



Australian Government

Department of Education, Employment and Workplace Relations

UETTDRDS44A Design power system substations modifications

Release: 1

UETTDRDS44A Design power system substations modifications

Modification History

Not applicable.

Unit Descriptor

Unit Descriptor

1) Scope:

1.1) Descriptor

This Competency Standard Unit covers the design of modifications within a substation. This may include busbar upgrades, equipment replacement projects and basic secondary upgrades or SCADA modifications. The design may include civil engineering aspects and must conform to safety regulations and environmental standards and incorporate 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 safety and compliance, industrial relations, environmental protection, anti discrimination and training.

License to practice**3)**

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

Prerequisite Unit(s) 4)

policies and procedures

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.

Elements and Performance Criteria

ELEMENT	PERFORMANCE CRITERIA
1 Plan for and coordinate the design of substations	1.1 OHS practices/procedures and environmental and sustainable energy procedures, which may influence the design of 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 Established organisational procedures, 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.
	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

ELEMENT**PERFORMANCE CRITERIA**

established procedures.

1.11 Personnel participating in the work, including plant operators and contractors, are fully briefed and respective responsibilities coordinated and authorised where applicable in accordance with established procedures.

2 Carry out and coordinate the design of 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 system are used to analyse the effectiveness of the finished project as per requirements and established procedures.

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.

ELEMENT	PERFORMANCE CRITERIA
3 Complete and coordinate the design of 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 substation modifications.

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

KS01-TDS44A Power system zone substations modifications - Design

Evidence shall show an understanding of the design of power system zone substations modifications to an extent indicated by the following aspects:

T1 Electrical computations encompassing:

- Graph functions and applications - linear, non linear, parabolic, hyperbolic, logarithmic and exponential
- Complex numbers - polar form and rectangular form
- Simultaneous equations
- Quadratic equations
- Phasor diagrams
- Star-delta transformations.

T2 Working safely on or around electrical equipment through the application of risk management principles and control measures for dealing with non-electrical hazards and extra-low voltage, low-voltage and high-voltage hazards and high-current hazards encompassing:

- Risk management and assessment of risk - principle and purpose of risk management and processes for conducting a risk assessment
- Hazards associated with low-voltage, extra-low voltage and high-currents - arrangement of power distribution and circuits in an electrical installations, parts of an electrical system and equipment that operate at low-voltage and extra-low voltage and parts of an electrical system and equipment where high-currents are likely.
- Risks and control measures associated with high-voltage - parts of an electrical system and equipment that operate at high-voltage, the terms 'touch voltage', 'step voltage', 'induced voltage' and 'creepage' as they relate to the hazards of high-voltage and control measures used for dealing with the hazards of high-voltage
- Optical fibre safety - coherent optical sources and joining procedures and laser safety class 3a devices or their replacement
- Risks and control measures associated with low voltage - risks associated with modifying electrical installations, fault finding, maintenance and repair, control measures before, while and after working on electrical installations, circuits or equipment, isolation and tagging-off procedures, risks and restrictions in working

REQUIRED SKILLS AND KNOWLEDGE

live and control measures for working live

- Risks and control measures associated with harmful dusts and airborne contaminants - thermal insulation, fibrous cement materials and asbestos and other fibre reinforced switchboard materials.
- Safety, selection, use, maintenance and care of test equipment - safety characteristics of electrical testing devices, safe use of electrical testing device and checks and storage methods for maintaining the safety of testing devices

T3 OHS enterprise responsibilities encompassing:

- Provisions of relevant health and safety legislation
- Principles and practice of effective occupational health and safety management
- Management arrangements relating to regulatory compliance
- Enterprise hazards and risks, control measures and relevant expertise required
- Characteristics and composition of workforce and their impact on occupational health and safety management
- Relevance of enterprise management systems to occupational health and safety management
- Analysis of working environment and design of appropriate occupational health and safety management systems
- Analysis of relevant data and evaluation of occupational health and safety system effectiveness
- Assess resources to establish and maintain occupational health and safety management systems.

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 - 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

REQUIRED SKILLS AND KNOWLEDGE

T6 Safe working on energised low voltage equipment encompassing:

- Standards, codes, Commonwealth, State/Territory/local government legislation, supply authority regulations and or enterprise requirements
- Safety precautions specific to working on or near energised low voltage conductors - safe working practices and procedures, identification of hazards, assessment and control of OHS risks and types, selection, maintenance and use of personal protective equipment
- Work on or near energised LV conductors - types and function of specialised tools, safe working practices when using specialised tools, methods of using specialised tools and safe procedures for work on panels and in cubicles on or near energised LV conductors
- Release and rescue procedures for work on or near exposed energised LV conductors

T7 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 - 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 testing and polarity testing

T8 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.

