



Australian Government

Department of Education, Employment and Workplace Relations

TDMMR1507B OPERATE, MONITOR AND EVALUATE ENGINE PERFORMANCE ON VESSELS OVER 750 KW PROPULSION POWER

Release: 1

TDMMR1507B OPERATE, MONITOR AND EVALUATE ENGINE PERFORMANCE ON VESSELS OVER 750KW PROPULSION POWER

Modification History

Not applicable.

Unit Descriptor

UNIT DESCRIPTOR:

This unit involves the skills and knowledge required to operate, monitor and evaluate the performance of engines within the limits of responsibility of a Marine Engineer Class 2 on a commercial vessel powered by main propulsion machinery of 750 kW propulsion power or above. This covers the knowledge and skills required to work as:

- **Chief Engineer on vessels between 750 kW and 3,000 kW propulsion power**
- **First Engineer (Second Engineer for STCW 95 Code) on vessels over 750 kW propulsion power.**

This includes the management and coordination of relevant maintenance and fault-finding activities and the application of diagnostic and problem solving techniques to maintenance procedures.

Application of the Unit

Application of the unit	The unit has application in qualifications for Chief Engineer on a vessel between 750 kW and 3,000 kW propulsion power operating in international waters, i.e. the Advanced Diploma of Transport&Distribution(Marine Engineering Class 2).
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Licensing/Regulatory Information

Licensing/legislative requirements	The unit is consistent with the relevant sections of STCW 95 and Marine Orders under the Australian Navigation Act, describing requirements for a Chief Engineer on a ocean-going vessel between 750 kW and 3,000 kW propulsion power.
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Pre-Requisites

Not applicable.

Employability Skills Information

Not applicable.

Elements and Performance Criteria Pre-Content

<i>Elements describe the essential outcomes of a unit of competency.</i>	<i>Performance Criteria describe the required performance needed to demonstrate achievement of the element. Assessment of performance is to be consistent with the Evidence Guide.</i>
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Elements and Performance Criteria

ELEMENT	PERFORMANCE CRITERIA
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1 Operate and maintain engines and associated propulsion plant	- a Internal combustion engines, gas turbines and auxiliary machinery are operated as per procedures - b The performance of engines and propulsion plant is monitored as per bridge orders, company procedures, survey requirements and manufacturer's instructions, and performance is compared with specifications and limits of performance - c The methods of measuring the load capacity and other operating parameters of the engines are in accordance with manufacturer's technical specifications - d Poor performance and faults are identified as per established marine practice - e Poor performance and faults are investigated as per marine practice and manufacturer's instructions, and appropriate action is taken to rectify the identified problem

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ELEMENT	PERFORMANCE CRITERIA
1 Operate and maintain engines and associated propulsion plant (continued)	- f Appropriate action is taken to prevent damage/failure as per planned maintenance procedures marine practice, safety regulations and manufacturer's instructions - g Faulty and worn engine (internal combustion or gas turbine) equipment and components are identified and are reported and action is initiated as required for repair or replacement in accordance with company procedures and established marine engineering practice - h Decisions are made to carry out temporary or permanent repairs depending on the vessel's position and circumstances - i Appropriate consultation is taken with class society and marine administration concerning the nature of the repairs and any contingency or emergency action required - j Repair processes and the organisation and control of engine room personnel are managed to facilitate repairs as per established procedures
2 Repair faults in engines, propulsion plant or auxiliary machinery	- a Identified faults in engines (internal combustion or gas turbine), propulsion plant or auxiliary machinery are investigated using advanced diagnostic techniques in accordance with established procedures - b Malfunctioning or faulty engines (internal combustion or gas turbine), propulsion plant or auxiliary machinery are correctly isolated and disassembled, if necessary, as per manufacturer's instructions and established marine engineering practice - c Damaged or faulty components are repaired or replaced in accordance with established procedures - d Repaired engines (internal combustion or gas turbine),

