

**1. Module details**

**Module name** **Electrical Installations - Design and Equipment Selection**

**Suggested structured learning time** A learner possessing the prerequisite skills and knowledge should achieve the module purpose in 72 to 80 hours.

**Module code** NUE 403

**Discipline code** 0703110

**2. Module purpose**

This module provides Learners with knowledge and understanding of the steps in the process for installing electrical systems and the underlying principle of safety and protection.

Learners will develop skills in designing/planning electrical installations up to 400 A<sup>1</sup> per phase that meet the performance standards required by the Wiring Rules. Learners will learn to determine the number and type of circuits required for lighting, heating, power and other purposes and to select wiring systems, compatible protection devices, switchgear and controlgear for a particular purpose and application, and which comply with the safety requirements of Wiring Rules.

Also covered are requirements for damp areas, ELV installations and an overview of special installations and skills in completing mandatory documentation and the need to record design and equipment selection decisions.

**3. Learning pathway**

**Intended use in the structured learning program** This module is intended to supplement workplace exposure to electrical installation work. In particular it applies to planning electrical installation work including the selection of equipment.

Therefore before undertaking this module a student should have a clear understanding and extensive experience in installing wiring and equipment and how the fundamental principles for safety apply.

**Recommended prerequisites** For the most effective learning this module should be undertaken only after modules in three phase systems and protection methods and device have been completed

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<sup>1</sup> Based on the electricity distributors (local service rules) design arrangement and installation for maximum size service fuses.

**4. Relationship to competency standards**

This module provides part of the underpinning knowledge and skills in the 'Evidence Guide' of specific units of competency in the National Electrotechnology Training Package and provides similar support, where mapped, to equivalent units in the National Metals and Engineering Competency Standards. For details refer to the module to unit maps, available from EEQSBA.

This module support the development of essential capabilities required for electrical licensing.

**5. Content**

1. Performance requirements- design consideration

- protection against harmful effects
- correct functioning
- supply characteristics
- determining maximum demand
- voltage drop limitations
- arrangements into circuits
- external factors

2. Performance requirements - protection for safety

- protection against
  - direct contact
  - indirect contact
  - thermal effects
  - overcurrent
  - faults
  - mechanical movement
- integrity of fire rated construction

3. Circuit arrangements

- factors in determining number and type of circuits
- daily and seasonal demand
- circuit layouts/schedules

4. Factors affecting the suitability of wiring systems
  - construction methods
  - installation conditions
  - external influences
  - selecting wiring systems
5. Selecting cables
  - determining maximum demand for main and submains
  - load requirements for final subcircuits
  - using cable selection standards
  - selecting conductor size
6. Selecting devices for protection against indirect contact
  - acceptable methods
  - Wiring Rules' requirements
7. Selecting devices for overload and short-circuit protection
  - coordination between conductors and protection devices
  - short-circuit hazards
  - selecting overload protection devices
  - selecting short-circuit protection devices
8. Selecting devices for isolation and switching
  - requirements for provision of isolation
  - need for protection against mechanical movement
  - selecting devices
9. Switchboard layout design
  - Wiring Rules' and local requirements
  - tariff structures
  - main switchboard equipment
  - layout for whole current metering
  - layout for CT metering (up to 400 A per phase)
10. Selecting equipment for damp situations
  - delineation of damp areas
  - selecting equipment

- 11. Selecting equipment for ELV installations
  - voltage range
  - SELV and PELV
  - selecting equipment
- 12. Special installations
  - other requirements and standards that apply
  - defining hazardous areas
- 13. Documenting installation design and equipment used
  - responsibilities
  - mandatory documentation
  - documenting design

**6. Assessment strategy**

**Assessment methods**

Assessment should be progressive reflecting a holistic approach to ensure the module purpose is met. To assist in ensuring validity, reliability and fairness assessment instruments should include practical exercises, assignments and written tests consisting of a number of item types, such as multiple choice, short answer and problem solving.

**Conditions of assessment**

Normally learning and assessment will take place in a formal learning environment.

**7. Learning outcome details**

**Learning outcome 1**

Explain the factors that affect acceptable performance of an electrical installation that shall be taken into account when designing/planning an installations

**Assessment criteria**

- 1.1 Outline the harmful effect against which the design of an electrical installation must provide protection.
- 1.2 Outline the acceptable performance standards of a correctly functioning electrical installation.
- 1.3 Explain each of the supply characteristics that shall be determined when designing an electrical installation
- 1.4 Describe the acceptable methods for determining the maximum demand in consumers mains and submains
- 1.5 State the Wiring Rules' requirements limiting voltage drop in an installation.

