. The candidate will have access to all drawings, drawing equipment, materials and documentation required. The candidate will be permitted to refer to any relevant workplace procedures, product and manufacturing specifications, codes, standards, manuals and reference materials.

**Methods of assessment**

Evidence can be gathered through a variety of ways including:

- observation of processes and procedures
- oral and/or written questioning on required knowledge and skills
- inspection of the final product or outcome





## **VU22330 – Select and interpret drawings and prepare three dimensional (3D) sketches and drawings**

- portfolio of documented evidence.

Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.



# VU22497 - Annotate and create assemblies using solid models

## Unit Descriptor

This unit of competency describes the knowledge and skills required to apply CAD software to create three dimensional (3D) solid models and assemblies for presentation purposes. This includes the applications in CAD modelling for creation of assemblies of components, use rendering techniques and the application of annotations.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency applies to a person working at para professional level in an engineering enterprise involved in the design and analysis of a wide range of engineering components and systems.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Prepare for solid assembly modelling task

2. Perform drawing for solid assembly

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 **Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements** for a given work area are determined.
- 1.2 **Solid modelling assembly task** requirements are identified from documentation, job sheets or through discussions with **appropriate personnel**.
- 1.3 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.4 **Resources** and computer aided drafting (CAD) **equipment** needed for the solid modelling assembly task are obtained in accordance with **enterprise procedures** and set up and checked for correct operation.
- 2.1 The most appropriate 3D modelling and assembly software is chosen for the given assembly task.
- 2.2 3D solid modelling software is applied to create the represent engineering components in accordance with the job requirements
- 2.3 Key assembly features of the solid modelling package are fully exploited to optimise presentation.
- 2.4 Rendering techniques are applied to 3D models to enhance presentation
- 2.5 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.
- 2.6 Solid models of components and assemblies are edited if required



- |                                       |  |
|---------------------------------------|--|
| 3. Complete solid model assembly task | 3.1 All required annotations and references are added to the presentation as required and in accordance with the enterprise procedures<br>3.2 Hard copies of 3D solid models and assemblies are produced<br>3.3 Documentation associated with the solid modelling assembly task is checked and signed off in accordance to enterprise procedures.<br>3.4 3D models and assemblies files are saved and stored for later retrieval |
|---------------------------------------|--|

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- determining the scope of the task in consultation with other project team members
- setting up CAD system and selecting appropriate software for the task
- using 3D solid modelling software to represent engineering components and parts
- edit solid models of components and assemblies
- applying necessary annotation
- applying rendering techniques to a 3D model:
- producing hard copies of 3D solid models, assemblies
- saving 3D models and assemblies files for later retrieval

### ***Required knowledge***

- principle tools used in the creation and manipulation of solid models
- creation of assemblies from library items e.g. off the shelf parts
- rendering types and preferences, render and lighting techniques, views and scenes
- 'top down' and 'bottom up' modelling techniques to produce components/parts

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures



**Appropriate personnel** may include:

- supervisor
- manager
- site engineer
- trainer
- mentor
- teacher

**Solid modelling assembly task**

- economic impact of design upon manufacturing
- principles of design
- engineering components and standard parts
- edit solid models and assemblies
- 3D manufacturing drawings and annotation
- rendering and use of colour on 3D models and assemblies
- production of hard copies of solid models, assemblies and 2D manufacturing drawings
- saving files for later retrieval

**Resources** may include:

- computer software
- stationary
- software reference documentation
- reference texts
- consumables

**Equipment** may include:

- Computer aided drafting (CAD) system
- printing equipment

**Enterprise procedures** may include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - Implement OHS/WHs procedures and practices including the use of risk control measures as specified in the performance criteria



- Demonstrate the ability to create models of solid object assemblies for computer processing and presentation purposes on more than one occasion and in different contexts.

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - Access to workplace or work real environment and a variety of conditions
  - Operational access to relevant CAD equipment, tools, materials and consumables
  - Access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22503 - Create and modify surfaces for simple consumer products

### Unit Descriptor

This unit of competency describes the knowledge and skills required to apply surface modelling techniques to three-dimensional drawings to display models of simple consumer products for computer processing and presentation purposes.

The unit includes applications in CAD, computer graphics and part geometric design, finite element mesh generation, Rapid prototyping, modelling testing, and surface visualisation.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at para professional level in an engineering enterprise involved in the design, development and analysis of a range of engineering products and component parts.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Prepare for surface modelling task

2. Perform drawing for surface modelling

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements*** for a given work area are determined.
- 1.2 ***Surface modelling task*** requirements are identified from documentation, job sheets or through discussions with ***appropriate personnel***.
- 1.3 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved in the modelling task.
- 1.4 ***Resources*** and ***equipment*** needed for the surface-modelling task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.
- 2.1 Relevant OHS/WHS requirements for carrying out the work are followed.
- 2.2 Drawing task associated with surface modelling is undertaken according to enterprise procedures.
- 2.3 Appropriate modelling methodology is chosen for the given modelling task.
- 2.4 Key features of the surface modelling package are fully exploited to optimise productivity.
- 2.5 Decisions and methods for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.



- |   |   |
|---|---|
| 3. Complete and document surface modelling task | 3.1 Relevant OHS/WHS requirements for carrying out the work are followed.   |
|   | 3.2 Produce hard copies of the surface-modelling task and review against job specifications with relevant personnel |
|   | 3.3 Documentation associated with the surface-modelling task is finalised and correct revision levels are assigned. |
|   | 3.4 Completion of the surface-modelling task is notified and outcomes are discussed with appropriate personnel.     |

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- Interpreting job instructions for solid modelling task
- preparing drawings for modelling task
- determine and applying most appropriate modelling methodology
- using various materials and surface finish options
- producing hard copies of 3D surface models
- saving 3D models in various file formats for retrieval into other CAD application software
- working and communicating with other to clarify job instruction and dealing with unexpected situations

### ***Required knowledge:***

- terminology associated with surface modelling:
  - geometric
  - free-form
  - derived surfaces
  - wire frame vs solids
- wire frame modelling techniques:
  - setting and using work-planes
  - shifting and working with coordinate system
  - moving through 3D space
  - changing 'Z' depth
  - construction techniques
  - wire frame editing
- surface modelling techniques:
  - definition and use of surface primitives
    - box
    - cylinder
    - cone
    - torus



- wedge
- editing surface primitives
- editing and manipulating of surfaces
  - building splines and surfaces from raw data
- surface types:
  - geometric, free-form, derived surfaces
  - draft, revolved, ruled, lofted, swept, coons, offset trimmed, fillet, blend, parametric and NURBS surfaces
  - surface normal, reversing
- viewing and annotating 3D surface models:
  - creating and manipulating multiple views, display isometric, orthographic, perspective
- cross section view generation:
  - using cutting plane
- analysis of surface data:
  - extracting properties from surface model
- apply rendering techniques to a 3D model:
  - rendering types and preferences
  - render lighting techniques
  - views and scenes

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Surface modelling task*** may include but are not limited to:

- wire frame modelling
- surface modelling techniques (primitives)
- surface types
- viewing and annotation
- creation of cross-section views
- analysis of surface data
- rendering techniques
- material finishes
- production of hard copies
- saving and retrieval of files in varying formats





**Appropriate personnel** may include but are not limited to:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

**Resources** may include but are not limited to:

- computer software
- stationary
- software reference documentation
- reference texts
- consumables

**Equipment** may include but are not limited to:

- computer hardware
- printing equipment

**Enterprise procedures** may include but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - Demonstrate the ability to create surface models for computer processing and presentation purposes on two occasions.



**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant CAD hardware/software, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manual.

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



# VU22542 - Use advanced 2D and 3D computer aided drafting (CAD) techniques

## Unit Descriptor

This unit of competency describes the knowledge and skills required to use computer aided drafting (CAD techniques to prepare complex 2D and 3D representations of products or components for engineering applications.

The unit includes the creation of 2D and 3D views, solid modelling and rendering techniques, manipulations of shapes, movement through space, editing, files management and producing hardcopy output.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit applies to a person working at para professional level in an engineering design environment using a CAD system at an advanced level to produce images of products and component parts.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

### 1. Prepare for drawing

### 2. Perform drawing

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement<sup>1</sup>. Assessment of performance is to be consistent with the evidence guide.

1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WH&S) requirements*** for a given work area are determined.

1.2 ***Drawing task*** including purpose, scope, and presentation requirements are confirmed with ***appropriate personnel***.

1.3 ***Resources*** and ***equipment*** needed for the drawing task are obtained in accordance with ***enterprise procedures*** and checked for correct operation.

2.1 Drawing task is carried out to industry standards and in accordance with enterprise procedures.

2.2 Key features of the CAD package are fully exploited to obtain optimum outcomes.

2.3 Decisions and methods for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications.

2.4 Editing function is used to facilitate modification of geometric shapes in completion of a three dimensional view.



- |   |   |
|---|---|
| 3. Save files and complete drawing task | 3.1 Hard copy of final drawings are printed and reviewed.   |
|   | 3.2 Drawing files are saved in various formats for retrieval and use in CAD system or other application software. |
|   | 3.3 Equipment is shut down according to enterprise procedures.  |
|   | 3.4 Drawing task is documented and appropriate personnel notified in accordance with enterprise procedures.       |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- consulting and coordinating drawing task with other relevant personnel
- setting up and using a CAD system
- applying the key features of a CAD program to prepare complex 2D and 3D images
- produce hardcopy of drawing images
- saving files in various formats to enable retrieval in other software applications

### **Required knowledge:**

- designing applications:
  - areas, perimeters, volumes, angles, starting, ending, other controlling points
- using other commercial programs:
  - editing, file manipulation, design drafting
  - inbuilt design and data handling
  - spreadsheets, bill of material, data base, programming languages
- manipulation of shapes:
  - complex lines and arcs, splines, special single entity multiple lines, unique involute profiles, Archimedean profiles
- multiple three dimensional views:
  - setting up the environment on screen, top view, front and side views, three dimensional views
- movement through space:
  - drawing on any created views, relocating coordinate system as necessary
- creation of views:
  - creation of three dimensional complex views by manipulation of drawing planes and location of geometric shapes
- editing:
  - use of function to facilitate modification of geometric shapes in completion of a three dimensional view
- display of three dimensional view:
  - wire line, solid face, isometric, perspective, orthographic
- saving:
  - use of assembly drawing file for plotting



- theory of the terminology associated with modelling:
  - region modelling, solids modelling, wire frame as opposed to solids
- region modelling techniques:
  - creating a region primitive, editing regions
  - extracting area properties from region models
- solid modelling techniques:
  - creating solid primitives, editing solid primitives, converting region models to solid models, creating composite regions, creating composite solids, sectioned models, cutting plane and cross hatching
- rendering types and preferences
- rendering techniques and surface finish options
- producing hard copies of 3D models
- saving 3D models in various formats for retrieval into CAD drawings or other application software

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- design engineer
- trainer
- mentor
- teacher
- team member

***Drawing task*** may include:

- complex 2D and 3D engineering drawings requiring the use of a wide range of features typically found in commercial drawing packages

***Resources*** may include:

- computer software
- library files
- stationary
- drawing standards
- software reference documentation



**Equipment** may include:

- computer with advanced graphics capability
- printer
- plotter
- digitisers

**Enterprise procedures** may include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - use CAD to prepare complex 2D and 3D images of products or parts which demonstrate the applications of a range of techniques which include:
    - editing;
    - manipulations of shapes;
    - creation of views;
    - movement through space;
    - region and solid modelling techniques;
    - rendering;
    - producing hard copy output and
    - saving files in other format to enable retrieval in other software application.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.



- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to CAD software and hardware materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

### **Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22567 - Use extended features of computer aided drafting (CAD)

### Unit Descriptor

This unit of competency describes the knowledge and skills required to coordinate CAD operations in the use of customisation techniques to suit a particular context. This includes the use of extended features in the CAD applications software. The unit also includes language programming, macros/icon files, configuration of peripherals, and the creation of complex menus

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at para professional level in an engineering design and development environment where CAD applications to optimise productivity by customising CAD software to suit a specified task or tasks is performed.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Identify customisation options for a given context

2. Customise CAD application software

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements*** for a given work area are determined.
- 1.2 Most appropriate CAD application software features are selected for the ***customisation task***.
- 1.3 ***Appropriate personnel*** are consulted to ensure the work is co-ordinated effectively with others involved at the workplace.
- 1.4 ***Resources*** and ***equipment*** needed for the customisation task are obtained in accordance with ***enterprise procedures*** and checked for correct operation.
- 2.1 Customisation task of CAD application software for the required context is carried out.
- 2.2 Customisation task of CAD application software is tested and performance evaluated.
- 2.3 Decisions and methods for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.





- |  |   |
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| 3. Coordinate customised CAD operation | 3.1 Customisation of CAD application software is demonstrated to appropriate personnel and validated.             |
|  | 3.2 Customisation task is documented and appropriate personnel notified in accordance with enterprise procedures. |

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- selecting appropriate CAD software for customisation task
- consulting and coordinating with other relevant personnel
- performing and testing customisation task
- demonstrating CAD customised application software to other relevant personnel
- carrying and completing customisation task in accordance to job instruction and enterprise procedures

### ***Required knowledge:***

- principles of menu structure
- customisation techniques
  - user define applications
  - function keys
  - line types
  - patterns
  - screen
  - tablet
  - button
  - pull down menu
  - icon menu
- text editing software
  - commands
  - menus
  - keystrokes
  - special software function keys
  - read
  - modification of help
  - modification of assistance screens
- macro and icon files
  - techniques for creation
  - techniques for customization
- configuring software
  - procedures related to CAD peripherals



- procedures for creation of complex CAD menus
  - screen and digitising tablet menus
  - compile files to operate screen and tablet menus
- file transfer procedures
- information on CAD consumables

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Customisation task*** includes

- CAD language programming
- text editing
- macros and icon files
- configuring CAD peripherals
- complex CAD menus
- rendering/texture mapping
- importing/exporting files
- applying style features

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

:

***Resources*** may include:

- computer software
- library files
- stationary
- drawing standards
- software reference documentation



**Equipment** may include:

- computer hardware
- computer software with advanced graphics capability
- printers
- plotters
- digitisers

**Enterprise procedures** may include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate customisation and implementation techniques on more than one occasion which include, CAD language programming, macros/icon files, configuration of CAD peripherals, and the creation of complex CAD menus.

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant CAD hardware and software, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals.



**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22568 - Manage computer aided drafting (CAD) systems

### Unit Descriptor

This unit of competency describe the knowledge and skills required to establish, maintain and review CAD management systems as an integral part of the planning process within an engineering business.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at para professional level in an engineering business and is responsible for the establishment and maintenance of CAD management systems.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Establish a CAD management system

2. Maintain efficient CAD management system

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements*** for a given work area are determined.
- 1.2 ***CAD system*** requirements are determined and discussed with ***appropriate personnel***.
- 1.3 CAD management policies and procedures are developed that integrate with established ***enterprise procedures***.
- 1.4 CAD system budget requirements are drawn up and approved by appropriate personnel.
- 1.5 CAD system risk management procedures are established.
- 1.6 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the project.
- 1.7 ***Resources*** and ***equipment*** needed for the task are obtained in accordance with enterprise procedures.
- 2.1 CAD system is monitored to ensure efficient operation.
- 2.2 Procedures for continuous improvement of CAD system services are established, promoted and implemented.
- 2.3 Maintenance schedules are established and implemented.



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|     | 2.4  | CAD system budget is monitored in accordance with enterprise procedures.   |     |   |     |  |
|     | 2.5  | Local standards for the CAD system are maintained through regular communications with users.   |     |   |     |  |
|     | 2.6  | CAD users are supported through established processes.   |     |   |     |  |
|     | 2.7  | Decisions and methods for dealing with unexpected situations are made from discussions with appropriate personnel and implementation of risk management and enterprise procedures.   |     |   |     |  |
| 3.  | Review CAD management system   | <table border="0"> <tr> <td>3.1</td> <td>Processes are developed to ensure that ongoing review of the CAD management system becomes part of enterprise procedures.</td> </tr> <tr> <td>3.2</td> <td>Policies and processes are modified to ensure the CAD management system is maintained to achieve optimum operating conditions.</td> </tr> </table> | 3.1 | Processes are developed to ensure that ongoing review of the CAD management system becomes part of enterprise procedures. | 3.2 | Policies and processes are modified to ensure the CAD management system is maintained to achieve optimum operating conditions. |
| 3.1 | Processes are developed to ensure that ongoing review of the CAD management system becomes part of enterprise procedures.      |  |     |   |     |  |
| 3.2 | Policies and processes are modified to ensure the CAD management system is maintained to achieve optimum operating conditions. |  |     |   |     |  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- consulting with appropriate personnel to determine system requirements
- preparing a list of CAD management system requirements
- implementing a CAD management system into an enterprise
- monitoring the management system and maintaining standards
- developing a review process

### **Required knowledge:**

- CAD system components
  - types of CPU and operating systems
  - peripheral input and output devices
  - importing/exporting drawing files
  - communication protocol standards
  - hardware
  - software
  - installing with a CAD package
  - backup storage devices
  - cabling and communication for specific hardware
- management of CAD system variables and layers
- Local Area Networks (LAN)
  - understanding concepts and functions
  - hardware and software requirements
  - configuring of CAD for networks



- planning layout
- Software storage requirements
- configuring the network to user operating applications
- input devices
- output devices
- file management
- security operations
- operations, coordination and control
  - storage devices
  - plotting mediums
  - plotter and consumables
- techniques for efficient system management
  - file management procedures for drawing projects
  - maintenance and recording of drawing files
  - adoption of drawing standards
  - procedures for achieving and backing up
  - establishment of internal security system
- CAD system implementation plan
  - installation
  - operation
  - staff development needs
  - support
  - data conversion between systems
  - back up procedures
- concepts of policy development and business planning
- budget planning and monitoring

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Appropriate personnel*** may include but are not limited to:

- supervisor
- leading hand
- foreman
- manager
- site engineer



- trainer
- mentor
- teacher
- team member

**CAD system** involves:

- organised components working together to achieve drawing

**Enterprise procedures** may include but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**Resources** may include but are not limited to:

- computer software
- library files
- stationary
- drawing standards
- software reference documentation

**Equipment** may include but are not limited to:

- computer hardware
- computer software
- printers
- plotters
- digitisers
- computer network

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - Implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to plan, establish, maintain and review of CAD management system. This includes development of a CAD system implementation plan, development of all relevant policies and procedures applicable to a specific engineering workplace, maintenance of local standards, providing user support and establishment of ongoing review processes.





**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations.
- The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to CAD hardware and software materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22569 - Manage computer aided drafting (CAD) in a business

### Unit Descriptor

This unit of competency describes the knowledge and skills required to translate the business plan into operational strategies to deliver Computer Aided Drafting (CAD) services. These strategies may involve managing CAD equipment, materials, premises and physical and human resources and the development of operational procedures.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at para professional level and managing an engineering CAD facility as a business unit.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Evaluate a CAD business opportunity

2. Comply with legal and regulatory requirements

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements*** for a given work area are determined.
- 1.2 Sources of information about a CAD business opportunity are identified and pursued.
- 1.3 Information about a CAD business opportunity is documented and analysed.
- 1.4 Expert advice on business structure and viability is sought and taken into consideration before taking over or establishing a CAD business.
- 2.1 Systems are established to ensure ***legal rights and responsibilities*** of the business are identified and the business is adequately protected, especially in regard to OHS/WHS requirements.
- 2.2 ***Taxation principles and requirements*** are identified and compliance ensured.
- 2.3 ***Insurance requirements*** are identified and adequate cover is acquired.
- 2.4 Compliance with legal and regulatory requirements is monitored.



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| 3. Implement operational strategies             | <p>3.1 Relevant OHS/WHS requirements for carrying out the work are followed.</p> <p>3.2 CAD services are provided in accordance with established technical, legal and ethical standards.</p> <p>3.3 Business plan is established to enable procedures to be drawn up to control expenditure, wastage, stock and costs.</p> <p>3.4 Quality procedures are established for service and client requirements.</p> <p>3.5 External business relationships are identified and a range of acceptable outcomes is negotiated.</p> <p>3.6 New CAD technologies and applications are identified and evaluated for opportunities to improve business performance.</p> |
| 4. Implement human resources strategies         | <p>4.1 Human resource management processes and procedures are developed and maintained.</p> <p>4.2 OHS/WHS training program is established and maintained.</p> <p>4.3 Appropriate OHS/WHS records are maintained.</p> <p>4.4 <b>Industrial agreements</b> are put in place in accordance with current industrial legislation.</p>  |
| 5. Manage finances                              | <p>5.1 Financial requirements are established to operate and extend the CAD business.</p> <p>5.2 Capital, profitability and cash flow requirements are identified to enable operation according to the <b>business plan</b>.</p> <p>5.3 <b>Financial record system</b> is established and maintained to ensure monitoring of financial performance.</p> <p>5.4. Adequate financial provisions for taxation, superannuation and accruing staff leave are made.</p> <p>5.5 Financial and statutory reporting is conducted in accordance with legal and administrative requirements.</p> <p>5.6 Cash flow estimates are prepared for each forward period</p>  |
| 6. Implement and monitor continuous improvement | <p>6.1 Business performance is monitored to identify ways in which planning and operations could be improved.</p> <p>6.2 Performance deviations are investigated and corrective action taken if necessary.</p> <p>6.3 Operational policies and procedures are changed to incorporate corrective action taken.</p> <p>6.4 Proposed changes to operational policies and procedures are recorded to inform future planning and evaluation.</p>  |



- 6.5 Continuous improvement processes are communicated to staff.
- 6.6 Employees are encouraged to identify opportunities for improvements in the operational management of the CAD business.

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- Evaluating a CAD business opportunity
- communicating with others and seeking expert advice
- identifying financial, taxation, insurance and industrial requirements
- establishing a business plan
- manage the establishment of a CAD business
- prepare operational policy and procedures

### ***Required knowledge:***

- business planning
  - setting goals and objectives
  - size and scale of business
  - market focus
  - financing a business
  - risk assessment and management
  - resources
  - ownership/management details
  - staffing
  - operational arrangements
  - financial procedures
  - drawing up business plan
  - monitoring and reviewing business plan
  - technical resources and skills
  - methods of evaluation
  - strategic planning
- human resource management
  - definition and aims of HRM
  - social and legal environments
  - Occupational Health and Safety
  - influence of changing technology
  - nature and quality of work
  - quality of work



- industrial relations and agreements
- continuous improvement cycle
- recruitment and retention
- training and development
- equal opportunity obligations
- financial management
  - analysis of financial state of a business
  - likely return on investment
  - financial projections
  - pricing strategies and margins
  - costing of estimates
  - budget planning
  - labour cost
  - minimising risk
  - monthly, quarterly, annual returns
  - cash flow estimates
  - capital
  - working
  - fixed
  - debt
  - equity
  - auditing
  - contract law
- resource management
  - project management
  - stock control
  - break even analysis

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

**OH&S requirements** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

**Legal rights and responsibilities** may include:

- international, national and local legislation and regulation:
  - OH&S



- environmental
- industrial
- taxation
- copyright
- patent law
- consumer
- Law of Torts
- business registration
- design regulations
- codes of practice
- standards
- anti-competitive behaviour
- marketing and advertising regulations and codes
- local planning and other permissions
- license to practice
- obligations imposed through the choice of business structure

***Taxation principles and requirements*** may include:

- tax file number
- Australian Business number
- GST registration
- PAYG and withholding arrangements
- current taxation requirements/obligations

***Insurance requirements*** may include:

- insurance
  - fire
  - theft
  - liability
  - workers compensation
  - motor vehicle
  - others (declared mandatory by national and state legislation)

***Industrial agreements*** including:

- Australian workplace agreements
- enterprise bargaining agreements
- awards

***Business plan*** including:

- long term plans
- short term plans
- strategic plans



- marketing plans

**Financial record system** including:

- job costing
- quotations
- income and expenditure records
- petty cash
- taxation
- wages/salaries
- files of paid purchases and service invoices
- insurance
- time sheets
- bank account records
- credit card transaction records

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### **Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHs procedures and practices including the use of risk control measures as specified in the performance criteria and range
  - demonstrate the ability to prepare a business plan and strategies for the provision of CAD services to clients on a profitable fee for service basis. The plan and strategies must include:
    - details of the CAD services to be provided
    - physical and human resources required
    - business set up costs
    - anticipated ongoing operational costs for the service provision
    - cash flow requirement/operation costs estimates and financial management system
    - details of small business management obligations and responsibilities
    - industrial relations considerations
    - continues improvement processes



**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations.
- The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant CAD hardware and software equipment, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals.

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence
- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.





# Computer Numerical Control

## VU22504 - Program a 3D milling machine centre

### Unit Descriptor

This unit of competency describes the knowledge and skills required to produce basic three dimensional (3D) computer aided machining (CAM) and numerical control (NC) programs for a computer numerical control (CNC) milling centre.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person using 3D programs for machining for use in a production process.

