



Australian Government

Department of Education, Employment and Workplace Relations

UETTDRDS37A Design power system distribution substations

Release: 1

UETTDRDS37A Design power system distribution substations

Modification History

Not applicable.

Unit Descriptor

Unit Descriptor

1) Scope:

1.1) Descriptor

This Competency Standard Unit covers the technical design of distribution substations to relevant standards and specifications, including earthing, location of substation relevant to load, customer and environmental needs and minor civil aspects. It also includes the necessary established procedures to ensure the substation design conforms to specific organisational technical standards operational and system planning requirements and encompasses the principles of safe design.

Application of the Unit

Application of the Unit 2)

This Competency Standard Unit is intended to augment formally acquired competencies. It is suitable for employment-based programs under an approved contract of training.

Licensing/Regulatory Information

License to practice 3)

The skills and knowledge described in this unit may require a licence/registration to practice in the work place subject to regulations for undertaking of electrical work. Practice in workplace and during training is also subject to regulations directly related to Occupational Health and Safety, electricity/telecommunications/gas/water industry

License to practice**3)**

safety and compliance, industrial relations, environmental protection, anti discrimination and training.
Commonwealth, State/Territory or Local Government legislation and regulations may exist that limits the age of operating certain equipment.

Pre-Requisites**Prerequisite Unit(s)****4)****Competencies****4.1)**

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

Where pre-requisite pathways have been identified. All competencies in the Common Unit Group must be have been completed plus all the competencies in one (1) of the identified Pathway Unit Group(s):

Common Unit Group

Unit Code	Unit Title
UEENEEE101A	Apply Occupational Health and Safety regulations, codes and practices in the workplace
UEENEEE102A	Fabricate, assemble and dismantle utilities industry components
UEENEEE104A	Solve problems in d.c. Circuits
UEENEEE107A	Use drawings, diagrams, schedules, standards, codes and specifications
UEENEEE125A	Provide engineering solutions for problems in complex multiple path circuits problems
UEENEEE126A	Provide solutions to basic engineering computational problems
UEENE EG101A	Solve problems in electromagnetic devices and related circuits

Prerequisite Unit(s)**4)**

UEENEEG102A	Solve problems in electromagnetic devices and related circuits
UEENEEG149A	Provide engineering solutions to problems in complex polyphase power circuits
UETTDREL11A	Apply sustainable energy and environmental procedures
UETTDREL16A	Working safely near live electrical apparatus
UETTD RIS62A	Implement and monitor the power system organisational OHS policies, procedures and programs
UETTD RIS63A	Implement and monitor the power system environmental and sustainable energy management policies and procedures
Pathway Unit Group 1	
UETTD RDS39A	Prepare and manage detailed construction plans for electrical power system infrastructure
UETTD RDS45A	Organise and implement ESI line and easement surveys
Pathway Unit Group 2	
UETTD RDS43A	Develop high voltage and low voltage distribution protection systems

Literacy and numeracy skills**4.2)**

Participants are best equipped to achieve this unit if they have reading, writing and numeracy skills indicated by the following scales. Description of each scale is given in Volume 2, Part 3 “Literacy and Numeracy”

Reading 5 Writing 5 Numeracy 5

Employability Skills Information

Employability Skills 5)

The required outcomes described in this unit of competency contain applicable facets of Employability Skills. The Employability Skills Summary of the qualification in which this unit of competency is packaged will assist in identifying Employability Skill requirements.

Elements and Performance Criteria Pre-Content

6) Elements describe the essential outcomes of a competency standard unit	Performance Criteria describe the required performance needed to demonstrate achievement of the element. Assessment of performance is to be consistent with the Evidence Guide.
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Elements and Performance Criteria

ELEMENT		PERFORMANCE CRITERIA	
1	Plan for and coordinate the safe design of distribution substations	1.1	OHS practices/procedures and environmental and sustainable energy procedures, which may influence the design of distribution substations, are reviewed and determined.
		1.2	Purpose of the design is established and expected outcomes of the work are confirmed with the appropriate personnel.
		1.3	Organisational established procedures on policies and specifications for the design are obtained or established with the appropriate personnel.
		1.4	Equipment/tools and personal protective equipment are selected and coordinated based on specified requirements and established procedures.