ELEMENT	PERFORMANCE CRITERIA
	propulsion plant or auxiliary machinery are reassembled and checked in accordance with manufacturer's instructions and established marine engineering practice e Repaired engines (internal combustion or gas turbine), propulsion plant or auxiliary machinery are restarted and adjusted as per vessel's procedures and manufacturer's instructions and in consultation with relevant personnel f Performance of repaired engines (internal combustion or gas turbine), propulsion plant or auxiliary machinery and associated safety devices, control systems and alarms is checked in accordance with manufacturer's instructions g Performance against recommended technical specifications is confirmed and engines (internal combustion or gas turbine), propulsion plant or auxiliary machinery is recommissioned in accordance with vessel's procedures

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ELEMENT	PERFORMANCE CRITERIA
3 Complete operational and performance evaluation documentation	a Correct records are made relating to the operation and performance evaluation of engines (internal combustion or gas turbine), propulsion plant and auxiliary equipment and any engine or gas turbine or machinery failure incidents b All operational and performance evaluation documentation is completed in accordance with vessel's procedures, bridge orders, survey and company requirements and regulations
4 Follow safety and hazard control procedures	a Vessel's safety management procedures and safety regulations are applied in the operation and performance evaluation of engines (internal combustion and gas turbines), propulsion plant and auxiliary machinery b Hazards involved in engines (internal combustion and gas turbines), propulsion plant and auxiliary equipment operation and performance evaluation are identified and action is taken

ELEMENT	PERFORMANCE CRITERIA
	to minimise or eliminate risk to personnel, vessel and the environment c Safety, hazard minimisation and pollution control procedures and national and international regulations are followed at all times during maintenance and repair operations d Where relevant, procedures and precautions necessary for entry into a pump-room, fuel tanks or other confined spaces on a vessel are correctly followed e Action is taken in the event of an engine or machinery failure or emergency to secure the engine (internal combustion and gas turbine) or machinery and the vessel and maintain the safety of the vessel and persons involved, and shipboard emergency and contingency plans are followed

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Required Skills and Knowledge

REQUIRED KNOWLEDGE

This describes the knowledge required for this unit.

- 1 National and international regulations, IMO Conventions and Codes, class rules, including AMSA Marine Orders applicable to the operation and performance evaluation of engines (internal combustion and gas turbines), propulsion plant and auxiliary machinery on vessels between 750 kW and 3,000 kW propulsion power
- 2 Relevant OH&S legislation, policies and procedures
- 3 Established engineering practice for the operation and performance evaluation of engines (internal combustion and gas turbines), propulsion plant and auxiliary machinery
- 4 Operational characteristics and performance specifications for the different types of marine engines, propulsion plant and auxiliary machinery usually found on a vessel between 750 kW and 3,000 kW propulsion power
- 5 Procedures for carrying out performance evaluation of engines (internal combustion and gas turbines), propulsion plant and auxiliary machinery as part of routine operational and maintenance procedures to ensure performance is in compliance with bridge orders, technical specifications, survey requirements and established safety and anti-pollution rules and regulations
- 6 The nature and causes of typical malfunctions and/or poor performance of engines, propulsion plant and auxiliary machinery and the available methods for their detection and rectification
- 7 Hazards and problems that can occur during the operation and performance evaluation of marine engines (internal combustion and gas turbines), propulsion plant and auxiliary machinery and appropriate preventative and remedial action and solutions
- 8 Safety, environmental and hazard control precautions and procedures relevant to the operation and performance evaluation of engines (internal combustion and gas turbines), propulsion plant and auxiliary machinery

REQUIRED KNOWLEDGE

- 9 Operational and performance evaluation records that must be maintained on a vessel to meet the requirements of the company, survey requirements and regulatory authorities
- 10 Maritime communication techniques needed during the operation and performance evaluation of engines, propulsion plant and auxiliary machinery
- 11 Typical material safety data sheets, vessel and machinery specifications, machinery design drawings, machine drawings, operational manuals, specifications and electrical and control circuit diagrams
- 12 Procedures for the testing and treatment of auxiliary boiler water, machinery cooling water and lubricating oil
- 13 Principles and operational characteristics of internal combustion engines, including:
 - a two stroke and four stroke cycles
 - b optimum combustion parameters and their control
 - c diesel engine scavenging systems both in normal and emergency operation
 - d atmospheric pollution caused by diesel engine combustion, and ways in which it can be minimised
 - e determination of shaft power