Work associated with this unit of competency is carried out at a para-professional level.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Determine task requirements

2. Construct 3D components geometry for 3D milling

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WH&S) requirements*** for a given work area are clarified.
- 1.2 Safety hazards are identified, documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.3 ***Task requirements*** and relevant ***documentation*** to plan and carry out the task are interpreted and clarified with appropriate personnel.
- 1.4 Appropriate personnel are consulted to ensure the work is coordinated effectively with other in the workplace.
- 1.5 Resources and equipment needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.
- 2.1 OHS/WH&S requirements for carrying out the work are followed.
- 2.2 Menus, variables and defaults are accessed and customised to create/manipulate 3D geometric elements.
- 2.3 3D entities/elements are created for common ***toolpath/surface*** using construction planes, layers and viewing angles.
- 2.4 Component geometry is edited, as required, to produce component to specification.
- 2.5 Decisions and methods for dealing with unexpected situations are made from discussions with appropriate



- personnel and implemented in accordance with enterprise procedures.
- |   |   |
|---|---|
| 3. Create and modify 3D CAM milling program files | 3.1 OHS/WHS requirements for carrying out the work are followed.                        |
|   | 3.2 Tool movements are graphically proved on computer and edited as necessary.          |
|   | 3.3 Tool path programs are converted to a CNC program file using a post processor.      |
|   | 3.4 Set-up sheets/job plans are created as required according to enterprise procedures. |
| 4. Manage 3D CAM files and finalise task          | 4.1 Files are transferred from computer to CNC/NC milling machine.                      |
|   | 4.2 <b>3D CAM files</b> are stored in various formats.                                  |
|   | 4.3 Work completion is notified in accordance with enterprise procedures.               |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- following relevant OHS/WHS procedures
- consulting and communicating with others in the work area
- creating and manipulating 3D geometric elements
- editing component geometry
- converting tool path programs to a CNC program file
- transferring files from computer to CNC/NC milling machine
- planning
  - identifying and clarifying task requirements
  - identifying specifications and required resources
  - planning the steps required to generate code files
  - reviewing and revising outcomes against task objectives and requirements
  - identifying corrective action

### **Required knowledge:**

- Occupational Health and Safety
  - workplace safety procedures
  - risk assessment and hazard control
  - personal protective equipment and safety devices
  - personal responsibilities
- construct 3D component geometry
  - operating principles of 3D CAM packages



- 3D CAM file types and support files
- customising system variables
- customising menus and system defaults
- identifying relevant machining surfaces from 3D component or drawing,
- creating, editing, copying, imaging, scaling, modifying, rotating and deleting 3D component geometry including:
  - o entities/elements
  - o lines
  - o arcs/circles
  - o ellipses
  - o splines/polylines
- constructing simple 3D wire frame, surface and /or solid model geometry using:
  - o construction planes
  - o construction axes
  - o layers/levels
  - o viewing angles
  - o machining axes/tool axes
- geometry/toolpaths for:
  - o contour
  - o ruled
  - o loft
  - o revolution/spun
  - o swept/translated
  - o coons/form patch
- identifying boundary elements and types of 3D machining surfaces
- analysing, modifying and deleting file elements
- retrieving and saving files in various formats
- produce files
  - producing tool paths
  - graphically proving tool paths on screen and hard copy
  - purpose of a post processor
  - converting milling tool path programs to CNC machine 3D contour, ruled, swept or translated, lofted, revolved or spun and coons or form patch surfaces
  - reverse posting from CNC to package specific file
  - changing post processor type
  - reposting file for different machine
  - transferring files to CNC machining centre
- document interpretation
  - work instructions and procedures
  - interpreting sketches and drawings
  - reference manuals and catalogues
- communication



- questioning and clarifying information
- following oral and written instructions
- analysing elements of a task

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Appropriate personnel*** may include but are not limited to:

- supervisor
- leading hand
- foreman
- workshop manager
- production engineer
- trainer
- mentor
- teacher
- team member



**Task requirements** may include but are not limited to:

- timeframe for task
- tools and equipment
- working with others
- materials, parts and other resources
- specifications
- procedures
- special reporting requirements
- quality measures

**Task requirements** may include but are not limited to:

- timeframe for task
- tools and equipment
- working with others
- materials, parts and other resources
- specifications
- procedures
- special reporting requirements
- quality measures

**Documentation** may include:

- task lists
- instructions
- work procedures
- manufacturer manuals
- wiring diagrams and schematics
- technical drawings and sketches
- parts lists
- computer records

**Enterprise procedures** may include but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures



**Toolpath/surfaces** such as:

- contoured
- ruled
- lofted
- revolution/spun
- swept/translated
- coons/form patch

**3D CAM files** such as:

- geometry (graphics) file
- generic tool path or intermediate file
- specific post processed CNC machine tool file

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- implement OHS/WHs workplace procedures and practices including the use of risk control measures as specified in the performance criteria
- demonstrate the ability to produce basic 3D CAM and NC programs for a CNC milling centre on more than one occasion and in different contexts.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant programming software /hardware, machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals



**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22570 - Program 4<sup>th</sup> axis applications

<b>Unit Descriptor</b>	<p>This unit of competency describes the knowledge and skills required to produce basic CAM and NC programs for 4 axis machining centres and Mill Turn lathes.</p> <p>No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.</p>
<b>Employability Skills</b>	<p>This unit contains employability skills.</p>
<b>Application of the Unit</b>	<p>This unit of competency applies to a person required to produce/modify basic CAM and NC programs for 4 axis machining centres and Mill Turn lathes as part of the production process.</p> <p>Work associated with this unit of competency is carried out at a para-professional level.</p>

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

1. Identify task requirements	<p>1.1 <b><i>Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements</i></b> for a given work area are determined.</p> <p>1.2 Safety hazards are identified, documented and risk control measures devised and implemented in consultation with <b><i>appropriate personnel</i></b>.</p> <p>1.3 Relevant <b><i>documentation</i></b> and <b><i>task requirements</i></b> are interpreted and clarified with appropriate personnel.</p> <p>1.4 Appropriate personnel are consulted to ensure the work is coordinated effectively with others involved at the work site.</p> <p>1.5 Resources and equipment needed for the task are obtained in accordance with <b><i>enterprise procedures</i></b> and checked for correct operation and safety.</p>
2. Construct 3D components geometry for 3D milling	<p>2.1 Safe work practices are applied during the 3D construction phase of the task.</p> <p>2.2 Menus, variables and defaults are accessed and customised to create/manipulate 3D geometric elements.</p> <p>2.3 Machining considerations are identified and incorporated into tool path development.</p> <p>2.4 3D entities/elements are created for common <b><i>tool path/surface</i></b> using construction planes, layers and viewing angles.</p> <p>2.5 Component geometry is edited as required to produce component to specification.</p>





	2.6	Decisions and methods for dealing with unexpected situations are made from discussions with appropriate personnel, and implemented in accordance with enterprise procedures.
3. Create and modify programs for four axes centre and mill turn multi-tasking machine	3.1	Tool movements are graphically proved on computer and edited as necessary.
	3.2	CNC machine program is created for nominated machine using a post processor.
	3.3	Set-up sheets/job plans are created as required according to enterprise procedures.
4. Transfer and manage 3D CAM files	4.1	Files are correctly transferred from computer to CNC machining centre.
	4.2	<b>3D CAM files</b> are managed and stored in various formats.
5. Machine surfaces to verify program	5.1	Machine is set/adjusted to meet operational requirements and specifications.
	5.2	Specified 3D toolpath surfaces are machined, observing all safety procedures.
	5.3	Program is verified and all surfaces checked for compliance with specifications.
	5.4	Program is edited as required to ensure job conforms to specification.
	5.5	Work completion is notified in accordance with enterprise procedures.

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- following relevant OHS/WHS and risk control procedures for the work area
- constructing 3D component geometry
- creating CNC machine program
- managing, store and transfer CAM files
- planning
  - identifying and clarifying task requirements
  - identifying specifications and required resources
  - planning the steps required to generate code files
  - reviewing and revising outcomes against task objectives and requirements
  - identifying corrective action
- communicating
  - questioning and clarifying information
  - following oral and written instructions
  - analysing elements of a task



**Required knowledge:**

- Occupational Health and Safety
  - workplace safety procedures
  - risk assessment and hazard control
  - personal protective equipment and safety devices
  - personal responsibilities
- 3D component geometry construction including:
  - operating principles of 3D CAM packages
  - 3D CAM file types and support files
  - system variables, menus and system defaults customisation
  - identifying relevant machining surfaces from 3D component or drawing,
  - 3D component geometry manipulation including:
    - entities/elements
    - lines
    - arcs/circles
    - ellipses
    - splines/polylines
  - simple 3D wire frame, surface and /or solid model geometry construction using:
    - construction planes
    - construction axes
    - layers/levels
    - viewing angles
    - machining axes/tool axes
  - usage of layers containing non tool path/work holding data:
    - work holding
      - clamps
      - fixtures
    - non tool path data
    - turning on and off
    - colours
  - machining considerations:
    - surface tolerance
      - across cut spacing
      - along cut length
      - cutter corner radius and effect of changing
      - cusp height
  - roughing cuts
  - creating geometry/tool paths for:
    - contour
    - ruled
    - loft
    - revolution/spun



- swept/translated
- coons/form patch
- creating combined tool path surfaces:
  - projected tool path
  - trim/blend two 3D surfaces
    - fillets
- effect of changing tool corner radius on surface tolerance
- effect of changing the across cut distance and along cut distance on surface tolerance
- identifying boundary elements and types of 3D machining surfaces
- analysing, modifying and deleting file elements
- retrieving and saving files in various formats
- produce files
  - producing tool paths
  - graphically proving tool paths on screen and hard copy
  - purpose of a post processor
  - developing milling programs for 3D contours, ruled, swept or translated, lofted, revolved/spun and coons/form patch surfaces
  - reverse posting from CNC to package specific file
  - changing post processor type
  - reposting file for different machine
  - transferring files to CNC machining centre
- machine setting and operation
  - file communications
  - work holding/fixtures
  - offsets
  - dry runs/program proving
  - operating machine
  - safe work practices and procedures
- document interpretation
  - work instructions and procedures
  - interpreting sketches and drawings
  - reference manuals and catalogues

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

**OHS/WHS requirements** may include but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- Awards provisions



**Appropriate personnel** may include but are not limited to:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

**Task requirements** may include but are not limited to:

- timeframe for task
- tools and equipment
- working with others
- materials, parts and other resources
- specifications
- procedures
- special reporting requirements
- quality measures

**Documentation** may include but are not limited to:

- task lists
- instructions
- work procedures
- manufacturer manuals
- wiring diagrams and schematics
- technical drawings and sketches
- parts lists
- computer records

**Enterprise procedures** involves:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**Machining considerations** may include:

- surface tolerance
  - roughing cuts

**Tool paths/surfaces** may include but are not limited to:

- contoured
- ruled



- lofted
- revolution/spun
- swept/translated
- coons/form patch

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### **Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHs workplace procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to produce and/or modify basic CAM and NC programs for 4 axis machining centres and Mill Turn lathes on more than one occasion and in different contexts.

### **Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant programming software/hardware, machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals



**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22571 - Create advanced programs for CNC machine centres

### Unit Descriptor

This unit of competency describes the knowledge and skills required to produce advanced three dimensional (3D) computer aided design/machining (CAD/CAM) and numerical control (NC) programs for 4 and/or 5 axes computer numerical control (CNC) machining centres.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working in a manufacturing/processes where complex production requires the use of CNC machine centres that require advanced programming techniques.

Work associated with this unit of competency is carried out at a para-professional level.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

#### 1. Identify task requirements

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety/OHS/WHs requirements*** for a given work area are determined.
- 1.2 Safety hazards are identified and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.3 Relevant ***documentation*** and ***task requirements*** are interpreted and clarified, if necessary, with appropriate personnel.
- 1.4 Appropriate personnel are consulted to ensure the work is coordinated effectively with others involved at the work place.
- 1.5 Resources and equipment needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.

#### 2. Construct and edit advanced multiple surfaces and solid model geometry

- 2.1 OHS/WHs requirements for carrying out the work are followed.
- 2.2 Menus, variables and defaults are accessed and customised to create/manipulate advanced multiple surfaces and solid model geometry.
- 2.3 ***Machining considerations*** are identified and incorporated into tool path development.



- |    |     |   |
|----|-----|---|
|    | 2.4 | 3D entities/elements are created for common <b>tool path/surface</b> using construction planes, layers and viewing angles.  |
|    | 2.5 | Advanced multiple surfaces and solid model geometry is created using construction planes, layers and viewing angles.  |
|    | 2.6 | Component geometry is edited as required to produce component to specification.   |
|    | 2.7 | Decisions and methods for dealing with unexpected situations are made from discussions with appropriate personnel, and implemented in accordance and enterprise procedures. |
| 3. |     | Produce programs for 3D profiles and or shapes utilizing the 4 <sup>th</sup> and /or 5 <sup>th</sup> axis of the machine tool   |
|    | 3.1 | OHS/WHs requirements for carrying out the work are followed.  |
|    | 3.2 | Tool movements are graphically proved on computer and edited as necessary.  |
|    | 3.3 | CNC machine program is created for nominated machine using a post processor.  |
|    | 3.4 | Set-up sheets/job plans are created as required according to enterprise procedures.   |
| 4. |     | Transfer and manage CAD/CAM files   |
|    | 4.1 | OHS/WHs requirements for carrying out the work are followed.  |
|    | 4.2 | <b>CAD/CAM files</b> are managed and stored in various formats.   |
|    | 4.3 | CAD/CAM surface and solid model files are imported from other CAD/CAM systems using industry standard <b>translators</b> .  |
|    | 4.4 | Files are correctly transferred from computer to CNC machining centre.  |
| 5  |     | Profiles and shapes are machined to verify program  |
|    | 5.1 | OHS/WHs requirements for carrying out and completing the work are followed.   |
|    | 5.2 | Machine is set/adjusted to meet operational requirements and specifications.  |
|    | 5.3 | Specified 3D toolpath surfaces are machined, observing all safety procedures.   |
|    | 5.4 | Program is verified and all surfaces checked for compliance with specifications.  |
|    | 5.5 | Program is edited as required to ensure job conforms to specification.  |
|    | 5.6 | Work completion is notified in accordance with enterprise procedures.   |





## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- creating advanced multiple surfaces and solid model geometry
- following relevant OHS/WHS procedures and risk control measures:
- creating 3D entities/elements
- producing CNC machine program
- managing CAD/CAM files
- verifying machine program operation
- producing files including:
  - graphically proving tool paths on screen and hard copy
  - developing programs for 3D profiles and or shapes utilizing the 4th and /or 5th axis of the machine tool reverse posting from CNC to package specific file
  - changing post processor type
  - reposting file for different machine
  - transferring files to CNC machining centre
- planning including:
  - identifying and clarifying task requirements
  - identifying specifications and required resources
  - planning the steps required to generate code files
  - reviewing and revising outcomes against task objectives and requirements
  - identifying corrective action
- consulting and communicating with others including:
  - questioning and clarifying information
  - following oral and written instructions
  - discussing and analysing elements of a task

### **Required knowledge:**

- occupational health and safety
  - workplace safety procedures
  - risk assessment and hazard control
  - personal protective equipment and safety devices
  - personal responsibilities
- construct 3D component geometry
  - operating principles of 3D CAM packages
  - 3D CAM file types and support files
  - system variables, menus and system defaults customisation
  - CAD/CAM surface and solid model files importation from other CAD/CAM systems using industry standard translators e.g. Para-solids, Step, IGES
  - identifying relevant machining surfaces from 3D component or drawing,



- creating, editing, copying, imaging, scaling, modifying, rotating and deleting 3D profiles and shapes using:
  - o entities/elements
  - o lines
  - o arcs/circles
  - o ellipses
  - o splines/polylines
- multiple surfaces and /or solid model geometry construction using:
  - o construction planes
  - o 4<sup>th</sup> and 5<sup>th</sup> axes
  - o layers/levels
  - o viewing angles
  - o machining axes/tool axes
- use of layers containing non toolpath/workholding data:
  - o workholding
    - clamps
    - fixtures
  - o non tool path data
  - o turning on and off
  - o colours
- machining considerations:
  - o surface tolerance
    - across cut spacing
    - along cut length
    - cutter corner radius and effect of changing
    - cusp height
  - o roughing cuts
- creating geometry/tool paths for:
  - o contour
  - o ruled
  - o lofted
  - o revolution/spun
  - o swept/translated
  - o coons/form patch
- creating combined toolpath surfaces:
  - o projected toolpath
  - o trim/blend two 3D surfaces
    - fillets
- effect of changing tool corner radius on surface tolerance
- effect of changing the across cut distance and along cut distance on surface tolerance
- identifying boundary elements and types of 3D machining surfaces



- analysing, modifying and deleting file elements
- retrieving and saving files in various formats
- machine setting and operation
  - file communications
  - workholding/fixtures
  - offsets
  - dry runs/program proving
  - operating machine
  - safe work practices and procedures

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

### ***OHS/WHS requirements***

may include but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

### ***Appropriate personnel***

may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Task requirements*** may include but are not limited to:

- timeframe for task
- tools and equipment
- working with others
- materials, parts and other resources
- specifications
- procedures
- special reporting requirements
- quality measures



**Documentation** may include but is not limited to:

- task lists
- instructions
- work procedures
- manufacturer manuals
- wiring diagrams and schematics
- technical drawings and sketches
- parts lists
- computer records

**Enterprise procedures** may include but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**Machining considerations** may include:

- surface tolerance
- roughing cuts

**Toolpath/surfaces** may include:

- contoured
- ruled
- lofted
- revolution/spun
- swept/translated
- coons/form patch

**CAD/ CAM files** may include:

- geometry (graphics) file
- generic tool path or intermediate file
- specific post processed CNC machine tool file

**Translators** may include:

- para-solids,
- step,
- IGES

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:



- implement OHS/WHS workplace procedures and practices including the use of risk control measures as specified in the performance criteria
- demonstrate the ability to produce advanced 3D CAD/CAM and NC programs for 4 and/or 5 axes CNC machining centres on two occasions.

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant software/hardware, machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



# VU22505 - Write and modify basic CNC programs

## Unit Descriptor

This unit of competency describes the knowledge and skills required to create and modify basic computer numerical control (CNC) programs for linear and circular turning and milling operations limited to two dimensional and two and half dimensional (2D and 2.5D).

(This excludes programming machines with multiple spindles and using complex programming structures such as canned cycles and subroutines).

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency applies to person working in a manufacturing environment where metallic and non-metallic components or parts are produced by CNC controlled machine centres.

Work associated with this unit of competency is carried out at a para-professional level.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

- 1 Determine programming requirements

- 2 Write/modify CNC machine program and operation sheet

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements*** for a given work area are determined.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Programming requirements are determined from documentation, work requests or discussions with ***appropriate personnel***.
- 1.4 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the workplace.
- 1.6 ***Resources*** and ***equipment*** needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation and safety.
- 2.1 Machine function and tool path is defined by referencing engineering drawings.
- 2.3 Coordinates for tool path and machine function are calculated.



- 2.4 CNC program is written and/or modified using EIA-274-D coding standard and according to enterprise procedures.
- 2.5 Operations sheets are produced in accordance with enterprise procedures.
- 2.6 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.
- 3 Verify CNC program
  - 3.1 Program is tested and verified by operating machine in manual mode.
  - 3.2 Corrective action is taken to eliminate any errors in the program and the program is manually revalidated.
  - 3.3 Program is documented with comments and stored according to enterprise procedures.

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- identifying and following relevant OHS/WHs requirements
- interpreting documentation, specifications and drawings
- planning and scheduling required operations
- calculating co-ordinates and references points for the components being produced
- visualising cutting tools movements
- writing CNC program code in using EIA-274-D standard
- producing operations sheets
- verifying CNC programs using manual mode
- editing and modifying CNC programs
- preparing and maintaining CNC programming records;
- working and communicating technical requirements to others in the workplace

### **Required knowledge:**

- motions of various machines centres;
- programmable functions;
- CNC process flow;
- point of reference;
- program structures;
- program codes and languages;
- program formatting;
- programming mistakes;
- linear and circular tool motion control;
- offsets and compensation techniques;
- tool length compensation



## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHs requirements*** may include but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- production engineer
- trainer
- mentor
- teacher
- team member

***Resources*** may include but are not limited to:

- reference manuals
- scientific calculator
- appropriate manuals
- CNC coding software
- CAD software
- stationery

***Equipment*** may include but is not limited to:

- computer workstation, either stand alone or networked
- CNC machining centre with single spindle operation
- selection of machine tools
- tools for fitting machine tools

***Enterprise procedures*** may include but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- operational procedures





## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHs workplace procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to write, modify CNC programs using EIA-274-D coding standard and verify CNC programs for single spindle machines for straight and circular tool motion on two occasions.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

### Methods of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons



- inspection of the final product or outcome
  - a portfolio of documented evidence
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



# VU22506 - Write advanced CNC programs and operate a vertical machining centre

## Unit Descriptor

This unit of competency describes the knowledge and skills required to write, and set up advanced CNC programs to operate vertical machining centres.

The unit includes incorporation of advanced techniques such as sub programs, nesting and 4<sup>th</sup> axis work.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency applies to person working at para professional level in a manufacturing or engineering processing environment where CNC machining is programmed and operated.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

### 1 Plan the machining process

- 1.1 **Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements** for a given work area are obtained and interpreted.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards, which have not previously been identified, are documented and risk control measures devised and implemented in consultation with **appropriate personnel**.
- 1.4 Work methods and procedures are planned and prioritised
- 1.5 Appropriate steps are taken to ensure the work is coordinated effectively with others.
- 1.6 Tools, equipment and materials needed are obtained and checked for correct and safe operation.

### 2 Write machine centre program

- 2.1 Engineering drawings are interpreted to define machine functions and tool path geometry
- 2.2 Coordinates are calculated as required
- 2.3 Program is written in standard code format in accordance with **enterprise procedures**.
- 2.4 **Programming structures** are selected and applied as appropriate.



- |   |                       |   |
|---|-----------------------|---|
|   | 2.5                   | Operation sheets are produced in accordance with enterprise procedures.                                 |
| 3 | Set up machine centre |   |
|   | 3.1                   | Appropriate mill tooling is selected.   |
|   | 3.2                   | Correct materials is selected to be machined according to drawing specifications                        |
|   | 3.3                   | Speeds, feeds and depth of cut for the appropriate tooling are set and according to cutting conditions. |
|   | 3.4                   | Tools and tool holding devices are used correctly and in accordance with manufacturers' specifications. |
|   | 3.5                   | Unexpected situations are dealt with safely and in discussion with appropriate personnel.               |
| 4 | Trial the program     |   |
|   | 4.1                   | CNC program is transferred to machine centre.   |
|   | 4.2                   | Machine centre is operated in manual mode to test and prove program.                                    |
|   | 4.3                   | Program is edited is appropriated to ensure correct operation.  |
|   | 4.4                   | Produced parts are checked to conform to specifications   |
|   | 4.5                   | On job completion cutting tools are maintained according to manufacturers' specifications.              |

## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- identifying and following relevant OHS/WHs procedures
- interpreting engineering drawings, specifications and instructions
- calculating coordinates of all relevant points on the part or product to be produced
- writing CNC code in standard format
- editing CNC programs
- using advanced CNC programming structures
- producing CNC operations sheets
- operating CNC machine in manual mode
- selecting correct machine centre tooling
- communicating technical and procedural requirements to others
- dealing effectively with unexpected situations when programming and/or operating CNC machines in manual mode

### ***Required knowledge:***

- relevant OHS/WHs requirements
- CNC process planning



- CNC machining centre tooling and cutting conditions
- communication with the control
- axis designation
- cutter compensation
- height compensation
- setting tool offsets
- linear interpolation
- circular Interpolation
- canned cycles
- sub programs
- nesting of subprograms
- 4<sup>th</sup> axis programming techniques

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHs requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Enterprise procedures*** may include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- operational procedures



## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- implement OHS/WHS workplace procedures and practices including the use of risk control measures as specified in the performance criteria
- demonstrate the ability to successfully program and set up vertical machine centres for two different applications.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant software, machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals.

### Methods of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.



- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



# VU22507 - Write advanced CNC programs and operate a multi axis turning centre

<b>Unit Descriptor</b>	<p>This unit of competency describes the knowledge and skills required to write an advanced CNC program and operate CNC multi axis turning centres.</p> <p>The unit includes incorporating advanced techniques such as sub program nesting and multi axis work.</p> <p>No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.</p>
<b>Employability Skills</b>	<p>This unit contains employability skills.</p>
<b>Application of the Unit</b>	<p>This unit of competency applies to a person working at para professional level in a manufacturing processing environment where CNC machining is used as part of the production process.</p>

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

### 1 Plan the machining process

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 **Occupational Health and Safety/Workplace Health and Safety (OHS/WH&S) requirements** for a given work area are determined.
- 1.2 Established OHS/WH&S requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards, which have not previously been identified, are documented and risk control measures devised and implemented in consultation with **appropriate personnel**.
- 1.4 Work methods and procedures are prioritised
- 1.5 Appropriate steps are taken to ensure the work is coordinated effectively with others.
- 1.6 Tools, equipment and materials needed are obtained and checked for correct safe operation.

### 2 Write a multi axis turning centre program.

- 2.1 Engineering drawings are interpreted to define functions and tool path geometry.
- 2.2 Coordinates are calculated as required.
- 2.3 Program is written in standard code format in accordance with **enterprise procedures**.
- 2.4 **Programming structures** are selected and appropriately applied
- 2.5 Operation sheets are produced in accordance with enterprise procedures.





