



Australian Government

MARL6021A Demonstrate advanced knowledge of marine electrical systems

Release 1

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Modification History

Release 1

This is the first release of this unit.

Unit Descriptor

This unit involves the skills and knowledge required to supply shipboard electrical power on board a commercial vessel. It includes analysing electrical layout systems, alternators, marine motors, lighting systems, power management and UPS systems, shipboard electrical equipment and high voltage power systems.

Application of the Unit

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).

Licensing/Regulatory Information

Not applicable.

Pre-Requisites

Not applicable.

Employability Skills Information

This unit contains employability skills.

Elements and Performance Criteria Pre-Content

Elements describe the essential outcomes of a unit of competency.

Performance criteria describe the required performance needed to demonstrate achievement of the element. Assessment of performance is to be consistent with the evidence guide.

Elements and Performance Criteria

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|--|---|
| 1 Evaluate advanced electrical layout systems | <ul style="list-style-type: none">1.1 Effects of power factor changes on prime mover, alternator and electrical system are analysed1.2 Methods of altering load power factor by means of capacitors or synchronous machines are explained1.3 Methods of obtaining constant frequency from a variable frequency output such as a main engine driven alternator and/or variable speed drives for a self discharging equipment are explained1.4 Protecting systems available for shaft driven alternators are evaluated |
| 2 Analyse construction and principles of operation of different types of marine alternators | <ul style="list-style-type: none">2.1 Construction and <i>operating parameters</i> of different types of marine alternators are compared and contrasted2.2 Cooling systems, leak detection, monitoring and protection systems in different types of marine alternators are compared and contrasted2.3 Procedures for drying out an alternator with a low insulation resistance are explained2.4 Excitation systems and methods of flashing alternator after loss of excitation are appraised2.5 Systems used for protecting against high winding temperatures, circulating currents, loss of excitation and internal short circuit are evaluated |
| 3 Analyse different types of direct current (DC) and alternating current (AC) marine motors | <ul style="list-style-type: none">3.1 Different types and applications of <i>marine motors</i> are compared and contrasted3.2 Difference between types of <i>encapsulation</i> is explained and where they should be used is justified3.3 <i>Motor ratings</i> and effect of overloading on different types of motor are assessed3.4 Possible <i>operational problems</i> associated with marine motors are analysed and appropriate |

- remedial action is devised
- 3.5 Procedure for drying out a motor that has become unserviceable due to either long-term storage or immersion in seawater is formulated
 - 3.6 Effects of operating star connected motors compared with delta connected motors are distinguished and when this may be required is suggested
 - 3.7 ***Different types and applications of special motors for deck and cargo operation*** are analysed
- 4 Analyse requirements of motor starters for 3 phase and synchronous motors**
- 4.1 Differentiation is made between different types of ***motor starters***
 - 4.2 Different types of starters are evaluated in terms of starting torque and current, and these are related to particular motor applications
 - 4.3 Simple starter circuit diagrams are evaluated and operating principles of motor starters are explained
 - 4.4 Documentation and circuit and wiring diagrams for fault-finding in motor starters are used
 - 4.5 Routine maintenance program for monitoring vibration and insulation resistance levels of motors is designed
- 5 Analyse lighting systems used on board ships**
- 5.1 Common types and applications of ***lighting systems*** are evaluated
 - 5.2 ***Distribution layout systems*** are explained
 - 5.3 Fault-finding method for lights and starter systems, including lighting in hazardous areas, is planned using circuit diagrams
- 6 Evaluate alternator excitation system design**
- 6.1 Different types of excitation systems and impact of load changes are compared
 - 6.2 Type, location and function of components involved in excitation are examined
 - 6.3 Function, cooling, failure mode and procedures for testing and changing diodes are explained

- 6.4 Functions of an AVR and how it may be incorporated into an excitation system are explained
 - 6.5 Process of fault-finding in an AVR and types, causes and remedies of common problems are explained
 - 6.6 ***How excitation systems impact on output in normal and adverse circumstances*** is assessed
- 7 **Analyse power management and uninterruptable power systems (UPS) fitted to vessels**
 - 7.1 Operational functions of power management systems during high load, overload and short circuit conditions are analysed
 - 7.2 Functions and components of UPS systems are evaluated
 - 7.3 Limitations of power management and UPS fitted to vessels are analysed
 - 7.4 System response under possible fault conditions of vessel power management and UPS are determined
- 8 **Analyse vessel cathodic protection system**
 - 8.1 Cathodic protection systems and how they interact are analysed
 - 8.2 Components of cathodic protection systems are identified and life cycle maintenance program is prepared
 - 8.3 Modifications required for operating parameters of cathodic protection systems when operating alongside an active wharf or another vessel are determined
 - 8.4 Likely causes of corrosion in relation to size, location or distribution of anodes or current densities are assessed
 - 8.5 Other corrosion problems in shipboard environment that may be cause of electrical problems are appraised
- 9 **Assess requirements and components associated with electrical systems for hazardous**
 - 9.1 Different types, limitation and nameplate identification of 'E' equipment are compared
 - 9.2 Requirements of classification societies are

