



Australian Government

MARL6020A Demonstrate advanced knowledge of marine diesel engines and 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 analyse the operation and maintenance of marine diesel engines and systems on a commercial vessel. This includes evaluating fuel, cooling and lubrication systems; analysing starting, manoeuvring and reversing systems; analysing causes of vibration, scavenger fires and explosions; and interpreting combustion diagnostic equipment faults.

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 diesel fuel systems | <ul style="list-style-type: none">1.1 Optimum combustion parameters, means of adjustment and legislation requirements limiting exhaust emissions are analysed1.2 Design modifications of pumps, camshafts and injectors for standard fuel types are evaluated1.3 Variable injection timing and fuel quality adjustments in service are justified, specifying common methods of adjustment1.4 Injection requirements for common diesel engine types, including combustion modifications for changes in engine service rating, are compared1.5 Faults and symptoms of common diesel fuel injection problems are analysed and appropriate adjustment is explained1.6 Work health and safety (WHS)/occupational health and safety (OHS) aspects of testing and handling fuel injection systems are explained1.7 Operation and normal operating pressures and temperatures of <i>fuel systems</i> are analysed |
| 2 Analyse cooling systems for main and auxiliary diesel engines | <ul style="list-style-type: none">2.1 Thermal efficiency optimisation of diesel engines and causes of thermal loads on engine components are explained2.2 Cooling media selection is justified and various diesel-cooling methods are evaluated2.3 Requirements of a coolant are identified2.4 Corrosion principles and combustion side corrosion problems are explained2.5 <i>Appropriate action to be taken with common cooling system faults</i> is evaluated2.6 How cooling systems are commissioned, monitored and stored during idle periods is explained2.7 Reasons for load-dependant cooling of diesel alternators on heavy fuels is explained2.8 Use of additives in cooling water is explained2.9 <i>Normal operating temperatures, pressures and flow paths</i> of typical methods of cooling medium and slow speed diesel engine pistons, exhaust valves, cylinders, turbochargers and cylinder heads |

		are specified
3 Evaluate diesel engine lubrication requirements	3.1	Principles of engine lubrication are explained
	3.2	Different lubrication systems and demands each puts on oil are explained
	3.3	Methods for lubricating marine diesel engine components are specified and common faults are interpreted
	3.4	Conventional and synthetic lubricant properties and applications are identified
	3.5	Sources of contamination and deterioration of lubricants are analysed, treatment, monitoring and testing methods are explained, results are evaluated and appropriate action to be taken is outlined
	3.6	How lubricating oil is distributed to the guides, top-end, bottom-end and main bearings of diesel engines is explained using diagrams showing direction of flow, typical clearances and stating normal operating temperatures and pressures
	3.7	Methods of crosshead lubrication are outlined and compared
	3.8	Methods of medium and slow speed cylinder lubrication are evaluated
4 Analyse diesel engine starting and manoeuvring	4.1	Starting procedures for diesel engines for power generation, propulsion and emergency use are specified
	4.2	Starting and manoeuvring sequences/requirements for direct-coupled reversible and geared propulsion diesels, including CPP applications, are specified
	4.3	Common faults are analysed and appropriate action to be taken with diesel starting and manoeuvring systems is specified
	4.4	Major components of a propulsion diesel engine typical manoeuvring and reversing system are outlined using labelled diagrams, explaining how remote, local and emergency manoeuvring is achieved
	4.5	Methods of achieving reversing capability with direct-coupled propulsion diesels are evaluated
5 Analyse causes of vibration	5.1	Common materials used in diesel engine construction are identified, justifying selection and specifying typical compositions and physical properties of components
	5.2	Dynamic loads and stresses are summarised, identifying service

limitations, and different ***methods of component fabrication and reclamation*** are evaluated

- 5.3 Two- and four-stroke operating cycle forces, couples and moments, relating to design principles of crankshafts, bedplates, foundations and crossheads are analysed
- 5.4 Out-of-balance gas and inertia forces, couples and moments, and their relationship with flywheels, balance weights, first/second order balancing and hull vibration are explained
- 5.5 Factors contributing to torsional vibration are specified and methods of minimising or eliminating harmful effects of critical speeds are outlined
- 5.6 Torsional vibration dampers/detuners are explained using labelled diagrams, indicating construction features and operating principles
- 5.7 Calibration is applied to identify wear patterns, limits and means of restoring working clearances and limits of pistons, liners, piston rings, bearings and crankshafts, sliding surfaces and interference fits of typical diesel engines
- 5.8 Alignment and adjustment criteria of crankshafts, chain-drives, integral thrust bearings and crossheads are specified
- 5.9 Crankshaft deflection measurements are prepared and evaluated, alignment diagrams are constructed, and realignment procedures including restoration of crankshaft shrink-fit slippage, are proposed

6 Analyse scavenge and uptake fires, air-line, crankcase and gearbox explosions

- 6.1 Operational and design factors contributing to waste heat unit fires are assessed
- 6.2 Appropriate strategies for extinguishing/containing soot and hydrogen fires are selected
- 6.3 ***Hazard*** reduction, inspection and isolation in service procedures are established
- 6.4 Operational factors that may contribute to scavenge fires are identified and hazard reduction is planned
- 6.5 Factors contributing to explosive mixtures are analysed and hazard reduction procedures for starting airlines are proposed and evaluated
- 6.6 Inspection and test intervals are specified
- 6.7 Causes of gearbox and crankcase explosions in propulsion and auxiliary drives are revised

