Australian Government

MARL052 Demonstrate advanced knowledge of marine steam turbines and main boilers

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.

Application

This unit involves the skills and knowledge required to operate and maintain main steam propulsion plant and associated control systems on a commercial vessel. It includes analysing: methods of improving plant efficiency; changes in feed system that occur during fluctuating loads; design and construction of high-pressure water tube boilers and ancillary equipment; operation, maintenance and performance of high-pressure water tube boilers and ancillary equipment; turbine operation, maintenance and performance; and turbine-gearing performance.

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	**Analyse methods of improving plant efficiency**	**1.1**	Heat losses in a turbine and turbine system are analysed
		1.2	An enthalpy/entropy diagram is used to show how steam properties change through a turbine
		1.3	The effect air heaters and economisers have on turbine plant efficiency is explained
		1.4	Increase in Rankine efficiency of plant by increasing the pressure and temperature is analysed
		1.5	How regenerative feed heating and steam reheating increases overall plant efficiency is shown on an enthalpy/entropy diagram
		1.6	Practical methods of verifying energy losses are detailed
2	**Explain construction and operation of feed system**	**2.1**	Operation and components of the complete feed system are outlined
		2.2	Construction, operating principles and maintenance requirements of a regenerative condenser are explained
		2.3	Causes of loss of vacuum are identified and test procedure to identify leaks in a condenser is created
		2.4	Construction and operation of air ejectors, vacuums and extraction pumps are explained
		2.5	Construction and operation of gland condensers, low-pressure heaters, drain coolers and high-pressure heaters are explained
		2.6	General arrangement and construction of turbo feed pumps is outlined

		2.7	Operating principles and construction details of de-aerators are explained
3	**Analyse changes in feed system that occur during fluctuating loads**	**3.1**	Changes that occur during fluctuating loads are identified, detailing how make up to the system and dump from the system are performed
		3.2	Condenser level control methods, how condenser is supported and how expansion stresses are avoided are explained
		3.3	Loss of efficiency when heat transfer rate is interrupted is explained
		3.4	Types, features, common defects and maintenance requirements of two-stage and super cavitating extraction pumps are compared and contrasted
		3.5	Operation of a vacuum pump for air removal from a condenser is explained
		3.6	Operation of a turbo feed pump differential pressure governor taking into account constant pressure, increasing pressure and decreasing pressure differential governing is explained
		3.7	Alarms, shutdowns, automatic cut-in arrangements and testing of over speed trips for a boiler feed pump are outlined
4	**Analyse design and construction and repair of high-pressure water tube boilers and ancillary equipment**	**4.1**	Various propulsion boiler designs are compared
		4.2	Operating principles and construction methods of integral and external superheaters are explained
		4.3	Drum, internal fittings and support and expansion arrangements are outlined
		4.4	Procedures for repairing a membrane wall furnace are clarified
		4.5	Operating principles of high-pressure boilers, including water and gas flow circulation, are explained

		4.6	Temperature load relationships and temperature control of superheater are analysed
		4.7	Operation of superheater with parallel, contra and cross flow of gas/steam flow is predicted
		4.8	Correct material for high temperature operation of superheater tubes and headers is identified
		4.9	Construction and operation of economisers and air heaters is explained
		4.10	Chemistry of combustion is explained
		4.11	Burner tip design and operation for steam atomising oil burners are compared
		4.12	Typical burner register arrangements are outlined
		4.13	Construction, operation and maintenance of boiler gauge glasses and safety valves is explained
		4.14	Operation of boiler control and soot blowing system is detailed
		4.15	Features of a three-element water level control system and relationship with burner management system are outlined
		4.16	Operation of a combustion control system fitted with cross limits on air and fuel is explained
		4.17	Blow-down procedure for a high-pressure boiler is prepared
5	**Analyse operation, maintenance and performance of high-pressure water tube boilers and ancillary equipment**	**5.1**	Warm-through procedure and checks to be carried out before connecting boiler to range are explained
		5.2	How boiler is laid up for short and/or long periods is explained
		5.3	Actions required after oil or saltwater contamination are detailed
		5.4	Chemical cleaning procedure to remove scale and oil