ELEMENT**PERFORMANCE CRITERIA**

	1.5	Work is prioritised and sequenced for the most efficient and effective outcome following consultation with others for completion within acceptable timeframes, to a quality standard and in accordance with established procedures.
	1.6	Risk control measures are identified, prioritised and evaluated against the work schedule.
	1.7	Relevant work permits are secured to coordinate the performance of work according to requirements and/or established procedures.
	1.8	Resources including personnel, equipment, tools and personal protective equipment required for the job are identified, scheduled and coordinated and confirmed in a safe and technical working order.
	1.9	Liaison and communication issues with other/authorised personnel, authorities, clients and land owners are resolved and activities coordinated to carry out work.
	1.10	Site is prepared according to the work schedule and to minimise risk and damage to property, commerce, and individuals in accordance with established procedures.
	2	Carry out and coordinate the design of distribution substations
	2.1	Circuit/systems modelling is used to evaluate alternative proposals as per established procedures.
	2.2	OHS and sustainable energy principles, functionality and practices to reduce the incidence of accidents and minimise waste are incorporated into the project in accordance with requirements and/or established procedures.
	2.3	System design decisions are made on the basis of safety and effective outcomes according to requirements and/or established procedures.
	2.4	Mathematical models of the distribution system are used to analyse the effectiveness of the finish project as per requirements and established procedures.

ELEMENT**PERFORMANCE CRITERIA**

	2.5	Technical advice is given to potential hazards, safety risks and control measures so that monitoring and preventative action can be undertaken and/or appropriate authorities consulted, where necessary, in accordance with requirements and established procedures.
	2.6	Essential knowledge and associated skills are applied to analyse specific data and compare it with compliance specifications to ensure completion of the project within an agreed timeframe according to requirements.
	2.7	Solutions to non-routine problems are identified and actioned using acquired essential knowledge and associated skills according to requirements.
	2.8	Quality of work is monitored against personal performance agreement and/or established organisational and professional standards.
3	Complete and coordinate the design of distribution substations	
	3.1	Final inspections of the design are undertaken to ensure they comply with all requirements and include all specifications and documentations needed to complete the design brief.
	3.2	Appropriate personnel are notified of completion and reports and/or completion documents are finalised.
	3.3	Reports and/or completion documents are submitted to relevant personnel/organisations for approval and, where applicable, statutory or regulatory approval.
	3.4	Approved copies of design documents are issued and records are updated in accordance with established procedures.

Required Skills and Knowledge

REQUIRED SKILLS AND KNOWLEDGE

8) Essential Knowledge and Associated Skills (EKAS): This describes the essential skills and knowledge and their level, required for this unit.

Evidence shall show that knowledge has been acquired of designing distribution substations.

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

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Evidence shall show an understanding of the designing of power system distribution substations to an extent indicated by the following aspects:

T1 Mathematics techniques encompassing:

- Calculations involving fractions, decimals, ratios, proportions
- Calculations involving area, volume, mass and density
- Calculations involving transposition and substitution of formulae
- Calculations involving simple trigonometric problems.

T2 Engineering mechanics encompassing:

- Identification of basic concepts, principles and applications - Application of velocity, acceleration, force, density, torque, and pressure
- Applications of the SI units
- The relationship between work, power and energy
- Behaviour of object under force - using a block and tackle under load, concept of mechanical advantage, determination of resultant forces and determining the sag in a catenary conductor and the force applied at each end
- Fundamentals of the basic laws of fluid mechanics.

T3 Materials properties encompassing:

- Identification and classification of engineering materials material properties
- Types and applications - properties of tensile strength, effects of temperature on the expansion of metals, ductility, malleability, work hardening and annealing and the conditions that lead to corrosion and the properties of timbers.

T4 Generation systems encompassing:

- Methods of generating electricity - types of power stations and reasons for their location, layout of thermal and hydroelectric power stations
- Relationship between power control and load requirements - operating speeds for thermal and hydroelectric generating sets, typical generator voltage levels and output ratings
- The purpose and features of typical types of co-generation systems.