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- f irregularities in the performance of machinery and plant
- 14 Principles and operational characteristics of marine gas turbines
- 15 Principles of operation of hydraulic and electronic governors and overspeed trips
- 16 Methods of providing air for combustion
- 17 Principles of fuel systems, including:
 - a typical injection pressures and viscosities for different grades of fuel
 - b alterations to fuel pumps, camshafts and injectors for varying fuel types

- f irregularities in the performance of machinery and plant
 - c differences between constant and variable injection timing of fuel
 - d injection requirements for different speeds of diesel engine
 - e common service faults, symptoms and causes of combustion problems and related solutions
 - f fuel line pulsation damping devices and leakage protection
 - g fuel valve cooling arrangements
 - h uni-fuel and dual fuel systems
- 18 Principles of engine cooling and lubrication, including:
- a different methods of diesel engine cooling
 - b need for treatment of engine cooling water
 - c methods of treating engine cooling water
 - d diesel engine lubrication requirements
 - e theory and types of lubrication, including methods of lubricating diesel engine components
 - f relative characteristics, and applications of mineral and synthetic oils
 - g contaminants that may affect lubricants, their effect on machinery performance, and action that can be taken to avoid and remedy contamination of lubricants
 - h common lubrication problems and their solution
- 19 Principles of marine control systems, including:
- a common sensors and their associated transmitters
 - b analysis of control loops
 - c temperature and pressure control systems used on board vessel
 - d load-dependent cooling of diesel alternators
 - e analysis of typical level control systems used on board vessel
 - f operation and application of electronic PID controllers

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- 20 Principles and functions of machinery space monitoring and alarm systems, including:
 - a central cooling and load-dependent cooling control systems
 - b main engine control arrangements for fixed pitch and controllable pitch propeller systems requiring sequential control
 - c alarm and monitoring systems involving data loggers, alarm loggers and trend analysis of collected data
- 21 Theory and preventative strategies for scavenge and uptake fires, and starting air-line, crankcase and gearbox explosions, including:
 - a plans for hazard reduction
 - b procedures for extinguishing scavenge fires and dealing with crankcase mist detector alarms
 - c regaining of control after starting air-line, crankcase and gearbox explosions
- 22 Principles of thermodynamics and heat and heat engines relevant to detection, identification and repair of faults, including:
 - a heat transfer, including log mean temperature and circular pressure vessels
 - b gases and gas cycles
 - c properties and expansion of steam
 - d steam cycles, including a specific understanding of the use of entropy charts and modifications to the steam cycle
 - e Auxiliary boilers and evaporators
 - f steam turbines, including an understanding of isentropic efficiency
 - g combustion with a specific understanding of volumetric analysis
 - h refrigeration and air-conditioning, including the use of entropy charts

- 20 Principles and functions of machinery space monitoring and alarm systems, including:
- 23 Principles and operational characteristics of steam turbines, gearing and associated equipment as they apply to auxiliary systems, including:
 - a lubrication
 - b gear configurations
 - c thrust blocks
 - d determination of shaft power
 - e irregularities in the performance of machinery and plant
- 24 Principles and operational characteristics of auxiliary boilers and associated equipment, including:
 - a boiler water tests and treatment
 - b corrosion
 - c superheaters

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- d de-aerators
air ejectors
- e open and closed feed systems
- f uptake fires

REQUIRED SKILLS

This describes the basic skills required for this unit.