T9 Electrical equipment associated with protection and control schemes encompassing:

- Types and applications of electrical equipment: characteristics and capabilities - schemes, overcurrent, frame leakage, cooling, buchholz, DC supplies, restricted earth, sensitive earth fault, CB fail, reclose, DC frame leakage, CEL Fail, under frequency load shed and earth fault

T10 Principles of safe design encompassing:

- Commonwealth/State/Territory legislation, standards, codes, supply authority regulations and or enterprise requirements associated with safe design principles
- Particular reference to state and territory regulations regarding: working near

REQUIRED SKILLS AND KNOWLEDGE

energised conductors, electrical access, heights, confined space, testing procedures and Licensing rules

- Application of safe design principles - safe design duty related information, safe design process related information and safe design evaluations

T11 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 - transformers, reactors, regulators, capacitors, relays, surge arrestors, fault indicators and mobile generators
- Installation procedures for switchgear and equipment - 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
- Testing and commissioning - electricity supply industry standards and procedures

T12 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 - identification, assessment and control of risks, compliance, best practice and sustainable energy
- Procedures in implementing management plans to ensure compliance

T13 Environmental fundamentals encompassing:

- Methods of obtaining updated environmental information and data sheets on the proper use and handling of equipment and materials
- Environmental standards, codes, environmental legislation, OHS legislation, hazardous substances/dangerous goods regulations, supply authority regulations and or enterprise requirements applicable environmental care when handling materials including provision of manufacturers and suppliers information such as material safety data sheets (MSDS)
- Types and application of personal protective equipment used for hazards substances
- Types and application of personal protective equipment used for hazards

REQUIRED SKILLS AND KNOWLEDGE

substances and dangerous goods

- Techniques in handling equipment to eliminate/reduce risks to the environment from spillages of oils, herbicides, pesticides and chemicals from such equipment - vehicle loading crane, chainsaw, enterprise vehicles and explosive power tools
- Procedures for handling and control of spillages of herbicides
- Methods of disposing and storage of herbicides, pesticides and chemicals
- Methods of cleaning mobile plant, equipment and tools
- Recording of data

T14 Substation safety practices encompassing:

- Standards, codes, Commonwealth, State/Territory/local government legislation, supply authority regulations and or enterprise requirements pertaining to substation safety practices
- Techniques in the use of protective apparatus and apparel for substations work, including responsibilities with regard to the use and maintenance of protective apparatus and apparel and the types of protective apparatus and apparel used for work in substations
- Requirements for the use of ladders and appropriate ladder types for work in substations - safe work methods when carrying, erecting, collapsing and lowering different types of extension ladder against substation structures, plant and equipment, maintenance checks on different types of ladders, renewal of extension ropes and the safety issues relating to clearances from energised conductors
- Requirements for climbing and working at heights in substations - attached climbing principles, selection, use and operation of elevated work platforms and any OHS requirements associated with the use of EWPs
- Control of small fires - the identification, selection and operation of the appropriate extinguishing mediums for various types of fires and the precautions for personal protection when fighting small fires
- Control of oil spills - the identification, use and maintenance of spill oil control equipment and materials, oil containment facilities and systems
- Rescue and release procedures - the rescue personnel from energised conductors, emergency descent from an EWP and may include rescue from confined spaces
- Enterprise requirements - safe access and Authorisation to Work procedures, use of mobile extendable equipment on or near energised HV conductors and emergency response procedures
- Hazards associated with work in substations including earthing systems, transfer potentials, step and touch effects, electrostatic and electromagnetic induction, dangers of near approach to energised conductors

T15 Design principles of high voltage insulation systems encompassing:

- Insulation design principles - common materials used, electrical characteristics, thermal characteristics, uses and applications to substation high voltage plant and equipment, grading, construction and cooling
- Common contaminants and their effects - internal contaminants and external

REQUIRED SKILLS AND KNOWLEDGE

contaminants

- Testing and measurement of insulation quality - test types and common measuring instruments and techniques, resistance and resistivity, losses, measurement errors, temperature corrections and safe work practices related to testing and measurement
- Safety precautions when testing and measuring high voltage insulation systems - safe working practices and procedures, identification of hazards, assessment and control of OHS risks and types, selection, maintenance and use of personal protective equipment

T16 Principles to design zone substation modifications encompassing:

- Commonwealth, State/Territory and local government legislation, Standards, codes, supply authority regulations and or enterprise requirements applicable to the zone substation design principles
- Requirements for the use of zone substation system construction manuals, system diagrams/plans and drawings and for plans such as work method statements for the control of OHS risks
- Types of designs - substation modification design include replacement of one item or a small quantity of items of primary plant, secondary equipment or SCADA equipment, full or partial retrofit of SCADA into an existing substation
- Types of zone substation primary plant - HV circuit breakers, reclosers, power, current or voltage transformers, disconnectors, surge arrestors, busbars, busbar supports, load control and frequency injection facilities
- Types of secondary equipment - batteries, battery chargers, protection relays, control devices or panels
- Types of SCADA modification - full or part implementation of SCADA retrofits, replacement of SCADA IEDs, RTUs and SMUs

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	Item List

	demonstrated	
A	Completion of six (6) compliant technical designs of different components of a Substation with at least one relating to each of the following project types:	Primary equipment upgrades or replacements Secondary equipment upgrades or replacements SCADA modifications
B	Designs should also included all the following:	Activities that address the correction of errors in designs. 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.

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 substation.

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 substations and may include the following equipment:

Pole (including wood, concrete, steel and composite) associated hardware including conductors (bare wire and aerial bundle cable), crossarms, insulators, ACR, regulator, earthing, air break switches, gas switches, capacitor units, transformers, links, fuses, sectionalisers, lead Arrestors, HV Switchgear, LV Switchgear, control boxes, communications equipment, lanterns, signage, supervisory cable, cable TV, Substations, relevant protection systems and associated civil works.

Substations, transformers, cables, Surge diverters, 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

RANGE STATEMENT

- MSDS
- Notification.
- OHS practices
- OHS issues
- Permits and/or permits to work
- Personnel
- Quality assurance systems
- Requirements
- Safe design principles
- Testing procedures
- Work clearance systems

Unit Sector(s)

Not applicable.

Competency Field

Competency Field **11)**
Design