- spaces on board vessels** distinguished from administrations regarding electrical installations on board vessels
- 9.3 Lighting and power supply requirements of pump rooms are identified
- 9.4 **Safety requirements** for electrical equipment and safety practices on board vessels and how these are extended when alongside a berth are analysed
- 10 Assess existing electrical shipboard equipment**
- 10.1 Existing and new shipboard electrical equipment and systems are compared to assess future requirements as well as potential problems and preventative measures
- 10.2 Performance of existing shipboard electrical equipment and systems is analysed and cost effectiveness studies for modifications or improvements are prepared
- 10.3 Factors involved in commissioning new electrical plant are evaluated
- 10.4 Procedures involved in organising survey of existing plant are outlined
- 10.5 Procedures involved in making recommendations for new systems consistent with modified new ship building requirements are outlined
- 11 Appraise high voltage electrical motor propulsion systems**
- 11.1 Safety requirements for working with high voltage systems are identified
- 11.2 Use of high voltage systems for propulsion and cargo handling is evaluated
- 11.3 Safe maintenance methods for high voltage switchgear and machines are analysed

Required Skills and Knowledge

This section describes the skills and knowledge required for this unit.

Required Skills:

- Assess own work outcomes and maintain knowledge of current codes, standards, regulations and industry practices
- Explain advanced principles of lighting, cathodic protection, high voltage systems and impart knowledge and ideas verbally, in writing and visually
- Identify and interpret complex numerical and graphical information in electrical diagrams and specifications for a commercial vessel
- Identify and suggest ways of rectifying electrical hazards and emergency situations on a vessel
- Identify methods, procedures and materials needed for operating, maintaining and repairing complex marine electrical systems
- Read and interpret written information related to electrical circuitry and components on commercial vessels
- Use electrical measuring and testing instruments

Required Knowledge:

- Alternating current (AC)/direct current (DC) voltage
- AC and DC marine motors
- Alternators:
 - alternator excitation system design
 - construction
 - characteristics
 - synchronised operation
 - types
- Cathodic protection system
- Electrical:
 - layout systems
 - measuring and testing instruments
 - shipboard equipment
 - symbols, basic electrical diagrams/circuits
- High voltage electrical motor propulsion systems
- Lighting systems used on board ships
- Motor starters for three-phase and synchronous motors
- Phase angle, power factor, and current flow
- Power management and UPS fitted to vessels

- Procedures for dealing with hazards and emergencies
- Requirements and components associated with electrical systems for hazardous spaces on board vessels
- Resistance, inductance and capacitance
- Safe electrical working practices
- Work health and safety (WHS)/occupational health and safety (OHS) legislation and policies

Evidence Guide

The evidence guide provides advice on assessment and must be read in conjunction with the performance criteria, the required skills and knowledge, the range statement and the Assessment Guidelines for the Training Package.

Critical aspects for assessment and evidence required to demonstrate competency in this unit

The evidence required to demonstrate competence in this unit must be relevant to and satisfy all of the requirements of the Elements, Performance Criteria, Required Skills, Required Knowledge and include:

- providing accurate and reliable information
- providing appropriate level of detail in responses.

Context of and specific resources for assessment

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

Resources for assessment include access to:

- industry-approved marine operations site where advanced knowledge of marine electrical systems can be demonstrated
- technical reference library with current publications on marine electrical systems
- tools, equipment and personal protective equipment currently used in industry
- relevant regulatory and equipment documentation that impacts on work activities
- range of relevant exercises, case studies and/or other simulated practical and knowledge assessments
- appropriate range of relevant operational situations in the workplace.

In both real and simulated environments, access is required to:

- relevant and appropriate materials and equipment
- applicable documentation including workplace procedures, regulations, codes of practice and operation manuals.

Method of assessment

Practical assessment must occur in an:

- appropriately simulated workplace environment and/or
- appropriate range of situations in the workplace.

A range of assessment methods should be used to assess practical skills and knowledge. The following examples are appropriate to this unit:

- direct observation of the candidate demonstrating advanced knowledge of marine electrical systems
- direct observation of the candidate applying relevant WHS/OHS requirements and work practices.

Guidance information for assessment

Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended.

In all cases where practical assessment is used it should be combined with targeted questioning to assess Required Knowledge.

Assessment processes and techniques must be appropriate to the language and literacy requirements of the work being performed and the capacity of the candidate.

Range Statement

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording, if used in the performance criteria, is detailed below.

Operating parameters may include:

- Excitation current
- Insulation grade
- Operating temperature
- Speed

Marine motors may include:

- Polyphase
- Reduced starting current motors
- Single
- Speed changing
- Synchronous
- Variable speed

Encapsulation may include:

- Drip proof
- Submersible
- TEFC

Motor ratings may include:

- Continuous
- Short time

Operational problems may include:

- Loss of insulation resistance
- Open circuit
- Overheating
- Short circuit
- Wrong connections

Different types and applications of special motors for deck and cargo operation may include:

- Common faults
- Remedies for common faults

Motor starters may include:

- DOL
- Primary and secondary resistance
- Soft or electronic starters
- Star-Delta
- Transformer starter

Lighting systems may include:

- Fluorescent
- Halogen
- Incandescent
- LED
- Mercury
- Sodium vapour

Distribution layout systems must include:

How excitation systems impact on output in normal and adverse circumstances must include:

Safety requirements may include:

- Emergency lights
- Safety lights
- Loss of excitation
- Short circuit
- Company requirements
- Manufacturer requirements.
- Statutory requirements

Unit Sector(s)

Not applicable.

Competency Field

Marine Engineering