



**Australian Government**

# **MARL018 Apply advanced principles of marine electrotechnology**

**Release: 1**

# MARL018 Apply advanced principles of marine electrotechnology

## Modification History

Release 1. New unit of competency.

## Application

This unit involves the skills and knowledge required to explain advanced marine electrotechnology principles and to perform advanced electrical calculations.

This unit applies to the work of a Marine Engineer Class 1 on commercial vessels of unlimited propulsion power and forms part of the requirements for the Certificate of Competency Marine Engineer Class 1 issued by the Australian Maritime Safety Authority (AMSA).

No licensing, legislative or certification requirements apply to this unit at the time of publication.

## Pre-requisite Unit

Not applicable.

## Competency Field

L – Marine Engineering

## Unit Sector

Not applicable.

## Elements and Performance Criteria

Elements describe the essential outcomes.

Performance criteria describe the performance needed to demonstrate achievement of the element.

|                                                                                        |     |                                                                                                                                                             |
|----------------------------------------------------------------------------------------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1 Analyse circuits incorporating resistance, inductance and capacitive elements</b> | 1.1 | Mathematical problems involving resistor inductor (RL) and resistor capacitor (RC) combinations in direct current (DC) circuits are solved                  |
|                                                                                        | 1.2 | Mathematical problems involving resistive, inductive and capacitive reactance and overall circuit impedance in alternating current (AC) circuits are solved |
|                                                                                        | 1.3 | Why large power factors are desirable in AC circuits is explained                                                                                           |
|                                                                                        | 1.4 | Mathematical problems related to power factor correction                                                                                                    |

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|          |                                                                      | mechanisms are solved                                                                                                                                                             |
|          | 1.5                                                                  | Conditions for resonance in series and parallel RLC circuit combinations are analysed                                                                                             |
|          | 1.6                                                                  | Mathematical problems involving resonance in series and parallel RLC circuit combinations are solved                                                                              |
|          | 1.7                                                                  | Differing consequences of resonance to both RLC series and RLC parallel circuit are illustrated                                                                                   |
| <b>2</b> | <b>Apply complex number theory to analyse AC circuit performance</b> |                                                                                                                                                                                   |
|          | 2.1                                                                  | J operator is explained                                                                                                                                                           |
|          | 2.2                                                                  | Rectangular notation of j operator is related to comparable trigonometric and polar notations                                                                                     |
|          | 2.3                                                                  | J operator is used in the addition and subtraction of phasors, applying the most appropriate notation to the solution of phasor problems involving current, voltage and impedance |
|          | 2.4                                                                  | Conductance, admittance and susceptance are distinguished from each other in terms of resistance, impedance and the j operator                                                    |
|          | 2.5                                                                  | Problems involving RL and C elements in different circuit combinations using j operator theory are solved                                                                         |
|          | 2.6                                                                  | Power in AC circuit applications using j operator theory is calculated                                                                                                            |
| <b>3</b> | <b>Analyse operating principles of electrical instrumentation</b>    |                                                                                                                                                                                   |
|          | 3.1                                                                  | Mathematical calculations are performed to demonstrate how moving coil and moving iron instruments may have their ranges changed                                                  |
|          | 3.2                                                                  | Mathematical calculations are performed to demonstrate how dynamometer type wattmeters may have their measuring ranges extended                                                   |
|          | 3.3                                                                  | Construction, operating principles and functions of electrical meters are outlined                                                                                                |
|          | 3.4                                                                  | Principal methods and instruments used in resistance measurement are detailed                                                                                                     |
|          | 3.5                                                                  | Resistance measurements are conducted and verified using appropriate electrical instrumentation                                                                                   |
| <b>4</b> | <b>Analyse operating principles of DC</b>                            |                                                                                                                                                                                   |
|          | 4.1                                                                  | EMF equation is applied to solve problems related to DC generators                                                                                                                |

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| <b>generators</b>                                               | 4.2 | Losses that may occur in DC generators are analysed                                                                                                                              |
|                                                                 | 4.3 | Appropriate parametric relationships for DC generator losses, together with expressions for output power and efficiency are derived and associated numerical problems are solved |
|                                                                 | 4.4 | Basic principles of DC armature winding techniques are explained                                                                                                                 |
|                                                                 | 4.5 | Generator armature reaction is explained                                                                                                                                         |
|                                                                 | 4.6 | Expression for armature EMF is derived and applied to solve problems related to DC generators                                                                                    |
|                                                                 | 4.7 | Commutator arcing and how this might be minimised or eliminated is explained                                                                                                     |
|                                                                 | 4.8 | Open circuit and load characteristic curves for separately excited, shunt, and compound wound DC generators are derived                                                          |
| <b>5 Analyse operating principles of DC motors</b>              | 5.1 | DC torque equation is applied to solve problems related to DC motors                                                                                                             |
|                                                                 | 5.2 | Losses that may occur in DC motors are analysed                                                                                                                                  |
|                                                                 | 5.3 | Appropriate parametric relationships for DC motor losses, together with expressions for output power and efficiency are derived and associated numerical problems are solved     |
|                                                                 | 5.4 | Speed equation for a DC motor is derived and corresponding characteristics for different winding configurations are sketched                                                     |
|                                                                 | 5.5 | Speed equation and characteristics of different DC motor configurations are applied to explain how DC motor speed may be controlled                                              |
|                                                                 | 5.6 | Reasons for armature reaction and methods of compensating for its effects are identified                                                                                         |
|                                                                 | 5.7 | Why DC motors need variable starting resistors are explained                                                                                                                     |
| <b>6 Compare operation of synchronous motors and generators</b> | 6.1 | Marine applications of synchronous motors and generators are identified                                                                                                          |
|                                                                 | 6.2 | Mathematical expression for the magnitude and rotational speed of the magnetic field produced by a three-phase supply                                                            |