			deposits from internal surfaces of a boiler is explained
		5.5	Tube failures are identified, and suitable methods of repair are selected
		5.6	Defects that can occur in economisers and how they can be repaired are listed
		5.7	Maintenance inspection procedures to prevent superheater and economise fires are produced
		5.8	Procedure to combat soot and steam/iron fires in generating banks, superheaters and economisers is outlined
		5.9	Coordinate and congruent feed water treatment is illustrated on a caustic/phosphate graph
		5.10	Different feed water tests, procedures for each test and appropriate chemical treatments are explained
		5.11	Program for an internal and external survey of a water tube boiler is compiled, defects that may be found and repair methods that will enable boiler to be returned to service are listed
		5.12	Procedures for setting lift, adjusting blow-down of safety valves and carrying out an accumulation test on a boiler are outlined
6	**Explain requirements for feed water treatment for high-pressure water tube boilers**	**6.1**	How salts are precipitated and how metal is corroded in the boiler and feed system is explained and method of prevention is outlined
		6.2	How oxygen is eliminated in high-pressure boilers is shown
		6.3	How pH is measured and controlled is explained
		6.4	Normal and maximum operating limits for boiler feed water treatment are identified and procedure to follow if these limits are exceeded is clarified
		6.5	Different feed water tests, procedure for each test and appropriate chemical treatments are explained
		6.6	Coordinate and congruent feed water treatment is illustrated on a caustic/phosphate graph

	Explain construction and operation of high-pressure turbines	**7.1**	Flow of steam through nozzles is analysed, and pressure and velocity compounding are illustrated
		2.2	Construction of blades, bearings, glands, rotors and casings is explained
		7.3	Warming-through procedure prior to start-up is explained
		7.4	Routine checks during operation are detailed
		7.5	Emergency operation of plant with one turbine inoperative is outlined
		7.6	Turbine shutdown procedure is clarified
		7.7	Procedures for opening up turbine for survey, routine checks of blades, casings, rotors, bearings, glands, drains and the reassembly of turbine are explained
		7.8	Precautions necessary when turbine and gearing casings are open are explained and any repairs or adjustments that may be required are identified
8	**Analyse turbine operation, maintenance and performance**	**8.1**	Relationship between sequential nozzle operation and bar lift in steam turbines is explained
		8.2	Principle of operation of different trips and cut-outs is explained
		8.3	Differentiation is made between resonance and critical speed, and their effect on the turbine operation is explained
		8.4	Types of turbine vibration and where each type is found in a turbine is analysed
		8.5	System torsional vibration and effect of operating at critical speeds and in-built design elements required to avoid critical speeds are explained
		8.6	Back pressure and self-condensing turbo alternators are compared
		8.7	Governor system is explained

		8.8	Turbine control systems are explained
		8.9	Procedure for straightening a bowed turbine rotor is outlined
		8.10	Effect of hull fouling, sea state and propeller design on turbine performance is discussed
		8.11	Limits for extended operation and overload operation are discussed
9	**Analyse turbine gearing arrangements and performance**	**9.1**	Single and double reduction gearing systems are compared and contrasted
		9.2	Features and applications of double helical involute gear teeth are outlined
		9.3	Advantages and disadvantages of single and double locked train gearboxes are analysed
		9.4	Construction and reason for installing flexible couplings in gearing system is explained
		9.5	Purpose of fitting a nodal drive in gearing system is clarified
		9.6	Features, functions and applications of star, planetary and solar epicyclic gearing are compared and contrasted
		9.7	Space savings resulting from use of epicyclic gearing are analysed
		9.8	Layout of a turbo-electric drive is detailed
10	**Analyse flow of air and gas through a simple cycle marine gas turbine**	**10.1**	Construction of compressor, combustion system and single and two shaft turbines is explained
		10.2	Necessary controls required for control and protection of plant are confirmed
		10.3	Accessories necessary for safe operation of simple cycle marine gas turbines are listed

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 MARL029 Demonstrate intermediate knowledge of marine steam turbines and main boilers.

This unit replaces and is equivalent to MARL035 Demonstrate advanced knowledge of marine steam turbines and main boilers.

Links

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