



Australian Government

UETTDRDS54 Design power system transmission and sub-transmission protection and control

Release: 1

UETTDRDS54 Design power system transmission and sub-transmission protection and control

Modification History

Release 1. This is the first release of this unit of competency in the UET Transmission, Distribution and Rail Sector Training Package.

Application

This unit covers the design of transmission, sub-transmission and zone substation protection and control systems. It includes basic secondary upgrades, supervisory control and data acquisition (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.

The application of the skills and knowledge described in this unit may require a licence/registration to practice in the workplace subject to regulations for undertaking of electrical work.

Other conditions may apply under state and territory legislative and regulatory licencing requirements which must be confirmed prior to commencing this unit.

Pre-requisite Unit

Common Unit Group

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 low voltage a.c. circuits

UETTDRDS39 Prepare and manage detailed construction plans for electrical power system infrastructure

UETTDRDS44 Design power system substations modifications

UETTDRREL11 Apply sustainable energy and environmental procedures

UETTDRREL16 Working safely near live electrical apparatus

UETTDRIS62 Implement and monitor the power system organisational WHS/OHS policies, procedures and programs

UETTDRIS63 Implement & monitor power system environmental & sustainable energy management policies & procedures

Competency Field

Design

Unit Sector

Not applicable.

Elements and Performance Criteria

ELEMENTS

Elements describe the essential outcomes.

1 Plan for and coordinate the design of transmission, sub-transmission and zone substation protection and control systems

PERFORMANCE CRITERIA

Performance criteria describe the performance needed to demonstrate achievement of the element.

- 1.1** Work health and safety (WHS)/occupational health and safety (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 appropriate personnel
- 1.3** Established policies, procedures and specifications for the design are obtained or established with appropriate personnel
- 1.4** Equipment/tools and personal protective equipment (PPE) 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 PPE, required for the job are identified, scheduled and

- coordinated and confirmed safe and in 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
- 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 in accordance with established procedures
- 2.2** WHS/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 in accordance with 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 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 it complies with all requirements and includes 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

Foundation Skills

Foundation skills essential to performance are explicit in the performance criteria of this unit of competency.

Range of Conditions

Range is restricted to essential operating conditions and any other variables essential to the work environment.

Non-essential conditions may be found in the Companion Volume Implementation Guide.

Unit Mapping Information

This unit replaces and is equivalent to UETTD RDS54A Design power system transmission and sub-transmission protection and control.

Links

UET Training Package Companion Volume Implementation Guide is found in VETNet - <https://vetnet.gov.au/Pages/TrainingDocs.aspx?q=229bace1-b7bc-4653-9300-dffb13ecfad7>

Assessment Requirements for UETTDRDS54 Design power system transmission and sub-transmission protection and control

Modification History

Release 1. This is the first release of this unit of competency in the UET Transmission, Distribution and Rail Sector Training Package.

Performance Evidence

Evidence required to demonstrate competence in this unit must be relevant to and satisfy all of the requirements of the elements and performance criteria on at least two separate occasions and include:

- applying relevant work health and safety (WHS)/occupational health and safety (OHS) requirements, including the use of risk control measures
- applying sustainable energy principles and practices
- completing two (2) compliant technical designs, including each of the following:
 - protection and control systems implemented to suit statutory and organisational requirements
 - alternating current (a.c.) and direct current (d.c.) circuit diagrams
 - supervisory control and data acquisition (SCADA) hardwired and serially communicated signals
 - metering
 - load control
 - power factor control
 - a.c. and d.c. supplies
 - protection and control panel layouts
 - control cable termination diagrams
- completing designs, including 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
- dealing with unplanned events on at least one (1) occasion.