- |   |                                    |  |
|---|------------------------------------|--|
| 3 | Set up a multi axis turning centre | <p>3.1 Appropriate tooling is selected.</p> <p>3.2 Correct materials to be machined are selected, according to drawing specifications.</p> <p>3.3 Speeds, feeds and depth of cut for the appropriate tooling are in accordance with the cutting conditions.</p> <p>3.4 Tools and tool holding devices are used in accordance with the manufactures' specifications.</p> <p>3.5 Unexpected situations are dealt with safely and in discussion with appropriate personnel.</p> |
| 4 | Trial the program.                 | <p>4.1 Program is transferred to the multi axis turning centre</p> <p>4.2 Multi axis turning centre is operated in dry run mode to test the program.</p> <p>4.3 Program editing is appropriate to ensure correct operation.</p> <p>4.4 Produced parts are measured to conform to the drawing specifications.</p> <p>4.5 On job completion cutting tools are maintained according to manufactures' specifications.</p>  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- identifying and following relevant OHS/WHS procedures
- working and communicating effectively with other team members
- interpreting engineering drawings, specifications and instructions
- calculating coordinates of all relevant points of the part or product to be produced
- writing CNC code on standard form
- editing CNC programs
- using advanced CNC programming techniques
- producing CNC operation sheets
- operating the multi axis turning centre in dry run mode
- selecting appropriate tooling to complete the required operations

### **Required knowledge:**

- process planning
- multi axis turning centre tooling
- cutting conditions
- communication with the CNC control
- axis designation
- cutter compensation
- setting tool offsets



- linear interpolation
- circular interpolation
- canned cycles
- subprograms
- 3<sup>rd</sup> axis

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Enterprise procedures*** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- operational procedures

***Programming structures*** including:

- external contour programs
- internal pocketing programs
- drilling, tapping and boring programs (canned cycles)
- internal threading
- external threading
- sub programs
- nesting sub programs
- multi axis machining



## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- implement OHS/WHS workplace procedures and practices including the use of risk control measures as specified in the performance criteria
- demonstrate the ability to successfully program and set up a multi axis turning centre consistently for two (2) different applications.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

### Methods of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.



- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



# VU22508 - Produce engineering components by programming and operating CNC manufacturing cells

<b>Unit Descriptor</b>	<p>This unit of competency describes the knowledge and skills required to produce engineering components by programming and operating CNC manufacturing cells.</p> <p>The unit includes planning, programming, producing and monitoring CNC machine operations.</p> <p>This work is typically carried out as part of a production team.</p> <p>No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.</p>
<b>Employability Skills</b>	This unit contains employability skills.
<b>Application of the Unit</b>	This unit of competency applies to a person working at para professional level in a production team responsible for setting up and the operation of CNC manufacturing cells in a production environment.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Establish a project plan for a CNC manufacturing task.
2. Set up and program a CNC manufacturing cell.

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement<sup>1</sup>. Assessment of performance is to be consistent with the evidence guide.

- 1.1 Specifications of the required project are obtained, discussed and agreed on with the production team and the **appropriate personnel**.
- 1.2 The **engineering objectives** for the project are clarified, defined and recorded according to **enterprise procedures**.
- 1.3 Constraints and limitations of the project are identified, agreed on and signed off by the production team and the appropriate personnel.
- 2.1 **Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements**, relevant Australian standards, codes of practice, manufacturers' specifications, **environmental requirements** and enterprise procedures are identified and followed.
- 2.2 **CNC manufacturing cell** is programmed according to specifications and enterprise procedures.
- 2.3 CNC manufacturing cell settings are adjusted in accordance with job requirements, machine and tool manufacturers' instructions and enterprise procedures.
- 2.4 Trial runs are conducted to check machine operation and quality of finished work.
- 2.5 Final adjustments are made to CNC programs and equipment according to enterprise procedures.



- |   |  |
|---|--|
| 3. Produce engineering components using a CNC manufacturing cell. | 3.1 CNC manufacturing cell is operated and monitored to ensure product quality of output.                                |
|   | 3.2 Waste quantities are checked and minimised.  |
|   | 3.3 CNC manufacturing cell malfunctions and problems are identified and reported to appropriate personnel.               |
|   | 3.4 <b>Specific safety requirements</b> are met throughout the task and can be explained.                                |
|   | 3.5 Routine lubrication and adjustments are performed according to requirements.   |
| 4. Complete CNC manufacturing and produce project report.         | 4.1 Material that can be reused is collected and stored.   |
|   | 4.2 Waste and scrap are removed following enterprise procedures.   |
|   | 4.3 Equipment and work area are cleaned and inspected for serviceable condition in accordance with workplace procedures. |
|   | 4.4 Unserviceable equipment is tagged and faults identified in accordance with workplace.                                |
|   | 4.5 Equipment and tooling are maintained in accordance with enterprise procedures.                                       |
|   | 4.6 Final production report is completed, reviewed and approved by the appropriate personnel.                            |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- identifying and following relevant OHS/WHS procedures
- working and communicating effectively with other team members responsible for setting up the CNC manufacturing cells
- planning programming and editing a CNC manufacturing cell
- operating CNC manufacturing cells
- preparing a production report

### **Required knowledge:**

- definition of numerical control (NC)
  - machine axes
  - X, Y and Z
  - others
  - axis drive
  - motors
  - types



- ball screws
- features
- industrial applications
  - lathes
  - mills
  - drills
  - grinders
  - others
  - justification
- CNC machine sub units
  - control unit
  - purpose
  - types
  - main parts
  - control systems
  - transducers
  - buffer storage
- work handling
- CNC programming
  - job planning
  - machine codes
  - absolute and incremental
  - intersection points
  - contouring
  - tool radius compensation
  - principal programming points
  - format
  - terminology
  - canned cycles
- program preparation
  - methods
  - entering
  - editing
  - setting up sheets
- loading program into machine memory
  - methods
- safety
- machine operation
  - control panel
  - operational modes
  - offsets



- stored stroke limit
- in cycle monitoring
- tool
- work holding
- coolant
- hydraulic pneumatic systems
- alarms and diagnostics
- material
- operation of program
  - proving
  - editing
- flexible manufacturing systems (FMS)
- maintenance

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- trainer/coach
- teacher

***Engineering objectives*** may include:

- functional specifications
- quality targets
- materials
- ergonomic considerations
- documented standards
- technical information
- cost considerations
- manufacturing processes

***Enterprise procedures*** may include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures





**OHS/WHS requirements** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operating procedures
- awards provisions

**Environmental requirements** may include:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

**CNC manufacturing cell** may include:

- CNC machining centres
- CNC turning centres
- CNC wire cutting
- CNC lathes
- CNC mills
- CNC press brakes
- CNC shears
- CNC boring mills
- CNC controllers

**Specific safety requirements** may include:

- working safely around machinery
- working safely with tools and equipment
- risk and hazard recognition
- emergency procedures
- awareness of electrical hazards
- follow confined spaces procedures
- first aid

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### **Critical aspects for assessment and evidence required to demonstrate competency in this unit**

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- implement OHS/WHS workplace procedures and practices including the use of risk control measures as specified in the performance criteria



- demonstrate the ability to successfully manufacturing components by programming and operating CNC manufacturing cells on at least two different occasions.

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or simulated workplace environment and a variety of conditions
  - operational access to relevant software, machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals.

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22509 - Apply computer aided manufacturing (CAM) processes

### Unit Descriptor

This unit of competency describes the knowledge and skills required to navigate a two dimensional (2D) CAM software package by creating or recalling CAD/CAM drawings, generating a 2D CAM code file, preparing basic CNC codes and producing a work piece on CNC machines.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at para professional level in a manufacturing environment where 2D code files using CAM for one or more lathe, mill, and wire cut machines are used for the production process.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- |                               |  |
|-------------------------------|--|
| 1. Identify task requirements | <p>1.1 <b><i>Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements</i></b> and <b><i>environmental requirements</i></b> for a given work area are determined.</p> <p>1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.</p> <p>1.3 Safety hazards, which have not previously been identified, are documented and risk control measures devised and implemented in consultation with <b><i>appropriate personnel</i></b>.</p> <p>1.4 Task outcomes and <b><i>task requirements</i></b> are identified and clarified, if necessary, with appropriate personnel.</p> <p>1.5 Relevant <b><i>documentation</i></b> to plan and carry out the task is interpreted.</p> <p>1.6 Appropriate personnel are consulted to ensure the work is coordinated effectively with others involved at the work site.</p> <p>1.7 <b><i>Resources and equipment</i></b> needed for the task are obtained in accordance with enterprise procedures and checked for correct operation and safety.</p> |
| 2. Navigate 2D CAM package    | <p>2.1 OHS/WHS requirements for carrying out the work are followed.</p> <p>2.2 Menus are accessed and customised to create/manipulate basic 2D geometric shapes.</p>   |



- 2.3 System variables and software defaults are customised to suit required application.
  - 2.4 **CAM files** in various formats are retrieved and saved.
  - 2.5 **Enterprise work procedures** are identified and followed where necessary.
3. Generate basic 2D code files
  - 3.1 OHS/WHS requirements for carrying out the work are followed.
  - 3.2 Part drawings are created and modified using basic graphical drawing tools in CAM package.
  - 3.3 Basic 2D machine tool paths are created to machine specified components for given **machine tool**.
  - 3.4 Tool movements are graphically displayed and proved on computer.
  - 3.5 Tool path programs are converted to a CNC machine program using a post processor.
  - 3.6 Decisions and methods for dealing with unexpected situations are discussed with appropriate personnel and selected on the basis of safety and specified work outcomes.
4. Produce components
  - 4.1 OHS/WHS requirements for carrying out and completing the work are followed.
  - 4.2 Files are correctly transferred from computer to CNC machine.
  - 4.3 Part is produced to specification.
  - 4.4 Work site is made safe in accordance with established safety procedures.
  - 4.5 Work completion is notified in accordance with enterprise procedures.

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- identifying and following relevant OHS/WHS procedures
- working and communicating effectively with other team members
- interpreting documentation and determining the required tasks
- using CAD package to create drawings
- operating the CAM system to creating machine tool paths
- customising system variables and customising menus and system defaults
- transferring files to CNC machines
- retrieving and saving files
- producing a part using CNC machine operations



**Required knowledge:**

- Occupational Health and Safety
  - workplace safety procedures
  - risk assessment and hazard control
  - personal protective equipment and safety devices
  - personal responsibilities
- application of CAM systems
  - commercial CAM packages used in industry and basic applications
  - CAM terminology
  - alternative methods of programming tool paths
  - advantages of using a CAM package compared to manual programming
  - applicable drafting standards/procedures
- navigating CAM systems
  - basic operating principles of a CAM package
  - file types
  - customising system variables
  - customising menus and system defaults
  - reasons for customising menus and system defaults
  - creating, modifying, deleting attributes using drawing tools
  - creating specified geometrical shapes comprising points, lines and arcs
  - analysing, modifying and deleting file elements
  - retrieving and saving files in various formats
- producing files
  - producing tool paths
  - purpose of a post processor
  - converting tool path programs to CNC machine programs transferring files to CNC machining centre
- planning
  - identifying and clarifying task requirements
  - identifying specifications and required resources
  - planning the steps required to generate code files
  - reviewing and revising outcomes against task objectives and requirements
  - identifying reasons why it was/was not met
  - identifying corrective action
- document interpretation
  - work instructions and procedures
  - interpreting sketches and drawings
  - reference manuals and catalogues
- communication
  - questioning and clarifying information
  - following oral and written instructions
  - analysing elements of a task



## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- award provisions

***Environmental requirements*** may include:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Task requirements*** may include:

- timeframe for task
- tools and equipment
- working with others
- materials, parts and other resources
- specifications
- procedures
- special reporting requirements
- quality measures

***Documentation*** may include:

- task lists
- instructions
- work procedures
- manufacturer manuals
- wiring diagrams and schematics



- technical drawings and sketches
- parts lists
- computer records

**Resources and equipment** may include:

- appropriate tools
- machining equipment
- reference manuals
- manufacturers' specifications
- consumables

**CAM files** may include:

- geometry (graphics) file
- generic tool path or intermediate file
- specific post processed CNC machine tool file

**Enterprise work procedures** may include but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**Machine tool** may include:

- lathe
- mill
- wire cut

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- implement OHS/WHs workplace procedures and practices including the use of risk control measures as specified in the performance criteria
- demonstrate the ability to use a Computer Aided Manufacturing (CAM) system to generate basic 2D code files and produce specified components on more than one occasion and in different contexts



**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include the demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.





# VU22510 - Apply computer aided manufacturing (CAM) 2D programming

## Unit Descriptor

This unit of competency describes the knowledge and skills required to produce two dimensional (2D) computer aided manufacturing (CAM) and numerical control (NC) programs for computer numerical controlled (CNC) machines.

The unit includes creating and manipulating 2D geometric shapes, creating and modifying CAM program files, operating a CAM system, setting and operating machines and producing components.

The No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency applies to a person working at para professional level in a manufacturing enterprise where 2D code files using CAM for one or more lathe, mill, and wire cut machines are created for the production process.

## ELEMENT

Elements describe the essential outcomes of a unit of competency.

Elements describe actions or outcomes that are demonstrable and assessable.

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

### 1. Identify task requirements

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements*** and ***environmental requirements*** for a given work area are determined
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards, which have not previously been identified, are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 Task outcomes and ***task requirements*** are identified and clarified, if necessary, with appropriate personnel.
- 1.5 Relevant ***documentation*** to plan and carry out the task is interpreted.
- 1.6 Appropriate personnel are consulted to ensure the work is coordinated effectively with others involved at the work site.
- 1.7 Resources and equipment needed for the task are obtained in accordance with ***enterprise procedures*** and checked for correct operation

### 2. Navigate 2D CAM package

- 2.1 OHS/WHS requirements for carrying out the work are followed.



- |   |   |
|---|---|
|   | <p>2.2 The full range of menus are accessed and customised to create/manipulate 2D geometric shapes.</p> <p>2.3 System variables and software defaults are customised to suit required application.</p> <p>2.4 <b>CAM files</b> are managed and stored in various formats.</p> <p>2.5 Enterprise procedures are identified and followed where necessary.</p>  |
| <p>3. Create and modify CAM program files</p> | <p>3.1 OHS/WHs requirements for carrying out the work are followed.</p> <p>3.2 2D component geometry is created and/or modified using graphical drawing tools in CAM package.</p> <p>3.3 Basic 2D wireframe models from other CAD/CAM systems are imported using various <b>translators</b>.</p> <p>3.4 Multiple 2D machine tool paths are created for a range of <b>common operations</b> for given <b>machine tool</b>.</p> <p>3.5 Tool movements are graphically proved on computer and edited as necessary.</p> <p>3.6 Tool path programs are converted to a CNC machine program using a post processor.</p> <p>3.7 Set-up sheets/job plans are created as required according to enterprise procedures.</p> <p>3.8 Decisions and methods for dealing with unexpected situations are discussed with appropriate personnel and selected on the basis of safety and specified work outcomes.</p> |
| <p>4. Produce components</p>                  | <p>4.1 OHS/WHs requirements for carrying out and completing the work are followed.</p> <p>4.2 Files are correctly transferred from computer to CNC machine.</p> <p>4.3 Machine is set or adjusted to meet operational requirements and specifications.</p> <p>4.4 Machine is operated to produce first-off samples, observing safety procedures.</p> <p>4.5 First-off samples are checked for compliance with specifications.</p> <p>4.6 Program editing to change speeds, feed and operational sequence requirements is undertaken as required, to ensure the job conforms to specification.</p> <p>4.7 Work site is made safe in accordance with enterprise procedures.</p> <p>4.8 Work completion is notified in accordance with enterprise procedures.</p>  |



## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- identifying and following relevant OHS/WHS procedures
- interpreting instructions and planning the task
- consulting and communicating including questioning and clarifying information with other team member and appropriate personnel to ensure the required task outcomes are achieved
- creating, examining and manipulate 2D geometric shapes
- producing component geometry using the graphical drawing tools in a CAM package
- creating and modifying CAM program files
- setting up and operating machines
- operating CAM systems and produce components

### ***Required knowledge:***

- CAM system operations including:
  - basic operating principles of a CAM package
  - CAM file types and support files
  - customising system variables
  - customising menus and system defaults
  - reasons for customising menus and system defaults
  - creating, copying, imaging, scaling, modifying, rotating and deleting geometric shapes
  - examining geometric shapes in orthogonal and isometric views
  - producing component geometry using the graphical drawing tools in a CAM package
  - viewing constructed geometry shapes in various views
  - creating CNC programs to produce milled contours with manual and automatic cutter compensation
  - creating CNC programs to drill and tap holes and machine pockets with islands on a CNC milling machine
  - creating CNC programs involving roughing, finishing and screw cutting on a CNC lathe
  - analysing, modifying and deleting file elements
  - retrieving and saving files in various formats
- production of files including:
  - producing tool paths
  - graphically proving tool paths on screen and hard copy
  - purpose of a post processor
  - converting tool path programs to CNC machine programs
  - reverse posting from CNC to package specific file
  - changing post processor type
  - reposting file for different machine



- editing tooling and offset numbers
- editing depths of cut
- editing feed rates and speeds
- editing machine setting data
- transferring files to CNC machining centre
- set up and operation of a machine including:
  - file communications
  - work-holding/fixtures
  - offsets
  - dry runs/program proving
  - operating machine
  - safe work practices and procedures
- OHS/WHS including:
  - workplace safety procedures
  - risk assessment and hazard control
  - personal protective equipment and safety devices
  - personal responsibilities
- document interpretation including:
  - work instructions and procedures
  - interpreting sketches and drawings
  - reference manuals and catalogues

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman



- manager
- site engineer
- trainer
- mentor
- teacher
- team member

**Task requirements** may include::

- timeframe for task
- tools and equipment
- working with others
- materials, parts and other resources
- specifications
- procedures
- special reporting requirements
- quality measures

**Documentation** may include:

- task lists
- instructions
- work procedures
- manufacturer manuals
- wiring diagrams and schematics
- technical drawings and sketches
- parts lists
- computer records

**Enterprise procedures** may include:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**CAM files** may include:

- geometry (graphics) file
- generic tool path or intermediate file
- specific post processed CNC machine tool file

**Translators** may include:

- IGES, DXF etc.

**Common operations** may include:

- drilling /tapping cycles
- contouring features
- pocketing routines



**Machine tool** may include:

- lathe
- mill
- wire cut

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- implement OHS/WHs procedures and practices including the use of risk control measures as specified in the performance criteria
- demonstrate the ability to create 2D CAM and NC programs for CNC machines and produce components on more than one occasion in different contexts.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant software, machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals



**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22511- Apply computer aided manufacturing (CAM) lathe programming

### Unit Descriptor

This unit of competency describes the knowledge and skills required to produce computer aided manufacturing (CAM) and numerical control (NC) programs for a given computer numerical controlled (CNC) lathe.

The unit includes creating computer generated drawings, generating program files for lathe control, using a post processor to convert path programs to CNC lathe, setting up a lathe to produce output.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working as a para professional in a manufacturing enterprises where CNC lathe operations are used in the production process.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Determine task requirements

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- |  |   |
|--|---|
| <ol style="list-style-type: none"> <li>1. Determine task requirements</li> </ol> | <ol style="list-style-type: none"> <li>1.1 <b><i>Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements and environmental requirements</i></b> for a given work area are considered.</li> <li>1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.</li> <li>1.3 Safety hazards, which have not previously been identified, are documented and risk control measures devised and implemented in consultation with <b><i>appropriate personnel</i></b>.</li> <li>1.4 Task outcomes and <b><i>task requirements</i></b> are identified and clarified, if necessary, with appropriate personnel.</li> <li>1.5 Relevant <b><i>documentation</i></b> to plan and carry out the task is interpreted.</li> <li>1.6 Appropriate personnel are consulted to ensure the work is coordinated effectively with others involved at the work site.</li> <li>1.7 <b><i>Resources and equipment</i></b> needed for the task are obtained in accordance with <b><i>enterprise procedures</i></b> and checked for correct operation and safety.</li> </ol> |
| <ol style="list-style-type: none"> <li>2. Navigate 2D CAM package</li> </ol>     | <ol style="list-style-type: none"> <li>2.1 OHS/WHS requirements for carrying out the work are followed.</li> </ol>  |





- 2.2 Menus are accessed and customised to create/manipulate 2D geometric shapes.
- 2.3 System variables and software defaults are customised to suit required application.
- 2.4 **CAM files** are managed and stored in various formats.
- 2.5 Enterprise procedures are identified and followed where necessary.
- 2.6 Decisions and methods for dealing with unexpected situations are discussed with appropriate personnel and selected on the basis of safety and specified work outcomes.
- 3. Develop and modify CAM program to produce a 2-axes lathe program
  - 3.1 Relevant OHS/WHS requirements for carrying out the work are followed.
  - 3.2 2D component geometry is created and/or modified using graphical drawing tools in CAM package.
  - 3.3 2D lathe tool paths are created for a range of **common operations** for nominated lathe components.
  - 3.4 Tool movements are graphically proved on computer and edited as necessary.
  - 3.5 Lathe tool path programs are converted to a CNC program file using a post processor.
  - 3.6 Set-up sheets/job plans are created as required according to enterprise procedures.
- 4. Produce components
  - 4.1 Relevant OHS/WHS requirements for carrying out and completing the work are followed.
  - 4.2 Files are correctly transferred from computer to CNC machine.
  - 4.3 Machine is set and adjusted to meet operational requirements and specifications.
  - 4.4 CNC lathe is set and adjusted to produce first-off samples, observing all safety procedures.
  - 4.5 First-off samples are checked for compliance with specifications.
  - 4.6 Program editing to change speeds, feed and operational sequence requirements is undertaken as required to ensure job conforms to specification.
  - 4.7 Work site is made safe in accordance with enterprise procedures.
  - 4.8 Work completion is notified in accordance with enterprise procedures.



## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- identifying and following relevant OHS/WHS procedures
- consulting and communicating including questioning and clarifying information with other team member and appropriate personnel to ensure the required task outcomes are achieved
- reading and clarifying engineering documentation, task objectives/job instruction/specifications
- identifying and accessing required resources from job instructions
- planning the steps required to generate code files
- reviewing and revising outcomes against task objectives
- creating computer generated drawings
- generating program files for tool path and lathe control
- using a post processor to convert path programs to CNC
- converting tool path programs to CNC machine programs transferring files to CNC machining centre
- setting up a lathe to produce output
- producing a component
- retrieving and saving files in various formats

### ***Required knowledge:***

- OHS/WHS procedures
- risk assessment and hazard control
- application of CAM systems
- commercial CAM packages used in industry and basic applications
- CAM terminology
- alternative methods of programming tool paths
- advantages of using a CAM package compared to manual programming
- applicable drafting standards/procedures
- CAM system navigation
- basic operating principles of a CAM package
- file types
- customisation of system variables
- customisation of menus and system defaults
- reasons for customising menus and system defaults
- application of drawing tools
- creating specified geometrical shapes comprising points, lines and arcs
- tool paths
- purpose of a post processor



## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHs requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- award provisions

***Environmental requirements*** may include:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Task requirements*** may include:

- timeframe for task
- tools and equipment
- working with others
- materials, parts and other resources
- specifications
- procedures
- special reporting requirements
- quality measures

***Documentation*** may include:

- task lists
- instructions
- work procedures
- manufacturer manuals



- wiring diagrams and schematics
- technical drawings and sketches
- parts lists
- computer records

**Resources and equipment** may include:

- appropriate tools
- machining equipment
- reference manuals
- manufacturers' specifications
- consumables

**Enterprise procedures** may include:

- the use of tools and equipment
- instructions, including job sheets, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**CAM files** may include:

- geometry (graphics) file
- generic tool path or intermediate file
- specific post processed CNC machine tool file

**Common operations** may include:

- turning
- shaping
- facing
- cutting screw threads
- boring

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- implement OHS/WHs workplace procedures and practices including the use of risk control measures as specified in the performance criteria
- demonstrate the ability to produce computer aided manufacturing (CAM) and numerical control (NC) programs for a given computer numerical controlled (CNC) lathe on more than one occasion.



**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant software, machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## Metrology

### VU22512 - Conduct and analyse precision engineering measurements

#### Unit Descriptor

This unit of competency describes the knowledge and skills required to conduct precision measurements and analyse the results.

This includes the use of precision measuring equipment, setting comparison measuring devices, maintaining measuring equipment and the analysis/interpretation of measurement results.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

#### Employability Skills

This unit contains employability skills.

#### Application of the Unit

The unit of competency applies to a person working at para professional level in an engineering workplace where precision measurements are undertaken with a range of measuring devices and where the results of these measurements are analysed and interpreted as part of quality control processes.

#### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

- 1 Select appropriate measuring technique and equipment

#### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHs) requirements and environmental requirements*** for a given work area are determined.
- 1.2 Established OHS/WHs requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards, which have not previously been identified, are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 The extent of the measurement task is determined from documentation or reports and discussed with appropriate personnel.
- 1.5 Appropriate technique and measuring equipment is selected according to requirements and ***enterprise procedures***.
- 1.6 Appropriate personnel are consulted to ensure that the work is co-ordinated effectively with others involved at the work site.
- 1.7 Resources for measurement task are obtained in accordance with enterprise procedures.



- |                                 |  |
|---------------------------------|--|
|                                 | 1.8 <b>Measuring equipment</b> is checked for calibration, correct operation and safety.   |
| 2 Conduct measurement           | <p>2.1 OHS/WHS requirements for carrying out the work are followed.</p> <p>2.2 Measuring equipment is set up according to manufacturer's specifications and enterprise procedures.</p> <p>2.3 <b>Measurements</b> are conducted to the accuracy required using appropriate techniques and recorded.</p> <p>2.4 Dimensions are determined or verified using calculations, where required.</p> <p>2.5 Decisions and methods of dealing with unexpected situations are selected on the basis of safety and specified work outcomes.</p> |
| 3 Maintain measuring equipment  | <p>3.1 OHS/WHS requirements for carrying out the work are followed.</p> <p>3.2 Measuring equipment is set, adjusted and maintained to required accuracy, using manufacturer's specifications and/or enterprise procedures.</p> <p>3.3 Measuring equipment is stored to manufacture's specifications and/or enterprise procedures.</p>  |
| 4 Analyse and interpret results | <p>4.1 Measurement results are analysed and interpreted against specifications</p> <p>4.2 Measurement task is documented and appropriate personnel are notified in accordance with enterprise procedures.</p>  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- identifying and following relevant OHS/WHS procedures
- reading and interpreting texts, drawings, specifications and other applicable reference documents
- analysing job requirements
- selecting appropriate measurement techniques and processes
- verifying and calculating dimensions and tolerances
- solving problems that arise from unexpected situations
- reading graduated scales accurately and efficiently
- communicating and working effectively with others involved in conducting the precision measurement task



**Required knowledge:**

- mechanical measuring devices
- calibration and adjustments
- accuracy, resolution and precision of measurements
- errors of measurements
- environmental conditions affecting measurements
- measurement techniques and procedures
- units and sub-units of measurements (metric and imperial)
- interpretation of manufacturers' specifications
- storage of precision measuring devices

**RANGE STATEMENT**

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHs requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions, dust
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member





**Enterprise procedures** may include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- operational procedures

**Measuring equipment** may include:

- strip gauges
- engineering squares
- vernier scaled measuring equipment
- angle dekkors
- sine bars
- dividing heads
- rotary tables
- precision levels
- micrometres
- height gauges
- hardness testers
- texture measuring equipment

**Measurements** may include:

- length
- circular
- straightness
- flatness
- hardness
- angles
- finishes
- textures
- roundness
- squareness
- alignment
- coordinate measurement



## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- implement OHS/WHs workplace procedures and practices including the use of risk control measures as specified in the performance criteria
- conduct and analyse precision engineering measurements on more than one occasion and in different context using different measuring devices.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to a range of precision measuring instruments, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

### Methods of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome



- a portfolio of documented evidence
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22513 - Apply principles of metrology in manufacturing

### Unit Descriptor

This unit of competency describes the knowledge and skills required to apply principles of metrology to the manufacture of products during and after fabrication.