**Learning outcome 2**

- 1.6 State the reason for dividing electrical installations into circuits and the factors that shall determine their number and type.
- 1.7 List typical external factors that may damage an electrical installation and that shall be considered in the installations design.

Demonstrate knowledge of methods intended to ensure the safety of persons, livestock and property against dangers and damage that may arise in the reasonable use of electrical installations.

**Assessment criteria**

- 2.1 Describe the methods for protecting person and livestock against direct contact with conductive parts.
- 2.2 Describe the methods for protecting persons and livestock against indirect contact and the typical application of each.
- 2.3 Describe the acceptable methods for protection against the risks of ignition of flammable materials and injury of burns from thermal effects of current in normal service.
- 2.4 Describe the likely sources of unwanted voltages and the methods for dealing with this potential hazard.
- 2.5 Describe the acceptable methods for protecting persons and livestock against injury and property against damage from the effects of overcurrent.
- 2.6 Outline the requirement for protection against fault current.
- 2.7 Outline the requirement for protection against the harmful effects of faults between live parts of circuits supplied at different voltages.
- 2.8 Explain the need for protection against injury from mechanical movement and how this may be achieved.
- 2.9 Describe the features of 'fire rated construction' and how the integrity of the fire rating can be maintained in relation to electrical installation.

**Learning outcome 3**

Design the circuit arrangements for a given electrical installation.

**Assessment criteria**

- 3.1 Describe the factors that shall be considered in determining the number and type of circuits required for an installation.
- 3.2 Determine the daily and seasonal demand for lighting power, heating and other loads in a given installation.
- 3.3 Determine the number and types of circuits required for a particular installation.

<b>Learning outcome 4</b>	3.4 Prepare a layout/schedule of circuits for given installations.
<b>Assessment criteria</b>	Demonstrate an understanding of the factors affecting the type of wiring system suitable for a range of installations. 4.1 Identify wiring systems typically used with various construction methods and particular environment. 4.2 Describe the installation conditions that may affect the current-carrying capacity of cables. 4.3 Explain the external influences that may affect the current-carrying capacity and/or may cause damage to the wiring system. 4.4 Apply the Wiring Rules' requirements for selecting wiring systems <sup>2</sup> for a range of circuits, installation conditions and construction methods into which the wiring system is to be installed.
<b>Learning outcome 5</b>	Select optimum cables for given circuits based on current-carrying capacity, voltage drop limitations, fault loop impedance requirements, installation condition and external influences.
<b>Assessment criteria</b>	5.1 Calculate the maximum demand for the consumers main and submains for given installations up to 400 A per phase. 5.2 Determine the current requirements for given final subcircuits. 5.3 Use cable selection standards to select conductor size based on the maximum current requirement while not exceeding voltage drop limitations or maximum fault loop impedance for a given circuit.
<b>Learning outcome 6</b>	Select methods and devices for protecting person and livestock against the dangers that may arise from contact with exposed conductive parts which may become live under fault conditions for a given installation. 6.1 Outline acceptable methods of protection against indirect contact. 6.2 Apply the Wiring Rules' requirements for selecting methods and devices to protect against indirect contact for a range of installation types and conditions.

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<sup>2</sup> Wiring systems include cable enclosures, Underground wiring, Aerial wiring, Catenary support, Emergency systems, Busbar Trunking and Earth Sheath Return.

<b>Learning outcome 7</b>	Select overload and short circuit protection devices in compliance with coordination requirements of Wiring Rules and load characteristics.
<b>Assessment criteria</b>	<p>7.1 Explain how the coordination between conductors and protection devices ensures the protection of cables from over heating due to over current.</p> <p>7.2 Describe the possible injuries to persons or livestock hazards from a short circuit.</p> <p>7.3 Apply the Wiring Rules' requirements for selecting devices to protect against overload current for a range of circuit and loads.</p> <p>7.4 Apply the Wiring Rules' requirements for selecting devices to protect against short-circuit current for a range of installations and conditions.</p>
<b>Learning outcome 8</b>	Select devices for isolation and switching in an electrical installation in compliance with the Wiring Rules.
<b>Assessment criteria</b>	<p>8.1 Explain the requirements for the provision of the isolation of every circuit in an electrical installation</p> <p>8.2 Explain the need for protection against mechanical movement of electrically activated equipment.</p> <p>8.3 Apply the Wiring Rules' requirements for selecting devices for isolation and switching for a range of installations and conditions.</p>
<b>Learning outcome 9</b>	Design the layout for main switchboards with capacities up to 400 A per phase to comply with the requirements of the Wiring Rules' and local electricity distributor's service rules.
<b>Assessment criteria</b>	<p>9.1 State the Wiring Rules' and local requirements for switchboards.</p> <p>9.2 Explain the typical tariff structures for the supply of electricity.</p> <p>9.3 List the equipment installed at main switchboards with capacities up to 400 A per phase.</p> <p>9.4 Sketch the layout of a main switchboard for an installation supplied with single phase multiple tariff and with whole current metering.</p> <p>9.5 Sketch the layout of a main switchboard and including metering arrangements for an installation supplied with three phases and with CT metering.</p>
<b>Learning outcome 10</b>	Select equipment for installation in damp situations to comply with the requirements of the Wiring Rules.

