



Australian Government

UETTDRTS21 Maintain interdependent network protection and control systems

Release: 1

UETTDRTS21 Maintain interdependent network protection and control systems

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 maintenance of network protection and control in interdependent situations and includes isolation, inspection, monitoring, testing, adjustment, and repair, refurbishment and/or overhaul and functional checks of interdependent network protection and control systems. It includes the requirements to prove the functionality of interdependent and discrete schemes, such as circuit breaker fail, master controlled earth fault, inter-tripping, blocking, synchronising, pilot wire, phase comparison, load shedding, voltage control, parallel operation and load rejection.

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

UEENEE104A Use engineering applications software on personal computers

UEENEE101A Apply Occupational Health and Safety regulations, codes and practices in the workplace

UEENEE102A Fabricate, assemble and dismantle utilities industry components

UEENEE104A Solve problems in d.c. circuits

UEENEE107A Use drawings, diagrams, schedules, standards, codes and specifications

UEENEE124A Compile and produce an energy sector detailed report

UEENEE125A Provide engineering solutions for problems in complex multiple path circuits

UEENEE126A Provide solutions to basic engineering computational problems

UEENEE101A Solve problems in electromagnetic devices and related circuits

UEENEE102A Solve problems in low voltage a.c. circuits

UEENEE149A Provide engineering solutions to problems in complex polyphase power circuits

UETTDREL11 Apply sustainable energy and environmental procedures

UETTDREL16 Working safely near live electrical apparatus

UETTDRI62 Implement and monitor the power system organisational WHS/OHS policies, procedures and programs

UETTDRI63 Implement & monitor power system environmental & sustainable energy management policies & procedures

UETTDRTS29 Develop power systems secondary isolation instructional documents

Competency Field

Testing

Unit Sector

Not applicable.

Elements and Performance Criteria

ELEMENTS

Elements describe the essential outcomes.

1 Plan for the maintenance of network protection and control systems (interdependent)

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 maintenance of network protection and control systems (interdependent), are reviewed and determined
- 1.2** Purpose of the maintenance of network protection and control systems (interdependent) is established after data is analysed and expected outcomes of the work are confirmed with appropriate personnel
- 1.3** Organisational established procedures on policies and specifications for the maintenance of network protection and control systems (interdependent) are obtained or established with appropriate personnel
- 1.4** Testing procedures are discussed with/directed to appropriate personnel in order to ascertain the project brief
- 1.5** Testing parameters are established from organisational

- established procedures on policies and specifications
- 1.6** Equipment/tools and personal protective equipment (PPE) are selected based on specified performance criteria and established procedures
 - 1.7** Work roles and tasks are allocated according to requirements and individual competencies
 - 1.8** Work is prioritised and sequenced for the most efficient/effective outcome, completed within an acceptable timeframe, to a quality standard and in accordance with established procedures
 - 1.9** Liaison and communication issues with others/authorised personnel, authorities, clients and land owners are resolved and activities coordinated to carry out work
 - 1.10** Risk control measures are identified, prioritised and evaluated against the work schedule
 - 1.11** Relevant work permits are secured to coordinate the performance of work according to requirements and/or established procedures
- 2 Carry out the maintenance of network protection and control systems (interdependent)**
- 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 incidents of accidents and minimise waste are incorporated into the project in accordance with requirements and/or established procedures
 - 2.3** Maintenance of network protection and control systems (interdependent) decisions are made on the basis of safety and effective outcomes according to requirements and/or established procedures
 - 2.4** Mathematical and/or engineering models of the scheme 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** Testing of network protection and control systems (interdependent) is undertaken according to requirements and established procedures
- 2.8** Work teams/groups are arranged/coordinated/evaluated to ensure planned goals are met according to established procedures
- 2.9** Solutions to non-routine problems are identified and actioned, using acquired essential knowledge and associated skills, according to requirements
- 2.10** Quality of work is monitored against personal performance agreement and/or established organisational and professional standards
- 2.11** Strategic plans are developed incorporating organisation initiatives in accordance with established procedures

3 Complete the maintenance of network protection and control systems (interdependent)

- 3.1** Final inspections of the network protection and control systems (interdependent) are undertaken to ensure they comply with all requirements and include all specifications and documentations needed to complete the project
- 3.2** Appropriate personnel are notified of completion and reports and/or completion documents are finalised/commissioned
- 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 the maintenance of network protection and control systems (interdependent) 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 UETTDRTS21A Maintain interdependent network protection and control systems.

