



Australian Government

MARL042 Apply basic principles of marine electrotechnology

Release: 1

MARL042 Apply basic principles of marine electrotechnology

Modification History

Release 1. This is the first release of this unit of competency in the MAR Maritime Training Package.

Application

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

This unit applies to people working in the maritime industry in the capacity of:

- Electro-Technical Officer (STCW Electro-Technical Officer Unlimited)
- Engineer Watchkeeper (STCW Engineer Watchkeeper Unlimited).

Licensing/Regulatory Information

- Legislative and regulatory requirements are applicable to this unit.
- This unit is one of the requirements to obtain Australian Maritime Safety Authority (AMSA) certification as an Electro-Technical Officer (STCW Electro-Technical Officer Unlimited) or Engineer Watchkeeper (STCW Engineer Watchkeeper Unlimited) and to meet regulatory requirements this unit must be delivered consistent with Marine Orders and with the relevant sections of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW).
- Those regulatory requirements include STCW International Maritime Organisation (IMO) model course competencies and areas of knowledge, understanding and proficiency, together with the estimated total hours required for lectures and practical exercises. Teaching staff should note that timings are suggestions only and should be adapted to suit individual groups of trainees depending on their experience, ability, equipment and staff available for training.

Pre-requisite Unit

Not applicable.

Competency Field

L – Engineering

Unit Sector

Not applicable.

Elements and Performance Criteria

ELEMENTS

Elements describe the essential outcomes.

PERFORMANCE CRITERIA

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

1 Explain how material properties affect resistance of electrical conductors

- 1.1** Terms and symbols used in the formula for resistivity are used correctly
- 1.2** How resistance varies with changes in conductor length and cross-sectional area is outlined
- 1.3** How resistance varies with temperature is outlined
- 1.4** Calculations are performed that illustrate how material properties affect resistance of electrical conductors

2 Apply Ohm's Law to electrical circuits

- 2.1** Main sources of electromagnetic field (EMF) are identified
- 2.2** Terms and symbols used in Ohm's Law are used correctly
- 2.3** Calculations are performed using Ohm's Law to solve problems involving internal, external and variable resistances in both series and parallel circuits
- 2.4** Calculations are performed to determine power required and/or energy expended by electrical devices
- 2.5** Circuits for a Wheatstone bridge and a slide wire bridge are sketched and their application on a ship is outlined
- 2.6** Calculations are performed dealing with resistances, currents and voltage drops in bridge circuits under null or balanced conditions

3 Apply principles of electrolytic action to electrical cells

- 3.1** How the theory of electrolytic disassociation when applied to common electrolytic solutions and electrode materials explains the generation of EMF from chemical sources, is outlined
- 3.2** Primary cells are distinguished from secondary cells
- 3.3** Calculations are performed to solve problems involving currents, voltage drops and terminal potential difference of cells connected to form batteries in series and in

- parallel
- 3.4** How capacity of a battery is measured is explained
- 3.5** Construction of typical batteries used in marine environments is outlined
- 4 Apply principles of electromagnetism to EMF generation**
- 4.1** Form and properties of the magnetic fields surrounding single conductor and multi-turn solenoid coils when carrying an electrical current are compared and contrasted
- 4.2** Terms and symbols used in Faraday's and Lenz's laws of electromagnetic induction are used correctly
- 4.3** Calculations are performed using Faraday's and Lenz's laws of electromagnetic induction to solve problems related to electromagnetism and EMF generation
- 4.4** Fleming's Right Hand Rule is outlined
- 5 Explain operation of direct current (DC) rotating machinery**
- 5.1** Construction and methods of maintaining and repairing typical DC machines are illustrated
- 5.2** Principle wiring arrangements used with DC machines are outlined
- 5.3** Action of the commutator in DC generators is outlined
- 5.4** Significance of Back EMF (E_b) in the operation of DC motors is outlined
- 5.5** Mathematical formulae are applied to show relationships between operational parameters of DC motors
- 5.6** Calculations are performed to solve simple problems relating to power output and efficiency in DC. motors
- 6 Explain operation of alternating current (AC) rotating machinery**
- 6.1** How three phase AC may be developed out of simple single phase AC is explained
- 6.2** Difference between Star and Delta connections is outlined
- 6.3** How a three phase supply can generate a rotating magnetic field is explained
- 6.4** Construction of an AC synchronous generator is

