



**Australian Government**

# **MEM18100 Fault-find, test and rectify AC machines and circuits**

**Release: 3**

# MEM18100 Fault-find, test and rectify AC machines and circuits

## Modification History

### Release 3. Prerequisite units updated

Release 2. Minor adjustments to reflect ERAC requirements for electrician licensing and revision of Essential Performance Capabilities

Release 1. New unit

## Application

This unit of competency has been developed for Engineering Tradesperson –industrial electrician apprenticeship training and the recognition of trade-level skills in locating and rectifying faults in alternating current (AC) machines and circuits.

It covers characteristics including their construction and operating principles. It also includes their application, control and protection methods, reversal of rotation and the requirements to limit starting current as well as skills in testing and fault finding, including abnormal operating conditions.

This unit covers the skills and knowledge required to meet the Electrical Regulatory Authorities Council (ERAC).

Essential Performance Capabilities (EPCs):

- EPC 12 – Demonstrate the rationale and operating principles and characteristics of three phase induction motors and generators. Describe AS/NZS 3000 requirements and knowledge of local Supply Authority requirements for three phase motor installations and starters.
- EPC 14 – Demonstrate knowledge of possible causes of malfunction of three phase induction motors and demonstrate the tests required for diagnosing faults.
- EPC 15 – Describe the operating principles, characteristics, and suitability of typical control methods for single-phase motors and their key components.

### And

Essential Performance Capability (EPC) classified as ‘critical’:

- EPC 13 – Demonstrate a knowledge of methods of electric motor selection, starting, connection and protection.

Some jurisdictions require the holder of this unit to be licensed or certified and users should check with the relevant authorities.

**Band: A**

**Unit Weight: 4**

## Pre-requisite Unit

|          |                                                                                                 |
|----------|-------------------------------------------------------------------------------------------------|
| MEM10016 | Terminate and test electrical wiring and accessories                                            |
| MEM10018 | Select cable types and sizes to suit loads and electrical installation environment              |
| MEM10019 | Select circuit protection devices by type and rating, fit to switchboards and install earthing  |
| MEM10023 | Design and connect control switching of circuits for building services and industrial equipment |
| MEM12023 | Perform engineering measurements                                                                |
| MEM18001 | Use hand tools                                                                                  |
| MEM18104 | Dismantle, replace and assemble electrical components and equipment                             |

## Competency Field

Maintenance and diagnostics

## Elements and Performance Criteria

|                                                        |                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Elements describe the essential outcomes.              | Performance criteria describe the performance needed to demonstrate achievement of the element.                                                                                                                                                                                                                                                                                 |
| 1. Determine job requirements                          | 1.1 Follow standard operating procedures (SOPs)<br>1.2 Comply with work health and safety (WHS) requirements at all times, including appropriate risk control measures<br>1.3 Use appropriate personal protective equipment (PPE) in accordance with SOPs<br>1.4 Research the nature of the fault through checking of documentation and/or consultation with appropriate person |
| 2. Prepare to fault find on AC machines and associated | 2.1 Obtain all necessary tools, equipment and testing instruments needed to conduct fault diagnosis of AC machines and circuits                                                                                                                                                                                                                                                 |

| Elements describe the essential outcomes.                 | Performance criteria describe the performance needed to demonstrate achievement of the element.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| control circuits                                          | 2.2 Isolate and tag circuits and equipment in accordance with procedures                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 3. Fault find AC machines and associated control circuits | <p>3.1 Apply diagnostic techniques to solve problems in AC machines and their associated control circuits, including the use of specialised test equipment</p> <p>3.2 Test single and three-phase windings for continuity and insulation resistance between windings and to earth with appropriate test equipment</p> <p>3.3 Dismantle and reassemble AC machine using appropriate fitting techniques, equipment and tools in accordance with specifications and procedures, if required</p> <p>3.4 Remove/repair/replace faulty components/circuits in accordance with manufacturer specifications and regulatory requirements</p> <p>3.5 Test AC machine/circuit to ensure functionality in accordance with specifications</p> <p>3.6 Document all necessary repairs in accordance with SOPs</p> |

## Foundation Skills

This section describes those required skills (reading, writing, oral communication and numeracy) that are essential to workplace performance in this unit of competency.

Foundation skills essential to performance are explicit in the performance criteria of this unit of competency.

## Range of Conditions

This field allows for different work environments and conditions that may affect performance. Essential operating conditions that may be present (depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts) are included.