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 UETTDRTS21 Maintain interdependent network protection and control systems

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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) requirement, including the use of risk control measures
- applying sustainable energy principles and practices
- demonstrating five (5) times, each of the following activities:
 - isolating protection, control and alarms associated with interdependent protection and control schemes
 - carrying out function tests (trips and alarms) on interdependent protection and control schemes
 - writing reports on performance of interdependent protection and control schemes
 - isolating 'in service' current transformers
- 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:

- 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 (HV)
 - particular reference to state and territory regulations regarding - working near energised conductors, electrical access, heights, confined space, testing procedures and licensing rules
- electrical equipment associated with protection and control schemes encompassing:
 - types and applications of electrical equipment – characteristics, capabilities (schemes: overcurrent, frame leakage, cooling, buchholz, direct current (d.c.) supplies, restricted earth, sensitive earth fault, circuit breaker fail, reclose, d.c. frame leakage, CEL fail, under frequency load shed and earth fault)
- principles of isolation and tagging procedures associated with protection testing

encompassing:

- standards, codes, Commonwealth/state/territory legislation, supply authority regulations and/or enterprise requirements associated with the installation, maintenance, isolation and tagging procedures
- requirements for the use of isolation and tagging, manuals, system diagrams/plans and drawings
- techniques in documenting isolations
- techniques in appropriate isolation and tagging procedures in accordance with Commonwealth/state/territory legislation, supply authority regulations and enterprise standards
- techniques in the installation and maintenance procedures protection devices in accordance with Commonwealth/state/territory legislation, supply authority regulations and enterprise standards
- maintenance and commissioning procedures associated with discrete protection schemes encompassing:
 - standards, codes, Commonwealth/state/territory legislation, supply authority regulations and/or enterprise requirements associated with the maintenance and commissioning procedures
 - requirements for the use of maintenance and commissioning manuals, system diagrams/plans and drawings
 - techniques in maintenance and commissioning procedures – planning, policy and testing techniques
 - close out requirements
- relay manufacturer specifications encompassing:
 - standards, codes, Commonwealth/state/territory and local government legislation, supply authority regulations and/or enterprise requirements applicable to the use and application of relay manufacturer specifications
 - requirements for the use of relay manufacturer manuals, system diagrams/plans and drawings
 - types, function and characteristics of specific relays - differences between specific relays used for the same functionality
- safe handling and/or disposing of insulation materials used in power distribution devices, which are potential environmental pollutants encompassing:
 - standards, codes, Commonwealth/state/territory and local government legislation, supply authority regulations and/or enterprise requirements applicable to the handling and disposing of insulation or heat dissipation materials used in power distribution devices
 - identification of environmental issues associated with the handling and disposing of insulation materials
 - safety precautions when handling and disposing of heat dissipation materials - safe working practices; WHS/OHS hazards and precautions; identification of hazards; assessing and controlling risks; types, selection, maintenance and uses of personnel protective equipment (PPE); permit to work systems and isolation procedures; types and function of specialised equipment; safe working practices when using specialised equipment; and emergency response and rescue, including first aid

