Australian Government

MARL051 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 of competency in the MAR Maritime Training Package Release 6.0.

Application

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

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

- Electro-Technical Officer (STCW Electro-Technical Officer Unlimited)
- Engineer Class 1 (STCW Chief Engineer Unlimited)
- Engineer Class 2 (STCW Second Engineer 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), Engineer Class 1 (STCW Chief Engineer Unlimited) or Engineer Class 2 (STCW Second Engineer 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 Organization (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		PERFORMANCE CRITERIA	
Elements describe the essential outcomes.		Performance criteria describe the performance needed to demonstrate achievement of the element.	
1	**Evaluate advanced electrical layout systems**	**1.1**	Effects of power factor changes on prime mover, alternator and electrical system are analysed
		1.2	Methods of altering load power factor by means of capacitors or synchronous machines are explained
		1.3	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 explained
		1.4	Protecting systems available for shaft driven alternators are evaluated
2	**Analyse common faults in shipboard electrical machinery**	**2.1**	Effects and ways of detecting earth on 3-wire insulated and 4-wire earthed neutral systems are explained
		2.2	Effects of short circuits and operation of discrimination protection are explained
		2.3	Symptoms and effects of ‘light’ and ‘heavy’ short circuits on components and circuits are compared
		2.4	Effects of open circuits on systems and components transformers are analysed
		2.5	Causes and effects of ‘hot spots’ in circuits are identified
		2.6	Cause and effects of static electricity on shafting and when cleaning tanks are identified
3	**Analyse construction and**	**3.1**	Construction and operating parameters of different types of

	principles of operation of different types of marine alternators		marine alternators are compared and contrasted
		3.2	Cooling systems, leak detection, monitoring and protection systems in different types of marine alternators are compared and contrasted
		3.3	Procedures for drying out an alternator with a low insulation resistance are explained
		3.4	Excitation systems and methods of flashing alternator after loss of excitation are appraised
		3.5	Systems used for protecting against high winding temperatures, circulating currents, loss of excitation and internal short circuit are evaluated
4	**Perform fault finding on electrical circuits**	**4.1**	Safe procedure for determining insulation resistance of a three phase motor or alternator, including protection of solid-state components and selection of suitable minimum insulation for the component, is applied
		4.2	Procedure for safely drying out an electrical machine with a low insulated resistance (IR) is outlined
		4.3	Open circuit in a three phase motor is safely tested
		4.4	Procedure for testing internal short circuit in a three phase motor is clarified
5	**Analyse different types of direct current (DC) and alternating current (AC) marine motors**	**5.1**	Different types and applications of marine motors are compared and contrasted
		5.2	Difference between types of encapsulation is explained and where they should be used is justified
		5.3	Motor ratings and effect of overloading on different types of motor are assessed
		5.4	Possible operational problems associated with marine motors are analysed and appropriate remedial action is devised

		5.5	Procedure for drying out a motor that has become unserviceable due to either long-term storage or immersion in seawater is formulated
		5.6	Effects of operating star connected motors compared with delta connected motors are distinguished and when this may be required is suggested
		5.7	Different types and applications of special motors for deck and cargo operation are analysed
6	**Analyse complex shipboard switchboard layouts**	**6.1**	Switchboard layouts are interpreted
		6.2	The effects and indications of earths on the system, including intermittent and multiple earths, are explained
		6.3	Safe procedure for locating earths on main and low voltage (LV) circuits, including 24 volt (V) system, is outlined
		6.4	Operation of preferential tripping arrangements for overload protection is explained
		6.5	Different methods of start-up after black outs are outlined
7	**Analyse requirements of motor starters for three phase and synchronous motors**	**7.1**	Differentiation is established between different types of motor starters
		7.2	Different types of starters are evaluated in terms of starting torque and current, and are compared to particular motor applications
		7.3	Simple starter circuit diagrams are evaluated, and operating principles of motor starters are explained
		7.4	Documentation and circuit and wiring diagrams are used for fault finding in motor starters
		7.5	Routine maintenance program for monitoring vibration and insulation resistance levels of motors is designed
8	**Explain electrical safety procedures**	**8.1**	Potential problems associated with shore maintenance personnel working on ship electrical equipment are identified

