



Australian Government

**Assessment Requirements for
UETTDRDS53 Design power system
transmission and sub-transmission
substation primary plant**

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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
- completing two (2) compliant technical designs, including each of the following:
 - electrical equipment in accordance with the single line diagram
 - bay spacing, busbar heights, statutory and maintenance clearances in accordance with AS 2067:2016 Substations and high voltage installations exceeding kV a.c. and organisational requirements
 - switchyard equipment layout
 - lightning protection
 - control and power cables routes within and outside switchyard
- 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:

- materials properties encompassing:
 - identification and classification of engineering materials material properties
 - types and applications - properties of tensile strength; effects of temperature on the expansion of metals; ductility, malleability, work hardening and annealing and the conditions that lead to corrosion and the properties of timbers

- 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 - basic impulse insulation (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 and on-load tap changer (OLTC) versus off load tap changer (TC) techniques - high speed resistor, reactor and vacuum types, Jansen mechanisms, dead tank and live tank types
 - control system characteristics
 - high voltage (HV) bushing selection - 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 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 and types; selection, maintenance and use of personal protective equipment (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 and assessment; control of WHS/OHS risks and types; selection, maintenance and use of PPE
- substation switching practices encompassing:
 - standards, codes, legislation, supply authority regulations and/or enterprise requirements applicable to substation switching
 - requirements for the use of manuals, substation diagrams/plans and drawings
 - types, characteristics and capabilities of HV substation equipment to be switched
 - procedures for obtaining correct HV switching authorisation - identification of hazards and controlling risks, safety procedures and precautions, responsibilities and protocols, and identifying switching resources
 - techniques in HV substation switching - isolation procedures and proving dead, earthing procedures, pre-switching checks, switching operational procedures, emergency fault procedures and commissioning procedures
 - use, care and operation of equipment associated with HV substation equipment - test instruments and sticks
 - HV switchgear - types, categories, application and operating capabilities
 - basic operation of protection systems
 - restrictions pertaining to HV substation switching equipment
 - restrictions pertaining to enterprise-specific procedures
- circuit breaker construction principles encompassing:
 - standards, codes, legislation, supply authority regulations and/or enterprise requirements applicable to circuit breakers
 - requirements for the use of manuals, circuit breaker diagrams/plans and drawings
 - types, characteristics and capabilities of HV substation circuit breakers installed
 - use, characteristics and capabilities of specialised tools and equipment
 - identification of components within the circuit breaker and associated control housings
 - identification of energy sources within the circuit breaker and associated control housings
 - identification of insulation paths within the circuit breaker

- types and characteristics of operating mechanisms
- types and characteristics of interrupter chambers
- safety precautions when constructing circuit breakers - safe working practices and procedures; identification of hazards; assessment and control of WHS/OHS risks and types; selection, maintenance and use of PPE
- synchronous condenser principles encompassing:
 - standards, codes, legislation, supply authority regulations and/or enterprise requirements applicable to synchronous condensers
 - requirements for the use of manuals, substation diagrams/plans and drawings
 - types, characteristics and capabilities of synchronous condensers installed
 - identification of components within the synchronous condensers and associated control housings
 - use, characteristics and capabilities of specialised tools and equipment
 - enterprise-specific policies and procedures for synchronous condensers
 - techniques in evaluating serviceability of synchronous condensers operation
 - safety precautions when testing and measuring synchronous condensers - safe working practices and procedures; identification of hazards and assessment and control of WHS/OHS risks; types, selection, maintenance and use of PPE; responsibilities and protocols; and safe working clearances
 - communicating worksite procedures
- 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 of instrument transformers encompassing:
 - voltage and current transformer principles and terminology
 - types and classes of current transformers
 - constructions of current transformers
 - characteristics of current transformers
 - testing of current transformers
 - types and categories of voltage transformers
 - constructions of voltage transformers
 - characteristics of voltage transformers
 - testing of voltage transformers
- 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 communication devices and principles encompassing:
 - types of communication systems
 - interface to power system equipment
 - hardware configurations
 - testing of communication links
- primary plant testing encompassing:
 - transformers - direct current (d.c.) HV tests, alternating current (a.c.) HV tests, induced HV tests, ratio tests, polarity tests, winding resistance tests, impedance tests, insulation resistance tests, transformer vector group tests, winding temperature indicator tests, alarm tests and neutral ct tests
 - circuit breakers - d.c. HV tests, a.c. HV tests, induced HV tests, function tests, operation timing, minimum voltage operation tests, insulation resistance tests, contact resistance test, auxiliary contact test and alarm tests
 - capacitor banks - d.c. HV tests, a.c. HV tests, induced HV tests, neutral ct tests, balance tests and insulation resistance
- 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
- basic design features and characteristics of underground cables, lines, poles/structures and associated equipment and/or components encompassing:
 - standards, codes, legislation, supply authority regulations and/or enterprise requirements applicable to installing conductors and associated equipment
 - overhead lines characteristics - type of components, characteristics of conductor material, mechanical limitations and physical dimensions of lines, current rating factors (heating, voltage drops and power losses) of conductors, aerial bundled cables (HV and low voltage (LV)) and covered conductors
 - characteristics and constructional features of poles and structures - types of poles and structures, characteristics of poles/structure materials, mechanical limitations of poles/structures, footings and additional support techniques
 - characteristics and constructional features of underground cables - underground cables constructional features, insulation materials and abbreviations, cable dielectrics, electric stress and cable voltage drop
 - calculation of cable voltage drop in relation to length of cable run
 - techniques in reducing electrical stress on cables
 - cable rating factors
 - methods of joining and terminating cables
 - techniques in the installation of cables above and below ground
 - techniques in cable testing and the location of cable faults
 - techniques in cable drawing
- power test equipment testing encompassing:
 - safety precautions specific to the use and connection of power test equipment

- meter operational principles, such as:
 - moving coil, moving iron, transducer, digital and analogue
- types, operation and use of meters - phase sequence meters, phase angle meters, instrument transformers, wattmeters, energy meters, phase system analysers, power oscilloscopes and frequency meters
- principles of transmission, sub-transmission and zone substation primary plant 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 primary plant designs parameters, such as:
 - electrical equipment in accordance with the single line diagram, bay spacing, busbar heights, statutory and maintenance clearances in accordance with AS 2067:2016 Substations and high voltage installations exceeding kV a.c, and organisational requirements, switchyard equipment layout, lightning protection, and control and power cable routes within and outside switchyard.

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 to undertake actual design of transmission, sub-transmission and zone substation primary plant
- 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>