



Australian Government

UETDRDS003 Design power system distribution substations

Release: 1

UETDRDS003 Design power system distribution substations

Modification History

Release 1. This is the first release of this unit of competency in the UET Transmission, Distribution and Rail Sector Training Package Release 2.0.

Application

This unit covers the technical design of distribution substations to relevant standards and specifications, including earthing, location of substation relevant to load, customer and environmental needs and minor civil aspects. It also includes the necessary established procedures to ensure the substation design conforms to specific organisational technical standards, operational and system planning requirements and encompasses 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 licensing requirements which must be confirmed prior to commencing this unit.

Pre-requisite Unit

All competencies in the Common Unit Group must have been completed, plus all competencies in one (1) of the identified Pathway Unit Group(s).

Common Unit Group

UEENEEE101A Apply Occupational Health and Safety regulations, codes and practices in the workplace

UEENEEE102A Fabricate, assemble and dismantle utilities industry components

UEENEEE104A Solve problems in d.c. circuits

UEENEEE107A Use drawings, diagrams, schedules, standards, codes and specifications

UEENEEE125A Provide engineering solutions for problems in complex multiple path circuits

UEENEEE126A Provide solutions to basic engineering computational problems

UEENEEG101A Solve problems in electromagnetic devices and related circuits

UEENEEG102A Solve problems in low voltage a.c. circuits

UEENEEG149A Provide engineering solutions to problems in complex polyphase power circuits

UETDREL001 Apply environmental requirements

UETDREL005 Work safely in the vicinity of live electrical apparatus

UETDRIS005 Implement & monitor power system environmental & sustainable energy management policies & procedures

UETDRIS006 Implement and monitor the power system organisational WHS/OHS policies, procedures and programs

Pathway Unit Group 1

UETDRDS013 Organise and implement ESI line and easement surveys

UETDRDS014 Prepare and manage detailed construction plans for electrical power system infrastructure

Pathway Unit Group 2

UETDRDS006 Develop high voltage and low voltage distribution protection systems

Competency Field

Design

Unit Sector

Not applicable.

Elements and Performance Criteria

ELEMENTS

Elements describe the essential outcomes.

1 Plan for and coordinate the safe design of distribution substations

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 distribution 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** Organisational established procedures on policies 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 landowners 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
- 2 **Carry out and coordinate the design of distribution substations**
 - 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 distribution system are used to analyse the effectiveness of the finished project in accordance with requirements and established procedures
 - 2.5 Technical advice is given to 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 distribution substations**
- 3.1 Final inspections of the design are undertaken to ensure they comply with all requirements and include all specifications and documentation 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 UET Transmission, Distribution and Rail Sector Training Package Companion Volume Implementation Guide.

Unit Mapping Information

This unit replaces and is equivalent to UETTDRDS37 Design power system distribution

substations.

Links

Companion Volume Implementation Guides are found in VETNet -

<https://vetnet.gov.au/Pages/TrainingDocs.aspx?q=229bace1-b7bc-4653-9300-dffb13ecfad7>

Assessment Requirements for UETDRDS003 Design power system distribution substations

Modification History

Release 1. This is the first release of this unit of competency in the UET Transmission, Distribution and Rail Sector Training Package Release 2.0.

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 six (6) technical designs of a distribution substation relating to at least two of the following project types:
 - multi-transformer substations
 - residential developments
 - industrial/commercial developments
 - alteration to existing assets
- completing designs, including:
 - 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:

- mathematics techniques encompassing:
 - calculations involving fractions, decimals, ratios and proportions
 - calculations involving area, volume, mass and density
 - calculations involving transposition and substitution of formulae
 - calculations involving simple trigonometric problems
- engineering mechanics encompassing:
 - identification of basic concepts, principles and applications:
 - application of velocity, acceleration, force, density, torque and pressure

- applications of the International System of Units (SI) units
- the relationship between work, power and energy
- behaviour of object under force:
 - using a block and tackle under load
 - concept of mechanical advantage
 - determination of resultant forces and determining the sag in a catenary conductor and the force applied at each end
- fundamentals of the basic laws of fluid mechanics
- 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
- generation systems encompassing:
 - methods of generating electricity:
 - types of power stations and reasons for their location
 - layout of thermal and hydroelectric power stations
 - relationship between power control and load requirements:
 - operating speeds for thermal and hydroelectric generating sets
 - typical generator voltage levels and output ratings
 - the purpose and features of typical types of co-generation systems
- substations and power transformers encompassing:
 - relationship between the substations within an overall power system:
 - purpose and location in relation to load centres
 - layout of high voltage (HV) equipment within the substation and auxiliary equipment
 - characteristics of a power transformer:
 - basic construction of distribution transformers
 - operation under load/no load conditions
 - types and basic operation of tap changing switches, including solid state types, efficiency and cooling
 - auxiliary equipment used on transformers:
 - function and basic operation
 - maintenance of a power transformer:
 - basic connections
 - restrictions to parallel operation
 - problems and remedies associated with harmonics
 - testing and fault-finding procedures
 - characteristics of a power transformer:

