Australian Government

MARL015 Apply intermediate principles of marine engineering thermodynamics

Release: 1

MARL015 Apply intermediate principles of marine engineering thermodynamics

Modification History

Release 1. New unit of competency.

Application

This unit involves the skills and knowledge required to apply intermediate principles of marine engineering thermodynamics to perform calculations and explain the operation of marine machinery, including engines, compressors, steam plants, refrigeration and air-conditioning units.

This unit applies to the work of a Marine Engineer Class 2 on commercial vessels greater than 3000 kW and forms part of the requirements for the Certificate of Competency Marine Engineer Class 2 issued by the Australian Maritime Safety Authority (AMSA).

No licensing, legislative or certification requirements apply to this unit at the time of publication.

Pre-requisite Unit

Not applicable.

Competency Field

L – Marine Engineering

Unit Sector

Not applicable.

Elements and Performance Criteria

Elements describe the essential outcomes.	Performance criteria describe the performance needed to demonstrate achievement of the element.
1 Calculate heat mixtures involving water equivalent, change of phase, and feed heating	1.1 Key terms associated with heat transmission are explained
	1.2 Heat transfer is calculated between liquids and solids using water equivalent
	1.3 Flow is differentiated from non-flow heating and cooling processes
	1.4 Effects of superheating and sub-cooling on steam plant

			efficiency are outlined
		1.5	Mass balance throughout a steam plant cycle is constructed and effects of pressure and temperature on cycle efficiency are analysed
2	**Determine fluid properties of steam**	2.1	Relationship between saturated and superheated steam, including dryness fraction, is explained
		2.2	Regions on a temperature/enthalpy diagram are constructed and identified
		2.3	Steam tables are used to determine fluid properties
		2.4	Changes of enthalpy throughout a system are identified
		2.5	Operating principles and application in steam plants of throttling, separating and combined throttling, and separating calorimeters are explained
		2.6	Calorimeters are applied to determine dryness fraction of steam
3	**Calculate boiler efficiency and boiler water density**	3.1	Efficiency of saturated and superheated steam boilers is calculated
		3.2	Where loss of efficiency occurs is shown
		3.3	Concept of parts per million for density of boiler water is explained
		3.4	Changes in boiler water density due to contaminated feed are calculated
		3.5	How acceptable dissolved solids and water levels may be maintained in a boiler is shown
4	**Determine steam turbine velocity**	4.1	Principles and differences between pressure and velocity changes in reaction and impulse steam turbines are explained
		4.2	Velocity diagrams to calculate steam velocity at exit of nozzles and blades are applied
		4.3	Graphical and mathematical methods to determine blade angle, steam velocity, thrust, power, and efficiency of single stage impulse and reaction steam turbines are applied
5	**Calculate calorific value and the air fuel**	5.1	Elements and compounds present in fuel and the products of combustion are evaluated

	ratio for solid and liquid fuels	5.2	Air/fuel ratio, gravimetric and volumetric analysis are explained
		5.3	Chemical equations for combustion elements and compounds are developed and elements of combustion are analysed
		5.4	Bomb calorimeter is used to find calorific value of a fuel
		5.5	Formula to calculate calorific value of a fuel from mass analysis of fuel is applied
		5.6	Air required for combustion is calculated
6	**Calculate thermal expansion**	6.1	Coefficient of linear expansion and its significance to different materials is explained
		6.2	Clearances and shrunk fit allowances are calculated
		6.3	Stresses generated with restricted expansion are calculated
		6.4	Volumetric expansion of solid and liquids, and allowance required for fluid expansion in tanks and systems is calculated
7	**Apply gas law equations**	7.1	Compression and pressure ratio is explained and related to combined gas law equation
		7.2	Combined gas law equation is applied to constant volume and constant pressure processes
		7.3	Specific gas constant of a gas or mixture of gases is calculated
		7.4	Differentiation is made between specific heat of gases, ratio of specific heats, work and change in internal energy
		7.5	Changes in internal energy associated with specific heat of gases, ratio of specific heats and work are calculated
8	**Calculate gas conditions, work and thermal efficiency of internal combustion engines**	8.1	Processes associated with expansion and compression of gases are explained
		8.2	Gas conditions and index of compression at end of each process are determined
		8.3	Work formula is derived for each process and derived formula is applied to calculate work and power per cycle
		8.4	Air standard cycle is applied to determine amount of fuel consumed and work produced by an internal combustion

		engine
	8.5	Differentiation is made between air standard efficiency and thermal efficiency
	8.6	Thermal efficiency of engine cycles is calculated
9 Perform calculations related to refrigeration and air conditioning cycles	9.1	Pressure/enthalpy diagram is applied to describe the refrigeration cycle
	9.2	Importance of superheating and under-cooling in determining stability and well-functioning of refrigeration systems is explained
	9.3	Properties and hazards of refrigerants used in refrigeration and air conditioning systems are identified
	9.4	Refrigeration tables are applied to calculate refrigeration effect, cooling load and coefficient of performance
	9.5	Basic air conditioning cycles are explained
	9.6	Wet and dry bulb temperatures are explained
	9.7	Humidity conditions are determined using psychrometric charts
10 Solve heat transfer problems involving flat plates and thin cylinders	10.1	Different forms of heat transfer are identified
	10.2	Heat flow through composite flat plates using thermal conductivity is calculated
	10.3	Interface temperatures of composite flat layers are calculated
	10.4	Radial conduction of heat through a thin cylinder is calculated
11 Solve problems related to single and multi stage air compression	11.1	Pressure–volume diagram is applied to describe operating cycle of reciprocating compressors
	11.2	Work done by constant pressure, isothermal processes and polytropic processes in reciprocating compressors is calculated
	11.3	Effect of clearance volume on efficiency of reciprocating compressors is explained
	11.4	Volumetric efficiency and free air discharge in reciprocating compressors is calculated

	11.5 Volume, mass flow and temperature are calculated at completion of each process in reciprocating compressors
	11.6 How inter-cooling and after-cooling affects overall efficiency of reciprocating compressors is explained
	11.7 Quantity of cooling water required by reciprocating compressors is calculated
12 Perform calculations related to engine power and heat balances	12.1 Indicator and timing diagrams for internal combustion engines are plotted
	12.2 Formula is applied to solve problems related to indicated power of internal combustion engines
	12.3 Formula is applied to solve problems related to brake power of internal combustion engines
	12.4 Morse test is applied to determine the indicated power of internal combustion engines
	12.5 Tabular and graphical heat balance diagrams are applied to calculate mechanical, thermal and overall efficiencies of internal combustion engines

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.

Key terms include:	• enthalpy of fusion • evaporation • sensible heat • transfer of heat energy
Processes include one or more of the following:	• adiabatic • isothermal • polytropic

Fluid properties include one or more of the following:	• density • dryness faction • enthalpy of water • pressure • saturated steam • specific volume • superheated steam • temperature
Forms of heat transfer must include:	• conduction • convection • radiation

Unit Mapping Information

This unit replaces and is equivalent to MARL6002A Apply intermediate principles of marine engineering thermodynamics.

Links

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