Australian Government

Department of Education, Employment and Workplace Relations

UETTDRDS54A Design power system transmission and sub-transmission protection and control

Release: 1

UETTDRDS54A Design power system transmission and sub-transmission protection and control

Modification History

Not applicable.

Unit Descriptor

Unit Descriptor **1) Scope:**

1.1) Descriptor

This Competency Standard Unit covers the design of transmission, sub-transmission and zone substation protection and control systems. This may include basic secondary upgrades, SCADA modifications or new installations on green field sites. The design 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
UEENEEE104A	Solve problems in d.c. Circuits
UEENEEE107A	Use drawings, diagrams, schedules, standards, codes and specifications
UEENEEG101A	Solve problems in electromagnetic devices and related circuits
UEENEEG102A	Solve problems in electromagnetic devices and related circuits
UETTDRDS39A	Prepare and manage detailed construction plans for electrical power system infrastructure
UETTDRDS44A	Design power system substations modifications
UETTDREL11A	Apply sustainable energy and environmental procedures

Prerequisite Unit(s) **4)**

UETTDREL16A	Working safely near live electrical apparatus
UETTDRIS62A	Implement and monitor the power system organisational OHS policies, procedures and programs
UETTDRIS63A	Implement and monitor the power system environmental and sustainable energy management 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 transmission, sub-transmission and zone substation protection and control systems	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 policies, procedures 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

ELEMENT	PERFORMANCE CRITERIA	
		and to minimise risk and damage to property, commerce, and individuals in accordance with 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 transmission, sub-transmission and zone substation protection and control systems	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 design are used to analyse the effectiveness of the finished project as per requirements and established procedures
	2.5	Technical advice is given regarding 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

ELEMENT	PERFORMANCE CRITERIA	
		organisational and professional standards.
3 Complete and coordinate the design of transmission, sub-transmission and zone substation protection and control systems	3.1	Final checks 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 transmission, sub-transmission and zone substation protection and control systems.
All knowledge and skills detailed in this unit should be contextualised to current industry practices and technologies.
KS01-TDS54A Power system transmission and sub-transmission protection and control
Evidence shall show an understanding of designing power system transmission and sub-transmission protection and control to an extent indicated by the following aspects:
T1 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 Date 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

T2 Commissioning procedures associated with discrete protection and control systems encompassing:

- Standards, codes, Commonwealth/State/Territory legislation, supply authority regulations and or enterprise requirements associated with the commissioning procedures
- Requirements for the use of commissioning manuals, system diagrams/plans and drawings
- Techniques in commissioning procedures - planning and policy, testing techniques and close out requirements

T3 Design principles of Substation LV AC and DC supply systems encompassing:

- Standards, codes, Commonwealth, State/Territory/local government legislation, supply authority regulations and or enterprise requirements
- Wiring conventions, systems and labelling conventions
- Substation equipment identification and layout, wiring and schematic diagrams and other appropriate diagrammatic representations
- LV design specifications, supply requirements, electrical load assessments
- Substation LV system distribution requirements including: substation batteries,

REQUIRED SKILLS AND KNOWLEDGE

isolation requirements, paralleling requirements, battery chargers, DC distribution panels and control systems, AC distribution panels and control systems and Auto change-over requirements

- Control equipment and auxiliary relays, flags and alarms
- Common panel layouts

T4 Design principles of Substation control systems encompassing:

- Standards, codes, Commonwealth, State/Territory/local government legislation, supply authority regulations and or enterprise requirements
- Wiring conventions, systems and labelling conventions
- Substation equipment identification and layout, wiring and schematic diagrams and other appropriate diagrammatic representations
- Control system design specifications, functions and alarms
- Substation control system requirements which may include:
  - Circuit breaker control - auto reclose, pole discrepancy, anti hunting, spring charge timer over run
  - Transformer control - parallel operations, cooling control, master/slave operation, tap changer control, alarm systems
  - Reactive plant control systems - over voltage/under voltage, under frequency load shed, VAR control

T5 Commissioning procedures associated with distribution protection and control systems encompassing:

- Standards, codes, Commonwealth/State/Territory legislation, supply authority regulations and or enterprise requirements associated with the commissioning procedures
- Requirements for the use of commissioning manuals, system diagrams/plans and drawings
- Techniques in commissioning procedures - planning, policy and testing techniques
- Close out requirements

T6 Operation and maintenance procedures associated with voltage regulation schemes encompassing:

- Standards, codes, Commonwealth/State/Territory legislation, supply authority regulations and or enterprise requirements associated with the operating procedures
- Requirements for the use of operating manuals, system diagrams/plans and drawings
- Principles of operation and operating sequences including: voltage control, VAR control, Live Bus/Dead Bus synchronising checks, tap changer principles, requirements for parallel operation, settings and grading
- Techniques associated with: isolation requirements, enterprise maintenance requirements, setting checks, LV injections and electrical measurements
- Ancillary equipment which may include transducers, Buswire schemes, tap

REQUIRED SKILLS AND KNOWLEDGE

position indicators, local/remote control systems, alarm systems

- Voltage regulation scheme types including electro mechanical, micro-processor or combinations of both

T7 Types and applications of test equipment encompassing:

- Standards, codes, Commonwealth, State/Territory and local government legislation, supply authority regulations and or enterprise requirements applicable to the use and application of electrical and/or electronic test equipment
- Types and applications of test equipment used on discrete protection scheme
- Techniques in the use of test equipment - electronic test equipment (Doble and Ohmnicrome, gas injection equipment, manufactures test equipment, multimeters, phase angle meters and meggers)

T8 Electrical equipment associated with distribution field device protection and control schemes encompassing:

- Types and applications of electrical equipment - characteristics and capabilities: note examples include the following schemes, automatic circuit reclosers (ACR's), gas switches, secondary injection tests, primary injection tests, TMR Radio's, SCADA, remote control, overcurrent, earth fault, sensitive earth fault, inverse time curves, definite time curves, tripping, reclose, DC supplies, AC supplies and alarms

T9 Circuit breaker auxiliary systems encompassing:

- Types and characteristics of high pressure air systems including air storage and air handling processes
- Types and characteristics of DC systems including battery types, charging systems, protection systems
- Types and characteristics of special ambient gases (SF6) systems including gas conditioning, storage and handling systems
- Types and characteristics of vacuum interrupters
- Types and characteristics of oil filled and oil handling

T10 Detailed operation and setting of discrete protection systems encompassing:

- Earth fault protection - master earth leakage schemes, sensitive earth fault relays and schemes, residual earth fault scheme, core balance earth fault scheme, frame/structure earth leakage scheme, time graded discrimination, backup protection
- Overcurrent protection - feeder overcurrent protection, instantaneous overcurrent schemes, inverse timed overcurrent schemes, types and location of components of an overcurrent scheme, CT summation, time graded discrimination, backup protection
- Alarms and controls - auxiliary relays, voltage regulating relays, line drop compensation, gas relay types, gas relay scheme operation and setting, over temperature schemes

T11 Detailed operation of interdependent protection systems encompassing:

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- Overcurrent and earth leakage schemes including intertripping, interlocking and blocking - logic mapping, master control, elctromechanical, electronic, shading coils
- Pilot wire, phase comparison - opposed voltage schemes, circulating current schemes, location of components of a scheme, pilot supervisory techniques,
- Load shedding, voltage control, parallel operation, load rejection
- Busbar Protection and CB failure protection
- Reclose system - applications, single shot, multishot, blocking schemes, synchronisation checking

T12 Detailed operation of complex protection systems encompassing:

- Distance - characteristics, electromechanical, electronic, impedance, mho, offset mho, switched schemes, non-switched schemes, blocking schemes, bus zone
- Differential, transformer differential, bus overcurrent - principles, feeder protection, transformer protection, bias systems, harmonic restraint, CT connections, bus protection, low impedance schemes, high impedance schemes, bus overcurrent schemes, generator protection, CT connections, special considerations, digital systems
- Types of revenue metering
- Applications of SCADA
- Complex protection systems for communications
- Harmonic control
- Point on wave switching

T13 Detailed operation of fundamental test equipment encompassing:

- Care and safe use
- Operating principles
- Comparison of different operating principle meters used for the same purpose
- Accuracy and loading effects of meters - measurement of voltage, current, power, resistance, insulation resistance, impedance and phase sequence and the use of oscilloscopes

T14 Detailed operation of protection test equipment encompassing:

- Care and safe use
- Operating principles
- Comparison of different operating principle meters used for the same purpose
- Accuracy and loading effects of meters - measurement of timing, voltage, current, resistance, inductance, capacitance, impedance, frequency, phase angle, phase difference and the use of primary, secondary and gas injection equipment

T15 Detailed operation of control equipment test equipment encompassing:

- Care and safe use
- Operating principles
- Comparing of different control system methods and equipment for the same

REQUIRED SKILLS AND KNOWLEDGE

purpose - circuit breaker, isolators, On Load Tap Changer, pumps, fans, fire systems,