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|          |                                                                            | is derived                                                                                                                                 |
|          | 6.3                                                                        | Operating principle of synchronous motors is explained                                                                                     |
|          | 6.4                                                                        | Operation of synchronous motors and generators are compared and contrasted                                                                 |
|          | 6.5                                                                        | Problems using phasor diagrams and mathematical expressions involving the effects of loads and excitation on synchronous motors are solved |
|          | 6.6                                                                        | Advantages and disadvantages of AC synchronous motors and generators are analysed                                                          |
| <b>7</b> | <b>Analyse operation of single and three phase transformers</b>            |                                                                                                                                            |
|          | 7.1                                                                        | Basic transformation ratio and EMF equation for an ideal transformer is derived                                                            |
|          | 7.2                                                                        | No load and on load phasor diagrams for an ideal transformer are constructed, with negligible voltage drop through its windings            |
|          | 7.3                                                                        | Causes of actual transformer losses are explained and relationships associated with the transformer equivalent circuit are derived         |
|          | 7.4                                                                        | Open circuit and short circuit tests are applied to calculate transformer efficiency and voltage regulation                                |
|          | 7.5                                                                        | Problems related to the operation of auto-transformers are solved                                                                          |
| <b>8</b> | <b>Analyse requirements for parallel operation of AC and DC generators</b> |                                                                                                                                            |
|          | 8.1                                                                        | Conditions required for shunt, series and compound wound DC generators to operate in parallel are identified                               |
|          | 8.2                                                                        | Numerical problems related to parallel operation of shunt, series and compound wound DC generators are solved                              |
|          | 8.3                                                                        | Conditions required for AC generators to operate in parallel are identified                                                                |
|          | 8.4                                                                        | Numerical problems related to parallel operation of AC generators are solved                                                               |

## 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.

Electrical meters include one or more of the following:

- energy meters
- frequency meters
- induction disc watt meters
- power factor meters

Problems include one or more of the following:

- tapping point
- turns
- voltages

## Unit Mapping Information

This unit replaces and is equivalent to MARL6005A Apply advanced principles of marine electrotechnology.

## Links

Companion Volume implementation guides are found in VETNet -

<https://vetnet.gov.au/Pages/TrainingDocs.aspx?q=772efb7b-4cce-47fe-9bbd-ee3b1d1eb4c2>

# **Assessment Requirements for MARL018 Apply advanced principles of marine electrotechnology**

## **Modification History**

Release 1. New unit of competency.

## **Performance Evidence**

Evidence required to demonstrate competence in this unit must be relevant to and satisfy all of the requirements of the elements, performance criteria and range of conditions on at least one occasion and include:

- applying relevant work health and safety/occupational health and safety (WHS/OHS) requirements and work practices
- assessing own work outcomes and maintaining knowledge of current codes, standards, regulations and industry practices
- identifying and applying relevant mathematical formulas and techniques to solve complex problems related to marine electrotechnology
- identifying and interpreting numerical and graphical information, and performing mathematical calculations to perform tasks such as using phasor diagrams and mathematical expressions to explain the effects of loads and excitation on synchronous motors
- identifying, collating and processing information required to perform complex calculations related to marine electrotechnology
- imparting knowledge and ideas through verbal, written and visual means
- reading and interpreting written information needed to perform complex electrical calculations
- solving problems using appropriate laws and principles
- using calculators to perform complex mathematical calculations.

## **Knowledge Evidence**

Evidence required to demonstrate competence in this unit must be relevant to and satisfy all of the requirements of the elements, performance criteria and range of conditions and include knowledge of:

- AC principles
- advanced principles of marine electrotechnology
- circuits:
  - resistance
  - inductance
  - capacitance
- complex number theory
- DC generators
- DC motors
- difference between AC and DC
- electrical:
  - circuits
  - current
  - power
  - safety
  - units of measurement
- electromagnetic:
  - force
  - induction
- electrical meters:
  - energy meters
  - frequency meters
  - induction disc watt meters
  - power factor meters
- Ohm's Law
- operating principles of:
  - DC generators
  - DC motors
  - electrical instrumentation
  - parallel circuits
- parallel operation of AC and DC generators
- power factor
- power factor correction mechanisms
- resistance
- single and three-phase transformers
- synchronous motors and generators
- WHS/OHS requirements and work practices.

## Assessment Conditions

Assessors must satisfy National Vocational Education and Training Regulator (NVR)/Australian Quality Training Framework (AQTF) assessor requirements.

Assessment must satisfy the National Vocational Education and Training Regulator (NVR)/Australian Quality Training Framework (AQTF) standards.

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.

Assessment must occur in workplace operational situations or where these are not available, in simulated workplace operational situations or an industry-approved marine operations site that replicates workplace conditions where advanced principles of marine electrotechnology can be applied.

Resources for assessment include access to:

- applicable documentation including workplace procedures, regulations, codes of practice and operation manuals
- electrical diagrams, specifications and other information required for performing advanced electrical calculations
- relevant regulatory and equipment documentation that impacts on work activities
- technical reference library with current publications on marine electrotechnology
- tools, equipment, materials and personal protective equipment currently used in industry.

Performance should be demonstrated consistently over time and in a suitable range of contexts.

## Links

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<https://vetnet.gov.au/Pages/TrainingDocs.aspx?q=772efb7b-4cce-47fe-9bbd-ee3b1d1eb4c2>