



Australian Government

Assessment Requirements for UETTDRTS24 Design testing and commissioning procedures for field devices and substations

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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
- developing testing and commission procedures for at least three (3) of the following substation equipment:
 - bus protection
 - feeder/line protection
 - transformer protection
 - earth fault protection
 - backup protection
 - metering schemes
 - communication and supervisory control and data acquisition (SCADA) schemes
- developing testing and commissioning procedures for at least two (2) of the following field devices:
 - regulators
 - automatic circuit reclosers (ACR)/gas switch
 - line capacitors
- 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:

- powerline safety practices encompassing:
 - protective apparatus and apparel for linework - responsibilities for the selection, use, maintenance and storage of protective apparatus and apparel and the types of protective apparatus and apparel used for the line worker

- requirements for the use of ladders - carrying, erecting, collapsing and lowering different types of extension ladder against a standing pole; maintenance checks on different types of ladders; renewal of extension ropes and the safety issues relating to clearances from overhead conductors
- requirements for climbing and working aloft - methods used to identify a pole is safe to climb; methods used to inspect a line worker's body belt; application of knots and hitches appropriate to the requirements of a line worker; height safety principles, including personal fall protection, prevention and related requirements; and the practical procedures of climbing an overhead structure and fitting a pole chair
- traffic management - purpose of traffic management and a line worker's responsibilities in accordance with relevant statutory requirements and electricity supply industry (ESI) requirements, procedures used to provide an effective traffic management scheme and the use of a two-way radio
- control of small fires - identification, selection and operation of the appropriate extinguishing mediums for various types of fires; general fire prevention methods and the precautions for personal protection when fighting small fires
- rescue victims from heights and confined spaces - planning and identifying procedures; establishing responses; developing techniques; involvement of external emergency services; and practical demonstration/rehearsals of rescuing a person from heights and from confined spaces and emergency procedures for the rescue of an electric shock victim, including cardiopulmonary resuscitation (CPR)
- requirements for aerial linework - planning, establishing and implementing relevant aviation authority clearances, determining system requirements, aircrew familiarisation with network operations and equipment, and requirements for effective communications operations for aerial work
- 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 - 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 for 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 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
- procedure 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 manufacturer data and measurements
- techniques in the processes involved in follow-up actions and recommendations resulting from analysis and interpretation of results and measurements
- 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 (EWP) and any WHS/OHS requirements associated with the use of EWP
 - control of small fires - 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 - identification, use and maintenance of spill oil control equipment and materials; and oil containment facilities and systems
 - rescue and release procedures - the rescue personnel from energised conductors, emergency descent from an EWP and/or 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, and dangers of near approach to energised conductors
- design principles of HV insulation systems encompassing:
 - insulation design principles - common materials used, electrical characteristics, thermal characteristics, uses and applications to substation HV plant and equipment, grading, construction and cooling
 - common contaminants and their effects - internal contaminants and external 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 HV insulation systems - safe working practices and procedures; identification of hazards; assessment and control of WHS/OHS risks; types, selection, maintenance and use of personal protective equipment (PPE)

- principles of power transformer construction and operations encompassing:
 - transformer types - shell, core, auto, double wound, three phase, single phase and combinations of these types, step up and step down transformers, transmission and generation types
 - reactor types - shunt and series, applications and design considerations
 - iron circuit characteristics - steel types, losses and techniques used to eliminate excess eddy currents and other circulating currents
 - winding configurations and construction techniques - helical, spiral, disc and interleaved disc types
 - insulation methods and techniques - fully insulated windings and graded insulation techniques, oil filled and gas filled power transformers
 - transformer and reactor ratings, losses and efficiency - equivalent circuits and vector relationships, and impedance percent
 - nameplate details - BIL, tapping winding detail, physical layout, cooling ratings and physical details
 - transformer and reactor cooling types and their effects on design and rating
 - transformer and reactor auxiliaries - temperature indicators, over pressure devices and control systems
 - winding configurations - star-star, star-delta, star-zigzag, nomenclature and common methods of diagrammatic representation of winding configuration
 - operating constraints as single units and in parallel
 - tapping windings - placement issues, tapping range, on-load tap changer (OLTC) versus off load tap changer techniques, types in use (high speed resistor, reactor and vacuum types, Jansen mechanisms, dead tank and live tank types) and control system characteristics
 - HV bushing selection – type, insulation system used, rating, BIL, selection criteria and testing considerations
- principles of power transformer construction and operations encompassing:
 - applications of static reactive plant in HV networks, including voltage control, VAR control and transient response capacity
 - types of static reactive plant, including HV capacitors, HV reactors, static VAR compensators (SVC) and combinations of these
 - operating characteristics and operational constraints, including point on wave switching issues
 - ratings, cooling systems and control systems and ancillary equipment used
 - configurations and system layout, including single star, double star and bridge type
 - typical protection systems used, including neutral unbalance current and neutral unbalance voltage
 - techniques used when balancing elements within static reactive plant
 - safety precautions when testing and maintaining HV static reactive plant - safe working practices and procedures; identification of hazards; assessment and control of WHS/OHS risks; types, selection, maintenance and use of PPE
- principles of power transformer high speed OLTC encompassing:

- selector types and applications for HV power transformers
- diverter switch types and applications for HV power transformers, including live tank, dead tank, resistor type, reactor type, vacuum type, pennant flag and pennant cycle
- ratings and construction principles
- operating mechanism types, stored energy systems and associated control systems
- operating principles and operating sequences of selectors and diverters
- measurement requirements, including contacts, differential wear, transition resistors and transient protection devices, rotation lag, out of sequence controls and end-of-life unit and component assessment
- online diagnostic tools and devices
- ancillary equipment, including online filters, over pressure relays and devices
- testing requirements, including cycle timing, differential delay, energy accumulator mechanical and operational tests and control system functional tests
- safety precautions when testing and maintaining HV power transformer OLTC - safe working practices and procedures; identification of hazards; assessment and control of WHS/OHS risks; types, selection, maintenance and use of PPE
- 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, including transducers, buswire schemes, tap position indicators, local/remote control systems and alarm systems
 - voltage regulation scheme types, including 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 Ohmmicrome), gas injection equipment, manufacturer test equipment, multimeters, phase angle meters and meggers
- voltage control techniques encompassing:
 - conditions leading to voltage collapse
 - effects on system of HV and LV
 - voltage control devices - voltage regulators applied to generators and synchronous phase modifiers, electromagnetic voltage regulators; series and parallel capacitors; OLTC

- transformers; and SVC, such as saturated reactor compensators, thyristor controlled reactor compensators and combined systems
- production of harmonics and methods of harmonic control
- location of voltage control devices within the system
- transient over voltages encompassing:
 - causes and effects of transient over voltages - switching transients and lightning transients, and effects on plant items
 - control techniques and systems - surge diverters, shield wires and circuit breaker arc control
 - insulation systems - insulation systems, insulation coordination and insulation grading
- procedure 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 device malfunction
 - techniques in determining wiring defects
- commissioning procedures associated with relevant equipment 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, testing techniques and close out requirements
- 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, 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
- detailed operation of metering devices and principles encompassing:

- common circuit configurations
- meters and measurement principles
- instrument transformer application
- testing of metering systems and devices
- implications of market operation
- 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 metering 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 - measurements of, voltage, current, power, reactive power, phase angle, resistance, inductance, capacitance, impedance, frequency, harmonics and the use of transient and data logging devices
- detailed operation of field device 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 - measurements of voltage, current, power, reactive power, phase angle, resistance, inductance, capacitance, impedance, frequency, harmonics and the use of transient and data logging devices
- procedure for the systematic fault isolation through the application of diagnostic techniques encompassing:
 - principles of analytical questioning
 - techniques in drawing valid conclusions from first observations
 - concepts of broad first-line testing
 - consideration of/responsibility for avoidance of further damage
 - interpretation of specific test results - cause/effect
 - techniques for isolation to appropriate level - half-split, module/function isolation (kernel

technique), substitution, diagnostic software, requirements for the use of manuals, system diagrams/plans, drawings, handbooks, specifications and fault pathways

- software/firmware functions awareness
- factors affecting field versus workshop repair costs
- scheduling minor/major repair activities and downtime
- implications of temporary repairs
- use of system knowledge and history
- data interpretation - expected versus actual
- feedback to design/production/installation processes
- subsystems and system structures
- system signals/status indicators
- known failure modes and trends
- action threshold warnings versus catastrophic failure
- component ratings/upgrades
- disassembly/reassembly techniques and care
- relative costs of repair and replacement - remaining life, ongoing maintenance, additional benefits of replacement equipment, e.g. improved productivity and quality.

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, equipment and PPE currently used in industry
- applicable documentation, including workplace procedures, 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>