The unit includes the control of tolerances in mechanical parts, methods of measurement, selection of measurement instrument and the application of statistics to the measurement process.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

The unit of competency applies to a person working at para professional level in a manufacturing/engineering environment where the principles of metrology are applied to products during and after fabrication.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

#### 1 Set up metrology process

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements*** and ***environmental requirements*** for a given work area are determined.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards, which have not previously been identified, are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 The metrology task is determined from documentation or reports and discussed with appropriate personnel.
- 1.5 Appropriate metrology technique, measuring equipment and process are selected according to requirements and ***enterprise procedures***.
- 1.6 Appropriate personnel *are* consulted to ensure that the work is co-ordinated effectively with others involved at the work site.
- 1.7 ***Resources*** for ***metrology process*** are obtained in accordance with enterprise procedures.
- 1.8 ***Equipment*** is checked for correct operation, safety and calibrated, where required.



- |   |   |  |
|---|---|--|
| 2 | Apply advanced metrology process                        | 2.1 Relevant OHS/WHS requirements for carrying out the work are followed.<br>2.2 Environmental conditions for the metrology process are checked and controlled.<br>2.3 Measurements are conducted to the accuracy required using appropriate techniques and results recorded.<br>2.4 Uncertainty of measurements are assessed and recorded<br>2.5 Decisions and methods of dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.  |
| 3 | Evaluate advanced metrology process for quality control | 3.1 Relevant OHS/WHS requirements for completing the work are followed.<br>3.2 Measurement results are analysed, interpreted and assessed against specifications and/or standards.<br>3.3 Statistical and uncertainty calculations are carried out, where required.<br>3.4 Metrology journal entries are made covering equipment, method, set up in accordance with enterprise procedures.<br>3.5 Recommendations are made with respect to inspected production process.<br>3.6 Metrology process is documented and appropriate personnel are notified in accordance with enterprise procedures. |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- identifying and following relevant OHS/WHS procedures
- reading and interpreting texts, drawings, specifications, standards and other applicable reference documents
- analysing job requirements and selecting appropriate metrology processes
- checking and controlling environmental conditions for metrology
- solving problems that arise from unexpected situations
- calibrating measuring equipment
- storing and handling metrology equipment correctly
- recording results, making correct entries into a metrology journal and filling out a certificate of calibration
- calculating statistics and uncertainties of measurements
- using metrology to improve quality of production
- communicating and working effectively with others in a manufacturing environment



**Required knowledge:**

- measurement systems
- international and Australia's measurement systems
- standards
- calibration
- accuracy, precision, error
- distribution statistics
- calculation of uncertainties
- tolerances and specifications
- measurement equipment
- measurement of:
  - straightness and flatness
  - squareness
  - roundness and concentricity
  - taper
  - surface texture
- limit gauging systems

**RANGE STATEMENT**

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHs requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions, dust
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site engineer



- trainer
- mentor
- teacher
- team member

**Enterprise procedures** may include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- operational procedures

**Resources** may include:

- relevant Australian and international standards
- specifications
- sample and production engineering objects
- sample and production surface texture examples
- appropriate manufacturing processes for inspection

**Metrology process** includes :

- assess specifications for:
  - straightness and flatness
  - squareness and angularity
  - taper and angularity
  - roundness and concentricity
  - surface texture
- limit gauge systems

**Equipment** may include:

- sine bar, length bars and accessories, beam callipers, micrometres, dial indicators and surface plate, monochromatic light and optical parallels
- tool maker's straight edge, precision level, auto collimator, optical flats
- master square, angle plate cylindrical square, dial gauge fixture, angles gauges
- internal and external taper, precision rollers, precision balls, and gauge blocks
- V block, precision centres
- comparison standards, stylus-type electronic instruments



## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- implement OHS/WHs workplace procedures and practices including the use of risk control measures as specified in the performance criteria
- demonstrate a range of metrology processes in different contexts and present a final report that includes:
  - details of the processes used
  - the assumptions made
  - control and environmental measures taken
  - the assessment of results obtained
  - statistical and error calculations
  - recommendations with respect to inspected manufacturing process

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, measuring equipment, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

### Methods of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills





- testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22572 - Apply principles of advanced metrology in manufacturing

### Unit Descriptor

This unit of competency describes the knowledge and skills required to apply principles of advanced metrology for large-scale production runs of products during and after fabrication. The unit includes process variability such as effects and control of tolerances, precise angular measurements, measurements of complex forms such as screw threads, gears and cams, selecting measurement instruments and the application of statistics to the measurement and production process. No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

The unit of competency applies to a person working at para professional level in a manufacturing/engineering environment where the principles of advanced metrology are applied to ensure product/component quality characteristics are maintained during large scale production runs.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

- 1 Set up advanced metrology process

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements and environmental requirements*** for a given work area are determined.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 Safety hazards, which have not previously been identified, are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 The advanced metrology task is determined from documentation or reports and discussed with appropriate personnel.
- 1.5 Appropriate advanced metrology technique, measuring equipment and process are selected according to requirements and ***enterprise procedures***.
- 1.6 Appropriate personnel *are* consulted to ensure that the work is co-ordinated effectively with others involved at the work site.
- 1.7 ***Resources*** for ***metrology process*** are obtained in accordance with enterprise procedures.
- 1.8 ***Equipment*** is checked for correct operation, safety and calibrated, where required.



- |   |  |   |
|---|--|---|
| 2 | Apply metrology process                        | 2.1 OHS/WHS requirements for carrying out the work are followed.  |
|   |  | 2.2 Environmental conditions for the <b>advanced metrology process</b> are checked and controlled.  |
|   |  | 2.3 Dimensional effects of non-standard tolerances are calculated and taken into consideration.   |
|   |  | 2.3 Complex measurements are conducted to the accuracy required using appropriate techniques and results recorded.  |
|   |  | 2.4 Uncertainty of complex measurements are assessed and recorded   |
|   |  | 2.5 Decisions and methods of dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures. |
| 3 | Evaluate metrology process for quality control | 3.1 OHS/WHS requirements for completing the work are followed.  |
|   |  | 3.2 Complex measurement results are analysed, interpreted and assessed against specifications and/or standards.   |
|   |  | 3.3 Statistical and uncertainty calculations are carried out, where required.   |
|   |  | 3.4 Process production viability is determined from the data obtained.  |
|   |  | 3.5 Metrology journal entries are made covering equipment, method, set up in accordance with enterprise procedures.   |
|   |  | 3.6 Recommendations are made with respect to inspected production process.  |
|   |  | 3.7 Advanced Metrology process is documented and appropriate personnel are notified in accordance with enterprise procedures  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- identifying and following relevant OHS/WHS procedures
- reading and interpreting texts, drawings, specifications, standards and other applicable reference documents
- analysing job requirements and selecting appropriate advanced metrology processes
- checking and controlling environmental conditions for advanced metrology
- solving problems that arise from unexpected situations
- calibrating and setting up complex measuring equipment
- storing and handling metrology equipment correctly



- writing skills for recording results, making entries into a metrology journal, filling out a certificate of calibration
- calculating statistics and uncertainties of measurements
- determining viability of process
- using advanced metrology techniques to improve quality of production
- communicating and working effectively with others involved in the application of advanced metrology in the manufacturing environment

**Required knowledge:**

- standards and their traceability
- advanced measuring equipment calibrations
- accuracy, precision, error
- minimising errors
- distribution statistics
- calculation of uncertainties
- tolerances and specifications
- types advanced measurement equipment
- precise measurement of:
  - angles
  - gauges
  - diameter and length
  - screw threads
  - gears
  - cams

**RANGE STATEMENT**

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions, dust
- excessive energy and water use
- excessive noise



**Appropriate personnel** may include:

- supervisor
- leading hand
- foreman
- manager
- site/production engineer
- trainer
- mentor
- teacher
- team member

**Enterprise procedures** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- operational procedures

**Resources** may include, but are not limited to:

- relevant Australian and international standards
- specifications
- sample and production engineering objects
- sample and production screw threads, gears and cams
- appropriate manufacturing processes for inspection
- appropriate specifications
- controlled environment

**Metrology process** includes requirements to:

- assess specifications for:
  - straightness and flatness
  - squareness and angularity
  - taper and angularity
  - roundness and concentricity
  - surface texture
- limit gauge systems

**Equipment** may include, but is not limited to:

- cylindrical standards
- diameter measuring machine
- gauges
- thread ring
- thread plug
- screw ring



- screw plug
- optical projector
- surface plate
- angle plate
- thread profile templates
- gear tooth vernier callipers
- prism and cylinders
- pantograph
- rollers
- micrometer
- dial test indicator
- rotary table
- long range dial indicator or LVDT
- height setting micrometer
- autocollimator
- precision polygon
- optical dividing head
- precision level
- angle dekkor
- high magnification comparator
- gauge blocks interferometer
- plain plug gauge
- tapered plug gauge

**Advanced metrology process** includes requirements to:

- assess specifications for precision measurement of:
  - angle
  - diameter
  - length
  - screw threads
  - gears
  - cams

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### **Critical aspects for assessment and evidence required to demonstrate competency in this unit**

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:



- implement OHS/WHS workplace procedures and practices including the use of risk control measures as specified in the performance criteria
- demonstrate a range of advanced metrology processes in different contexts and present a final report that includes:
  - details of the processes used
  - the assumptions made
  - control and environmental measures taken
  - the assessment of results obtained
  - statistical and error calculations
  - recommendations with respect to inspected manufacturing process

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant advanced measuring equipment, machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.



- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.





## VU22573 - Program and set up co-ordinate measuring machines (CMM)

### Unit Descriptor

This unit of competency describes the knowledge and skills required to develop programs for co-ordinate measuring machines (CMM), setting up measurement probes and preparing the CMM for measurement data acquisition of engineering components.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

The unit of competency applies a person working at para professional level in an engineering/manufacturing enterprise where co-ordinate measuring machines need to be programmed, set up and prepared for measuring tasks in support of the design and/or production of engineering components to specified tolerances and quality standards.

### ELEMENT

Elements describe the essential outcomes of a unit of competency.

Elements describe actions or outcomes that are demonstrable and assessable.

- 1 Develop a co-ordinate measuring machine part program

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WH&S) requirements*** and ***environmental requirements*** for a given work area are determined.
- 1.2 Established OHS/WH&S requirements and risk control measures and procedures are followed in preparation of the work area.
- 1.3 ***Co-ordinate measuring machine*** parts program is determined from documentation or reports and discussed with ***appropriate personnel***.
- 1.4 CMM parts program is developed using real parts and/or CAD part models according to specifications and ***enterprise procedures***.
- 1.5 Integrated program development environment and parts libraries are used efficiently.
- 1.6 Single/multiple Direct Computer Control (DCC) alignment is created.
- 1.7 Appropriate personnel are consulted to ensure that the work is co-ordinated effectively with others involved at the work site.
- 1.8 ***Resources*** for CMM operation are obtained in accordance with enterprise procedures.



- |   |   |   |
|---|---|---|
| 2 | Set up co-ordinate measuring machine                  | 2.1 OHS/WHS requirements for carrying out the work are followed.  |
|   |   | 2.2 Safety hazards, which have not previously been identified, are documented and risk control measures devised and implemented in consultation with appropriate personnel. |
|   |   | 2.3 <b>Probe</b> selection and configuration is determined according to job specifications and enterprise procedures.   |
|   |   | 2.4 Probe or probes are adjusted according to manufacturer's specifications and enterprise procedures.  |
|   |   | 2.5 Probe angles are checked for compliance and adjusted as required  |
|   |   | 2.6 CMM is re-set and calibrations are checked according to enterprise procedures.  |
| 3 | Prepare co-ordinate measuring machine for measurement | 3.1 OHS/WHS requirements for carrying out the work are followed.  |
|   |   | 3.2 Most appropriate method of clamping/support is determined to minimise distortion and maximise measuring access.   |
|   |   | 3.3 Components/fixtures/clamping devices are correctly setup and oriented.  |
|   |   | 3.4 Decisions and method for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.         |
| 4 | Conduct trial run                                     | 4.1 OHS/WHS requirements for carrying out the work are followed.  |
|   |   | 4.2 Parts program is run and verified in accordance with job specifications and enterprise procedures.  |
|   |   | 4.3 Parts are measured in accordance with enterprise procedures.  |
|   |   | 4.4 Results are interpreted and non-conforming and out of tolerance measurements are identified and reported  |
|   |   | 4.5 Parts program is correctly shut down, backed up, and components, fixtures and clamps are removed  |
|   |   | 4.6 CMM, accessories and surrounds are left in a clean and safe condition.  |



## REQUIRED SKILLS AND KNOWLEDGE

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

### ***Required skills:***

- identifying and following relevant OHS/WHS procedures
- reading and interpreting texts, drawings, specifications, standards and other applicable reference documents
- analysing and clarifying job requirements
- using methods of co-ordinate measurement
- determining part program parameters
- entering data for part program software
- checking conformance to specifications
- using precision measurement equipment
- measuring components to specified tolerances
- determining probe configuration
- calculating/determining and qualify probe angles
- positioning/aligning/securing components/part to appropriate orientation on CMM table and complying with probe configuration and calibrated angles.
- taking an appropriate number of hits to create an accurate manual alignment
- demonstrating the correct procedure for creating DCC alignment
- measuring component/part features in correct sequence and location
- defining and verifying parameters
- correctly dimensioning basic features such as circles, points etc
- running the part program and verifying the accuracy of the results
- editing part program
- outputting result in the format required
- archiving and backing up part program

### ***Required knowledge:***

- co-ordinate measurement methods
- geometric tolerancing
- parts program development
- program writing/debugging/editing
- parts libraries
- DCC alignment
- types of measurement probes
- configuring probes
- defining and verifying probe movements
- probe angles
- component/parts securing and clamping
- CMM set up/calibration/operation



- environmental control of measurements
- hazards and safe work practices

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provision

***Environmental requirements*** may include:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions, dust
- excessive energy and water use
- excessive noise

***Co-ordinate measuring machine*** may include:

- control
  - manual
  - motor drive
  - computer controlled
  - networked
- orientation/application
  - vertical
  - horizontal
  - gantry
  - high accuracy

***Appropriate personnel*** may include:

- supervisor
- leading hand
- foreman
- manager
- site/production engineer
- trainer
- mentor
- teacher
- team member



**Enterprise procedures** may include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications
- operational procedures

**Resources** may include:

- relevant Australian and international standards
- parts specifications
- online and/or offline CMM integrated programming capability
- appropriate computer hardware and network connections
- Co-ordinate measuring machines and manuals

**Probe** may include:

- touch trigger
- proximity
- displacement measurements
- scanning
- manual probes
- motorised probes

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- implement OHS/WHS workplace procedures and practices including the use of risk control measures as specified in the performance criteria
- program and set up co-ordinate measuring machines on more than one occasion and in different contexts.
- program and set up for co-ordinate measuring machines (CMM), configure measurement probes and preparing the CMM for measurement data acquisition of engineering components on more than one occasion.



**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant equipment, machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



# Engineering Management

## Management and Quality Management

Current versions of the units listed below may be found at [training.gov.au](http://training.gov.au)

BSBINM601 - Manage knowledge and information
BSBMGT502 - Manage people performance
BSBMGT517 - Manage operational plan
BSBMGT605 - Provide leadership across the organisation
BSBMGT608 - Manage innovation and continuous improvement
BSBPMG411 - Apply project quality management techniques
BSBPMG414 - Apply project information management and communications techniques
BSBPMG513 - Manage project quality
BSBPMG516 - Manage project information and communication
BSBPMG521 - Manage project integration
BSBPMG522 - Undertake project work
BSBPMG605 - Direct quality management of a project program
BSBPMG609 - Direct procurement and contract for a project program
BSBREL402 - Build client relationships and business networks
BSBRISK501 - Manage risk
BSBSUS501 - Develop workplace policy and procedures for sustainability
BSBWHS501 - Ensure a safe workplace
BSBWHS507 - Contribute to managing WHS information systems
MEM14005A - Plan a complete activity
MEM14091A – Integrate manufacturing fundamentals into an engineering task
MEM16010A - Write reports
MEM22012A - Coordinate resources for an engineering project or operation
MEM22013A - Coordinate engineering projects
MEM22014A - Coordinate engineering-related manufacturing operations
MSS015002 - Develop strategies for more sustainable use of resources
MSS015007 - Develop a business case for sustainability improvements
MSS015008 - Develop strategic sustainability plans
MSS405001 - Develop competitive systems and practices for an organisation
MSS405030 - Optimise cost of a product or service
MSS404052 - Apply statistics to operational processes
MSS405075 - Facilitate the development of a new product
MSMSUP400 - Develop and monitor quality systems



## Supply Chain Management

Current versions of the units listed below may be found at **[training.gov.au](http://training.gov.au)**

TLIL5055 - Manage a supply chain
TLIR5006 - Develop, implement and review purchasing strategies
TLIR5014 - Manage suppliers
MEM30016A - Assist in the analysis of a supply chain





## VU22514 - Manage inventory and operational controls within the supply chain

<b>Unit Descriptor</b>	<p>This unit of competency describes the knowledge and skills required to manage organisational inventory and operational controls across the supply chain. The unit includes the implementation, evaluation and improvement of a supply chain inventory and operational control system.</p> <p>No licensing, legislative, regulatory or certification requirements apply to this unit of competency at the time of publication.</p>
<b>Employability Skills</b>	<p>This unit contains employability skills.</p>
<b>Application of the Unit</b>	<p>Work may be undertaken in various contexts within the supply chain and logistics management sectors of industry. The unit generally applies to those who provide leadership of others individually or in teams. This unit is normally packaged at Diploma level or above.</p>

### ELEMENT

Elements describe the essential outcomes of a unit of competency.

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold/italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

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|---|--|
| 1. Assist in the implementation of an inventory management and operational controls framework | <p>1.1 <b><i>Principles of inventory management and operational controls</i></b> are interpreted and adhered to.</p> <p>1.2 An organisation's current practices in inventory management and operational controls are defined and the commercial costs of these practices are identified using relevant <b><i>tools, technology and strategies</i></b></p> <p>1.3 An existing inventory management and operational control framework is reviewed and mapped for comparative benchmarking against an <b><i>industry best practice</i></b> example using relevant tools, technology and strategies</p> <p>1.4 A comparative benchmarking report identifying performance differences and specifying defined actions to achieve industry best practice is prepared and presented to relevant <b><i>stakeholders</i></b></p> <p>1.5 An inventory management and operational controls framework is trialled using relevant tools, technology and strategies in accordance with industry best practice</p> |
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| 2. Monitor and evaluate a framework for inventory management and operational controls  | <p>2.1 A framework is monitored and evaluated for performance against defined business objectives and industry best practice key performance indicators using relevant tools, technology and strategies</p> <p>2.2 A report is prepared and presented to relevant stakeholders identifying gaps in the performance of a framework and recommending further improvements</p>   |
| 3. Analyse risk and solve inventory management and operational controls problems       | <p>3.1 Problem solving and decision making strategies are applied to generate options for achieving continuous improvement to inventory management and operational control frameworks</p> <p>3.2 Strategic, Measurable, Achievable, Relevant &amp; Timely (SMART) objectives and action planning to improve an inventory management and operational control framework are established and disseminated to relevant stakeholders</p> <p>3.3 A risk management assessment is conducted against each established SMART objective and action plan, to determine the value-adding impact upon supply chain and logistics management performance</p>  |
| 4. Apply resources to optimise inventory management and operational controls           | <p>4.1 An evaluation matrix for assessing the continuous improvement of inventory management and operational controls is developed and trialled in accordance with industry best practice</p> <p>4.2 Relevant tools, technology and strategies are selected, adapted and applied to optimise inventory management and operational control framework performance in accordance with industry best practice</p> <p>4.3 Continuous improvement strategies are assessed for compliance with legislation, standards and regulatory codes of practice, environmental sustainability and commercial viability</p> <p>4.4 Improvement strategies related to inventory management and operational control are documented as part of standard practice in accordance with industry best practice</p> <p>4.5 A training session is planned to assist relevant stakeholders interpret and apply a framework for inventory management and operational controls</p> |
| 5. Prepare and present reports on the management of inventory and operational controls | <p>5.1 An evaluation matrix is implemented to assess the outcomes of continuous improvement SMART objectives and action plans</p> <p>5.2 An evaluation report is prepared and presented in accordance with industry best practice, identifying the value-adding outcomes of continuous improvement activities</p>   |



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| 6. | Align the management of inventory and operations to business objectives | 6.1 | A framework for inventory management and operational controls is evaluated using triple bottom line performance indicators (economic, environmental and social) to determine value-adding and non-value-adding effects |
|    |   | 6.2 | Waste (effort/activity) reduction tools, technology and strategies are applied and the outcomes assessed for return on investment within a supplier-customer network   |
|    |   | 6.3 | Continuous improvement and comparative benchmarking activities are strategically mapped to organisational business objectives and operational planning practices   |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required knowledge:**

- principles of process management and capacity management
- principles and practices of inventory management
- inventory systems, their strengths and non-strengths
- economic Order Quantity (EOQ) model of inventory management
- software systems for inventory and operations management, for example, MRP, SAP, ERP, and ERP II
- forecasting systems and practices
- aggregate planning processes
- operations planning processes for inventory management, warehousing and transportation

### **Required skills:**

- communicating effectively, using appropriate operations management terminology to assist in managing organisational inventory and operational controls across the supply chain
- identifying certain standard concepts and techniques useful in the resolution of normal operations decisions and problems, and being aware of the advantages and disadvantages inherent in their use
- selecting and interpreting operations management policies and procedures relevant to the specific organisation for which one works
- identifying product and market characteristics that might be specific to one's particular type of employment
- making reasonable analyses and decisions involving operations management
- demonstrating awareness of how operations management can contribute effectively to organisational goals and strategies
- implementing and optimising relevant supply chain and logistics tools and technology
- implementing effective OHS/WHs workplace practices
- implement environmentally sustainable practices



## RANGE STATEMENT

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording in the Performance Criteria is detailed below. Add any essential operating conditions that may be present with training and assessment depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts.

***Principles of inventory management and operational controls*** may include:

- inventory and operational control planning preparation, implementation and evaluation considerations
- economics of commercially viable and environmentally sustainable inventory and operational controls
- triple bottom line (economic, environmental and social) implications in inventory and operational controls
- quality assurance best practice inventory and operational controls
- recognised industry best practice in local and international contexts
- futures-based scenario development for inventory and operational controls
- future considerations for the performance of inventory and operational controls
- relevant and current AS/NZ and ISO standards

***Tools, technology and strategies*** ***Tools:*** may include:

- 5S's principles and practices
- Activity Based Costing (ABC)
- Activity Based Management (ABM)
- Bill of Materials (BOM) templates
- Cash-to-Cash Conversion metrics (CTCC)
- comparative benchmarking templates
- Economic Order Quantity (EOQ)
- Fixed-Order-Quantity (FOQ)
- Flow Process Mapping (FPM)
- High Intensity KAIZEN Event's (HIKE's)
- Just-in-Time (JIT)
- KAIZEN
- KANBAN
- Lot-for-Lot (LFL)
- Net Present Value (NPV)
- performance review matrix templates
- Return-on-Investment (ROI)
- risk analysis modelling
- Six Sigma
- Statistical Process Control (SPC)
- Strategic, Measurable, Achievable, Relevant & Timely objectives (SMART objectives)



- TAKT time
- Total Productive Maintenance (TPM)
- Total Quality Management (TQM)
- Toyota Production System (TPS)
- Value Chain Analysis (VCA)
- Value Stream Mapping (VSM)

**Technologies:**

- Computer Integrated Manufacturing (CIM)
- Distribution Requirements Planning (DRP)
- Enterprise Resource Planning II (ERP II)
- Master Scheduling (MS)
- Materials Requirements Planning II (MRP II)
- Statistical Process Control (SPC)
- Supervisory Control and Data Acquisition (SCADA)
- Systems Applications and Products (SAP)

**Strategies:**

- continuous improvement and 9 Wastes strategies
- human capacity building strategies
- Lean Manufacturing principles and practices
- OH&S analysis
- Theory of Constraints (TOC)
- Three Fields Resource Utilisation planning
- Triple Bottom Line strategies (economic, environmental and social factors)

**Stakeholders** may include:

- relevant internal and external supply chain personnel across all organisational levels
- relevant authorities and institutions
- management and other representative bodies and agencies
- process improvement specialists
- OHS/WHs advisors
- legal representation and specialist advisors
- industrial engineers
- inventory control specialists
- materials management specialists
- operations management specialists
- organisational communication consultants
- coaching and mentoring advisors
- organisational development advisors
- financial advisors
- statisticians
- training and development advisors



**Legislation, standards and regulatory codes of practice** may include:

- AS/NZS ISO 31000:2009 Risk Management – Principles, Guidelines and Standard (or current equivalent)
- ISO 9000 Standards
- ISO 14000 Standards
- BASAL Standards
- United Nations Convention on Contracts
- Law of Torts and Contract Law (State/National)
- APICS Codes of Practice and Certification protocols
- Council of Supply Chain Management – International Codes of Practice and supply chain and logistics management nomenclature
- National and State Occupational Health & Safety legislation, Standards and Codes of Practice
- relevant environmental protection codes of practice

## EVIDENCE GUIDE

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.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

Evidence of the following is essential.