- 6.8 How risks may be minimised in service by hazard reduction is specified
- 6.9 Procedures to be implemented for hazardous atmosphere warning in oil and dual-fuel engines are evaluated
- 6.10 Relevant diagrams are used to identify operating principles of oil-mist detectors, crankcase breathers and explosion relief doors
- 6.11 Maintenance strategies are developed and criteria for piston rod scraper box inspection and maintenance intervals are specified
- 7 **Plan safe working practices associated with diesel engine maintenance, operation and repair**
 - 7.1 ***Safe working practices for isolating main and propulsion diesels*** under all operational contingencies are planned
 - 7.2 ***Safe working practices for machinery in enclosed spaces*** are planned
 - 7.3 Hazard reduction procedures for safe working with flammable liquids under pressure, chemicals, acids and hydrocarbons associated with engine overhaul and maintenance are planned
 - 7.4 Safe working strategies for diesel engine maintenance are planned according to manufacturer instruction manuals and product data safety sheets
- 8 **Interpret combustion diagnostic equipment faults and relate to fuel injection and pressure charging systems**
 - 8.1 Two- and four-stroke theoretical cycle diagrams are produced and discrepancies with results recorded by diagnostic tools are accounted for
 - 8.2 Combustion faults related to fuel injection and pressure charging systems are diagnosed, corrective action is specified and service values with trials or test bed figures are analysed
 - 8.3 Methods of pressure charging diesel engines are evaluated, efficiencies are determined from records, efficiency losses are accounted for and means of correction are identified
 - 8.4 Maintenance and emergency procedures for turbochargers and charge air coolers are planned
 - 8.5 ***Design features of turbochargers and charge air coolers*** are evaluated
 - 8.6 ***Relevant diagrams*** are applied to evaluate diesel scavenging systems, under normal and emergency operation modes

Required Skills and Knowledge

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

Required Skills:

- Access diagnostic information related to marine diesel engines and systems
- Assess own work outcomes and maintain knowledge of current codes, standards, regulations and industry practices
- Explain operation of marine diesel engines and systems, and impart complex information and ideas verbally, in writing and visually
- Identify and apply relevant solutions for addressing problems associated with marine diesel engines and systems
- Identify and interpret complex diagnostic information and perform mathematical calculations related to operating, repairing and maintaining marine diesel engines and systems
- Identify methods, procedures and materials needed for operating, maintaining and repairing marine diesel engines and systems
- Read and interpret manuals, technical specifications, safety data sheets (SDS)/material safety data sheets (MSDS) and manufacturer guides related to operating, repairing and maintaining marine diesel engines and systems

Required Knowledge:

- Basic principles of diesel engine operation
- Causes of vibration
- Combustion diagnostic equipment faults
- Components of diesel engines
- Cooling systems for main and auxiliary diesel engines
- Crankcase and air-line explosions, scavenge and uptake fires
- Diesel engine:
 - components
 - lubrication requirements
 - lubrication systems
 - propulsion and power generation
 - starting and manoeuvring
- Diesel fuel systems
- Fuel injection and pressure charging systems
- Manoeuvring systems of diesel engines
- Pressure charging diesel engines, including common service faults, actions to rectify faults, emergency operation and isolation procedures
- Properties and characteristics of fires

- Safe working practices associated with diesel engine maintenance, operation and repair
- Scavenge and uptake fires, air-line, crankcase and gearbox explosions
- Starting methods of diesel engines
- Turbocharger operation
- WHS/OHS legislation, policies and procedures

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:

- performing accurate and reliable calculations
- developing effective planning documents
- producing accurate and reliable information.

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 diesel engines and systems can be demonstrated
- diagrams, specifications and other information required for performing basic calculations related to marine diesel engines and systems
- technical reference library with current publications on marine diesel engines and 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 diesel engines and 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.

Fuel systems may include:	• Conventional, low-inertia and dual-fuel (oil fuel/gas) injectors • Fuel line pulsation damping devices • Leakage protection • Uni-fuel and dual-fuel systems (high/medium viscosity fuel types)
Appropriate action to be taken with common cooling system faults may include:	• Contamination • Different cooling water treatments
Normal operating temperatures, pressures and flow paths may include:	• Bore cooling techniques • Honeycomb techniques • Strong-back techniques
Sources of contamination may include:	• Bacterial infection
Methods of medium and slow speed cylinder lubrication may include:	• Optimisation • Running-in requirements • Speed and load-dependant lubrication
Methods of component fabrication and reclamation may include:	• Ceramics • Composite • Forged • Laser-hardening • Plasma-spraying • Welded
Hazards may include:	• Acids • Chemicals • Defective or bypassed machinery protective devices • Defective or inappropriately adjusted exhaust systems • Enclosed spaces • Flammable liquids under pressure • Hydrocarbons • Leaking oil and fuel • Lifting heavy components both unaided and with lifting gear
Safe working practices for isolating main and propulsion diesels may include:	• Identifying hazards • Minimising hazards

Safe working practices for machinery in enclosed spaces may include:

- Handling heavy components
- Use of hydraulic tools

Design features of turbochargers and charge air coolers may include:

- Bearing types
- Materials

Relevant diagrams must include:

- Light spring diagrams

Unit Sector(s)

Not applicable.

Competency Field

Marine Engineering