T16 Protection schemes encompassing:

- Standards, codes, legislation, supply authority regulations and or enterprise requirements applicable to protection schemes
- Types of protection schemes encompassing reasons for use, application of protection zones around system elements and degree of protection
- Types of feeder protection equipment - over current protection inverse time-current operating characteristics
- Operation of over current protection equipment used on distribution systems
- Operation of ACRs and their time-current characteristics
- Types and characteristics of over-current relays
- Coordination methods of a distribution feeder protection scheme
- Earth fault protection used on a distribution feeder
- Operation of a single wire earth return (S.W.E.R) system

T17 Principles of transmission, sub-transmission and zone substation control and protection designs encompassing:

- Commonwealth, State/Territory and local government legislation, Standards, codes, supply authority regulations and or enterprise requirements applicable to the substation design management principles
- Requirements for the use of the 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 drawings to be produced - AC and DC circuit diagrams, panel layouts, connection diagrams, label lists and control cable schedules
- Types of control and protection designs parameters - protection and control systems implemented to suit statutory and organisational requirements, AC and DC circuit diagrams correct and documented
- SCADA hardwired and serially communicated signals, metering, load control, power factor control, AC and DC supplies, protection and control panel layouts and control cable termination diagrams

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 is based, 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 two (2) compliant technical designs including each of the following:	Protection and control systems implemented to suit statutory and organisational requirements. AC and DC circuit diagrams correct and documented. SCADA hardwired and serially communicated signals. Metering. Load control. Power factor control. AC and DC supplies. Protection and control panel layouts. Control cable termination diagrams.
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.

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 transmission, sub-transmission and zone substation protection and control systems.

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 concurrent assessments with this unit, however in some cases efficiencies may be gained in terms of learning and assessment effort being concurrently managed.

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 transmission, sub-transmission and zone substation protection and control systems and may include the following:
Manufacturer's recommendations; Reliability performance profiles; Knowledge of local history and experience; Consultation with other Authorities; Environmental influences; Present practices.
Equipment includes; Sectionalisers, air break switches, capacitor banks, transformer taps, metering and protection equipment, data communication systems
Primary and secondary voltage and current injection equipment; time delay measuring equipment; Current transformers; Voltage transformers; Power transformers; Tapchangers; Circuit breakers; Capacitor banks; Ring main units; Audio frequency load control; Circuit breaker auxiliary systems; Substation and metal structure earthing systems; SCADA interfaces and transducer inputs; local opto-isolated alarms: PLC programs; Auto Reclosers (ACRs); protection relays; metering; control circuits; Statistical metering systems; Frame leakage relays; Distance relays; Pilot wire relays; Transformer differential relays; Busbar differential relays; Impedance bus zone relays; Overcurrent and earth fault relays; Transformer neutral check relays; Circuit breaker fail relays; Multi-trip relays; Auto recloser relays; Voltage transformer failure relays; Surge protection relays; Buchholz relays; Winding temperature relays; Sensitive earth fault relays; Phase failure relays; Frequency relays; Load shedding relays; General protection LV devices; Oil temperature protection devices; Oil surge protection devices; Power supplies. differential relays; power systems; multi-facetted schemes; interactive overload schemes, distance protection (incorporating relay selection, switched/non-switched schemes; mutual coupling and teed feeder systems); protection signalling (incorporating series, direct, permissive, distance acceleration, block interruption); telecommunication circuits and equipment.
AC protection circuits: HV FDRs, TFRs, BBP/LBU, LV FDRs
DC protection and control circuits: Supplies and auxiliaries, protection, BBP, trip circuit monitoring, CB monitoring, serially communicated SCADA, control and indication
Hard wire communicated SCADA
TFR tap changer and cooling control circuits
Power factor correction capacitor protection/control
AC Supplies (400/230 V AC)
DC Supplies (125/48 V DC)
Indication lighting timer circuit
Miscellaneous circuits may include: Metering, frequency injection, radio/communication, intertripping, frame leakage and SMU control
Connection diagrams may include: Control panels, HV circuit breakers, LV circuit breakers, Line and TFR CT's, TFR neutral CT's, Line VT's, TFR's, disconnectors, battery chargers, fire control panel, power factor and control caps.

RANGE STATEMENT

Other areas may include: Control panel layouts, control cable schedule and label list. 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
- Personnel.
- Quality assurance systems.
- Requirements.
- Safe design principles
- Testing procedures
- Work clearance systems

Unit Sector(s)

Not applicable.

Competency Field

Competency Field **11)**

Design