



Australian Government

MARL050 Demonstrate advanced knowledge of marine diesel engines and systems

Release: 1

MARL050 Demonstrate advanced knowledge of marine diesel engines and systems

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 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, scavenge fires and explosions; and interpreting combustion diagnostic equipment faults.

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

- 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 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 diesel fuel systems

- 1.1** Optimum combustion parameters, means of adjustment and legislation requirements limiting exhaust emissions are determined and analysed
- 1.2** Design modifications of pumps, camshafts and injectors for standard fuel types are evaluated
- 1.3** Variable injection timing and fuel quality adjustments in service are justified, specifying common methods of adjustment
- 1.4** Injection requirements for common diesel engine types, including combustion modifications for changes in engine service rating, are compared
- 1.5** Faults and symptoms of common diesel fuel injection problems are analysed and appropriate adjustments are explained
- 1.6** Work health and safety (WHS)/occupational health and safety (OHS) aspects of testing and handling fuel injection systems are explained
- 1.7** Operation and normal operating pressures and temperatures of fuel systems are analysed, including uni-fuel and dual fuel systems of varying viscosity fuel types

2 Analyse cooling systems for main and auxiliary diesel engines

- 2.1** Thermal efficiency optimisation of diesel engines and causes of thermal loads on engine components are explained
- 2.2** Cooling media selection is justified, and advantages and disadvantages of various diesel cooling methods are evaluated
- 2.3** Requirements of a coolant are identified and recorded
- 2.4** Corrosion principles and combustion side corrosion problems are explained

- 2.5 Appropriate action to be taken with common cooling system faults is established and evaluated
- 2.6 How cooling systems are commissioned, monitored and stored during idle periods is explained
- 2.7 Reasons for load-dependant cooling of diesel alternators on heavy fuels is explained
- 2.8 Use of additives in cooling water is explained, including water treatment
- 2.9 Normal operating temperatures, pressures and flow paths 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 different lubricant properties are explained and assessed
 - 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 actions to be taken are outlined
 - 3.6 Diagrams showing direction of flow, typical clearances and stating normal operating temperatures and pressures are used to explain how lubricating oil is distributed to the guides, top-end, bottom-end and main bearings of diesel engines
 - 3.7 Methods of crosshead lubrication are outlined and compared
 - 3.8 Methods of medium and slow-speed cylinder lubrication are evaluated
 - 3.9 Bearing materials and faults are evaluated and remedies to prevent them from occurring are determined
- 4 **Analyse diesel engine starting and**
 - 4.1 Starting procedures for diesel engines for power generation, propulsion and emergency use are specified

manoeuvring	4.2	Starting and manoeuvring sequences/requirements for direct-coupled reversible and geared propulsion diesels, including controllable pitch propeller (CPP) applications, are determined
	4.3	Common faults are analysed and appropriate actions to be taken with diesel starting and manoeuvring systems are determined
	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
	4.6	Layout of a diesel-electric drive is compared and contrasted with the layout of a turbo-electric drive
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 of waste heat units in service procedures are established
	6.4	Operational factors that may contribute to scavenge fires are identified and methods of extinguishing and hazard reduction are determined
	6.5	Factors contributing to explosive mixtures are analysed and hazard reduction procedures for starting air systems are proposed and evaluated
	6.7	Causes of gearbox and crankcase explosions in propulsion and auxiliary drives are revised
	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, including use of protective devices, interlocks and evaluation of their status
	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 safety data sheets (SDS)/material safety data sheets (MSDS)
	7.5	Safe working practices associated with safe handling of hydraulic tools and dangers of lifting/isolating heavy components both unaided and with lifting gear are explained
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
9. Analyse construction and operation of marine gas turbines	9.1	Flow of air and gas through a simple cycle marine gas turbine is analysed
	9.2	Materials and construction of compressor, combustion system and turbine in single and two-shaft designs are outlined
	9.3	Controls required for control and protection of marine gas turbines are detailed
	9.4	Functions of accessories necessary for safe operation of marine gas turbines are explained

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 MARL027 Demonstrate intermediate knowledge of marine diesel engines and systems.