T5 Substations and power transformers encompassing:

- Relationship between the substations within an overall power system: note

REQUIRED SKILLS AND KNOWLEDGE

examples include purpose, location in relation to load centres, layout of HV equipment within the substation and auxiliary equipment

- Characteristics of a power transformer - basic construction of distribution transformers, operation under load/no load conditions, types and basic operation of tap changing switches including solid state types, efficiency and cooling
- Auxiliary equipment used on transformers - function and basic operation
- Maintenance of a power transformer - basic connections, restrictions to parallel operation, problems and remedies associated with harmonics, testing and fault finding procedures
- Characteristics of a reactors - description and purpose

T6 The installation of metering and control equipment encompassing:

- Standards, codes, legislation, supply authority regulations and or enterprise requirements pertaining to the installation and maintenance of energy meters and associated equipment
- Types of meters: note examples include kilowatt-hour meters single and polyphase, demand meters, recording meters and electronic recording metering systems summators
- Installation and removal methods - direct connection and plug in method and enterprise specific
- Types of associated equipment and accessories - meter boards, service fuse, links, contactors, time switch, audio frequency injection relay
- Testing procedures - safety and polarity testing

T7 Principles of Statutory and safety considerations encompassing:

- Commonwealth/State/Territory legislation, standards, codes, supply authority regulations and or enterprise requirements associated with working on High Voltage
- Particular reference to State and Territory regulations regarding - working near energised conductors, electrical access, heights, confined space, testing procedures, licensing rules.

T8 The installation of switchgear and associated equipment encompassing:

- Types and function of various switchgear - isolators, air-break switches, gas-filled switches, vacuum type, links, fuses, oil disconnectors, fuse switches, circuit breakers, operating characteristics, advantages and disadvantages of different types switchgear, installation procedures, earthing, requirements and techniques
- Types of equipment: note examples include transformers, reactors, regulators, capacitors, relays, surge arrestors, fault indicators and mobile generators
- Installation procedures for switchgear and equipment encompassing: standards, codes, legislation, supply authority regulations and or enterprise requirements, assembly and erecting procedures, earthing requirements and techniques and pole mounted locations
- Maintenance procedures for switchgear and equipment - diagnosing and rectifying faults according to electricity supply industry standards and procedures

REQUIRED SKILLS AND KNOWLEDGE

- Testing and commissioning - electricity supply industry standards and procedures

T9 High voltage distribution transformer principles encompassing:

- Operation of HV distribution transformers - principle governing factors for transformer ratings, protection and alarms, operating limitations and the relationship between transformer and HV fuse rating, purpose and principle operation of HV distribution transformer tap changers, HV distribution transformer and transformer — cable combination switching practices, paralleling requirements, isolation and earthing procedures for access, common distribution transformer and associated electrical apparatus faults
- HV underground switching equipment - arc strangles, switch operation, load break elbows, switching cubicles, canister fuses, bayonet fuses, F and G switching cubicles, voltage indicators and phasing testers

T10 Feeder automation system encompassing:

- Function of feeder automation system and the main components
- Operation procedure for a remote field device from a local control station
- Functions of “System Control and Data Acquisition” (SCADA) (or any other relevant Data Acquisition and Control) systems and its main components
- SCADA system security interlocks and access restrictions
- SCADA system operation when switching apparatus or retrieving data via a remote access device such as; Remote Access Terminal (RAT), Dial Up Voice Annunciated System and Local Control Station
- Function of the main components of a local/remote control system
- Operation of a field devices using SCADA systems via a Remote Access Terminal (RAT), Dial Up Annunciated System and Local Control Station

T11 Environmental fundamentals encompassing:

- Environmental standards, codes, environmental legislation, supply authority regulations and or enterprise requirements applicable to the control of environment associated with the worksite encompassing, relevant federal legislation, relevant state/territory legislation, relevant local government by-laws, relevant government or quasi government policies and regulations and relevant community planning and development agreements - land care agreements.
- Employer and employee responsibilities
- Methods of obtaining information on environmental issues and updates
- Methods of identifying environmental impacts from work related activities
- Meaning of environmental terms encompassing identification, assessment and control of risks, compliance and best practice and sustainable energy
- Procedures in implementing management plans to ensure compliance

T12 Layout principles for a distribution substation minor upgrade encompassing:

- Commonwealth, State/Territory and local government legislation, Standards, codes, supply authority regulations and or enterprise requirements applicable to a distribution substation minor upgrade

REQUIRED SKILLS AND KNOWLEDGE

- Requirements for the use of distribution substation minor upgrade construction manuals, system diagrams/plans and drawings and for plans such as work method statements for the control of OHS risks
- Methods in determining material, equipment and tool lists - components types and quantity required, spacing of components and equipment, costings of items and components.
- Purchasing and contractual arrangements to include a requirement to eliminate OHS hazards, minimise risks and provide residual OHS risk information
- Determination of conductor size, type and route length
- Resources needed for the laying of conductors, cables and equipment
- Determining the appropriate installation sequence
- Minimum clearances between conductors and equipment
- Estimation of the duration of underground distribution extension project

T13 Fundamentals of distribution transformers encompassing:

- Standards, codes, legislation, supply authority regulations and or enterprise requirements pertaining to the safe operation and testing of distribution transformers and auxiliary equipment
- Drawing layouts, conventions and symbols, note: examples include vector group of transformers and three phase transformers
- Construction of a distribution transformer
- Characteristics when operated under load and no load conditions
- Percentage impedance determinations by test and calculation
- Function and operation of tap charging switches including solid state tap changing equipment
- Function and operation of transformer auxiliary equipment
- Problems caused by harmonics in transformers
- Methods and equipment used to overcome harmonics in transformers

T14 Testing procedures of distribution transformers encompassing:

- Safety precautions specific to the testing of distribution transformers
- Procedures for safely connecting distribution transformers for testing
- Testing of distribution transformers to determine losses
- Calculation of transformer's efficiency
- Methods and types of equipment used to cool transformers encompassing: properties of transformer oil and tests performed on transformer oil
- Techniques in performing selected tests on transformer oil
- Techniques in performing testing procedures on armer
- Techniques in testing distribution transformers
- Distribution transformer parallel connections - conditions and restrictions for parallel operations
- Calculations of loading on transformers operating in parallel
- Connection of transformer in parallel to supply a common load

REQUIRED SKILLS AND KNOWLEDGE

T15 Distribution earthing system encompassing:

- Standards, codes, legislation, supply authority regulations and or enterprise requirements applicable to the distribution earthing system
- Reason and types of distribution earthing systems
- Terminologies used in the earth systems including, touch and step potential
- Conditions associated when an active HV conductor fails to earth
- Selection of earthing electrodes and grids
- Determination of the earthing resistance of copper clad rods using earthing monograms

Evidence Guide

EVIDENCE GUIDE

9) This provides essential advice for assessment of the unit of competency and must be read in conjunction with the Performance Criteria and the range statement of the unit of competency and the Training Package Assessment Guidelines.

The Evidence Guide forms an integral part of this Competency Standard Unit and shall be used in conjunction with all component parts of this unit and, performed in accordance with the Assessment Guidelines of this Training Package.

Overview of Assessment 9.1)

Longitudinal competency development approaches to assessment, such as Profiling, require data to be reliably gathered in a form that can be consistently interpreted over time. This approach is best utilised in Apprenticeship programs and reduces assessment intervention. It is the Industry's preferred model for apprenticeships. However, where summative (or final) assessment is used it is to include the application of the competency in the normal work environment or, at a minimum, the application of the competency in a realistically simulated work environment. It is recognised that, in some circumstances, assessment in part or full can occur outside the workplace. However, it must be in accord with Industry and, Regulatory policy in this regard.

Methods chosen for a particular assessment will be influenced by various factors. These include the extent of the assessment, the most effective locations for the assessment activities to take place, access to physical resources, additional safety measures that may be required and the critical nature of the competencies being

assessed.

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

Activities associated with normal every day work have a bearing on the decision as to how much and how detailed the data gathered will contribute to its 'richness'. Some skills are more critical to safety and operational requirements while the same skills may be more or less frequently practiced. These points are raised for the assessors to consider when choosing an assessment method and developing assessment instruments. Sample assessment instruments are included for Assessors in the Assessment Guidelines of this Training Package.