- 1 Communicate effectively with other personnel when managing the operation, monitoring and evaluation of the performance of engines (internal combustion and gas turbines) on vessels between 750 kW and 3,000 kW propulsion power
- 2 Interpret and follow procedures for the operation, monitoring and evaluation of the performance of engines (internal combustion and gas turbines) on vessels between 750 kW and 3,000 kW propulsion power
- 3 Read and interpret equipment performance readings and instrumentation
- 4 Read and interpret material safety data sheets
- 5 Read and interpret vessel and machinery specifications, machinery design drawings, machine drawings, operational manuals, specifications and electrical and control circuit diagrams
- 6 Work collaboratively with other shipboard personnel when managing the operation, monitoring and evaluation of the performance of engines (internal combustion and gas turbines) on vessels between 750 kW and 3,000 kW propulsion power
- 7 Identify problems that can occur during the operation, monitoring and evaluation of the performance of engines (internal combustion and gas turbines) on vessels between 750 kW and 3,000 kW propulsion power
- 8 Carry out calculations required when operating, monitoring and evaluating the performance of engines (internal combustion and gas turbines) on vessels between 750 kW and 3,000 kW propulsion power
- 9 Adapt to differing types of fuel, bilge and ballast systems from one vessel to another and when equipment and systems are changed
- 10 Select and use tools and equipment required for the operation, repair, monitoring and evaluation of the performance of engines (internal combustion and gas turbines) on vessels between 750 kW and 3,000 kW propulsion power

Evidence Guide

Evidence Guide

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PERFORMANCE ON VESSELS OVER 750 KW PROPULSION POWER

The Evidence Guide provides advice on assessment and must be read in conjunction with the Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment Guidelines for this Training Package.

1 Critical aspects of evidence required to demonstrate competency in this unit	Assessment must confirm appropriate knowledge and skills to: - a Manage the operation, monitoring and evaluation of the performance of engines (internal combustion and gas turbines), propulsion plant and auxiliary machinery on a vessel between 750 kW and 3,000 kW propulsion power - b Identify malfunctioning and faulty engines (internal combustion and gas turbines), propulsion plant and auxiliary machinery and initiate appropriate action for repair or replacement - c Exercise all required safety, environmental and hazard control precautions and procedures when overseeing the operation and performance evaluation of engines (internal combustion and gas turbines), propulsion plant and auxiliary machinery - d Identify typical operational and performance evaluation problems and hazards and take appropriate action - e Communicate effectively with others during the operation and performance evaluation of engines (internal combustion and gas turbines), propulsion plant and auxiliary machinery
2 Evidence required for demonstration of consistent performance	- a Performance is demonstrated consistently over a period of time and in a suitable range of contexts - b Consistently applies underpinning knowledge and skills when: 1 operating, monitoring and evaluating the performance of engines (internal combustion and gas turbines), propulsion plant and auxiliary machinery 2 identifying malfunctioning and faulty engines (internal combustion and gas turbines), propulsion plant and auxiliary machinery and initiating appropriate action for repair or replacement

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| 3 | exercising all required safety, environmental and hazard control precautions and procedures when overseeing the operation and performance evaluation of engines (internal combustion and gas turbines(internal combustion, propulsion plant and auxiliary machinery |
| 4 | identifying and implementing improvements to procedures for the operation and performance evaluation of engines (internal combustion and gas turbines), propulsion plant and auxiliary systems |
| 5 | completing required documentation, reports and records when operating, monitoring and evaluating the performance of engines (internal combustion and gas turbines (internal combustion, propulsion plant and auxiliary machinery |
| c | Shows evidence of application of relevant workplace procedures, including: |

Evidence Guide (continued)

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2 Evidence required for demonstration of consistent performance (continued)

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| 1 | relevant sections maritime regulations |
| 2 | OH&S regulations and hazard prevention policies and procedures |
| 3 | safety management system procedures and work instructions on the operation and performance evaluation of engines (internal combustion and gas turbines (internal combustion, propulsion plant and auxiliary machinery |
| 4 | following on-board housekeeping processes |
| 5 | waste, pollution and recycling management processes |
| d | Action is taken promptly to report and/or rectify engine, plant and machinery malfunctions, non-conformities, accidents, hazardous occurrences and safety incidents in accordance with statutory requirements, company procedures and the ISM Code |
| e | Work is managed, controlled and completed systematically with required attention to detail |