An ability to:

- carry out all work in compliance with all the relevant regulations, standards and codes of practice
- apply commercially viable aspects of inventory control and operations management within supply chain and logistics management
- apply appropriate tools and related technology to optimise inventory control and operations management
- apply decision-making and problem-solving techniques related to inventory control and operations
- prepare and present reports on inventory control and operations management
- ability to apply environmentally sustainable inventory control and operations management practices
- demonstrate the contribution of inventory control and operations management strategies to organisational goals and objectives



**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant equipment, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Method of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



# VU22515 - Manage supply chain forecasting and materials planning

## Unit Descriptor

This unit of competency describes the knowledge and skills required to effectively address inventory management through the application of various tools and strategies for forecasting and materials planning.

A key focus of the unit is the development and implementation of strategies to monitor, evaluate and improve forecasting and materials planning practices within a supply chain.

No licensing, legislative, regulatory or certification requirements apply to this unit of competency at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

Work may be undertaken in various contexts within the supply chain and logistics management sectors of industry. The unit generally applies to those who provide leadership of others individually or in teams. This unit is normally packaged at Diploma level or above.

## ELEMENT

Elements describe the essential outcomes of a unit of competency.

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold/italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

1. Analyse and evaluate forecasting and materials planning practices

- 1.1 ***Principles of forecasting and materials planning*** are interpreted and adhered to
- 1.2 'Where are we now?' evaluation of forecasting and materials planning practices is conducted in accordance with ***industry best practice*** and mapped against business objectives
- 1.3 'Where are we now?' evaluation report is prepared and presented to relevant ***stakeholders*** in accordance with industry best practice
- 1.4 ***Tools, technology and strategies*** are selected and adapted to achieve industry best practice in forecasting and materials planning
- 1.5 Framework for evaluating the performance of forecasting and materials planning is developed, documented and disseminated to relevant stakeholders, in accordance with industry best practice
- 1.6 Forecasting and materials planning practices are evaluated against current risk management ***legislation, standards and regulatory codes of practice***





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|  | 1.7 | Strategic, Measurable, Achievable, Relevant & Timely (SMART) objectives are prepared and problem solving and decision-making strategies are applied to generate recommendations for continuous improvement of forecasting and materials planning practices |
| 2. Apply resources to optimise forecasting and materials planning performance            | 2.1 | Forecasting and materials planning tools, technology and strategies for continuous improvement are applied in accordance with defined SMART objectives, organisational guidelines and industry best practice   |
|  | 2.2 | Outcomes of the implementation of a forecasting and materials planning framework are mapped against a 'where are we now' report, the results are documented and a report prepared and presented to relevant stakeholders                                   |
|  | 2.3 | Outcomes of the implementation of a forecasting and materials planning framework are assessed for compliance to legislation, standards, regulatory codes of practice, environmental sustainability and commercial viability                                |
|  | 2.4 | Evaluation of tools, technology and strategies used in forecasting and materials planning is conducted and presented   |
| 3. Complete comparative forecasting and materials planning benchmarking studies          | 3.1 | Comparative benchmarking best practice framework is selected and validated for application in evaluating forecasting and materials planning practices  |
|  | 3.2 | Comparative benchmarking activity is completed in accordance with industry best practice guidelines and legislation, standards and regulatory codes of practice  |
|  | 3.3 | Outcomes of a comparative benchmarking activity are documented and a report prepared and presented to relevant stakeholders  |
| 4. Monitor and report on the performance of forecasting and materials planning practices | 4.1 | Forecasting and materials planning evaluation matrix is developed in accordance with industry best practice and business objectives  |
|  | 4.2 | Forecasting and materials planning evaluation matrix is applied, the findings documented and a report to stakeholders prepared and presented   |
|  | 4.3 | Feedback from stakeholders on the effectiveness and commercial viability of a forecasting and materials planning evaluation matrix is sourced  |
|  | 4.4 | Improvements to a forecasting and materials planning evaluation matrix are documented and disseminated to relevant stakeholders  |



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|   | 4.5 | Training session is planned to assist relevant stakeholders to apply tools, technology and strategies to meet business objectives, and to interpret the commercial viability of current practices  |
|   | 4.6 | Environmentally sustainable and commercially viable practices in forecasting and materials planning are aligned to legislation, standards and regulatory codes of practice   |
| 5. Manage compliance of suppliers to revised forecasting and materials planning practices | 5.1 | Supplier-customer framework for collaborative forecasting and materials planning is established to enable contributions for continuous improvement from relevant stakeholders  |
|   | 5.2 | SMART objectives action planning targeted to continuous improvement opportunities is disseminated to relevant stakeholders within a given supplier-customer network  |
|   | 5.3 | Forecasting and materials planning practices within a given supplier-customer network are reviewed using triple bottom line performance indicators (economic, environmental and social) to determine both their value-adding and non-value-adding effect |
|   | 5.4 | Return on Investment (ROI) after the application of tools, technology and strategies for waste (effort/activity) reduction within a given supplier-customer network is reviewed  |
|   | 5.5 | Continuous improvement options contributed by relevant stakeholders are mapped for their commercial viability to defined business objectives and operational planning  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required knowledge:**

- strategies for inventory planning
- principles of supply chain inventory management, competitive manufacturing inventory management and distribution system inventory management
- techniques for inventory valuation, inventory management optimization and push vs pull inventory management
- strategies for addressing inventory management challenges such as 'bullwhip effect'
- approaches to benchmarking and best practice inventory performance incorporating quality, financial and productivity measures
- principles of collaborative forecasting
- best practice techniques for reducing, measuring and managing demand variability



- procedures for the application of economic order quantity
- strategies for the establishment of optimal order quantities
- techniques for reducing lead time within the supply chain
- methods for measuring and achieving optimal purchase order cost structures and supply agreements
- procedures for the application of best practice tools to the aligning of supply to manufacture
- strategies to ascertain optimal safety stock needs
- methods for establishing continuous replenishment systems and practices
- practice of global inventory deployment planning
- principles and practices of postponement and inventory flexibility
- cycle counting techniques within supply chain and logistics management models
- principles of 'four-wall' inventory management – how, what, when, where, why and who?
- practice of collaborative deployment across the supply chain and logistics management framework

***Required skills:***

- selecting and applying forecasting tools and techniques to improve forecast accuracy
- selecting and applying forecasting and planning models to an enterprise specific supply chain and logistics management framework
- developing and applying fill rate planning practices in line with the group's or individual's company based needs
- evaluating and establishing best practice collaborative planning, forecasting and replenishment control models and procedures
- evaluating, selecting, adapting and modifying supply chain and logistics management network-wide control policies, practices and procedures utilising most relevant industry platforms – ERP, MRP and DRP as examples only
- optimising relevant supply chain and logistics tools and technology
- implementing effective OHS/WHS workplace practices
- implementing environmentally sustainable practices

**RANGE STATEMENT**

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording in the Performance Criteria is detailed below. Add any essential operating conditions that may be present with training and assessment depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts.

***Principles of forecasting and materials planning*** may include:

- forecasting and materials planning design considerations
- forecasting and materials planning strategy selection



- economics of commercially viable and environmentally sustainable forecasting and materials planning
- triple bottom line implications (economic, environmental and social) in forecasting and materials planning
- quality assurance best practice in forecasting and materials planning
- recognised best practice in local and international contexts
- futures-based scenario development
- future considerations in packaging
- relevant and current AS/NZ and ISO standards

Indicators for ***industry best practice*** may be found in:

- report entitled "Supply Chain Management 2007" (Research Foundation 2007)
- report entitled "Supply Chains are the Business Review, Vol 10, No 6, 2006)
- report entitled "Supply Chain Uncertainty: An Irrationality" (K. Mahadevan 2005)
- report entitled "Environmental Supply Chain Management" (2004)
- report entitled "Business Guide to a Sustainable Supply Chain" (Zealand Business Council for Sustainable Development 2004)
- company case studies

***Stakeholders*** may include:

- relevant internal and external supply chain personnel
- relevant authorities and institutions
- management and other representative bodies
- process improvement specialists
- OHS/WHS advisors
- industrial engineers
- materials management specialists
- organisational communication consultants
- coaching and mentoring advisors
- organisational development advisors
- financial advisors
- statisticians
- training and development advisors



***Tools, technology and strategies***

***Tools*** may include:

- 5S's principles and practices
- Activity Based Costing (ABC)
- Activity Based Management (ABM)
- Bill of Materials (BOM) templates
- Cash-to-Cash Conversion metrics (CTCC)
- comparative benchmarking templates
- Economic Order Quantity (EOQ)
- Fixed-Order-Quantity (FOQ)
- Flow Process Mapping (FPM)
- High Intensity KAIZEN Event's (HIKE's)
- Just-in-Time (JIT)
- KAIZEN
- KANBAN
- Lot-for-Lot (LFL)
- Net Present Value (NPV)
- performance review matrix templates
- Return-on-Investment (ROI)
- risk analysis modelling
- Six Sigma
- Statistical Process Control (SPC)
- Strategic, Measurable, Achievable, Relevant & Timely objectives (SMART objectives)
- TAKT time
- Total Productive Maintenance (TPM)
- Total Quality Management (TQM)
- Toyota Production System (TPS)
- Value Chain Analysis (VCA)
- Value Stream Mapping (VSM)

***Technologies:***

- Computer Integrated Manufacturing (CIM)
- Distribution Requirements Planning (DRP)
- Enterprise Resource Planning II (ERP II)
- Master Scheduling (MS)
- Materials Requirements Planning II (MRP II)
- Statistical Process Control (SPC)
- Supervisory Control and Data Acquisition (SCADA)
- Systems Applications and Products (SAP)



**Strategies:**

- continuous improvement and 9 Wastes strategies
- human capacity building strategies
- Lean Manufacturing principles and practices
- OHS/WHs analysis
- Theory of Constraints (TOC)
- Three Fields Resource Utilisation planning
- Triple Bottom Line strategies (economic, environmental and social factors)

**Legislation, standards and regulatory codes of practice** may include:

- AS/NZS ISO 31000:2009 Risk Management – Principles, Guidelines and Standard (or current equivalent)
- ISO 9000 Standards
- ISO 14000 Standards
- BASAL Standards
- United Nations Convention on Contracts
- Council of Supply Chain Management – International Codes of Practice and supply chain and logistics management nomenclature
- National and State Occupational Health & Safety legislation, Standards and Codes of Practice
- relevant environmental protection codes of practice

**EVIDENCE GUIDE**

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.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

Evidence of the following is essential.

An ability to:

- carry out all work in compliance with relevant regulations, standards and codes of practice
- apply commercially viable aspects of forecasting and materials planning within supply chain and logistics management
- apply appropriate tools and technology to optimise forecasting and materials planning strategies



- apply tools to analyse current forecasting and materials planning practices
- analyse metrics for continuous improvement of forecasting and materials planning
- apply comparative benchmarking strategies
- apply decision-making, problem-solving and analysis techniques related to forecasting and materials planning situations
- prepare and present reports on forecasting and materials planning and continuous improvement strategies
- apply environmentally sustainable forecasting and materials planning practices
- demonstrate the contribution of forecasting and materials planning strategies to organisational goals and objectives

**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant equipment, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals.

**Method of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills



- testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.





## VU22516 - Manage supply chain quality

### Unit Descriptor

This unit of competency describes the knowledge and skills required to apply best practice in quality management within supply chains. The unit focuses on a broad application of quality assurance standards through developing, evaluating and reporting on a quality assurance framework and implementing improved practices.

The unit includes terminology, concepts, tools and techniques for improving total quality management within the purchasing and supply chain management function.

No licensing, legislative, regulatory or certification requirements apply to this unit of competency at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

Work may be undertaken in various contexts within the supply chain and logistics management sectors of industry. The unit generally applies to those who provide leadership of others individually or in teams.

This unit is normally packaged at Diploma level or above.

### ELEMENT

Elements describe the essential outcomes of a unit of competency.

1. Assist in the development and evaluation of a supply chain quality assurance framework

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold/italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Principles of managing supply chain quality*** are interpreted and adhered to
- 1.2 Organisation's current practices in supply chain quality assurance are mapped for compliance to ***legislation, standards and regulatory codes of practice*** and ***industry best practice***
- 1.3 Industry best practice indicators of supply chain quality assurance performance, both national and international, are researched and categorised using relevant ***tools, technology and strategies***
- 1.4 Industry best practice indicators of quality assurance are evaluated for their commercially viable effect on business objectives
- 1.5 Supply chain quality assurance framework is developed in compliance with legislation, standards and regulatory codes of practice, using relevant tools, technology and strategies and in accordance with industry best practice



- 1.6 Evaluation matrix for best practice supply chain quality assurance is developed using tools, technology and strategies, and is disseminated to relevant **stakeholders** for feedback
- 1.7 Quality assurance practices are evaluated and benchmarked using relevant tools, technology and strategies and in accordance with current legislation, standards and regulatory codes of practice and industry best practice
- 1.8 Outcomes of quality assurance evaluation and benchmarking are reported to relevant stakeholders
- 1.9 Bench-marked performance of quality assurance practices is examined to determine both value-adding and non-value-adding effects, using triple bottom line performance indicators (economic, environmental and social)
- 2. Apply resources to improve a quality assurance framework
  - 2.1 'Where are we now?' situational analysis of supply chain quality assurance is conducted in accordance with industry best practice
  - 2.2 Outcomes of a 'where are we now?' situational analysis of supply chain quality assurance are compared to industry best practice, and are reported to relevant stakeholders
  - 2.3 Flow process map for improving the performance of quality assurance is developed using relevant tools, technology and strategies, legislation, standards and regulatory codes of practice, and industry best practice guidelines
- 3. Implement an improved quality assurance framework
  - 3.1 Strategic, Measurable, Achievable, Relevant & Timely (SMART) objectives and action plans for the continuous improvement of quality assurance practices are prepared and implemented using relevant tools, technology and strategies and industry best practice guidelines
  - 3.2 Outcomes of the implementation of continuous improvement quality assurance practices are assessed for their compliance to legislation, standards, regulatory codes of practice, their commercial viability and environmental sustainability
  - 3.3 Tools, technology and strategies are selected for their applicability to quality assurance continuous improvement activities in accordance with industry best practice



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| 4. Manage compliance of suppliers to revised quality assurance practices | 4.1 Supplier-customer feedback on the implementation of a quality assurance framework is documented and disseminated to all relevant stakeholders<br>4.2 Industry best practice risk assessment strategies are applied to evaluate quality assurance practices for compliance with relevant legislation, standards and regulatory codes of practice<br>4.3 Key performance indicators for non-compliance with agreed objectives of supply chain quality assurance are identified and action plans are developed to rectify non-compliance in accordance with legislation, standards and regulatory codes of practice  |
| 5. Align a quality assurance framework to business objectives            | 5.1 Supply chain quality assurance practices are evaluated using triple bottom line performance indicators (economic, environmental and social) to determine both their value-adding and non-value-adding effect<br>5.2 Commercial viability of quality assurance within a supply chain network is interpreted and demonstrated in practice, in accordance with organisational strategic planning and industry best practice<br>5.3 Tools, technology and strategies to eliminate waste (effort/activity) are applied within a supply chain network, in accordance with industry best practice, and the outcomes are assessed for Return on Investment (ROI)<br>5.4 Training session is planned to assist relevant stakeholders interpret and apply a framework for quality assurance |

## REQUIRED SKILLS AND KNOWLEDGE

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

### Required knowledge:

- organisational cultures of quality
- basic principles of 'total quality'
- basic principles of 'service quality'
- the challenge-based approach "Total Quality Management (TQM)"
- TQM practices and 'total quality' in services
- step-by-step implementation processes for TQM
- systems of continuous improvement and reengineering
- human aspects of total quality
- practices for planning and organizing total quality
- systems for total quality assessment and control



- total quality assurance practices for purchasing management
- practice of total quality management and ISO 9000 quality management
- applications for statistical process control (SPC) for quality management
- tools and technology for quality improvement
- quality service practices

#### Required skills:

- communicating quality issues effectively, using appropriate terminology relating to Total Quality Management (TQM) and Quality Improvement (QI)
- identifying certain standard concepts and techniques useful in the resolution of normal quality decisions and problems, and being aware of the advantages and disadvantages inherent in their use
- selecting and interpreting quality policies and procedures relevant to the specific organisation for which one works
- identifying product and market characteristics of supply chain quality that might be special to one's particular type of employment
- making reasonable analyses and decisions involving quality
- demonstrating awareness of how TQM and QI can contribute effectively to organisational goals and strategies
- optimising relevant supply chain and logistics tools and technology
- implementing effective OHS/WHS workplace practices
- implementing environmentally sustainable practices

#### RANGE STATEMENT

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording in the Performance Criteria is detailed below. Add any essential operating conditions that may be present with training and assessment depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts.

#### ***Principles of managing supply chain quality*** may include:

- planning design and strategy considerations
- economics of commercially sustainable supply chain quality
- triple bottom line implications (economic, environmental and social) for supply chain quality
- ethical business practices
- future considerations in managing quality and quality evaluation
- relevant and current AS/NZ and ISO standards
- quality assurance assessment of quality practices
- benchmarking to industry best practice in local and international contexts



**Legislation, standards and regulatory codes of practice** may include:

- AS/NZS ISO 31000:2009 Risk Management – Principles, Guidelines and Standard (or current equivalent)
- ISO 9000 Standards
- ISO 14000 Standards
- BASAL Standards
- United Nations Convention on Contracts
- Council of Supply Chain Management – International Codes of Practice and supply chain and logistics management nomenclature
- National and State Occupational Health & Safety legislation, Standards and Codes of Practice
- relevant environmental protection codes of practice

Indicators for **industry best practice** may be found in:

- report entitled “Total Quality Management in Supply Chain” (CCSE International Business Research, Vol. 2, No. 2 April 2009)
- report entitled “Procurement Quality assurance Handbook” L3 Communications Combat Propulsion Systems, 2005
- report entitled “Global Chief Procurement Officer Survey 2009” Cap Gemini Consulting
- report entitled “Supply Chain Management 2010 and Beyond” (APICS Educational and Research Foundation 2007)
- report entitled “Supply Chains are the Business” (J. Gattorna, Supply Chain Management Review, Vol 10, No 6, 2006)
- report entitled “Supply Chain Uncertainty: An Insight for Australian CEO’s and Managers” (K. Mahadevan 2005)
- report entitled “Environmental Supply Chain Management” (Five Winds International 2004)
- report entitled “Greening the Supply Chain at S.C. Johnson” (Five Winds International 2004)
- report entitled “Business Guide to a Sustainable Supply Chain – A Practical Guide” (New Zealand Business Council for Sustainable Development 2003)



**Tools, technology and strategies**  
may include:

- company case studies

**Tools:**

- 5S's principles and practices
- Activity Based Costing (ABC)
- Activity Based Management (ABM)
- Bill of Materials (BOM) templates
- Cash-to-Cash Conversion metrics (CTCC)
- comparative benchmarking templates
- Economic Order Quantity (EOQ)
- Fixed-Order-Quantity (FOQ)
- Flow Process Mapping (FPM)
- High Intensity KAIZEN Event's (HIKE's)
- Just-in-Time (JIT)
- KAIZEN
- KANBAN
- Lot-for-Lot (LFL)
- Net Present Value (NPV)
- performance review matrix templates
- Return-on-Investment (ROI)
- risk analysis modelling
- Six Sigma
- Statistical Process Control (SPC)
- Strategic, Measurable, Achievable, Relevant & Timely objectives (SMART objectives)
- TAKT time
- Total Productive Maintenance (TPM)
- Total Quality Management (TQM)
- Toyota Production System (TPS)
- Value Chain Analysis (VCA)
- Value Stream Mapping (VSM)

**Technologies:**

- Computer Integrated Manufacturing (CIM)
- Distribution Requirements Planning (DRP)
- Enterprise Resource Planning II (ERP II)
- Master Scheduling (MS)
- Materials Requirements Planning II (MRP II)
- Statistical Process Control (SPC)
- Supervisory Control and Data Acquisition (SCADA)
- Systems Applications and Products (SAP)

**Strategies:**

- continuous improvement and 9 Wastes strategies
- human capacity building strategies
- Lean Manufacturing principles and practices
- OHS/WHs analysis
- Theory of Constraints (TOC)
- Three Fields Resource Utilisation planning



**Stakeholders** may include:

- Triple Bottom Line strategies (economic, environmental and social factors)
- relevant internal and external supply chain personnel across all organisational levels
- relevant authorities and institutions
- management and other representative bodies and agencies
- Six Sigma Green Belt practitioners
- Six Sigma Black Belt practitioners
- Six Sigma Champions
- 5S's consultants
- Lean Systems consultants
- Value Stream Mapping consultants
- industrial engineers
- Total Productive Maintenance consultants
- process improvement specialists
- benchmarking and evaluation specialists
- OHS/WHs advisors
- organisational development advisors
- financial advisors
- statisticians
- training and development advisors

## EVIDENCE GUIDE

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.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

Evidence of the following is essential.

An ability to:

- carry out all work in compliance with all the relevant regulations, standards and codes of practice
- apply commercially viable aspects of end-to-end supply chain and logistics quality assurance
- apply national and international quality assurance standards
- apply appropriate tools and technology for quality improvement
- apply tools to analyse performance of current quality assurance practices
- analyse metrics for continuous improvement of quality assurance practices



### Context of and specific resources for assessment

- apply monitoring and reporting systems that comply with quality assurance standards and regulatory requirements
- apply environmentally sustainable quality practices
- demonstrate the application of Total Quality Management (TQM) and Quality Improvement (QI) systems and their effective contribution to organisational goals and strategies
- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

### Method of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.





# VU22517 - Manage and maintain supply chain network communication and relationships

**Unit Descriptor** This unit of competency describes the knowledge and skills required to develop, manage, maintain and implement frameworks for communications and supplier-customer relationships.

This includes aspects of continuous improvement and the strategic roles of information management within a supply chain network.

No licensing, legislative, regulatory or certification requirements apply to this unit of competency at the time of publication.

**Employability Skills** This unit contains employability skills.

**Application of the Unit** Work may be undertaken in various contexts within the supply chain and logistics management sectors of industry. The unit generally applies to those who provide leadership of others individually or in teams.

This unit is normally packaged at Diploma level or above.

## ELEMENT

Elements describe the essential outcomes of a unit of competency.

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold/italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

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| 1. Implement and maintain supply chain network communication and relationship frameworks      | <p>1.1 <b><i>Principles of supply chain network communication and relationships</i></b> are interpreted, adhered to and assessed for their relevance and currency</p> <p>1.2 Comparative benchmarking measures are selected, adapted and mapped to <b><i>industry best practice</i></b> guidelines using <b><i>tools, technology and strategies</i></b></p> <p>1.3 Comparative benchmarking measures are evaluated for their validity and relevance to given business objectives and industry best practice guidelines</p> <p>1.4 Framework based on industry best practice is developed and trialled using tools, technology and strategies</p> <p>1.5 Outcomes of the trialling of a communication and relationships framework are evaluated against industry best practice guidelines and relevant <b><i>legislation, standards and regulatory codes of practice</i></b></p> <p>1.6 Strategic, Measurable, Achievable, Relevant &amp; Timely (SMART) objectives and an action planning template are developed and disseminated to relevant <b><i>stakeholders</i></b>, to achieve continuous improvement to a communication relationships framework</p> |
| 2. Conduct an analysis of the management of supplier-customer communication and relationships | <p>2.1 Analysis tools, technology and strategies are selected and adapted in accordance with industry best practice to assess communication and relationships</p> <p>2.2 Supply chain network is analysed to determine the comparative performance of supplier-customer communication and relationships against established industry best practice</p>   |



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|  | 2.3 | Results of a supplier-customer communication and relationships analysis are examined to identify and define indicators of measurable variances compared to established industry best practice   |
|  | 2.4 | Problem solving and decision making strategies are applied to generate improvement options and action plans for managing supplier-customer communication and relationships  |
|  | 2.5 | Improvement options, action plans and specified tools, technology and strategies for managing supply chain network communication and relationships are documented and disseminated to relevant stakeholders   |
| 3. Implement, monitor and report on a framework for managing supplier-customer communication and relationships | 3.1 | Selected options and action plans from a communication framework are implemented using relevant tools, technology and strategies  |
|  | 3.2 | Industry best practice monitoring matrix for evaluating communication and relationship improvements is developed using tools, technology and strategies, and disseminated to relevant stakeholders for feedback   |
|  | 3.3 | Evaluation of communication and relationship improvements is completed and a report is prepared and presented to relevant stakeholders defining the outcomes of the evaluation  |
| 4. Review and update policies and procedures for supplier-customer information management                      | 4.1 | Policies and procedures are reviewed and updated in collaboration with relevant stakeholders using industry best practice guidelines and tools, technology and strategies   |
|  | 4.2 | Feedback template is developed, trialled and disseminated to relevant stakeholders to enable continuous improvement of policies and procedures  |
|  | 4.3 | Mediation code of practice for conflict resolution is agreed to by all relevant stakeholders, in accordance with industry best practice guidelines  |
| 5. Align the management of communication and relationships to business objectives                              | 5.1 | Communication and relationship management practices are evaluated in accordance with industry best practice using tools, technology and strategies, and triple bottom line performance indicators (economic, environmental and social) to determine both their value-adding and non-value-adding effect |
|  | 5.2 | Commercial viability of supply chain communication and relationship performance is interpreted and demonstrated in practice, in accordance with organisational strategic planning and industry best practice guidelines   |
|  | 5.3 | As part of a framework for managing communication and relationship performance, a strategy map for optimising the reduction of waste (effort/activity) is developed and trialled using tools, technology and strategies and in accordance with industry best practice                                   |



## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required knowledge:**

- fundamental concepts in teamwork and interpersonal communications
- methods for effective oral communication and presentations
- effective approaches to report writing
- basic principles of technical communication
- strategies for relationship building
- strategies for information sharing and controlling information overload
- effective approaches to presenting proposals

### **Required skills:**

- evaluating the strengths and weaknesses of current models of communication
- describing current methods of technical communication including formal documentation, email and oral presentations
- communicating effectively within and outside the organisation
- applying constructive feedback to advance current communication skills
- developing supply chain relationship building skills
- demonstrating an understanding of the difference between strategic and tactical information sharing
- explaining the strategic role of information sharing in managing supply chains
- demonstrating an understanding of the causes and symptoms of information overload, and developing strategies for coping with information overload
- delivering a business proposal presentation before a professional audience
- optimising relevant supply chain and logistics tools and technology
- implementing effective OHS/WHs workplace practices
- implementing environmentally sustainable practices

## RANGE STATEMENT

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording in the Performance Criteria is detailed below. Add any essential operating conditions that may be present with training and assessment depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts.