	for ship and shore personnel		
		8.2	Safe procedure of isolating electrical machinery for repair or maintenance is applied
		8.3	Safe method of working on live electrical circuitry for purpose of repair or maintenance is explained
		8.4	Problems associated with shipboard electrical fires are explained
		8.5	Safe procedures for fighting shipboard electrical fires, including fires in switchboards, are clarified
9	**Analyse lighting systems used onboard ships**	**9.1**	Common types and applications of lighting systems are evaluated
		9.2	Distribution layout systems are explained
		9.3	Fault-finding method for lights and starter systems, including lighting in hazardous areas, is planned using circuit diagrams
10	**Synchronise, parallel and load share alternators on manual and auto modes**	**10.1**	Process of manually synchronising alternator and sharing kilowatt (kW) and kilovolt-amperes reactive (kVAR) loading under all loading conditions is explained
		10.2	Process of starting, testing and, where applicable, of transferring emergency generator power onto main board, is explained
		10.3	Operation of synchronising lights, synchroscope and all meters associated with synchronising is outlined
		10.4	Operation of automatic voltage regulator (AVR) and prime mover governor with respect to synchronising is outlined and how these can be adjusted at set points is explained
11	**Evaluate alternator excitation system design**	**11.1**	Different types of excitation systems and impact of load changes are compared
		11.2	Type, location and function of components involved in excitation are examined
		11.3	Function, cooling, failure mode and procedures for testing and

		changing diodes are explained
		11.4 Functions of an AVR and how it may be incorporated into an excitation system are explained
		11.5 Process of fault finding in an AVR and types, causes and remedies of common problems are explained
		11.6 The impact excitation systems have on output in normal and adverse circumstances is assessed
12	**Examine operation, construction and maintenance of circuit breakers**	**12.1** Features and applications of different types of circuit breakers are differentiated
		12.2 Closing and opening systems of circuit breakers are explained
		12.3 Arc extinguishing systems are explained
		12.4 Method for accessing an air circuit breaker for inspection is analysed
		12.5 Function and operation of protection devices associated with air circuit breaker and molded case circuit breaker are examined
13	**Analyse power management and UPS fitted to vessels**	**13.1** Operational functions of power management systems during high load, overload and short circuit conditions are analysed
		13.2 Functions and components of UPS systems are evaluated
		13.3 Limitations of power management and UPS fitted to vessels are analysed
		13.4 System response under possible fault conditions of vessel power management and UPS are determined
14	**Analyse function of emergency battery systems**	**14.1** Different types and characteristics of batteries used for emergency supplies are identified
		14.2 Methods of battery charging and ways in which charge condition of the battery can be determined are explained
		14.3 Requirements of emergency supply and how transfer can occur without adversely affecting solid state components are explained

		14.4 Safety hazards associated with batteries, and procedures to be adopted to minimise explosion and short circuits are appraised
15	**Analyse vessel cathodic protection system**	**15.1** Cathodic protection systems and how they interact are analysed
		15.2 Components of cathodic protection systems are identified and life cycle maintenance program is prepared
		15.3 Modifications required for operating parameters of cathodic protection systems when operating alongside an active wharf or another vessel are determined
		15.4 Likely causes of corrosion in relation to size, location or distribution of anodes or current densities are assessed
		15.5 Other corrosion problems in shipboard environment that may be the cause of electrical problems are appraised
16	**Assess requirements and components associated with electrical systems for hazardous spaces onboard vessels**	**16.1** Different types, limitations and nameplate identification of ‘E’ equipment are compared
		16.2 Requirements of classification societies are distinguished from administrations regarding electrical installations onboard vessels
		16.3 Lighting and power supply requirements of pump rooms are identified
		16.4 Safety requirements for electrical equipment and safety practices onboard vessels and how these are extended when alongside a berth are analysed
17	**Assess existing electrical shipboard equipment**	**17.1** Existing and new shipboard electrical equipment and systems are compared to assess future requirements as well as potential problems and preventative measures
		17.2 Performance of existing shipboard electrical equipment and systems is analysed and cost-effectiveness studies for modifications or improvements are prepared

17.3 Factors involved in commissioning new electrical plant are evaluated

17.4 Procedures involved in organising survey of existing plant are outlined

17.5 Procedures involved in making recommendations for new systems consistent with modified new ship building requirements 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 not equivalent to MARL028 Demonstrate intermediate knowledge of marine electrical systems.

This unit replaces and is equivalent to MARL034 Demonstrate advanced knowledge of marine electrical systems.

Links

Companion Volume implementation guide can be found in VetNet - https://vetnet.gov.au/Pages/TrainingDocs.aspx?q=772efb7b-4cce-47fe-9bbd-ee3b1d1eb4c2