- description and purpose
- the installation of metering and control equipment encompassing:
 - standards, codes, legislation, supply authority regulations and/or enterprise requirements pertaining to the installation and maintenance of energy meters and associated equipment
 - types of meters:
 - kilowatt-hour meters single and polyphase
 - demand meters
 - recording meters and electronic recording metering systems summators
 - installation and removal methods:
 - direct connection and plug in method
 - enterprise specific
 - types of associated equipment and accessories:
 - meter boards, service fuse, links, contactors, time switch and audio frequency injection relay
 - testing procedures:
 - safety and polarity testing
- principles of statutory and safety considerations encompassing:
 - Commonwealth/state/territory legislation, standards, codes, supply authority regulations and/or enterprise requirements associated with working on HV systems
 - particular reference to state and territory regulations regarding working near energised conductors, electrical access, heights, confined space, testing procedures and licensing rules
- the installation of switchgear and associated equipment encompassing:
 - types and function of various switchgear:
 - isolators, air-break switches, gas-filled switches, vacuum type, links, fuses, oil disconnectors, fuse switches and circuit breakers
 - operating characteristics
 - advantages and disadvantages of different types of switchgear
 - installation procedures
 - earthing requirements and techniques
 - types of equipment, including:
 - transformers, reactors, regulators, capacitors, relays, surge arrestors, fault indicators and mobile generators
 - installation procedures for switchgear and equipment encompassing:
 - standards, codes, legislation, supply authority regulations and/or enterprise requirements
 - assembly and erecting procedures
 - earthing requirements and techniques and pole mounted locations
 - maintenance procedures for switchgear and equipment:
 - diagnosing and rectifying faults according to electricity supply industry (ESI) standards and procedures

- testing and commissioning:
 - ESI standards and procedures
- HV distribution transformer principles encompassing:
 - operation of HV distribution transformers:
 - principle governing factors for transformer ratings, protection and alarms
 - operating limitations and the relationship between transformer and HV fuse rating
 - purpose and principle operation of HV distribution transformer tap changers
 - HV distribution transformer and transformer - cable combination switching practices, paralleling requirements, isolation and earthing procedures for access, common distribution transformer and associated electrical apparatus faults
 - HV underground switching equipment:
 - arc strangles, switch operation, load break elbows, switching cubicles, canister fuses, bayonet fuses, F and G switching cubicles, voltage indicators and phasing testers
- 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 supervisory control and data 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 RAT, dial up annunciated system and local control station
- environmental fundamentals encompassing:
 - environmental standards, codes, environmental legislation, supply authority regulations and/or enterprise requirements applicable to the control of environment associated with the worksite encompassing, relevant federal legislation, relevant state/territory legislation, relevant local government by-laws, relevant government or quasi government policies and regulations and relevant community planning and development agreements (land care agreements)
 - employer and employee responsibilities
 - methods of obtaining information on environmental issues and updates
 - methods of identifying environmental impacts from work related activities
 - meaning of environmental terms encompassing:
 - identification, assessment and control of risks
 - compliance and best practice and sustainable energy
 - procedures in implementing management plans to ensure compliance
- layout principles for a distribution substation minor upgrade encompassing:
 - Commonwealth, state/territory and local government legislation, standards, codes, supply authority regulations and/or enterprise requirements applicable to a distribution substation

minor upgrade

- requirements for the use of distribution substation minor upgrade construction manuals, system diagrams/plans and drawings and for plans such as work method statements for the control of WHS/OHS risks
- methods in determining material, equipment and tool lists:
 - components types and quantity required
 - spacing of components and equipment
 - costings of items and components
- purchasing and contractual arrangements, including requirements to eliminate WHS/OHS hazards, minimise risks and provide residual WHS/OHS risk information
- determination of conductor size, type and route length
- resources needed for the laying of conductors, cables and equipment
- determining the appropriate installation sequence
- minimum clearances between conductors and equipment
- estimation of the duration of underground distribution extension project
- fundamentals of distribution transformers encompassing:
 - standards, codes, legislation, supply authority regulations and/or enterprise requirements pertaining to the safe operation and testing of distribution transformers and auxiliary equipment
 - drawing layouts, conventions and symbols:
 - vector group of transformers
 - three phase transformers
 - construction of a distribution transformer
 - characteristics when operated under load and no-load conditions
 - percentage impedance determinations by test and calculation
 - function and operation of tap changing switches, including solid state tap changing equipment
 - function and operation of transformer auxiliary equipment
 - problems caused by harmonics in transformers
 - methods and equipment used to overcome harmonics in transformers
- testing procedures of distribution transformers encompassing:
 - safety precautions specific to the testing of distribution transformers
 - procedures for safely connecting distribution transformers for testing
 - testing of distribution transformers to determine losses
 - calculation of transformer's efficiency
 - methods and types of equipment used to cool transformers:
 - properties of transformer oil and tests performed on transformer oil
 - techniques in performing selected tests on transformer oil
 - techniques in performing testing procedures on armer
 - techniques in testing distribution transformers
 - distribution transformer parallel connections:

- conditions and restrictions for parallel operations
- calculations of loading on transformers operating in parallel
- connection of transformer in parallel to supply a common load
- distribution earthing system encompassing:
 - standards, codes, legislation, supply authority regulations and/or enterprise requirements applicable to the distribution earthing system
 - reason and types of distribution earthing systems
 - terminologies used in the earth systems including, touch and step potential
 - conditions associated when an active HV conductor fails to earth
 - selection of earthing electrodes and grids
 - determination of the earthing resistance of copper clad rods using earthing monograms.

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
- applicable documentation, including workplace procedures, relevant industry standards, equipment specifications, regulations, codes of practice and operation manuals.

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