**Critical aspects
of evidence
required to
demonstrate
competency in
this unit**

9.2)

Before the critical aspects of evidence are considered all prerequisites shall be met.

Evidence for competence in this unit shall be considered holistically. Each element and associated Performance Criteria shall be demonstrated on at least two occasions in accordance with the "Assessment Guidelines – UET12UET12". Evidence shall also comprise:

- A representative body of Performance Criteria demonstrated within the timeframes typically expected of the discipline, work function and industrial environment. In particular this shall incorporate evidence that shows a candidate is able to:
 - Implement Occupational Health and Safety workplace procedures and practices including the use of risk control measures as specified in the Performance Criteria and range; and
 - Apply sustainable energy principles and practices as specified in the Performance Criteria and range; and
 - Demonstrate an understanding of the essential knowledge and associated skills as described in this unit to such an extent that the learner's performance outcome is reported in accordance with the preferred approach; namely a percentile graded result, where required by the regulated

- environment; and
- Demonstrate an appropriate level of employability skills; and
- Conduct work observing the relevant Anti Discrimination legislation, regulations, policies and workplace procedures; and
- Demonstrated performance across a representative range of contexts from the prescribed items below:

Range of tools/equipment/materials/procedures/workplaces/other variables		
Group No	The minimum number of items on which skill is to be demonstrated	Item List
A	Completion of six (6) technical designs of a Distribution Substation relating to at least two of the following project types:	Multi-transformer substations Residential developments Industrial/commercial developments Alteration to existing assets
B	Designs should also include all the following:	Activities that address the correction of errors in the process. Application of a design control checklist, which lists all of the required design activities to be carried out in this process.
C	At least one occasion	Dealing with an unplanned event by drawing on essential knowledge and associated skills to provide appropriate solutions incorporated in the holistic assessment with the

		above listed items.
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Context of and specific resources for assessment **9.3)**

This unit should be assessed as it relates to normal work practice using procedures, information and resources typical of a workplace. This should include:

- OHS policy and work procedures and instructions.
- Suitable work environment, facilities, equipment and materials to undertake actual design of distribution substations

In addition to the resources listed above, in Context of and specific resources for assessment, evidence should show demonstrated competency working realistic environment and a variety of conditions.

Method of assessment **9.4)**

This Competency Standard Unit shall be assessed by methods given in Volume 1, Part 3 “Assessment Guidelines”.

Note:

Competent performance with inherent safe working practices is expected in the Industry to which this Competency Standard Unit applies. This requires that the specified essential knowledge and associated skills are assessed in a structured environment which is primarily intended for learning/assessment and incorporates all necessary equipment and facilities for learners to develop and demonstrate the essential knowledge and associated skills described in this unit.

Concurrent assessment and relationship with other units **9.5)**

There are no recommended concurrencies for this unit.

Range Statement

RANGE STATEMENT

10) This relates to the unit of competency as a whole providing the range of contexts and conditions to which the Performance Criteria apply. It allows for different work environments and situations that will affect performance.

This Competency Standard Unit shall be demonstrated in relation to the design of distribution substations and may include the following equipment:

Substations, transformers, cables, Surge Div, HV Switchgear, LV Switchgear, links, relays, power supply, signage, busbars, relevant protection systems including fuses and circuit breakers and associated civil works.

The following constants and variables included in the element/Performance Criteria in this unit are fully described in the Definitions Section 1 of this volume and form an integral part of the Range Statement of this unit:

- Appropriate and relevant persons (see Personnel)
- Appropriate authorities
- Appropriate work platform
- Assessing risk
- Assessment
- Authorisation
- Confined space
- Diagnostic, testing and restoration
- Documenting detail work events, record keeping and or storage of information
- Drawings and specifications
- Emergency
- Environmental and sustainable energy procedures
- Environmental legislation
- Environmental management documentation
- Established procedures
- Fall prevention
- Hazards
- Identifying hazards
- Inspect
- Legislation
- MSDS
- Notification
- OHS practices
- OHS issues
- Permits and/or permits to work

RANGE STATEMENT

- Personnel
- Quality assurance systems
- Requirements
- Safe design principles
- Testing procedures
- Work clearance systems

Unit Sector(s)

Not applicable.

Competency Field

Competency Field **11)**
Design.