Knowledge Evidence

Evidence required to demonstrate competence in this unit must be relevant to and satisfy all of the requirements of the elements and performance criteria and include knowledge of:

- 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 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 RAT, dial up annunciated system and local control station
- 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
- design principles of substation low voltage (LV) a.c. and d.c. 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 and electrical load assessments
 - substation LV system distribution requirements - substation batteries, isolation requirements, paralleling requirements, battery chargers, d.c. distribution panels and control systems, a.c. distribution panels and control systems and auto change-over requirements
 - control equipment and auxiliary relays, flags and alarms
 - common panel layouts
- 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, such as:
 - circuit breaker control - auto reclose, pole discrepancy, anti-hunting and spring charge timer over run
 - transformer control - parallel operations, cooling control, master/slave operation, tap changer control and alarm systems
 - reactive plant control systems - over voltage/under voltage, under frequency load shed

and VAR control

- 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
- 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 - voltage control, VAR control, live bus/dead bus synchronising checks, tap changer (TC) 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, such as:
 - transducers, buswire schemes, tap position indicators, local/remote control systems and alarm systems
 - voltage regulation scheme types, including electro mechanical, micro-processor or combinations of both
- 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 Ohmmicrome, gas injection equipment, manufacturer test equipment, multimeters, phase angle meters and meggers)
- electrical equipment associated with distribution field device protection and control schemes encompassing:
 - types and applications of electrical equipment - characteristics and capabilities, such as:
 - schemes, automatic circuit reclosers (ACRs), gas switches, secondary injection tests, primary injection tests, TMR radios, SCADA, remote control, overcurrent, earth fault, sensitive earth fault, inverse time curves, definite time curves, tripping, reclose, DC supplies, AC supplies and alarms
- circuit breaker auxiliary systems encompassing:
 - types and characteristics of high pressure air systems - air storage and air handling processes
 - types and characteristics of DC systems - battery types, charging systems and protection systems

- types and characteristics of special ambient gases (SF6) systems - gas conditioning, storage and handling systems
- types and characteristics of vacuum interrupters
- types and characteristics of oil filled and oil handling
- 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 and 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 and backup protection
 - alarms and controls - auxiliary relays, voltage regulating relays, line drop compensation, gas relay types, gas relay scheme operation and setting, and over temperature schemes
- detailed operation of interdependent protection systems encompassing:
 - overcurrent and earth leakage schemes - intertripping, interlocking and blocking - logic mapping, master control, electromechanical, electronic and shading coils
 - pilot wire, phase comparison - opposed voltage schemes, circulating current schemes, location of components of a scheme and pilot supervisory techniques
 - load shedding, voltage control, parallel operation and load rejection
 - busbar protection and CB failure protection
 - reclose system - applications, single shot, multi-shot, blocking schemes and synchronisation checking
- detailed operation of complex protection systems encompassing:
 - distance - characteristics, electromechanical, electronic, impedance, mho, offset mho, switched schemes, non-switched schemes, blocking schemes and 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 and digital systems
 - types of revenue metering
 - applications of SCADA
 - complex protection systems for communications
 - harmonic control
 - point on wave switching
- 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
- 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
- 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 purpose - circuit breaker, isolators, OLTC, pumps, fans and fire systems
- 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 - overcurrent 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 overcurrent relays
 - coordination methods of a distribution feeder protection scheme
 - earth fault protection used on a distribution feeder
 - operation of a single wire earth return (SWER) system
- 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 WHS/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.

Assessment Conditions

Assessors must hold credentials specified within the Standards for Registered Training Organisations current at the time of assessment.

Assessment must satisfy the Principles of Assessment and Rules of Evidence and all regulatory requirements included within the Standards for Registered Training Organisations current at the time of assessment.

Assessment must occur in workplace operational situations where it is appropriate to do so; where this is not appropriate, assessment must occur in simulated conditions involving realistic and authentic activities that replicate operational workplace conditions.

Assessment processes and techniques must be appropriate to the language, literacy and numeracy requirements of the work being performed and the needs of the candidate.

Resources for assessment must include access to:

- a range of relevant exercises, case studies and/or other simulations
- relevant and appropriate materials, tools, facilities, equipment and personal protective equipment (PPE) currently used in industry to undertake design of transmission, sub-transmission and zone substation protection and control systems
- applicable documentation, including workplace procedures, relevant industry standards, equipment specifications, regulations, codes of practice and operation manuals.

Links

UET Training Package Companion Volume Implementation Guide is found in VETNet - <https://vetnet.gov.au/Pages/TrainingDocs.aspx?q=229bace1-b7bc-4653-9300-dffb13ecfad7>