**Assessment criteria**

- 10.1 Delineate the restricted zones around baths, showers, fixed water containers pools, sauna heaters and fountains/water features for given installations.
- 10.2 Select equipment suitable for installation in given damp situations.

**Learning outcome 11**

Select equipment for extra-low voltage installations to comply with the requirements of the Wiring Rules.

**Assessment criteria**

- 11.1 Describe the voltage range that defines extra-low voltage.
- 11.2 Describe a ‘Separated extra-low voltage system’ (SELV) and a ‘Protected extra-low voltage system’ (PELV).
- 11.3 Apply the Wiring Rules’ requirements for selecting extra-low voltage systems and devices for a range of installations and conditions.

**Learning outcome 12**

Demonstrate knowledge of special installations and locations that shall comply with additional requirement of the Wiring Rules’ and/or other standards.

**Assessment criteria**

- 12.1 List the standards that apply to specific electrical installations.
- 12.2 Define a hazardous area and outline the reasons for the need for special requirements for electrical wiring and equipment associated with these areas.

**Learning outcome 13**

Explain the need for documenting the reasons for a particular installation design and the equipment selected and installed.

**Assessment criteria**

- 13.1 Outline the responsibilities of those engaged in working with fixed wiring and equipment. (electrical installations)
- 13.2 Apply the requirements to complete mandatory documentation in relation to work on electrical installations.
- 13.3 Explain the need to record the reasons for a particular installation design and equipment used.
- 13.4 Document the design and equipment selected for a given installation.

**8. Delivery of the module**

**Delivery strategy**

Delivery strategies must be suitable for learning both theoretical and practical aspects described in the module purpose. It is considered that the most effective way to achieve this is by the integration of theory and practice where students learn by experimentation and through research and assignment reports. It is recommended that learning and assessment be facilitated in a holistic manner, which may require a learning outcome sequence other than that indicated in the module.

**Resource requirements**

Resources should be sufficient for students to carry out exercises on an individual basis.

Useful references include:

Jenneson, J. R. 1996, *Electrical Principles for Electrical Trades*, 4<sup>th</sup> Ed., McGraw Hill, Sydney

Van den Bergen, B. 1996, *Mathematics for the Electrical Trades*. TAFE Publications, RMIT, Melbourne

Pethebridge, K., and Neeson, I., 2001, *Electrical Wiring Practice*, 6<sup>th</sup> Ed, Vol.1& 2., McGraw Hill, Sydney.

Standards Australia, Standards New Zealand<sup>3</sup>:

AS/NZS 3000:2000 *Wiring rules*

AS/NZS 3008: 1998 *Electrical installations — Selection of cables*. Part 1.1: Cables for alternating voltages up to and including 0.6/1kV – Typical Australian installation conditions.

HB300:2001 *Electrical Equipment for hazardous area*

HB300:2001 *Electrical installations—A guide to using the wiring rules*

AS/NZS 3018:2001 *Electrical installation – Domestic installations*

AS/NZS 3001:2001 *Moveable premises and their site installation*

AS/NZS 3002:2001 *Electrical installation – shows and carnivals*

AS/NZS 3003:1999 *Electrical installations – patient treatment areas of hospitals and medical and dental practices*

AS/NZS 3004:2001 *Electrical installations*

AS/NZS 3012:1995 *Electrical installation – Construction and demolition sites*

AS/NZS 4836 *Safe working practice on low-voltage electrical installations*

WorkCover Codes of Practice

Local electricity distributor and authority regulations

Where this module is used in an approved Traineeship or Apprenticeship program learners should be advised to obtain, where available, respective EEQSBA<sup>4</sup> **User Guides** (*these outline in detail what training and work performance the Learner is required to undertake for the program*)

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<sup>3</sup> Standards Australia, Standards New Zealand AS/NZS3008.1.2, Electrical installations - Selection of cables. Part 1.2 Cables for alternating voltages up to and including 0.6/1 kV Typical New Zealand installation conditions.

<sup>4</sup> EEQSBA – ElectroComms and EnergyUtilities Qualifications Standards Body of Australia Ltd.

**Occupational health  
and safety requirements**

A safe and healthy environment will be provided for learners and teachers. Safety procedures for the particular learning facilities shall be followed as part of the learning / teaching activity and assessment.