		outlined
	6.5	Construction of an AC induction motor is outlined
	6.6	Calculations are performed to show how driving torque is produced in an induction motor
7	Explain parallel operation and load sharing of generator	
	7.1	Load/voltage curves of AC and DC generators are compared
	7.2	Main requirements for satisfactory power sharing between both AC and DC generators are outlined
	7.3	Sequences that occur when load changes on two DC generators working in parallel without an equaliser connection are outlined
	7.4	Effect of varying power factors on the load/voltage curve of an AC generator is outlined
8	Explain coupling and breaking connections between switchboard and distribution panels	
	8.1	Construction, equipment and service of main switchboard and emergency switchboard and distribution panel are outlined
	8.2	Construction and operation principle of measuring instruments in main and emergency switchboards and distribution panels are outlined
	8.3	Construction and operation principle of circuit breakers and their tripping devices are outlined
	8.4	Procedures for restarting ship equipment after power supply failure are outlined
	8.5	Connection between main and emergency switchboards and necessary safeguards are outlined
	8.6	Procedures for changeover to shore-connection supply are outlined

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.

Unit Mapping Information

This unit replaces and is equivalent to MARL010 Apply basic principles of marine electrotechnology.

Links

Companion Volume implementation guide can be found in VetNet -

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

Assessment Requirements for MARL042 Apply basic principles of marine electrotechnology

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Performance Evidence

- 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 basic problems related to marine electrotechnology
- identifying and interpreting numerical and graphical information, and performing mathematical calculations, such as resistance of electrical conductors, power output and efficiency in direct current (DC) motors, and driving torque in induction motors
- identifying, collating and processing information required to perform basic calculations related to marine electrotechnology
- performing accurate and reliable calculations
- reading and interpreting written information needed to perform basic electrical calculations
- solving problems using appropriate laws and principles.

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:

- basic principles of marine electrotechnology
- batteries
- cables
- circuit breakers
- coupling, load sharing and changing over generators, including:
 - conditions for automatic start of emergency generator and starting methods
 - control systems for distribution for active and reactive power
 - excitation systems of generators
 - methods of synchronisation
 - power factor
 - principles of power management, including:
 - control of start-release of big consumers directly supplied from main switchboard
 - automatic three-step disconnection of non-essential power consumers

- load depending start and stop of generator and automatic load sharing
- protections for generators and diesel engines, including:
 - asymmetrical voltage and current
 - frequency and voltage stabilisation of shaft generators
 - open circuit, wire fault and earth-fault monitoring
 - overload
 - reverse power
 - short circuit
 - under and overvoltage
 - under and over frequency
- safety systems of generators
- voltage and frequency control systems
- DC motors and rotating machinery
- difference between alternating current (AC) and DC
- distribution panels
- electrical:
 - current
 - power
 - safety
 - units of measurement
- electromagnetic:
 - force
 - induction
- effective verbal, written and visual communication techniques
- electrical theory, including:
 - electrical circuits
 - impedance and inductance
 - Kirchhoff's Law
 - Ohm's Law
- electrical motors including:
 - AC motor
 - DC motor
- electrical motor starting methodologies
- emergency switchboard
- fundamentals of AC, including:
 - principles
 - rotating machinery
- high voltage (HV)
- lighting
- main switchboard

- measuring instruments for switchboards
- operational parameters of DC motors, including:
 - current
 - flux density
 - torque
 - voltage
- parallel circuits
- power distribution systems, including:
 - distribution
 - insulation
 - transformers
- principles of electromagnetism and electrolytic action
- resistance
- series circuits
- shore connection
- work health and safety (WHS)/occupational health and safety (OHS) requirements and work practices.

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 processes and techniques must be appropriate to the language, literacy and numeracy requirements of the work being performed and the needs of the candidate.

Practical assessment must occur in a workplace, or realistic industry approved marine operations site or simulated workplace, under the normal range of workplace conditions.

Simulations and scenarios may be used where situations cannot be provided in the workplace or may occur only rarely, in particular for situations relating to emergency procedures and adverse weather conditions where assessment would be unsafe, impractical or may lead to environmental damage.

Resources for assessment must include access to:

- applicable documentation, such as legislation, regulations, codes of practice, workplace procedures and operational manuals
- tools, equipment, machinery, materials and relevant personal protective equipment (PPE) currently used in industry.

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