- techniques in the handling and disposing of insulation materials - polychlorinated bi-phenyls (PCB's), asbestos, insulating oil and sulfur hexafluoride (SF6) gas
- procedures to undertake a visual inspection of a scheme encompassing:
 - standards, codes, Commonwealth/state/territory legislation, supply authority regulations and/or enterprise requirements associated with visual inspection procedures of a scheme
 - requirements for the use of manuals, system diagrams/plans and drawings
 - identifying obvious deficiencies in operating to the standard functionality
 - techniques in determining relay malfunction - targeting
 - techniques in determining wiring defects
- operation and maintenance procedures associated with discrete protection and control systems encompassing:
 - standards, codes, Commonwealth/state/territory legislation, supply authority regulations and/or enterprise requirements associated with operating procedures
 - requirements for the use of operating manuals, system diagrams/plans and drawings
 - techniques - gas collection and analysis, bleeding and resetting, calibration, operational and sensitivity checks, and trip and alarm checks
 - surge relay types and uses, including transformer main tanks and diverter switch chambers
- measurements and the interpretation and analysis of those measurements related to the plant and/or equipment type encompassing:
 - type of measurements - timing, current, voltage, capacitance, inductance, impedance, phase angle, phase shift, resistance, dielectric dissipation factor, frequency, polarisation index, ratio, vector group and temperature
 - interpretation and analysis the use of techniques - digital comparison of data, extrapolation, use of graphs and charts, statistics and tables, mathematical calculation of expected values and comparison with manufacturers data and measurements
 - techniques in the processes involved in follow-up actions and recommendations resulting from analysis and interpretation of results and measurements
- infra-red imaging principles encompassing:
 - standards, codes, legislation, supply authority regulations and/or enterprise requirements applicable to Infrared Imaging
 - requirements for the use of manuals, substation diagrams/plans and drawings
 - types of enterprise-specific computer software
 - techniques in storing and retrieving data and reports from the computer
 - use, characteristics and capabilities of specialised tools and equipment
 - enterprise-specific policies and procedures for infra-red imaging reporting
 - techniques in evaluating serviceability of circuit breaker operation
 - procedures for obtaining correct HV switchyard arrangements - identification of hazards and controlling risks, safety procedures and precautions, responsibilities and protocols, and identifying switching resources
 - safety precautions when testing and measuring equipment with infra-red imaging - safe working practices and procedures; identification of hazards; assessment and control of WHS/OHS risks; types, selection, maintenance and use of PPE; responsibilities and

protocols

- 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 principles, requirements for parallel operations, settings and grading
 - techniques associated with isolation requirements, enterprise maintenance requirements, setting checks, low voltage (LV) injections and electrical measurements
 - ancillary equipment - transducers, buswire schemes, tap position indicators, local/remote control systems and alarm systems
 - voltage regulation scheme types - electromechanical, 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 Ohmicrome), 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, capabilities (schemes: automatic circuit reclosers (ACR), gas switches, secondary injection tests, primary injection tests, trunked mobile radio (TMR), supervisory control and data acquisition (SCADA), remote control, overcurrent, earth fault, sensitive earth fault, inverse time curves, definite time curves, tripping, reclose, direct current (d.c) supplies, and alternating current (a.c.) supplies and alarms)
- circuit breaker auxiliary systems encompassing:
 - types and characteristics of high-pressure air systems, including air storage and air handling processes
 - types and characteristics of d.c. systems, including battery types, charging systems and protection systems

- types and characteristics of special ambient gas (SF6) systems, including 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, including inter-tripping, interlocking and blocking - logic mapping, master control, electromechanical, electronic and shading coils
 - pilot wire and 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 circuit breaker failure protection
 - reclose systems - applications, single shot, multi-shot, blocking schemes and synchronisation checking
- procedures for the location and rectification of faults in electrical equipment up to 1000 volts a.c. and or 1500 volts d.c. encompassing:
 - relationship of WHS/OHS to the location and rectification of faults in electrical equipment - acts and regulations, identification of personal safety, workplace hazards, working with electrically operated tools and equipment, emergency first aid/resuscitation, rescue from a live electrical situation, and enterprise policies and procedures
 - types of drawings - differentiation between symptoms, faults and causes in malfunctioning equipment, fault-finding techniques and procedures
 - fundamental electrical concepts - effects of current; practical resistors; sources of electromagnetic field; series, parallel and series-parallel circuits; electrical measurement; capacitors; inductors and magnetism
 - fundamentals of general appliances - basic principles of appliances (non-mathematical), appliance identification, appliance ratings, basic principles of operation of control equipment and protection devices, fault conditions and symptoms, safe isolation procedures, test equipment, safe testing procedures, including continuity, fault types in appliances and fault-finding procedures (prescriptive)
 - fundamentals of single phase induction motors - basic principles of operation (non-mathematical); motor identification; motor ratings; basic principles of operation of control equipment and protection devices; fault conditions and symptoms; safe isolation procedures; test equipment; safe testing procedures, including continuity; fault types in phase splitting and universal type motors; and fault-finding procedures (prescriptive)
 - fundamentals of three phase induction motors - basic principles of operation