***Principles of supply chain network communication and relationships*** may include:

- preparation, implementation and evaluation considerations
- economics and commercial impact of best practice
- triple bottom line implications (economic, environmental and social)
- quality assured communication and relationship management
- recognised industry best practice in local and international contexts



- futures-based scenario design for the evaluation of communication and relationship management
- future considerations for the development of communication and relationship management
- relevant and current AS/NZ and ISO standards

Indicators for **industry best practice** may be found in:

- report entitled “A Review of Approaches to Supply Chain Communications: From Manufacturing to Construction” (Anne-Francoise Cutting-Decelle, Professor, University of Evry/IUT France, at <http://itcon.org/2007/5/>)
- report entitled “Strategic Communication Audits” (Julia Coffman, Communications Consortium Media Center, October 2004)
- presentation entitled “Supply Chain Communication” (L. Heezen, PRISME2 workshop, June 2009)
- report entitled “The Supplier Relationship Management Market Trends” (Eulalio G. Campelo F. and Wolffried Stucky, World Academy of Science, Engineering and Technology 28, 2007)
- presentation entitled “Category Management Toolkit – Supplier Relationship Management” (the UK Office of Government Commerce, 2006)
- report entitled “Agile Product Lifecycle Management for Process - Supply Chain Relationship Management User Guide” (Release 5.2 Part No. E11003-01, ORACLE, February 2008)
- report entitled “Supply Chain Management 2010 and Beyond” (APICS Educational and Research Foundation 2007)
- report entitled “Supply Chains are the Business” (J. Gattorna, Supply Chain Management Review, Vol 10, No 6, 2006)
- report entitled “Supply Chain Uncertainty: An Insight for Australian CEO’s and Managers” (K. Mahadevan 2005)
- report entitled “Environmental Supply Chain Management” (Five Winds International 2004)
- report entitled “Greening the Supply Chain at S.C. Johnson” (Five Winds International 2004)
- report entitled “Business Guide to a Sustainable Supply Chain – A Practical Guide” (New Zealand Business Council for Sustainable Development 2003)
- report entitled “Supply chain coordination through contract negotiation” (Y. Arda, J. Hennet 2005)
- State and National legal statutes
- company case studies

**Tools, technology and strategies** may include:

**Tools:**

- 5S’s principles and practices
- Activity Based Costing (ABC)
- Activity Based Management (ABM)
- Bill of Materials (BOM) templates



- Cash-to-Cash Conversion metrics (CTCC)
- comparative benchmarking templates
- Economic Order Quantity (EOQ)
- Fixed-Order-Quantity (FOQ)
- Flow Process Mapping (FPM)
- High Intensity KAIZEN Event's (HIKE's)
- Just-in-Time (JIT)
- KAIZEN
- KANBAN
- Lot-for-Lot (LFL)
- Net Present Value (NPV)
- performance review matrix templates
- Return-on-Investment (ROI)
- risk analysis modelling
- Six Sigma
- Statistical Process Control (SPC)
- Strategic, Measurable, Achievable, Relevant & Timely objectives (SMART objectives)
- TAKT time
- Total Productive Maintenance (TPM)
- Total Quality Management (TQM)
- Toyota Production System (TPS)
- Value Chain Analysis (VCA)
- Value Stream Mapping (VSM)

***Technologies:***

- communication equipment and systems including – video and audio recording equipment, telephone, fax, email, internet, and oral, aural and written communication
- Computer Integrated Manufacturing (CIM)
- Distribution Requirements Planning (DRP)
- Enterprise Resource Planning II (ERP II)
- Master Scheduling (MS)
- Materials Requirements Planning II (MRP II)
- Statistical Process Control (SPC)
- Supervisory Control and Data Acquisition (SCADA)
- Systems Applications and Products (SAP)

***Strategies:***

- continuous improvement and 9 Wastes strategies
- human capacity building strategies
- Lean Manufacturing principles and practices
- OHS/WHs analysis
- Theory of Constraints (TOC)
- Three Fields Resource Utilisation planning
- Triple Bottom Line strategies (economic, environmental and social factors)
- AS/NZS ISO 31000:2009 Risk Management – Principles, Guidelines and Standards (or current equivalent)
- ISO 9000 Standards

***Legislation, standards and regulatory codes of practice*** may include:



- ISO 14000 Standards
- BASAL Standards
- United Nations Convention on Contracts
- Law of Torts and Contract Law (State/National)
- APICS Codes of Practice and Certification protocols
- Council of Supply Chain Management – International Codes of Practice and supply chain and logistics management nomenclature
- National and State Occupational Health & Safety legislation, Standards and Codes of Practice
- relevant environmental protection codes of practice

**Stakeholders** may include:

- relevant internal and external supply chain personnel across all organisational levels
- relevant authorities and institutions
- management and other representative bodies and agencies
- process improvement specialists
- OHS/WHs advisors
- Legal representation and specialist advisors
- industrial engineers
- customer relationship management specialists
- inventory control specialists
- materials management specialists
- operations management specialists
- organisational communication consultants
- dispute resolution and mediation advocates
- coaching and mentoring advisors
- organisational development advisors
- financial advisors
- statisticians
- training and development advisors

## EVIDENCE GUIDE

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.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

Evidence of the following is essential>

An ability to:

- carry out all work in compliance with all the relevant regulations, standards and codes of practice
- assess the commercially viable aspects of effective communication and supplier-customer relationships



**Context of and specific resources for assessment**

- perform a metrics-based analysis of communication and supplier-customer relationships
  - prepare and present reports on the outcomes of continuous improvement strategies for effective communication and relationship building
  - align effective communication and relationship building strategies to organisational goals and objectives
  - apply management and control strategies for sharing and disseminating information
- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
  - Resources required for assessment include:
    - OHS/WHS policy and work procedures and instructions
    - access to workplace or work real environment and a variety of conditions
    - operational access to relevant equipment, tools, materials and consumables
    - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Method of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22518 - Manage global sourcing and supply of domestic supply chains

### Unit Descriptor

This unit of competency describes the knowledge and skills required to strategically manage the flow of goods, services and knowledge within and among organisations both domestically and internationally.

The unit focuses on management capabilities to successfully analyse, monitor and mitigate sourcing challenges such as currency ratios, exchange rates, international contractual variables and expectations, lead times, delays and business continuity. It also includes aspects of cross-cultural business communication and some common frustrations.

No licensing, legislative, regulatory or certification requirements apply to this unit of competency at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

Work may be undertaken in various contexts within the supply chain and logistics management sectors of industry. The unit generally applies to those who provide leadership of others individually or in teams.

This unit is normally packaged at Diploma level or above.

## ELEMENT

Elements describe the essential outcomes of a unit of competency.

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold/italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

1. Analyse existing global sourcing practices and establish best practice performance, risk and compliance criteria

- 1.1 ***Principles of global sourcing and supply of domestic supply chains*** are interpreted and adhered to
- 1.2 Organisation's existing global sourcing practices are identified and mapped to ***legislation, standards and regulatory codes of practice*** and ***industry best practice***
- 1.3 Performance benchmarks and assessment indicators are established against triple bottom line measures (economic, environmental and social) and commercially viable business objectives
- 1.4 Business continuity risk assessment indicators are developed using ***tools, technology and strategies***
- 1.5 Compliance policies and procedures for security of intellectual property are established and documented in accordance with industry best practice

2. Monitor and improve global sourcing practices

- 2.1 Report on an organisation's 'where are we now?' global sourcing practices is prepared and presented to relevant ***stakeholders***





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|  | 2.2 | Organisation's existing global sourcing practices are comparatively benchmarked against a comparable industry best practice organisation   |
|  | 2.3 | Performance gaps arising from comparative benchmarking are identified and Strategic, Measurable, Achievable, Relevant & Timely (SMART) objectives and action plans for improving practices are established               |
|  | 2.4 | Tools, technology and strategies are selected, adapted and applied to improve global sourcing practices  |
| 3. Apply and maintain international logistics documentation                              | 3.1 | International Logistics Documentation is selected or adapted, applied to a given supply chain scenario and tested for compliance with legislation, standards and regulatory codes of practice and industry best practice |
|  | 3.2 | Supplier-customer feedback for the continuous improvement of International Logistics Documentation is sought, evaluated and disseminated to relevant stakeholders  |
| 4. Monitor and respond to international currency variations in a global sourcing context | 4.1 | Principles and nomenclature of international currency dealings are interpreted and adhered to in accordance with legislation, standards and regulatory codes of practice and industry best practice                      |
|  | 4.2 | Program is developed for training relevant stakeholders in currency monitoring and hedging strategies, currency trend interpretation and assessment and response mechanisms in accordance with industry best practice    |
|  | 4.3 | Currency variation strategy for monitoring currency cycle trends and exchange rates is developed using industry best practice guidelines   |
|  | 4.4 | Industry best practice strategies for cross-currency risk mitigation are applied and their performance is evaluated  |
| 5. Apply cross-cultural business strategies in a global sourcing context                 | 5.1 | Country-specific cultural profiles are researched using tools, technology and strategies and a report is presented to relevant stakeholders  |
|  | 5.2 | Country-specific negotiation strategies are researched, documented and disseminated to relevant stakeholders   |
|  | 5.3 | Given cultural/national grouping within a global supply chain network is analysed and inherent differences, sensitivities and business customs are documented  |
|  | 5.4 | Training session is planned to assist stakeholders with cross-cultural business practices  |
| 6. Manage global sourcing risk   | 6.1 | Tools, technology and strategies are used to monitor and sustain supplier business continuity  |
|  | 6.2 | Risk management strategies are selected or adapted to assess the inherent risk within a given global sourcing and supply chain network   |



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| 6.3 | Risk mitigation strategies are identified, related action plans are created and a report is presented to relevant stakeholders  |
| 7.  | Align global sourcing practices to business objectives  |
| 7.1 | Framework for assessing waste (effort/activity) reduction within a global supplier-customer network is developed in accordance with industry best practice and trialled using tools, technology and strategies                |
| 7.2 | Existing practices are evaluated for their measurable value-adding and non-value-adding effect on triple bottom line performance (economic, environmental and social), and the outcomes are reported to relevant stakeholders |
| 7.3 | Strategy Map, Balanced Scorecard and evaluation indicators are prepared for a given scenario of global sourcing   |
| 7.4 | An cost benefit and return on investment analysis of improvements to global sourcing practices is conducted and mapped to strategic business objectives and operational planning  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required knowledge:**

- benefits and risks of low-cost country sourcing for domestic supply chains
- practices related to free trade agreement sourcing
- aspects of negotiation with intermediaries
- practices related to freight and payment terms and conditions
- the Sarbanes-Oxley Act of 2002 and its impact on global business
- cultural issues in business negotiations
- security issues related to global sourcing
- global sourcing applications
- service strategies
- aspects of services purchasing
- aspects of business continuity planning
- international logistics documentation requirements
- processes and procedures for security of intellectual property (I.P.)
- Smart and Secure Tradelines (SST) initiative
- inventory levelling practices to minimise obsolescence of supplied parts
- strategies for effective communication and negotiation
- professional ethics
- effect of currency exchange rate on manufacturing costs and profit margins
- strategies for supplier-customer relationship building
- international environmental standards and codes of practice
- forecasting and materials planning practices
- freight movement planning
- risk management contingency planning



**Required skills:**

- optimising relevant supply chain and logistics tools and technology
- implementing effective OHS/WHS workplace practices
- implementing environmentally sustainable practices
- liaising across differing work ethic business cultures
- implementing international fund transfers
- applying risk management to supply delivery
- converting units of measure
- completing international logistics documentation

**RANGE STATEMENT**

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording in the Performance Criteria is detailed below. Add any essential operating conditions that may be present with training and assessment depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts.

***Principles of global sourcing and supply of domestic supply chains*** may include:

- global sourcing and supply of domestic supply chains business models and current history
- global sourcing and supply of domestic supply chains business continuity planning
- economics of commercially viable and environmentally sustainable global sourcing and supply of domestic supply chains
- triple bottom line implications (economic, environmental and social) in global sourcing and supply of domestic supply chains
- quality assurance best practice in global sourcing and supply of domestic supply chains
- recognised industry best practice
- conflict resolution in global sourcing and supply of domestic supply chains
- future strategic considerations and trends in global sourcing
- relevant and current AS/NZ and ISO standards
- compliance, security and maintenance of intellectual property
- historical narrative of global sourcing and supply of domestic supply chains success' and failures



**Legislation, standards and regulatory codes of practice** may include:

- AS/NZS ISO 31000:2009 Risk Management – Principles, Guidelines and Standard (or current equivalent)
- ISO 9000 Standards
- ISO 14000 Standards
- BASAL Standards
- country specific environmental sustainability laws and regulations
- country specific international partnership laws and contract laws
- United Nations Convention on Contracts
- United Nations child labour regulations
- Council of Supply Chain Management – International Codes of Practice and supply chain and logistics management nomenclature
- National and State Occupational Health & Safety legislation, Standards and Codes of Practice
- International Labour Organisation (ILO) standards of engagement regulations

Indicators for **industry best practice** may include:

- report entitled “Supply Chain Coordination through Contract Negotiation” (Proceedings of the 44<sup>th</sup> IEEE Conference on Decision and Control, and European Control Conference - December 2005)
- report entitled “Selection of Currency and Hedging Strategy in Global Supply Management” (79<sup>th</sup> Annual International Conference Proceedings – Institute for Supply management 1994)
- report entitled “Supply Chain Management 2010 and Beyond” (APICS Educational and Research Foundation 2007)
- report entitled “Supply Chains are the Business” (J. Gattorna, Supply Chain Management Review, Vol 10, No 6, 2006)
- report entitled “Supply Chain Uncertainty: An Insight for Australian CEO’s and Managers” (K. Mahadevan 2005)
- report entitled “Environmental Supply Chain Management” (Five Winds International 2004)
- report entitled “Greening the Supply Chain at S.C. Johnson” (Five Winds International 2004)
- report entitled “Business Guide to a Sustainable Supply Chain – A Practical Guide” (New Zealand Business Council for Sustainable Development 2003)
- company case studies



**Tools, technology and strategies** may include:

**Tools:**

- 5S's principles and practices
- Activity Based Costing (ABC)
- Activity Based Management (ABM)
- Bill of Materials (BOM) templates
- Cash-to-Cash Conversion metrics (CTCC)
- comparative benchmarking templates
- Economic Order Quantity (EOQ)
- Fixed-Order-Quantity (FOQ)
- Flow Process Mapping (FPM)
- High Intensity KAIZEN Event's (HIKE's)
- International Logistics Documentation (ILD)
  - Export irrevocable letter of credit
  - Bank draft or bill of exchange
  - Bill of lading
  - Combined transport document
  - Commercial invoice
  - Insurance certificate/s
  - Certificate of origin
- Just-in-Time (JIT)
- KAIZEN
- KANBAN
- Lot-for-Lot (LFL)
- Net Present Value (NPV)
- performance review matrix templates
- Return-on-Investment (ROI)
- risk analysis modelling
- Six Sigma
- Statistical Process Control (SPC)
- Strategic, Measurable, Achievable, Relevant & Timely objectives (SMART objectives)
- TAKT time
- Total Productive Maintenance (TPM)
- Total Quality Management (TQM)
- Toyota Production System (TPS)
- Value Chain Analysis (VCA)
- Value Stream Mapping (VSM)

**Technologies:**

- Computer Integrated Manufacturing (CIM)
- Distribution Requirements Planning (DRP)
- Enterprise Resource Planning II (ERP II)
- Master Scheduling (MS)
- Materials Requirements Planning II (MRP II)
- Statistical Process Control (SPC)
- Supervisory Control and Data Acquisition (SCADA)
- Systems Applications and Products (SAP)



**Strategies:**

- Business continuity strategies
- Central Intelligence Agency – Country Profile Web Site
- continuous improvement and 9 Wastes strategies
- human capacity building strategies
- Lean Manufacturing principles and practices
- OH&S analysis
- Theory of Constraints (TOC)
- Three Fields Resource Utilisation planning
- Transparency International Annual Report
- Triple Bottom Line strategies (economic, environmental and social factors)

**Stakeholders** may include:

- cross-cultural business development consultants
- international business associations
- bi-lingual language specialists
- relevant internal and external supply chain personnel across all organisational levels
- relevant authorities and institutions
- management and other representative bodies and agencies
- international contract law advisors and advocates
- process improvement specialists
- OHS/WHS advisors
- industrial engineers
- materials management specialists
- organisational communication consultants
- coaching and mentoring advisors
- organisational development advisors
- financial advisors
- cross-currency financial advisors
- statisticians
- cross-cultural negotiation advocates
- training and development advisors



## EVIDENCE GUIDE

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.

### **Critical aspects for assessment and evidence required to demonstrate competency in this unit**

Evidence of the following is essential.

An ability to:

- carry out all work in compliance with all the relevant regulations, standards and codes of practice
- apply commercially viable aspects of effective global sourcing of supply
- apply tools and technology to optimise global sourcing strategies
- analyse metrics for continuous improvement of global sourcing of supply
- prepare and present reports on global sourcing of supply and continuous improvement strategies
- align strategies for effective global sourcing of supply with the domestic end-user's organisational goals and objectives
- communicate effectively within a range of cross-cultural business situations
- complete international logistics documentation required for global sourcing of supply

### **Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant equipment, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals



**Method of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.





## VU22519 - Manage warehouse packaging, materials handling and operational performance

### Unit Descriptor

This unit of competency describes the knowledge and skills required to minimise the costs and environmental impact of packaging, storage and movement of product, through safe and diligent materials handling practices.

The focus of the unit is on evaluation, improvement and alignment of warehouse packaging and materials handling practices to business objectives. The intent is to translate the theories of packaging, materials handling and lean warehouse practices into both practical and value-adding outcomes for organisations.

No licensing, legislative, regulatory or certification requirements apply to this unit of competency at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

Work may be undertaken in various contexts within the supply chain and logistics management sectors of industry. The unit generally applies to those who provide leadership of others individually or in teams.

This unit is normally packaged at Diploma level or above.

## ELEMENT

Elements describe the essential outcomes of a unit of competency.

1. Establish and maintain a framework for packaging design and materials selection

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold/italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 Packaging design and materials selection options are identified and documented
- 1.2 Packaging design and materials selection options are evaluated in accordance with fundamental ***principles of packaging***
- 1.3 Criteria for the selection of packaging suppliers are developed, validated and documented based on industry research and in accordance with relevant ***legislation, standards and regulatory codes of practice***
- 1.4 Commercial cost of environmentally sustainable packaging is calculated and benchmarked against environmental, economic and social criteria, i.e. 'Triple Bottom Line'
- 1.5 Further development of packaging design and warehousing is planned for, using environmentally and commercially viable legislation, standards and regulatory codes of practice



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| <p>2. Establish and maintain systems for the production, storage and inventory control of packaging</p> | <p>2.1 Systems for the production, storage and inventory control of packaging are determined and planned for</p> <p>2.2 System of production, assembly and quality assurance of packaging is established in accordance with environmental, economic and social criteria</p> <p>2.3 Packaging inventory controls and related costs are reviewed and continuously improved to meet all business objectives and client focused quality assurance demands</p> <p>2.4 Packaging and related warehouse plant and equipment are monitored and maintained to optimise online operating effectiveness</p> <p>2.5 OHS/WHS continuous improvement outcomes pertaining to warehouse packaging plant and equipment are risk assessed, reviewed and documented</p> <p>2.6 Relevant tools technology and strategies are used to evaluate systems for the production, storage and inventory control of packaging</p> <p>2.7 Benchmarking review of best practice in competitor and industry-wide packaging systems is conducted and a report is produced and presented</p> |
| <p>3. Evaluate and improve a materials handling system</p>  | <p>3.1 Packaging materials handling system is reviewed and a <b>materials handling best practice</b> framework for the selection, application and implementation of materials handling tools, equipment in-line with business objectives and OHS/WHS requirements is established</p> <p>3.2 Relevant <b>tools technology and strategies</b> are used to assist in the evaluation and improvement of a materials handling system</p> <p>3.3 Organisation's warehouse packaging and materials handling practices and their effectiveness is analysed, evaluated and reported on and recommendations to sustain continuous improvement based on <b>materials handling best practice</b> are presented</p> <p>3.4 Review of current materials handling and packaging cost ratios is conducted and the economic gains to be achieved through ongoing continuous improvement activities based on materials handling best practice is evaluated and reported</p>  |



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| <p>4. Optimise warehouse strategic performance</p>                   | <p>4.1 A warehouse current status ‘where are we now?’ analysis is implemented and outcomes are evaluated against established <b>industry warehouse best practice</b> indicators</p>                                   |
|  | <p>4.2 Continuous improvement <b>tools, technology and strategies</b> are selected and applied, to determine targets for measurably increasing warehouse performance, productivity and customer satisfaction</p>      |
|  | <p>4.3 Relevant tools, technology and strategies are used to optimise warehouse strategic performance</p>   |
|  | <p>4.4 Downstream and upstream supply chain members are informed of strategies for continuously improving warehouse performance outcomes across the supply chain</p>  |
|  | <p>4.5 Relevant <b>stakeholders within the warehouse environment</b> are consulted to establish strategies for aligning warehouse performance to business related objectives</p>                                      |
| <p>5. Establish and maintain warehouse integrity and reliability</p> | <p>5.1 Existing <b>warehouse security and emergency management</b> systems and practices are analysed and documented</p>  |
|  | <p>5.2 Accurate interpretation of systems, processes, legislation, standards and regulatory codes of practice in relation to warehouse security and emergency management and environmental impact is demonstrated</p> |
|  | <p>5.3 Internet-based research into international best practice in warehouse security and emergency management is conducted and reported on, and recommendations for improved practices are provided</p>              |
|  | <p>5.4 Establish a framework for the creation of improved warehouse security and emergency management practices</p>   |
|  | <p>5.5 Training session for capacity building in warehouse security and emergency management practices is planned</p>   |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required knowledge:**

- methodology for evaluating warehouse performance, for example, what to measure, when to measure it, how to measure it and how to interpret the outcomes of the measurement activity
- methods for quality management of packaging systems and processes
- applications for statistical process control (SPC) in warehouse management



- tools and technology for quality improvement in warehouse operational performance
- quality service practices
- environmental responsibilities in the warehousing and distribution operational context, in accordance with sustainability frameworks such as Triple Bottom Line and ISO 14000
- packaging design, materials and selection considerations and their commercial implications
- cost of space and its effective utilisation
- warehouse operational flow and the elimination of waste
- current and future trends in warehouse operations management
- best practice in site safety, service and relationships management
- warehouse security and risk management initiatives
- operational and maintenance requirements relating to warehouse plant and equipment

***Required skills:***

- determining and defining lean warehouse performance indicators
- using best practice materials handling strategies
- integrating the warehouse as a strategic supply chain and logistics management partner, both internally and externally
- optimising relevant tools and technology
- applying effective OHS/WHS workplace practices
- applying environmentally sustainable practices

## **RANGE STATEMENT**

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording in the Performance Criteria is detailed below. Add any essential operating conditions that may be present with training and assessment depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts.