	f Recognises and adapts appropriately to cultural differences in the workplace, including modes of behaviour and interactions among crew and others
3 Context of assessment	a Assessment of competency must comply with the assessment requirements of the relevant maritime regulations b Assessment of this unit must be undertaken within relevant marine authority approved and audited arrangements by a registered training organisation: 1 As a minimum, assessment of knowledge must be conducted through appropriate written/oral examinations, and 2 Appropriate practical assessment must occur: - i at the registered training organisation; and/or - ii on an appropriate working or training vessel
4 Specific resources required for assessment	Access is required to opportunities to: a participate in a range of practical and theoretical assignments, exercises, case studies and other assessments that demonstrate the skills and knowledge to operate and evaluate the performance of marine engines, propulsion plant and auxiliary systems typically found on a vessel between 750 kW and 3,000 kW propulsion power; and/or b operate, maintain and evaluate the performance of marine engines, propulsion plant and auxiliary systems in a range of operational situations on a commercial or training vessel between 750 kW and 3,000 kW propulsion power

Range Statement

Range Statement

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The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance.

VARIABLE

SCOPE

1. GENERAL CONTEXT

a. Work must be carried out:	1 in compliance with mandatory rules and regulations and IMO Conventions and Codes, including the relevant sections of the AMSA Marine Orders. Applicable codes, guidelines and standards recommended by IMO, the classification societies and maritime industry organisations must be taken into account
b. Work is performed:	1 relatively independently under broad operational requirements, with accountability for self and others in achieving the prescribed outcomes
c. Work involves:	1 the application of marine engineering practice to the operation, repair maintain, monitoring and evaluation of engine (internal combustion and gas turbine) performance on a vessel between 750 kW and 3,000 kW propulsion power in typical operational contexts. Contribution to the development and implementation of a broad plan or strategy for the operation, monitoring and evaluation of engine performance is required and accountability and responsibility for self and others in achieving the outcomes is involved

The Range Statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance.

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| d. Work requires: | 1 significant judgement in planning, engineering and leadership functions related to operation, monitoring and evaluation of engine or gas turbine and propulsion plant performance. This includes management and control of personnel, analysis of the situation and decision making |
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2. WORKSITE ENVIRONMENT

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| a The operation, monitoring and evaluation of engine performance may be carried out: | 1 on an Australian or international commercial vessel between 750 kW and 3,000 kW propulsion power |
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Range Statement (continued)

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VARIABLE	SCOPE
b The operation, monitoring and evaluation of engine performance may be carried out:	1 by day or night in both normal and emergency situations 2 under any permissible conditions of weather 3 while underway 4 during berthing and unberthing operations 5 while anchored or moored 6 when bunkering 7 alongside or during cargo operations

VARIABLE	SCOPE
c Propulsion plant configurations may include:	1 low speed, medium and high speed diesel propulsion 2 stern tube bearing 3 fixed pitch or CPP 4 direct drive shaft or those using a clutch 5 diesel electric 6 steam turbine plant and boilers 7 gas turbine 8 reduction gears 9 thrust blocks, detuners and shaft bearings
d Types of engines, propulsion equipment and related auxiliary machinery may include:	1 diesel, diesel electric and gas turbine propulsion systems and controls 2 steam boilers (as they apply to auxiliary systems) 3 steering gear, stabilisers, bow thrusters, rudders 4 fluid power systems and controls 5 pumps and pumping systems 6 auxiliary systems and controls, including - i fresh and salt water cooling systems - ii lubricating oil cooling systems - iii fuel, oil, gas, coal systems and centrifuges - iv air starting systems - v lubrication - vi air compressors and compressed air and control air systems - vii waste management and pollution control systems

Range Statement (continued)**TDMMR1507B OPERATE, MONITOR AND EVALUATE ENGINE PERFORMANCE ON VESSELS OVER 750 KW PROPULSION POWER**