- (non-mathematical), motor identification, motor ratings, motor starter principles, basic principles of operation of control equipment and protection devices, fault conditions and symptoms, safe isolation procedures, safe testing procedures and fault-finding procedures (prescriptive)
- fundamentals of single and three phase electrical heaters - basic principles of operation, types of electrical heaters, electrical heater identification, electrical heater ratings, basic principles of operation of control and protection devices, fault conditions and symptoms, safe testing procedures and fault-finding procedures (prescriptive)
 - disconnection and reconnection procedures for fixed wiring electrical equipment up to 1000 volts a.c. and or 1500 volts d.c. encompassing:
 - safe electrical work practices and procedures according to standards such as AS/NZ 4836:2001 Safe working on or near low-voltage electrical installations and equipment, or equivalent
 - safe use of tools and plant
 - safe use of ladders and elevated work platforms (EWP)
 - safe use of PPE
 - hazards in the (electrical) work environment - shock hazards, fire hazards, chemical hazards and other hazardous areas
 - special situations
 - procedures for dealing with fires associated with electrical equipment
 - procedures for dealing with PCBs
 - electric shock victim rescue methods and procedures - basic first aid treatment for shock, burns and bleeding
 - purpose of each procedure and application - expired air resuscitation (EAR), external cardiac-compression (ECC), cardiopulmonary resuscitation (CPR), combined application of EAR and ECC (purpose of each procedure and application)
 - components of a basic electrical circuit(s) – source, control, protection and load
 - types of circuit diagrams – symbols, conventions, interpretations and free sketches
 - types of circuit connections and functions - open circuit, closed circuit and short circuit
 - techniques in basic electrical measurement - use of multimeters; use of ammeter; use of voltage measuring and indicating devices; testing of measuring instruments; care of measuring instruments; voltage, current and resistance measurement; estimating values of voltage, current and resistance; and using Ohms law
 - fundamental principles of electrical concepts - effects of current; practical resistors; sources of electromagnetic field; simple practical circuit; series, parallel and series-parallel circuits; electrical measurement; capacitors; inductors and magnetism
 - techniques in insulation resistance measurement and requirements
 - earthing principles and systems
 - disconnection and reconnection procedures for fixed wiring electrical equipment up to 1000 volts a.c. and or 1500 volts d.c. encompassing:
 - methods for testing insulation resistance - continuity of prospective earthing conductor, continuity between exposed conductive parts and the earthing system
 - methods of recognising acceptable test results for compliance with safety requirements

- methods of recognising unacceptable test results requiring an appropriate qualified person for further investigation
- cable types and conductor termination methods and techniques - conductors solid, stranded and flexible, and colour codes
- single and three phase systems and loads - number of active and live conductors required, line and phase voltage, and typical loads
- identification and rating of general appliances
- single phase induction motors - motor identification, motor ratings and direction of rotation
- three phase induction motors - motor identification, motor ratings and direction of rotation
- single and three phase heaters - types of heaters, heater identification and heater ratings
- electrical distribution arrangement - power systems within premises, purpose of switchboards/distribution boards (residual current devices and EL circuit breakers)
- circuit isolation and protection devices
- isolation procedures - work clearance, testing for voltage, lock-off and tagging, techniques in isolation and tagging, regulation, codes of practice and procedures
- disconnection procedures, practices and requirements
- types of replacement equipment
- methods of ensuring equipment is safe to connect to supply
- methods of reconnection procedures, practices and requirements
- methods of return equipment to service
- effects of harmonics encompassing:
 - characteristics and effects of harmonics on protection device functions/malfunction
 - effects of harmonics on transformers, generators, motors and quality of supply.

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 PPE currently used in

industry

- applicable documentation, including workplace procedures, relevant industry standards, equipment specifications, regulations, codes of practice and operation manuals
- working at realistic heights above ground i.e. above 3 metres, in limited spaces, with different structural/construction types and methods and in a variety of environments.

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