***Principles of packaging*** may include:

- packaging design considerations
- packaging materials selection
- economics of commercially sustainable packaging
- triple bottom line implications (economic, environmental and social) sourcing of responsible packaging
- future considerations in packaging
- relevant and current AS/NZ and ISO standards
- recognised industry best practice in local and international contexts



**Legislation, standards and regulatory codes of practice** may include:

- AS/NZS ISO 31000:2009 Risk Management – Principles, Guidelines and Standard (or current equivalent)
- ISO 9000 Standards
- ISO 14000 Standards
- BASAL Standards
- United Nations Convention on Contracts
- Council of Supply Chain Management – International Codes of Practice and supply chain and logistics management nomenclature
- National and State Occupational Health & Safety legislation, Standards and Codes of Practice
- relevant environmental protection codes of practice

**Systems for the production, storage and inventory control of packaging** may include:

- worksite effective space utilisation
- effective storage of packaging materials and related resources
- costs of packaging materials inventory
- packaging materials risk management
- safe handling of packaging materials
- packaging materials equipment condition monitoring
- quality assurance assessment and continuous improvement of packaging practices
- benchmarking to best practice

**Tools technology and strategies** may include: **Tools:**

- 5S's principles and practices
- Activity Based Costing (ABC)
- Activity Based Management (ABM)
- Bill of Materials (BOM) templates
- Cash-to-Cash Conversion metrics (CTCC)
- Comparative Benchmarking templates
- Economic Order Quantity (EOQ)
- Fixed-Order-Quantity (FOQ)
- Flow Process Mapping (FPM)
- High Intensity KAIZEN Event's (HIKE's)
- Just-in-Time (JIT)
- KAIZEN
- KANBAN
- Lot-for-Lot (LFL)



- Net Present Value (NPV)
- performance review matrix templates
- Return-on-Investment (ROI)
- risk analysis modelling
- Six Sigma
- Statistical Process Control (SPC)
- Strategic, Measurable, Achievable, Relevant & Timely objectives (SMART objectives)
- TAKT time
- Total Productive Maintenance (TPM)
- Total Quality Management (TQM)
- Toyota Production System (TPS)
- Value Chain Analysis (VCA)
- Value Stream Mapping (VSM)

***Technologies:***

- Computer Integrated Manufacturing (CIM)
- Distribution Requirements Planning (DRP)
- Enterprise Resource Planning II (ERP II)
- Master Scheduling (MS)
- Materials Requirements Planning II (MRP II)
- Statistical Process Control (SPC)
- Supervisory Control and Data Acquisition (SCADA)
- Systems Applications and Products (SAP)

***Strategies:***

- Continuous improvement and 9 Wastes strategies
- error count minimisation strategies and costs incurred studies
- Human capacity building strategies
- Lean Manufacturing principles and practices
- linking strategic planning to warehouse performance
- OHS/WHs analysis
- supplier and downstream pathway management
- Theory of Constraints (TOC)
- Three Fields Resource Utilisation planning
- Triple Bottom Line strategies (economic, environmental and social factors)

***Materials handling best practice***  
may include:

- selection of materials handling tools/equipment/technology for task
- OHS/WHs analysis, audit and review of materials handling and packaging practices
- evaluation of current materials handling operational practices



- cost benefit analysis of materials handling practices
- benchmarking to best practice
- company case studies

**Industry warehouse best practice** may be found in:

- report entitled "Supply Chain Management 2010 and Beyond" (APICS Educational and Research Foundation 2007)
- report entitled "Supply Chains are the Business" (J. Gattorna, Supply Chain Management Review, Vol 10, No 6, 2006)
- report entitled "Supply Chain Uncertainty: An Insight for Australian CEO's and Managers" (K. Mahadevan 2005)
- report entitled "Environmental Supply Chain Management" (Five Winds International 2004)
- report entitled "Greening the Supply Chain at S.C. Johnson" (Five Winds International 2004)
- report entitled "Business Guide to a Sustainable Supply Chain – A Practical Guide" (New Zealand Business Council for Sustainable Development 2003)
- company case studies

**Stakeholders within the warehouse environment** may include:

- relevant internal and external supply chain personnel across all organisational levels
- relevant authorities and institutions
- management and other representative bodies and agencies
- warehousing, packaging, materials handling and process improvement specialists
- OHS/WHS advisors
- organisational development advisors
- financial advisors
- statisticians
- training and development advisors

**Warehouse security and emergency management** may include:

- what can go wrong
- who to report what to
- worst case scenario analysis
- benchmarking to best international practice



- emergency management
- environmental accountabilities
- legislation, rules, regulations, systems and processes

## EVIDENCE GUIDE

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.

### **Critical aspects for assessment and evidence required to demonstrate competency in this unit**

Evidence of the following is essential.

An ability to:

- carry out all work in compliance with all the relevant regulations, standards and codes of practice
- apply the commercially viable aspects of warehouse packaging and materials handling
- apply the principles and practices associated with packaging processes and system optimisation
- design, select and apply packaging materials in order to minimise their impact upon the environment
- apply and interpret operational performance metrics within the warehouse packaging and materials handling context
- apply the principles and practices associated with warehouse security and risk management
- match warehouse performance outcomes to the strategic objectives of the supply chain

### **Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant equipment, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals





**Method of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



# VU22528 - Manage and review supply chain continuous improvement and benchmarked performance

## Unit Descriptor

This unit of competency describes the knowledge and skills required to establish a culture of continuous improvement of supply chain practice within organizations.

The unit focuses on strategies for benchmarking, analysing and reviewing performance. It provides opportunities for comparing the day-to-day performance of a broad range of supply chain and logistics networks.

No licensing, legislative, regulatory or certification requirements apply to this unit of competency at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

Work may be undertaken in various contexts within the supply chain and logistics management sectors of industry. The unit generally applies to those who provide leadership of others individually or in teams.

This unit is normally packaged at Diploma level or above.

## ELEMENT

Elements describe the essential outcomes of a unit of competency.

1. Develop and validate a framework for continuous improvement and benchmarked performance of supply chain and logistics practices

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold/italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Principles of continuous improvement and comparative benchmarking*** are interpreted and adhered to
- 1.2 Organisation's current supply chain and logistics practices are defined and aligned to commercially viable business objectives
- 1.3 Comparative benchmarking criteria are defined and categorised against commercially viable business objectives
- 1.4 Comparative benchmarking and continuous improvement ***tools, technology and strategies*** are selected and adapted to meet business objectives
- 1.5 Criteria for quality assuring continuous improvement and comparative benchmarking tools, technology and strategies are established and validation testing is completed in accordance with organisational goals and objectives and ***industry best practice***
- 1.6 Framework for the implementation of a benchmarking activity and continuous improvement to supply chain and logistics practices is developed in accordance with ***comparative benchmarking and continuous improvement best practice***



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| 2. Conduct and report on a supply chain and logistics comparative benchmarking project                   | 2.1 Comparative benchmarking is implemented in accordance with organisational guidelines and relevant <b>legislation, standards and regulatory codes of practice</b><br>2.2 Outcomes of a comparative benchmarking activity are evaluated and mapped against industry best practice an established framework and related business objectives<br>2.3 Report is prepared addressing the outcomes of a comparative benchmarking activity and making recommendations for action plans to achieve industry best practice  |
| 3. Select and apply resources to optimise continuous improvement of supply chain and logistics practices | 3.1 Appropriate tools, technology and strategies for analysing supply chain and logistics practices are selected and tested for relevance against defined workplace scenarios and business objectives<br>3.2 Supply chain and logistics practices are analysed and mapped against both an organisation's business objectives and defined industry best practice<br>3.3 Outcomes of an analysis and mapping activity are reviewed and documented in accordance with organisational guidelines<br>3.4 Analysis and review documentation is shared with relevant stakeholders in accordance with organisational guidelines  |
| 4. Prepare recommendations for improvements to supply chain and logistics practices                      | 4.1 Analysis and review documentation is evaluated to define performance gaps between 'what is the current situation?' and defined business objectives<br>4.2 Problem solving and decision-making strategies are applied to generate options for achieving continuous improvement across the supply chain network<br>4.3 Continuous improvement options are assessed against relevant legislation, standards and regulatory codes of practice and industry best practice in environmental and sustainable supply chain management<br>4.4 Continuous improvement options are evaluated for their commercial viability and 'Return on Investment' (ROI) potential<br>4.5 Continuous improvement report is prepared and presented in accordance with organisational guidelines and industry best practice |
| 5. Assist in the establishment of a supplier-customer culture of continuous improvement                  | 5.1 <b>Stakeholders</b> are provided with revised documentation demonstrating the commercially viable and ROI benefits of improved supply chain and logistics practices<br>5.2 Stakeholders feedback is sought to continuously improve supply chain and logistics practices<br>5.3 Supplier-customer framework for ongoing continuous improvement is established   |



- 5.4 Review meetings with relevant stakeholders are conducted to identify continuous improvement opportunities
  - 5.5 Continuous improvement opportunity action plans including Strategic, Measurable, Achievable, Relevant & Timely (SMART) objectives are disseminated to all stakeholders
6. Align continuous improvement and comparative benchmarking activities to business objectives
  - 6.1 Existing continuous improvement practices are evaluated using triple bottom line performance indicators (economic, environmental and social) to determine both their value-adding and non-value-adding effect
  - 6.2 Waste (effort/activity) reduction tools, technology and strategies are applied and the outcomes evaluated for ROI within a supplier-customer network
  - 6.3 Continuous improvement and comparative benchmarking activities are mapped to organisational business objectives and operational planning

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required knowledge:**

- principles and practices of 'value adding'
- operational flow analysis and benchmarking
- Value Chain Analysis (VCA) and Value Stream Mapping (VSM) tools
- current state mapping
- future state mapping
- methods of 'observation' as a data collection strategy
- negotiation methods related to process improvement in a supply chain
- Value Chain (VC) and VSM return on investment metrics
- Toyota production systems case studies
- effective strategies for managing synchronous operations
- effective strategies for managing short-term capacity issues
- theory of constraints including process flow and bottlenecks
- effective strategies for managing variability and uncertainty issues
- planning and control procedures
- aggregate planning processes
- software systems for inventory and operations management, including, Material Requirements Planning (MRP) and Enterprise Resource Planning (ERP)
- Master Scheduling (MS) processes



**Required skills:**

- determine value in the supply chain network
- identify waste and determine its real cost
- link and apply 5S, Lean and Six Sigma to supply chain performance
- analyse and evaluate process flow
- conduct a supply chain and logistics management continuous improvement project
- prepare a written report and present information on VC and VSM project outcomes
- optimise relevant supply chain and logistics tools and technology
- implement effective OHS/WHS workplace practices
- implement environmentally sustainable practices

**RANGE STATEMENT**

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording in the Performance Criteria is detailed below. Add any essential operating conditions that may be present with training and assessment depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts.

***Principles of Continuous Improvement and Comparative Benchmarking*** may include:

- continuous improvement and benchmarking planning and design considerations
- continuous improvement and benchmarking strategy selection
- economics of commercially sustainable continuous improvement and benchmarking
- triple bottom line implications (economic, environmental and social) in continuous improvement
- ethical business practices
- future considerations in continuous improvement
- future considerations in comparative benchmarking performance evaluation
- relevant and current AS/NZ and ISO standards
- quality assurance assessment and continuous improvement practices
- benchmarking to recognised industry best practice in local and international contexts

***Tools, technology and strategies*** may include:

***Tools:***

- 5S's principles and practices
- Activity Based Costing (ABC)
- Activity Based Management (ABM)
- Bill of Materials (BOM) templates
- Cash-to-Cash Conversion metrics (CTCC)
- Comparative Benchmarking templates
- Economic Order Quantity (EOQ)
- Fixed-Order-Quantity (FOQ)
- Flow Process Mapping (FPM)
- High Intensity KAIZEN Event's (HIKE's)
- Just-in-Time (JIT)
- KAIZEN



- KANBAN
- Lot-for-Lot (LFL)
- Net Present Value (NPV)
- performance review matrix templates
- Return-on-Investment (ROI)
- risk analysis modelling
- Six Sigma
- Statistical Process Control (SPC)
- Strategic, Measurable, Achievable, Relevant & Timely objectives (SMART objectives)
- TAKT time
- Total Productive Maintenance (TPM)
- Total Quality Management (TQM)
- Toyota Production System (TPS)
- Value Chain Analysis (VCA)
- Value Stream Mapping (VSM)

**Technologies:**

- Computer Integrated Manufacturing (CIM)
- Distribution Requirements Planning (DRP)
- Enterprise Resource Planning II (ERP II)
- Master Scheduling (MS)
- Materials Requirements Planning II (MRP II)
- Statistical Process Control (SPC)
- Supervisory Control and Data Acquisition (SCADA)
- Systems Applications and Products (SAP)

**Strategies:**

- Continuous improvement and 9 Wastes strategies
- error count minimisation strategies and costs incurred studies
- Human capacity building strategies
- Lean Manufacturing principles and practices
- OH&S analysis
- supplier and downstream pathway management
- Theory of Constraints (TOC)
- Three Fields Resource Utilisation planning
- Triple Bottom Line strategies (economic, environmental)

**Industry best practice**  
may be found in:

- report entitled "Supply Chain Management 2010 and Beyond" (APICS Educational and Research Foundation 2007)
- report entitled "Supply Chains are the Business" (J. Gattorna, Supply Chain Management Review, Vol 10, No 6, 2006)
- report entitled "Supply Chain Uncertainty: An Insight for Australian CEO's and Managers" (K. Mahadevan 2005)
- report entitled "Environmental Supply Chain Management" (Five Winds International 2004)
- report entitled "Greening the Supply Chain at S.C. Johnson" (Five Winds International 2004)
- report entitled "Business Guide to a Sustainable Supply Chain – A Practical Guide" (New Zealand Business Council for Sustainable Development 2003)
- company case studies



**Comparative benchmarking and continuous improvement best practice** may include:

- OHS/WHS analysis, audit and review of comparative benchmarking policies and procedures
- evaluation of current comparative benchmarking implementation level policies and procedures
- cost benefit analysis of competitive benchmarking policies and procedures
- comparative performance assessment and evaluation to best practice
- objective reporting and presentations

**Legislation, standards and regulatory codes of practice** may include:

- AS/NZS ISO 31000:2009 Risk Management – Principles, Guidelines and Standard (or current equivalent)
- ISO 9000 Standards
- ISO 14000 Standards
- BASAL Standards
- United Nations Convention on Contracts
- Council of Supply Chain Management – International Codes of Practice and supply chain and logistics management nomenclature
- National and State Occupational Health & Safety legislation, Standards and Codes of Practice
- relevant environmental protection codes of practice

**Stakeholders** may include:

- relevant internal and external supply chain personnel across all organisational levels
- relevant authorities and institutions
- management and other representative bodies and agencies
- industrial engineers
- process improvement specialists
- benchmarking and evaluation specialists
- OHS/WHS advisors
- organisational development advisors
- financial advisors
- statisticians
- training and development advisors

## EVIDENCE GUIDE

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.

**Critical aspects for assessment and evidence required to demonstrate competency in this unit**

Evidence of the following is essential.  
An ability to:

- carry out all work in compliance with all the relevant regulations, standards and codes of practice
- apply the commercially viable aspects of continuous improvement and comparative benchmarking within supply chain and logistics management
- apply appropriate tools and technology to analyse current performance of a supply chain and logistic network and to conduct comparative benchmarking



**Context of and specific resources for assessment**

- analyse the outcomes of continuous improvement and comparative benchmarking strategies
  - prepare and present reports on continuous improvement and the outcomes of comparative benchmarking
  - apply environmentally sustainable continuous improvement practices
  - demonstrate the application of continuous improvement and comparative benchmarking strategies to organizational goals and objectives.
- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
  - Resources required for assessment include:
    - OHS/WHS policy and work procedures and instructions
    - access to workplace or work real environment and a variety of conditions
    - operational access to relevant equipment, tools, materials and consumables
    - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals.

**Method of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by an appropriate person such as a workplace supervisor.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.





# VU22529 - Perform competitive bidding, contract preparation and contract management tasks

## Unit Descriptor

This unit of competency describes the knowledge and skills required to contribute to competitive bidding and contract management processes within an organisation.

It includes continuous improvement practices in the context of competitive bidding, procurement planning, negotiation, contract preparation and the monitoring of compliance to contract conditions.

No licensing, legislative, regulatory or certification requirements apply to this unit of competency at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

Work may be undertaken in various contexts within the supply chain and logistics management sectors of industry. The unit generally applies to those who provide leadership of others individually or in teams.

This unit is normally packaged at Diploma level or above.

## ELEMENT

Elements describe the essential outcomes of a unit of competency.

1. Assist in the development and maintenance of a competitive bidding and procurement framework

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold/italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 **General contract principles** relating to competitive bidding and procurement are interpreted and adhered to in line with **industry best practice**
- 1.2 Request for Proposal (Quotation/ Tender) documentation, guidelines for implementation and templates are developed or selected and adapted in accordance with **legislation, standards and regulatory codes of practice** and organisational guidelines
- 1.3 Competitive bidding and procurement implementation framework is developed in accordance with industry best practice using **tools, technology and strategies**
- 1.4 Supplier selection matrix is designed using tools, technology and strategies and mapped against organisational guidelines and industry best practice
- 1.5 Standard procedure for providing feedback to unsuccessful bidders is determined and documented in accordance with industry best practice
- 1.6 Competitive bidding and procurement practices are monitored and evaluated against current risk management legislation, standards and regulatory codes of practice



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| 2. Assist in contract negotiation and the completion of contractual arrangements | <p>2.1 General contract principles relating to contract preparation and contract management are interpreted and adhered to in line with industry best practice</p> <p>2.2 Contract negotiation strategies and ethical models of best practice are developed and recorded in accordance with organisational guidelines and the requirements of the supplier-customer network</p> <p>2.3 Appropriate contract documentation is selected and adapted from existing contracts, and a contract is prepared in accordance with legislation, standards and regulatory codes of practice, organisational guidelines and industry best practice</p> <p>2.4 Contract negotiation, preparation and completion outcomes are disseminated to relevant <b>stakeholders</b></p> <p>2.5 Completed contracts are documented, recorded and stored in accordance with organisational guidelines, and state and national legislation, standards and regulatory codes of practice</p> <p>2.6 Supplier-customer benchmarked code of practice for effective communication is developed and agreed to by relevant stakeholders</p> <p>2.7 Standard procedures for mediating supplier-customer contract discrepancies are developed and agreed to by relevant stakeholders</p> <p>2.8 Training session for relevant stakeholders in contract discrepancy mediation is planned</p> |
| 3. Monitor and report on supplier contract compliance agreements                 | <p>3.1 Contract compliance guidelines and an implementation strategy are developed and trialled using contract management tools, technology and strategies and in accordance with state and national legislation, standards and regulatory codes of practice</p> <p>3.2 Supplier-customer contract is monitored and reviewed for stakeholder compliance with organisational guidelines and current legislation, standards and regulatory codes of practice</p> <p>3.3 Strategies for ongoing review and maintenance of contract compliance are developed in consultation with stakeholders and in accordance with industry best practice</p> <p>3.4 Supplier contract compliance report and action plan is prepared and disseminated to relevant stakeholders</p>  |
| 4. Manage competitive bidding and contract administration risk                   | <p>4.1 Relevant legislation, standards and regulatory codes of practice are interpreted and adhered to in assessing and mitigating risk in the competitive bidding and contract administration process</p>   |



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|    | 4.2   | Risk management assessment documentation is prepared and shared across a supplier-customer stakeholder network   |
|    | 4.3   | Framework for competitive bidding and contract management risk assessment and reporting is developed and trialled within an industry best practice network   |
| 5. | Align the competitive bidding and contract management processes to strategic objectives | <p>5.1 Organisation's competitive bidding and contract management processes are mapped against defined strategic objectives and business planning targets</p> <p>5.2 Economics and commercial viability of competitive bidding and contract management processes is interpreted and demonstrated in practice, in-line with organisational and industry best practice</p> <p>5.3 Competitive bidding, contract preparation and contract management processes are continually improved using relevant tools, technology and strategies and in accordance with industry best practice</p> |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required knowledge:**

- conditions for successful bidding
- the bidding process and electronic bidding
- processes involved in Request For Proposal (RFP) / Request For Quotation
- types of contracts, for example, 'fixed price' and 'cost-plus'
- legal aspects of contracts related to authority, liability and validity
- legal rules established by the UN Convention on Contracts for the International Sale of Goods (CISG)1980
- principles of provincial contract law
- contract writing including contract terms and protection against environmental uncertainty
- basic principles of contract management including performance review, dispute resolution and breach of contract
- basic principles of competitive bidding for the provision of goods or services through a tender process

### **Required skills:**

- contributing to competitive tendering and planning processes
- communicating with all stakeholders
- monitoring work progress
- ordering materials and supplies
- applying relevant legislation
- conducting investigations



- preparing and presenting reports
- optimising relevant supply chain and logistics tools and technology
- implementing effective OHS/WHs workplace practices
- implementing environmentally sustainable practices

## RANGE STATEMENT

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording in the Performance Criteria is detailed below. Add any essential operating conditions that may be present with training and assessment depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts.

### ***General contract***

***principles*** may include:

- implementation, compliance and evaluation considerations
- economics of commercially viable and environmentally sustainable practices
- triple bottom line implications (economic, environmental and social)
- quality assurance best practice
- recognised industry best practice in local and international contexts
- futures-based scenario development
- future considerations
- relevant and current AS/NZ and ISO standards

Indicators for ***industry best practice*** may be found in:

- report entitled "Supply Chain Management 2010 and Beyond" (APICS Educational and Research Foundation 2007)
- report entitled "Supply Chains are the Business" (J. Gattorna, Supply Chain Management Review, Vol 10, No 6, 2006)
- report entitled "Supply Chain Uncertainty: An Insight for Australian CEO's and Managers" (K. Mahadevan 2005)
- report entitled "Environmental Supply Chain Management" (Five Winds International 2004)
- report entitled "Greening the Supply Chain at S.C. Johnson" (Five Winds International 2004)
- report entitled "Business Guide to a Sustainable Supply Chain – A Practical Guide" (New Zealand Business Council for Sustainable Development 2003)
- report entitled "Supply chain coordination through contract negotiation" (Y. Arda, J. Hennet 2005)
- State and National legal statutes
- company case studies

***Legislation, standards and regulatory codes of practice*** may include:

- AS/NZS ISO 31000:2009 Risk Management – Principles, Guidelines and Standard (or current equivalent)
- ISO 9000 Standards



- ISO 14000 Standards
- BASAL Standards
- United Nations Convention on Contracts
- Law of Torts and Contract Law (State/National)
- Council of Supply Chain Management – International Codes of Practice and supply chain and logistics management nomenclature
- National and State Occupational Health & Safety legislation, Standards and Codes of Practice
- relevant environmental protection codes of practice

**Tools, technology and strategies** may include:

**Tools:**

- competitive bidding and procurement performance matrix's and templates
- Bill of Materials (BOM) templates
- 5S's principles and practices
- Activity Based Costing (ABC)
- Activity Based Management (ABM)
- Bill of Materials (BOM) templates
- Cash-to-Cash Conversion metrics (CTCC)
- Comparative Benchmarking templates
- Economic Order Quantity (EOQ)
- Fixed-Order-Quantity (FOQ)
- Flow Process Mapping (FPM)
- High Intensity KAIZEN Event's (HIKE's)
- Just-in-Time (JIT)
- KAIZEN
- KANBAN
- Lot-for-Lot (LFL)
- Net Present Value (NPV)
- performance review matrix templates
- project scoping and work breakdown templates and development tools
- Return-on-Investment (ROI)
- risk analysis modelling
- Six Sigma
- Statistical Process Control (SPC)
- Strategic, Measurable, Achievable, Relevant & Timely objectives (SMART objectives)
- TAKT time
- Total Productive Maintenance (TPM)
- Total Quality Management (TQM)
- Toyota Production System (TPS)
- Value Chain Analysis (VCA)
- Value Stream Mapping (VSM)



**Technologies:**

- Computer Integrated Manufacturing (CIM)
- Distribution Requirements Planning (DRP)
- Enterprise Resource Planning II (ERP II)
- Master Scheduling (MS)
- Materials Requirements Planning II (MRP II)
- Statistical Process Control (SPC)
- Supervisory Control and Data Acquisition (SCADA)
- Systems Applications and Products (SAP)

**Strategies:**

- continuous improvement and 9 Wastes strategies
- review of contract types and best practice examples
- review of current State and National contract laws
- human capacity building strategies
- Lean Manufacturing principles and practices
- OHS/WHs analysis
- Theory of Constraints (TOC)
- Three Fields Resource Utilisation planning
- Triple Bottom Line strategies (economic, environmental and social)

**Stakeholders** may include:

- relevant internal and external supply chain personnel across all organisational levels
- relevant authorities and institutions
- management and other representative bodies and agencies
- process improvement specialists
- OHS/WHs advisors
- Legal representation and specialist advisors
- industrial engineers
- materials management specialists
- organisational communication consultants
- coaching and mentoring advisors
- organisational development advisors
- financial advisors
- statisticians
- training and development advisors



## EVIDENCE GUIDE

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.

### **Critical aspects for assessment and evidence required to demonstrate competency in this unit**

Evidence of the following is essential.

An ability to:

- carry out all work in compliance with all the relevant regulations, standards and codes of practice
- apply the commercially viable aspects of effective competitive bidding and contract administration across the supply chain and logistics network
- develop Request for Proposal / Request for Quotation / Request for Tender as part of the competitive bidding process
- analyse proposals, quotations and tenders as part of the competitive bidding process
- prepare and present reports on the outcomes of the competitive bidding process
- interpret contracts and monitor supplier-customer compliance
- align strategies for effective competitive bidding and contract administration to organizational goals and objectives
- apply relevant legislation for enterprise contract preparation and administration
- prepare and administer different types of supplier-customer contracts
- apply business negotiation strategies
- administer documentation for competitive bidding and contract administration
- identify and minimise risks involved in contract administration

### **Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.



- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant equipment, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

### **Method of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must include demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.





## Engineering Maintenance Management (EMM)

Current versions of the units listed below may be found at [training.gov.au](http://training.gov.au)

MEM14088A - Apply maintenance engineering techniques to equipment and component repairs and modifications
MEM14092A - Integrate maintenance fundamentals into an engineering task
MEM23125A - Evaluate maintenance systems
MEM30017A - Use basic preventative maintenance techniques and tools



# VU22530 - Plan, implement and apply preventative maintenance procedures

## Unit Descriptor

This unit of competency describes the knowledge and skills required to plan and implement a preventative maintenance task in an engineering workplace.

This includes planning the preventative maintenance task according to already established procedures, taking appropriate measures to set up the operational conditions for implementing the task and finally coordinate and carry out the preventative maintenance work.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency applies to a person working at para professional level in an engineering production environment where regular preventative maintenance for a wide range of engineering equipment and machinery is required on a scheduled basis.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

### 1. Plan preventative maintenance task

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements and environmental requirements*** for a given work area are determined.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures in preparation for the work area are followed.
- 1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 Preventative maintenance procedural requirements are determined from ***enterprise procedures*** and equipment documentation and discussed with appropriate personnel
- 1.5 Preventative ***maintenance task*** is planned taking operational requirements into consideration and, if appropriate, documented.
- 1.6 Preventative maintenance work is scheduled and operational consequences communicated to the appropriate personnel.