VARIABLE	SCOPE
d Types of engines, propulsion equipment and related auxiliary machinery may include: (continued)	- vii sewage plant - i - ix portable and fixed firefighting installations and fire control and monitoring systems - x auxiliary boilers and waste heat generators
e Potential hazards during operations and performance evaluation of engines, propulsion plant and auxiliary machinery may include:	1 cold pipes and valves (refrigeration and liquefied gas cargoes) 2 dangerous atmosphere 3 electrical wiring and systems 4 faulty machinery equipment handling equipment and lifting gear 5 flammable liquids, vapours and fuel 6 hot pipes and valves (water, steam, gas, fuel oil, lubricating oil) 7 machinery overload 8 moving and rotating machinery 9 moving heavy loads using unsafe lifting procedures 10 non-compliance with safe working procedures 11 noxious and dangerous cargoes 12 operating equipment beyond safe working limits

VARIABLE	SCOPE
	13 overspeed of electrical machinery, emergency trips 14 poor housekeeping procedures 15 power tools and other sharp tools and implements 16 slippery deck 17 unsecured machinery, components or equipment 18 using equipment beyond safe working limits 19 working at heights and in confined spaces
f Testing and repair equipment may include:	1 Test equipment meters and gauges (including micrometers, vernier callipers, rules) 2 computer displays of performance parameters 3 hand tools, such as spanners, wrenches, screwdrivers, hacksaws, etc. 4 greasing and lubrication tools

Range Statement (continued)

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VARIABLE	SCOPE
f Testing and repair equipment may include: (continued)	5 electric power tools, such as grinders, lathes, drills, etc. 6 pneumatic power tools, such as grinders, sanders, drills, etc. 7 welding equipment 8 block and tackle or a crane 9 portable and manual lifting equipment and hydraulic jacks 10 material safety data sheets

VARIABLE	SCOPE
	11 protective clothing and equipment such as: - i eye and ear protection and safety boots - ii dust and fume masks - iii safety helmet - iv boilersuit/overalls
g Emergencies may include:	1 loss of propulsion 2 loss of electrical power 3 loss of steering 4 flooding of engine room 5 fire or explosion in engine room 6 fuel oil, lubrication oil, steam and gas leaks 7 overheating and overspeed of machinery, governors, emergency trips 8 foundering/grounding of vessel
h Documentation and records may include:	1 ISM Code safety management system plans, procedures, checklists and instructions 2 vessel and company's planned maintenance system, repair procedures and instructions 3 manufacturer's specifications, instructions and recommended procedures for engines (internal combustion and gas turbines), propulsion plant and auxiliary machinery on vessels between 750 kW and 3,000 kW propulsion power 4 operational and performance log, running sheets and records, including computer database of operational and performance records where relevant 5 vessel's survey as it relates to engines (internal combustion and gas turbines), propulsion plant and auxiliary machinery

Range Statement (continued)**TDMMR1507B OPERATE, MONITOR AND EVALUATE ENGINE PERFORMANCE ON VESSELS OVER 750 KW PROPULSION POWER**

VARIABLE	SCOPE
h Documentation and records may include: (continued)	6 relevant sections of national and international regulations, IMO Conventions and Codes, including AMSA Marine Orders and class society rules dealing with the operation and performance evaluation of engines (internal combustion and gas turbines), propulsion plant and auxiliary machinery on vessels between 750 kW and 3,000 kW propulsion power
	7 instructions of relevant maritime authorities and class societies concerning the operation and performance evaluation of engines (internal combustion and gas turbines), propulsion plant and auxiliary machinery
i Applicable legislation, regulations and codes may include:	1 sections of national and international regulations, IMO Conventions and Codes, including AMSA Marine Orders and class society rules related to the operation and performance evaluation of engines (internal combustion and gas turbines), propulsion plant and auxiliary machinery on vessels between 750 kW and 3,000 kW propulsion power
	2 relevant international, Commonwealth, State and Territory OH&S legislation
	3 relevant international, Commonwealth, State and Territory engineering practice standards

Unit Sector(s)

Not applicable.

Field

Field R Carry Out Operations on Equipment and Systems

Relationship to other units

Relationship to other units	The unit may be assessed in conjunction with other units that relate to the functions of the occupation(s) concerned.
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