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|                                                                           |                                                                                                                                                                                                                             |
|---------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>AC machines include three (3) or more of the following:</b>            | <ul style="list-style-type: none"><li>• single-phase motors</li><li>• three-phase motors</li><li>• variable speed drives (VFDs)</li><li>• synchronous machines</li><li>• non-rotating AC equipment and components</li></ul> |
| <b>Control starter circuits include one (1) or more of the following:</b> | <ul style="list-style-type: none"><li>• direct-on-line (DOL)</li><li>• star-delta</li><li>• autotransformer</li><li>• primary resistance</li><li>• secondary resistance</li></ul>                                           |
| <b>Split phase induction motors include:</b>                              | <ul style="list-style-type: none"><li>• split-phase motor</li><li>• capacitor-start motor</li><li>• capacitor-start, capacitor-run motor</li><li>• permanently-split capacitor motor</li><li>• shaded-pole motor</li></ul>  |
| <b>Environmental protection and general enclosure types include:</b>      | <ul style="list-style-type: none"><li>• open motors</li><li>• protected motors</li><li>• drip-proof motors</li><li>• duct ventilated</li><li>• totally enclosed</li><li>• flameproof</li></ul>                              |
| <b>Specialised test equipment includes one or more of the following:</b>  | <ul style="list-style-type: none"><li>• built-in systems (software and site displays)</li><li>• vibration monitors</li><li>• infra-red temperature sensing device</li></ul>                                                 |
| <b>Rotating electrical machines in general requirements include:</b>      | <ul style="list-style-type: none"><li>• AS 1359.106-1996 Rotating electrical machines – General requirements – Methods of cooling (IC Code)</li></ul>                                                                       |
| <b>Regulatory requirements include:</b>                                   | <ul style="list-style-type: none"><li>• AS/NZS 3000:2007 Electrical installations (known as the Australian/New Zealand Wiring Rules)</li></ul>                                                                              |
| <b>Safe working practices include:</b>                                    | <ul style="list-style-type: none"><li>• Demonstration of safe working practices and installation in accordance with industry established safe and sound practices</li></ul>                                                 |

## Unit Mapping Information

Release 2. Equivalent. Minor adjustments to reflect ERAC requirements for electrician licensing and revision of Essential Performance Capabilities.

## Links

Companion Volume implementation guides are found in VETNet -

<https://vetnet.gov.au/Pages/TrainingDocs.aspx?q=b7050d37-5fd0-4740-8f7d-3b7a49c10bb2>

# Assessment Requirements for MEM18100 Fault-find, test and rectify AC machines and circuits

## Modification History

### Release 3. Prerequisite units updated

Release 2. Minor adjustments to reflect ERAC requirements for electrician licensing and revision of Essential Performance Capabilities

Release 1. New unit

## Performance Evidence

Evidence required to demonstrate competence in this unit must be relevant to and satisfy the requirements of the elements and performance criteria on at least two (2) occasions and include:

- following work instructions, standard operating procedures (SOPs) and safe work practices
- identifying and interpreting circuits, drawings and specifications relevant to the work to be undertaken
- determining the electrical and non-electrical isolation requirements to prevent the creation of hazards linked from the loss of machine/system/process control according to established procedures
- using lock out tag procedures with appropriate tags/signs
- proving electrical isolation and following established safety rules prior to working on electrical equipment or wiring
- ensuring all electrical equipment and tools are tested and tagged and up to date
- using specialised test equipment, including condition monitoring equipment to conduct on-line analysis
- carrying out on-line functional tests for voltage and current using a voltmeter or multimeter and a clip on ammeter
- applying fault finding and diagnostic techniques on at least three (3) or more of the following AC machines and circuits:
  - single-phase motors
  - three-phase motors
  - variable speed drives (VSDs)
  - synchronous machines
  - non-rotating AC equipment and components
- carrying out electrical tests for continuity and insulation resistance tests; between windings and to earth of single and three-phase motors
- dismantling, replacing and assembling single and three-phase AC machines using appropriate hand and power tools in accordance with manufacturer specifications, if required

- complying with the Australian/New Zealand Wiring Rules and local supply requirements for three-phase motor installations and starters
- using a synchroscope for paralleling of alternators
- documenting all necessary repairs in accordance with SOPs.

## Knowledge Evidence

Evidence required to demonstrate the required knowledge for this unit must be relevant to and satisfy the requirements of the elements and performance criteria and include knowledge of:

- safe work practices and procedures and use of personal protective equipment (PPE)
- three-phase induction motors, including:
  - basic component parts of a three-phase induction motor, i.e. stator and rotor (squirrel-cage and wound rotor)
  - motor enclosures
  - terminal block arrangements – connecting a three-phase motor in both star and delta
  - operating principles, including:
    - rotating magnetic fields
    - rate of rotation and factors affecting it
    - direction of rotation and reversal
  - induction and its effects, including:
    - torque
    - slip
    - rotor frequency
  - operating characteristics, including:
    - squirrel-cage rotors
    - special purpose squirrel-cage rotors
    - wound-rotor motors
  - operating parameters for induction motors
- single-phase induction motors, characteristics and operating principles of the following:
  - split-phase motor
  - capacitor-start motor
  - capacitor-start, capacitor-run motor
  - permanently-split capacitor motor
  - shaded-pole motor
- series motor – operating characteristics and reversing the direction of rotation
- comparison of single-phase and three-phase motors and advantages and disadvantages of three-phase motors
- abnormal operating conditions for three-phase motors, including:
  - phase reversal, single phasing and overloading
  - voltage fluctuation, higher operating temperatures, frequency variation, overloading and frequent starting