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|  | 1.7 | Preventative maintenance risk management procedures are established.  |
|  | 1.8 | Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.                                     |
|  | 1.9 | <b>Resources</b> and <b>equipment</b> needed for the task are obtained in accordance with enterprise procedures and checked for correct operation and safety. |
| 2. Implement preventative maintenance task | 2.1 | Relevant OHS/WHS requirements for carrying out the work are followed.   |
|  | 2.2 | Equipment/machines/plant is checked as being isolated where necessary in strict accordance with OHS/WHS requirements.   |
|  | 2.3 | Preventative maintenance task is carried out according to prepared work plan.   |
|  | 2.4 | Maintenance personnel are coordinated to perform the task in an efficient manner, if appropriate.   |
|  | 2.5 | Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.          |
|  | 2.6 | Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.   |
| 3. Complete preventative maintenance task  | 3.1 | Relevant OHS/WHS requirements for completing the work are followed.   |
|  | 3.2 | Work site is made safe in accordance with established safety procedures.  |
|  | 3.3 | Preventative maintenance task is completed, and machinery/equipment is checked for correct operation.   |
|  | 3.4 | The preventative maintenance task is documented and the appropriate personnel notified.   |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- establishing a maintenance plan that includes:
  - characteristics of plant operation
  - assessment of failure characteristics
  - link failure characteristics to maintenance systems
  - identification production windows
  - creation of a work schedule
  - required physical and human resources



- implementation procedures
- writing preventative maintenance tasks
- scheduling preventative maintenance tasks
- identification critical equipment/components
- plant performance and history
- equipment spares
- implementing and carrying out the maintenance plan
- co-ordinating the work of maintenance personnel
- completing and updating maintenance hardcopy and/or computerised documentation

***Required knowledge:***

- maintenance principles
  - maintenance function
  - role of maintenance department
  - occupational health and safety requirements
  - maintenance and management
  - rationale for maintenance
  - elements in effective maintenance
  - maintenance effort and business operations
  - roles and responsibilities
  - tools and techniques of maintenance
- maintenance systems
  - maintenance terminology
  - preventative maintenance
  - predictive maintenance
  - corrective maintenance
- maintenance data collection
  - review of available software
  - collection of data
  - input of data
  - project updating
  - plant history cards/files
  - inspection techniques
  - predictive maintenance
  - remote visual inspection
  - non-destructive testing
  - thermography
  - vibration analysis
  - oil analysis
- maintenance plan
  - characteristics of plant operation



- assessment of failure characteristics
- link failure characteristics to maintenance systems
- identify production windows
- creation of a work schedule
- resources
- establish plan
- implementation procedures
- writing preventative maintenance tasks
- scheduling preventative maintenance tasks
- recording of information
- identify critical equipment/components
- assess plant performance and history
- identify labour and material requirements with prior history
- origin of maintenance work
- work order/request routing
- equipment spares
- review of maintenance plan
  - analysis of records
  - manual recording methods
  - computerised recording methods
  - collection of data
  - comparison of present information with prior history

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHs requirements*** may include but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise



**Appropriate personnel** may include but are not limited to:

- supervisor
- leading hand
- foreman
- manager
- site/production engineer
- trainer
- mentor
- teacher
- team member

**Enterprise procedures** may include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**Maintenance task** may involve:

- programmed operational maintenance to machines/equipment in a manufacturing or engineering setting

**Resources** may include:

- plant data
- log sheets
- production schedules
- operational and performance records
- maintenance schedules
- manufacturers' instructions, specifications and services manuals
- appropriate consumables and spare parts
- lubricants
- maintenance computer software

**Equipment** may include:

- appropriate hand and power tools
- test equipment
- measuring and aligning equipment
- computer equipment
- personal protective equipment



## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- implement OHS/WHs procedures and practices including the use of risk control measures as specified in the performance criteria
- demonstrate the ability to plan and implement a preventative maintenance task in an engineering workplace on two occasions.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

### Methods of assessment

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.



- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.





## VU22531 - Establish and manage maintenance systems

### Unit Descriptor

This unit of competency describes the knowledge and skills required to establish and manage maintenance systems within an engineering environment that are cost effective and causes minimum disruption to plant/equipment.

The unit includes the application of computerised maintenance management systems and the development of preventative maintenance policy.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at para professional level in an engineering production environment where regular maintenance for a wide range of plant/equipment is carried out and where these activities need to be control through a set of enterprise policies and procedures.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Prepare maintenance systems policies and procedures

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements*** and ***environmental requirements*** for a given work area are determined.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures in preparation for the work area are followed.
- 1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 ***Maintenance system*** goals are developed through negotiations with stakeholders.
- 1.5 ***Maintenance*** policies and procedures are developed and integrated into established ***enterprise procedures***.
- 1.6 ***Maintenance costs*** are identified and quantified.
- 1.7 Maintenance budget requirements are drawn up and approved by appropriate personnel
- 1.8 Communication strategies are established to build positive workforce attitude and commitment to maintenance.



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| 2. Manage maintenance systems | <p>2.1 Relevant OHS/WHS requirements for carrying out the work are followed.</p> <p>2.2 Resource requirements are identified, secured and included in budgets and operational plans.</p> <p>2.3 Mentoring and training to support the maintenance system is provided in the use and care of technology and equipment.</p> <p>2.4 Maintenance procedures and schedules are implemented to minimise production interruptions, costs, waste and impact on the environment.</p> <p>2.5 Record keeping systems are maintained in accordance with established procedures.</p> <p>2.6 Potential risks are analysed and management strategies are recommend to appropriate personnel.</p> <p>2.7 Contingency plans are implemented in collaboration with appropriate personnel.</p> |
| 3. Review maintenance systems | <p>3.1 Relevant OHS/WHS requirements for carrying out the work are followed.</p> <p>3.2 Procedures for continuous improvement of the maintenance system are established, promoted and implemented.</p> <p>3.3 Ongoing data collection strategies are developed and implemented.</p> <p>3.4 Processes are developed to ensure that the ongoing review of the maintenance system becomes part of enterprise procedures.</p> <p>3.4 Policies are modified to ensure that the maintenance system is maintained to achieve optimum safety and efficiency.</p>  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- developing an operational plan, policies and procedures for maintenance systems
- preparing and managing maintenance systems budget
- managing the implementation of maintenance systems
- providing mentoring and training for maintenance personnel
- establishing and maintaining record keeping procedures for maintenance systems
- analysing potential risks and establishing strategies to manage the risk
- establishing procedures for ongoing review of maintenance systems



**Required knowledge:**

- management theories
  - total productive maintenance (TPM)
  - terotechnology
  - mechanistic management
  - administrative management
  - human relations management
  - decision management
  - system management
  - contingency management
  - centralised versus decentralised
- maintenance audit
  - identify labour and material resources
  - in-house versus contract services
  - identify critical equipment/components
  - assess plant performance and history
  - production trends
  - maintenance management
  - software and hardware requirements
  - justification of computerised systems
  - plant numbering systems
  - ways of collecting data
  - create specific forms of data collection
  - plan a common and uniform approach to input data
  - create flow charts for the input of data
  - organise plant into hierarchical order
  - using maintenance management software
  - input data
- maintenance objectives
  - defining the maintenance department's objectives
  - requirements of a maintenance department
  - factors affecting a maintenance department
  - producing a strategy to meet the objectives
  - responsibilities of management
  - preventative maintenance
  - predictive maintenance
  - selection of appropriate equipment to suit each category
  - setting equipment on computer for each strategy
  - failure patterns of equipment



- Occupational Health and Safety
  - management's responsibilities
  - management system
  - Recording methods
- management tools and techniques
  - computer systems
  - performance indicators
  - maintenance indices
  - analysis tools
  - budgets
  - estimating
  - documentations systems
  - retrieve from computer plant history and costs
  - retrieve from computer plant costs through the hierarchical structure

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may:

- supervisor
- leading hand
- foreman
- manager
- site/production engineer
- trainer
- mentor
- teacher
- team member



**Maintenance system** may include:

- manual
- computerised

**Maintenance** may include:

- preventative
- responsive
- routine

**Enterprise procedures** may include:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**Maintenance cost** may include:

- labour
- part and materials
- maintenance facilities
- equipment and tools
- training
- data collection and reports

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
- demonstrate the ability to develop, implement and manage maintenance systems within an engineering or manufacturing environment.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an



individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.

- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals.

### **Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22532 - Select and apply lubrication principles

### Unit Descriptor

This unit of competency describes the knowledge and skills required to apply lubrication principles and select lubrication products within an engineering or manufacturing environment.

The unit includes the requirement to classify and select common and special lubricants for various applications and to diagnose problems in lubrication systems.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at para professional level in engineering/manufacturing environment where lubricants are selected and used as part of production and/or preventative maintenance work.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Select appropriate lubrication products

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements and environmental requirements*** for a given work area are determined.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures in preparation for the work area are followed.
- 1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with ***appropriate personnel***.
- 1.4 Lubrication task requirements are identified through relevant job requests or documentation and clarified with appropriate personnel.
- 1.5 ***Lubricants***, appropriate for the task, are selected and obtained in accordance with manufacturers' specifications and ***enterprise procedures***.
- 1.6 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.7 ***Resources*** and ***equipment*** needed for the task are obtained in accordance with enterprise procedures and checked for correct operation and safety.



- |    |   |     |  |
|----|---|-----|--|
| 2. | Apply appropriate lubrication principles and products | 2.1 | Relevant OHS/WHS requirements for carrying out the work are followed.  |
|    |   | 2.2 | Equipment, machines or plant are checked as being isolated where necessary in strict accordance with OHS/WHS requirements.                           |
|    |   | 2.3 | The application of lubricants is coordinated and carried out according to enterprise procedures.   |
|    |   | 2.4 | Safety precautions when storing, handling and dispensing lubricants are followed.  |
|    |   | 2.5 | Faults in the lubrication system are diagnosed and rectified.  |
|    |   | 2.6 | Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures. |
| 3. | Review performance of applied lubrication products    | 3.1 | Relevant OHS/WHS requirements for carrying out the work are followed.  |
|    |   | 3.2 | Work site is made safe in accordance with established safety procedures.   |
|    |   | 3.3 | Problems associated with the oil and grease lubricating systems are resolved.  |
|    |   | 3.4 | Quality evaluation tests, if required, are undertaken on lubrication systems to ensure compliance with standards.                                    |
|    |   | 3.5 | Lubrication task is documented and appropriate personnel advised on completion.  |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- Identifying and applying relevant OHS/WHS requirements
- interpreting job requests/instructions
- selecting appropriate lubricants for a given application
- communicating and consulting with other team member involved in the task
- coordinating the application of lubricants
- performing lubrication tests
- diagnosing and rectifying lubrication system faults
- maintain documentation related to lubricant tasks





**Required knowledge:**

- safety and care in use
  - fire hazards and extinguishers
  - effects on the skin and eyes, etc
  - oil spills and cleaning up
  - storage requirements
  - handling precautions
  - dispensing equipment
  - legal requirements for disposal
  - environmental considerations
- lubrication principles
  - functions of lubricants
  - categories of lubricants e.g. oils and greases
  - basic production of lubricants
  - basic theory of friction
  - lubricating films e.g. boundary, hydrodynamic and elasto-hydrodynamic
  - lubrication
- lubricating oils
  - oil types e.g. cutting, grinding, engine, transmission, hydraulic, air compressor, fire resistant and synthetic
  - types of lubricating systems/circuits
  - viscosity grades in S.A.E. and kinematic /I.S.O
  - viscosity index including use of A.S.T.M. tables
  - additives and synergistic effects
  - quality evaluation e.g. A.P.I., A.S.T.M., Australian/U.S. military, civil, gear oil GL number
  - compatibility of oil to components
  - oil and lubricating system problem solving
  - equipment manufacturer's specifications
  - compatibility of oils to oils
- lubricating greases
  - grease types e.g. composition and base for high temperature, high loads, water resistance etc. consistency as per A.S.T.M. and N.L.G.I. classifications additives, performance and applications
  - methods of use
  - problem solving
  - equipment manufacturer's specifications
- lubricant analysis
  - simple tests for viscosity, density, demulsibility
  - contamination of lubricants
  - oil analysis methods and benefits
  - spectrometric analysis and uses
  - particle counting and advantages



- basic tribology
- precautions when using lubricants in manufacturing of food products

## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Appropriate personnel*** may include but are not limited to:

- supervisor
- leading hand
- foreman
- manager
- site engineer
- trainer
- mentor
- teacher
- team member

***Lubricants*** include:

- lubricating oils
- lubricating greases

***Enterprise procedures*** may include but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures



**Resources** may include but are not limited to:

- plant data
- log sheets
- production schedules
- operational and performance records
- maintenance schedules
- manufacturers' instructions, specifications and services manuals
- appropriate consumables and spare parts
- lubricants
- maintenance computer software

**Equipment** may include but are not limited to:

- appropriate hand and power tools
- test equipment
- measuring and aligning equipment
- computer equipment
- personal protective equipment

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
- demonstrate the ability to select, apply and review lubrication principles and products in an engineering or manufacturing application on two occasions.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.



- Resources required for assessment include:
  - OHS/WHs policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

### **Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



## VU22533 - Maintain bearing and rotary shaft assemblies

### Unit Descriptor

This unit of competency describes the knowledge and skills required to maintain plain and anti-friction bearing and rotary shaft seals assemblies.

This includes determining maintenance requirements, selecting and applying appropriate lubricants, diagnosing premature failure patterns and selecting replacement bearings and seals.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### Employability Skills

This unit contains employability skills.

### Application of the Unit

This unit of competency applies to a person working at para professional level in an engineering or manufacturing environment with responsibility for the care and maintenance of plain and anti-friction bearing assemblies and rotary shaft seals and diagnosing premature failure patterns.

### ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Determine maintenance requirements for bearing and rotary shaft seal assemblies

### PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 **Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements** and **environmental requirements** for a given work area are determined.
- 1.2 Established OHS/WHS requirements and risk control measures and procedures in preparation for the work area are followed.
- 1.3 Safety hazards which have not previously been identified are documented and risk control measures devised and implemented in consultation with **appropriate personnel**.
- 1.4 Maintenance requirements for **bearings** and/or rotary shaft assemblies are determined from documentation, work requests or discussions with appropriate personnel.
- 1.5 Suitable assembly or part of an assembly is selected for replacement from documentation, engineering drawings or spare part catalogues, if appropriate.
- 1.6 Appropriate lubricants are selected in accordance with manufacturer's specifications and **enterprise procedures**.
- 1.7 Appropriate personnel are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.8 **Resources** and **equipment** needed for the task are obtained in accordance with enterprise procedures and checked for correct operation and safety.



- |   |   |
|---|---|
| 2. Maintain bearing and rotary shaft seal assemblies                | <p>2.1 Relevant safe work practices for carrying out maintenance are followed.</p> <p>2.2 Equipment/machines/plant are checked as being isolated where necessary in strict accordance with OHS/WHS requirements.</p> <p>2.3 Routine checks on bearings and rotary shaft seals are carried out or delegated according to enterprise procedures with the equipment/plant either operational or non-operational.</p> <p>2.4 Bearing and rotary shaft seal faults are diagnosed and corrective action determined.</p> <p>2.5 Bearings and rotary shaft seals are replaced according to manufacturer's specifications and enterprise procedures.</p> <p>2.6 Lubricants are applied to bearings and rotary shaft seals according to manufacturer's specifications and enterprise procedures.</p> <p>2.6 Decisions for dealing with unexpected situations are made from discussions with appropriate personnel, job specifications and enterprise procedures.</p> <p>2.7 Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.</p> |
| 3. Complete maintenance of bearing and rotary shaft seal assemblies | <p>3.1 Premature failure analysis is undertaken on bearings and rotary shaft seals</p> <p>3.2 Corrective action, based on analysis, is proposed and reported to appropriate personnel.</p> <p>3.3 Bearing and rotary shaft seal maintenance procedure is documented and completion reported to appropriate personnel.</p> <p>3.4 Work site is made safe in accordance with established safety procedures.</p>   |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- determining and coordinating bearing and rotary shaft seal assemblies maintenance requirements
- performing routine maintenance checks on bearing and rotary shaft seal assemblies
- selecting and replacing bearings and seals
- performing failure analysis of bearing and rotary shaft seal assemblies
- updating maintenance documentation



**Required knowledge:**

- plain bearings
  - -bearing materials, metals and non-metals; characteristics, bearing types and construction, uses, advantages and limitations
  - -plain bearing material selection criteria
  - -selection of fits, dimensions and tolerances for specific applications.
  - -limits of size for bearings, shafts and housings
  - -machining methods for bearings, shafts and housings
  - -plain bearing fitting and removal methods
- anti-friction bearings
  - -types, uses, components and terminology
  - -ISO basic and supplementary designations
  - -shaft and housing fits, selection criteria, dimensions and tolerance grades, limits of size
  - -reduction of, and residual radial internal clearance with interference fits
  - -machining considerations for shafts and housings
  - -installation and removal, fitting and alignment methods for parallel and taper bore bearing and bearing assemblies
- rotary shafts seals
  - -types and characteristics
  - -selection criteria
  - -shaft and housing considerations
  - -fitting and removal methods
  - -premature failure analysis
  - -bearings and seals
- lubricants and lubrication systems
  - -plain and anti-friction bearing lubrication theory
  - -lubricant types, selection criteria
  - -lubrication systems, design and application
- premature failure analysis
  - -analysis and rectification of the cause(s) of premature failure in plain and anti-friction bearing assemblies due to contamination, improper lubrication, faulty installation, careless handling, distortion and misalignment, severe service, vibration, electric current, bearing defects

**RANGE STATEMENT**

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

**OHS/WHS requirements** may include:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions



**Environmental requirements** may include:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

**Appropriate personnel** may include:

- supervisor
- leading hand
- foreman
- manager
- site/production engineer
- trainer
- mentor
- teacher
- team member

**Bearings** may include:

- plain bearings
- ball bearings
- angular contact ball bearings
- cylindrical roller bearings
- needle roller bearings
- spherical roller bearings
- tapered roller bearings

**Enterprise procedures** may include:

- use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**Resources** may include:

- bearing assemblies
- rotary shaft seal assemblies
- lubricants
- catalogues
- manufacturers' specifications
- engineering drawings
- data sheets





**Equipment** may include:

- hand tools
- power tools
- measuring instruments
- gauges
- machining tools
- mounting and dismounting tools

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:

- implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
- demonstrate maintenance of plain and anti-friction bearing and rotary shaft seals assemblies on a range of equipment and/or plant. It must include:
  - bearing selection
  - routine checks
  - replacements
  - lubrication
  - fault analysis.

### Context of and specific resources for assessment

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals



**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.



# VU22534 - Perform vibration measurement and control

## Unit Descriptor

This unit of competency describes the knowledge and skills required to select suitable vibration measuring equipment, apply the instruments to evaluate and monitor machine vibrations and to design vibration control mechanisms.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

## Employability Skills

This unit contains employability skills.

## Application of the Unit

This unit of competency applies to a person working at para professional level in an engineering environment and is required to establish and conduct a machinery vibration monitoring, testing and control program.

## ELEMENT

Elements describe the essential outcomes of a unit of competency. Elements describe actions or outcomes that are demonstrable and assessable.

1. Monitor machines and collect vibration data

2. Analyse and evaluate vibration data

## PERFORMANCE CRITERIA

Performance criteria describe the required performance needed to demonstrate achievement of the element – they identify the standard for the element. Where bold/italicised text is used, further information or explanation is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.

- 1.1 ***Occupational Health and Safety/Workplace Health and Safety (OHS/WHS) requirements and environmental requirements*** for a given work area are determined.
- 1.2 Equipment/machines/plant are monitored and identified for testing in accordance with ***plant vibration monitoring program***.
- 1.3 Established OHS/WHS requirements and risk control measures and procedures are followed.
- 1.4 ***Transducers and related instrumentation*** for given vibration measurement task are selected and used in accordance with ***enterprise procedures***.
- 1.5 ***Appropriate personnel*** are consulted to ensure the work is co-ordinated effectively with others involved at the work site.
- 1.6 Results/data are recorded in accordance with enterprise procedures.
- 2.1 OHS/WHS requirements for carrying out the work are followed.
- 2.2 Methods of frequency and/or amplitude analysis are selected appropriate to given task.
- 2.3 Appropriate means of data recording selected to suit required data analysis.
- 2.4 Machine condition analysis report is produced for specific machines and machine components, detailing ***essential information***.



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| 3. | Design and evaluate mechanisms to control machine vibration | 2.5 | Methods for dealing with unexpected situations are selected on the basis of safety and specified work outcomes.                              |
|    |   | 3.1 | OHS/WHS requirements for carrying out and completing the work are followed.  |
|    |   | 3.2 | Suitable vibration isolators are selected for specified task, taking all <b>design factors</b> into consideration.                           |
|    |   | 3.3 | Mechanical configurations are designed to ensure correct operational loading on vibration isolators including run-up and rundown conditions. |
|    |   | 3.4 | Ancillary fittings are designed for optimum performance of vibration isolators.  |
|    |   | 3.5 | Performance of vibration control mechanism is evaluated using, testing equipment and methods appropriate to the design.                      |
|    |   | 3.6 | Results are documented in accordance and work completion is notified in accordance with enterprise procedures.                               |

## REQUIRED SKILLS AND KNOWLEDGE

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

### **Required skills:**

- consulting and communicating with other to ensures work task is coordinated effectively
- identifying and following relevant OHS/WHS procedures
- selecting and use a range of vibration measuring instruments
- analysing test data and designing vibration control mechanism
- evaluating and monitoring controlling mechanism
- preparing machine condition analysis report and completing related documentation

### **Required knowledge:**

- mechanical vibration measurement
  - principle of vibration analysis as an indicator of machine condition
  - difference between harmonic, periodic and random vibration
  - relationship between displacement, velocity and acceleration
  - process of summation of harmonic waveforms to create a complex waveform
  - common units for amplitude measurement of vibration
  - features of a frequency spectrum
  - describe methods of amplitude analysis
  - considerations in selecting and mounting vibration transducers
  - function and operation of proximity (eddy current) sensors
  - considerations and precautions to enable consistently accurate machine vibration readings



- ISO vibration severity standards.
  - expected error for measurement with specified instruments
- vibration analysis
  - methods of frequency analysis
  - methods of amplitude analysis
  - data recording
  - vibration "trend analysis"
  - calculations applicable to vibration measurement and analysis, including allowable exposure using AS2670
  - effects of exposure to "whole body" and hand/arm vibration and action needed to control exposure
- fundamentals of linear vibration
  - frequency
  - displacement
  - velocity
  - acceleration
  - vibration values
  - peak to peak
  - peak
  - root mean square (RMS)
  - crest factor
  - broadband (complex) vibrations
  - resonance
  - machine vibration standards
  - limitations of broadband vibration analysis trend analysis
- elements of a plant vibration monitoring program
  - machine selection and classification
  - machine component register
  - machine measuring points, selection and identification
  - plant monitoring route
  - plant monitoring frequency
  - machine fingerprinting
  - setting baseline and alarm levels
  - judgement criteria; relative level, comparative, absolute value
  - machine vibration severity standards
  - condition analysis reports
- vibration control
  - selecting transducers with required frequency and amplitude response
  - selecting appropriate conditioning amplifiers to suit a specified transducer or measurement task
  - calibration methods for specified transducers and measurement systems
  - mounting methods for transducers



## RANGE STATEMENT

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold / italicised wording in the Performance Criteria is detailed below.

***OHS/WHS requirements*** may include, but are not limited to:

- legislation
- protective equipment
- material safety management systems
- hazardous substances and dangerous goods code
- local safe operation procedures
- awards provisions

***Environmental requirements*** may include, but are not limited to:

- liquid waste
- solid waste
- gas, fume, vapour, smoke emissions, including fugitive emissions
- excessive energy and water use
- excessive noise

***Plant vibration monitoring program*** may include:

- manual system or computer data base, including:
- machine classification
- survey route
- "fingerprinting" machines
- measurement points
- vibration parameters for each machine

***Transducers and related instrumentation*** may include, but are not limited to:

- vibration meters (broadband)
- shock pulse meters (SPM)
- high frequency detection (HFD) (shock pulse)
- spectral emitted energy (SEE)
- real time analyser (RTA)
- fast Fourier transform (FFT) (narrowband)
- digital signal processor (DSP)
- oscilloscope
- computer aided analysis
- selection, application and mounting considerations of signal sensors
- transducers for displacement, velocity, acceleration
- proximity (eddy current) sensor
- tape recorder
- bandpass filter



**Enterprise procedures** may include, but are not limited to:

- the use of tools and equipment
- instructions, including job sheets, cutting lists, plans, drawings and designs
- reporting and communication
- manufacturers' specifications and operational procedures

**Appropriate personnel** may include:

- supervisor
- leading hand
- foreman
- manager
- site/production engineer
- trainer
- mentor
- teacher
- team member

**Essential information** includes:

- machine condition,
- source of vibration,
- repair/replacement lead time
- recommended action

**Design factors** may include, but are not limited to:

- required isolation
- required natural frequency
- working environment
- machine support conditions

## EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Elements, Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment section in Section B of the Accreditation Submission.

### Critical aspects for assessment and evidence required to demonstrate competency in this unit

- Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the associated performance criteria, including required skills and knowledge. Specifically they must be able to:
  - implement OHS/WHS procedures and practices including the use of risk control measures as specified in the performance criteria
  - demonstrate the ability to select suitable vibration measuring instruments and use the instruments to measure, monitor and record vibration data.
  - demonstrate the ability to analyse the data and design suitable vibration control mechanism on two occasions.



**Context of and specific resources for assessment**

- This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.
- Resources required for assessment include:
  - OHS/WHS policy and work procedures and instructions.
  - access to workplace or work real environment and a variety of conditions
  - operational access to relevant machines, tools, materials and consumables
  - access to relevant plans, drawings and instructions and manufacturer's specifications/manuals

**Methods of assessment**

- For valid and reliable assessment of this unit, evidence should be gathered through a range of methods to indicate consistent performance.
- Evidence must involve demonstration of practical skills and may also include:
  - observation of processes and procedures
  - oral and/or written questioning on required knowledge and skills
  - testimony from supervisors, colleagues, clients and/or other appropriate persons
  - inspection of the final product or outcome
  - a portfolio of documented evidence.
- Where performance is not directly observed any evidence should be authenticated by colleagues, supervisors, clients or other appropriate persons.
- Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