This unit replaces and is equivalent to MARL033 Demonstrate advanced knowledge of marine diesel engines and systems.

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 MARL050 Demonstrate advanced knowledge of marine diesel engines and systems

Modification History

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

Performance 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 on at least one occasion and include:

- accessing diagnostic information related to marine diesel engines and systems
- applying relevant work health and safety (WHS)/occupational health and safety (OHS) requirements and work practices
- assessing own work outcomes and maintaining knowledge of current codes, standards, regulations and industry practices
- explaining operation of marine diesel engines and systems, and imparting complex information and ideas verbally, in writing and visually
- identifying and applying relevant solutions for addressing problems associated with marine diesel engines and systems
- identifying and interpreting complex diagnostic information and performing mathematical calculations related to operating, repairing and maintaining marine diesel engines and systems
- identifying methods, procedures and materials needed for operating, maintaining and repairing marine diesel engines and systems
- reading and interpreting 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.

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:

- appropriate actions to be taken with common cooling, including:
 - contamination
 - different cooling water treatments
- causes of vibration
- combustion diagnostic equipment faults
- common service faults, actions to rectify faults, emergency operation and isolation procedures
- cooling systems for main and auxiliary diesel engines

- crankcase and air-line explosions, scavenge and uptake fires
- design features and operating mechanism of marine diesel engine and associated auxiliaries, including:
 - combustion chamber components of diesel engine
 - fuel injection equipment of diesel engine
 - operative mechanism of diesel engine systems
 - piston rings, compatibility to cylinder liner and cylinder lubrication employed in a diesel engine
 - running gear of diesel engine
 - structure of diesel engine
- design features of turbochargers and charge air coolers, including:
 - bearing types
 - materials
- design features and operative mechanism of marine diesel engine and associated auxiliaries, including:
 - material selection and design features of the:
 - combustion chamber components of diesel engine
 - diesel engine system
 - fuel injection equipment of diesel engine
 - piston rings, compatibility to cylinder liner and cylinder lubrication employed in a diesel engine
 - running gear of diesel engine
 - structure of diesel engines
- diesel engines, including:
 - components
 - condition monitoring
 - engine system diagnostics
 - lubrication requirements
 - lubrication systems
 - propulsion and power generation
 - starting and manoeuvring
- diesel fuel systems
- fuel injection and pressure charging systems
- fuel systems, including:
 - 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)
- hazards, including:
 - 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
- manoeuvring systems of diesel engines
- methods of:
 - component fabrication and reclamation, including:
 - ceramics
 - composite
 - forged
 - laser-hardening
 - plasma-spraying
 - welded
 - medium and slow cylinder lubrication, including:
 - optimisation
 - running-in requirements
 - speed and load-dependant lubrication
- normal operating temperatures, pressures and flow paths, including:
 - bore cooling techniques
 - honeycomb techniques
 - strong-back techniques
- multi-engine propulsion arrangement
- pressure charging diesel engines
- principles of diesel engine operation, including precautions and procedures
- relevant diagrams, including light spring diagrams
- scavenge and uptake fires, air line, crankcase and gearbox explosions
- sources of contamination, including bacterial infection
- starting and reversing methods of diesel engine
- turbocharger operation
- WHS/OHS requirements and safe work practices, including:
 - diesel engine control and safety
 - diesel engine emergency operation
 - isolating main and propulsion diesels, including:
 - identifying hazards
 - minimising hazards
 - machinery in enclosed spaces, including:

- handling heavy components
- using hydraulic tools
- safe working practices associated with diesel engine maintenance, operation and repair.

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 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:

- relevant documentation, including workplace procedures, regulations, codes of practice and operation manuals
- tools, equipment, materials, relevant personnel and personal protective equipment (PPE) currently used in industry.

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