- other factors, including exposure to corrosive fumes, explosive vapours, dust, steam, salt air, high humidity, operation in ambient temperature of below approximately 100C or above 400C, or operation at altitudes in excess of 1000 metres
- abnormal operating conditions for single-phase motors, including centrifugal switch failure
- diagnostic techniques including the use of specialised test equipment, including growlers
- electrical tests for continuity and insulation resistance tests; between windings and to earth of single and three-phase motors
- testing, including the following:
  - DC test – to determine the stator resistance
  - no-load test – to determine the rotational losses and magnetisation current
  - locked rotor test – to determine the rotor and stator impedances
  - thermography and condition monitoring
- dismantling three-phase motors, including application of ‘witness marks’
- operation of a ‘growler’ to perform voltage drop testing of armatures of the series or universal motor
- electric motor control and protection, including:
  - reasons why motor protection is required
  - Australian/New Zealand Wiring Rules and local supply requirements for three-phase motor installations and starters, including:
    - isolation and switching
    - automatic starting
    - emergency stopping
    - starting methods for limitation of starting currents
- three-phase motor starters and their operating principles and characteristics, including:
  - DOL
  - star-delta
  - autotransformer
  - primary resistance
  - secondary resistance
- various types of motor overload protection, including high rupture capacity (HRC) fuses
- operating principles of magnetically activated over-current relays, thermally activated over-current relays and combined thermal-magnetic over-current relays
- temperature-dependent resistor protection
- under-voltage and over-voltage protection
- single-phasing and reverse-phase sequence protection and the protection methods
- types of enclosures to give environmental protection, including:
  - open - ends of machine are open allowing free ventilation with fan attached to the motor shaft to draw air through the motor
  - protected - protection obtained by fastening steel wire mesh or perforated metal over enclosures with fan attached to the motor shaft to draw air through the motor

- drip proof - an advance on the protected motors with openings further protected by a hood to prevent foreign materials or moisture from falling vertically into motor
- duct ventilated - air is drawn from outside through a duct or air is forced via a blower through a duct to the motor
- totally enclosed - no contact between the air outside and inside the machine can be classified as waterproof, weatherproof or submersible
- flameproof - totally enclosed motor with additional precautions, including to seal bearings and used where there are flammable gases and risk of explosion if spark enters the atmosphere
- AS 1359.106-1996 Rotating electrical machines – General requirements – Methods for cooling (IC Code)
- three-phase motor braking and the principles of operation of the major types, including mechanical, eddy current, dynamic, regenerative and plug
- altering the speed of AC induction motors by varying the number of poles or frequency
- VSDs, including:
  - methods and operating principles
  - installation requirements
  - shielding and filtering
  - harmonics and power factor
  - performance characteristics
  - set up and commissioning
  - common faults – their symptoms and causes
- three-phase synchronous machines – alternators:
  - construction and operating principles
  - excitation and generated voltage
  - effect of load on alternator voltage
  - effect of power factor on output voltage of an alternator
  - voltage regulation
  - alternator ratings expressed in kVA
  - parallel operation of alternators – synchronising and the methods used to achieve synchronisation, including the use of a synchroscope
  - effects of a change in excitation when connecting two alternators in parallel
- three-phase synchronous machines – motors:
  - construction and operating principles
  - effect of a load on a synchronous motor
  - effect on varying the field (DC) excitation, including changes in power factor
- hunting in three-phase synchronous machines and the methods used to reduce this effect, including the use of amortisseur windings in the pole faces of the rotor
- starting methods and applications of three-phase synchronous motors
- single-phase synchronous motors:
  - the primary purpose and the major types: reluctance and hysteresis motors
  - applications of single-phase synchronous motors

- standby power supplies including uninterruptable power supplies (UPS) and the purpose they provide, i.e. mains power at a specified voltage and frequency
- standby engine driven alternators starting methods and sequence of operation
- non-rotating AC equipment and components including construction, operation and application of:
  - linear motors and actuators
  - solenoids, relays and contactors
  - welders and other non-rotating AC machines.

## Assessment Conditions

- Assessors must:
  - have vocational competency in fault finding, testing and rectifying AC machines and circuits at least to the level being assessed with relevant industry knowledge and experience
  - satisfy the assessor requirements in the *Standards for Registered Training Organisations 2015* and comply with the *National Vocational Education and Training Regulator Act 2011* or equivalent legislation covering VET regulation in a non-referring State as the case requires.
- Where possible assessment must occur in operational workplace situations. Where this is not possible or where personal safety or environmental damage are limiting factors, assessment must occur in a sufficiently rigorous simulated environment that reflects realistic operational workplace conditions. This must cover all aspects of workplace performance, including environment, task skills, task management skills, contingency management skills and job role environment skills.
- Conditions for assessment must include access to all tools, equipment, materials and documentation required, including relevant workplace procedures, product and manufacturing specifications.
- 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.

## Links

Companion Volume implementation guides are found in VETNet -

<https://vetnet.gov.au/Pages/TrainingDocs.aspx?q=b7050d37-5fd0-4740-8f7d-3b7a49c10bb2>