Australian Government

MARL6006A Apply advanced principles of marine engineering thermodynamics

Release 1

INDUSTRY SKILLS COUNCILS
Creating Australia's Future

MARL6006A Apply advanced principles of marine engineering thermodynamics

Modification History

Release 1
This is the first release of this unit.

Unit Descriptor

This unit involves the skills and knowledge required to apply advanced principles of marine engineering thermodynamics to perform calculations and explain the operation of marine machinery, including internal combustion and gas turbine engines, air compressors, steam condensers and refrigeration units.

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

1	**Calculate heat energy with and without phase change**	1.1	Enthalpy is applied to heat mixture calculations with or without phase change
		1.2	Enthalpy is applied to calculate resultant conditions of hot wells involving multiple returns
		1.3	Steam conditions in a system when using throttling devices and separators are calculated
		1.4	Entropy is distinguished from enthalpy
		1.5	Entropy values are determined from standard tables
2	**Analyse change of phase and state diagrams**	2.1	***Tables and/or diagrams*** are use to find enthalpy and entropy values for liquid, part liquid-part vapour and vapour states
		2.2	Carnot cycle is outlined
		2.3	Rankine cycle is outlined
		2.4	Isentropic efficiency is explained
		2.5	Problems are solved involving the efficiency of steam turbines operating in the Rankine cycle
3	**Apply Dalton’s law of partial pressures to steam condensers**	3.1	Dalton’s Law is applied to calculate air and condensate extraction from condensers
		3.2	Problems are solved involving cooling water mass flow and cooling water pump work
4	**Apply chemical equations for complete and incomplete combustion**	4.1	Atomic and molecular weights and kilogram-mol are explained
		4.2	Calorific value of a fuel is calculated by chemical formula
		4.3	Mass of air required for stoichiometric combustion is calculated by gravimetric and volumetric analysis
		4.4	Air fuel ratio is determined when supplied with composition of fuel and exhaust gas analysis

5 Apply gas laws to analyse internal combustion engine efficiencies	5.1 Universal gas constant form AVOGADRO S hypothesis is determined
	5.2 Heat transfer is calculated for constant volume and constant pressure processes
	5.3 First law of thermodynamics is applied to ***thermodynamic processes*** in a closed system
	5.4 Second law of thermodynamics is applied to find thermal efficiency of Carnot cycle
	5.5 Mathematical formula is applied to solve problems related to ideal constant volume air standard cycle
	5.6 Mathematical formula is applied to solve problems related to diesel and dual cycles
6 Calculate performance of internal combustion and gas turbine engines	6.1 P/V and out of phase engine indicator diagrams are analysed
	6.2 Work, power, mean effective pressure and thermal efficiency of internal combustion engine cycles is calculated
	6.3 Heat transfer to jacket cooling systems is calculated
	6.4 Open and closed systems for gas turbines are outlined
	6.5 Temperature/entropy diagrams are applied to illustrate gas turbine cycles
	6.6 Power, isentropic efficiencies, thermal efficiency, work and fuel consumption for gas turbine cycles is calculated
	6.7 Methods to increase efficiency of gas turbines are specified
	6.8 Reheaters and intercoolers and how they improve efficiency is explained
7 Analyse air compressor performance	7.1 Compressor types are classified
	7.2 Volumetric efficiency at free air conditions is explained

	7.3 Work is calculated for isothermal and adiabatic compression, and effect of clearance for reciprocating compressor
	7.4 Pressure ratio for compressor types is analysed
	7.5 Problems are solved relating to multi-staging and intercooling
	7.6 Heat transfer to air or cooling water from an air compressor is calculated
	7.7 Formula to calculate work and efficiency of centrifugal compressors is derived
8 Analyse vapour compression refrigeration cycles	8.1 Design parameters for a vapour compression cycle are explained
	8.2 Pressure/enthalpy diagram is prepared for a refrigeration cycle
	8.3 Heat rejected, work done and coefficient of performance (COP) for a basic cycle is calculated
	8.4 Effect of sub cooling and superheating is shown on a temperature/entropy diagram
	8.5 COP is calculated with evaporators operating at two different pressures
9 Apply psychrometric principles to solve air conditioning problems	9.1 Comfort conditions for air conditioning systems are defined
	9.2 Key ***parameters*** used in defining air condition are illustrated on a psychrometric chart
	9.3 Cooling loads are calculated
	9.4 Problems associated with air delivering and distribution methods are analysed
	9.5 ***Methods*** of controlling noise and vibration in air conditioning systems are analysed
10 Analyse different methods of heat transfer	10.1 Heat flow through composite divisions is calculated
	10.2 Insulation dimensions and interface temperatures are determined

10.3 Problems relating to radiated energy are solved by applying Stefan-Boltzmann Law

10.4 Problems in heat exchangers are solved by applying log mean temperature difference

10.5 Relative efficiency of contra-flow heat exchange is determined

Required Skills and Knowledge

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

Required Skills:

- Assess own work outcomes and maintain knowledge of current codes, standards, regulations and industry practices
- Explain advanced principles of marine engineering thermodynamics
- Identify and apply relevant mathematical formulas and techniques to solve advanced problems related to marine engineering thermodynamics
- Identify and interpret numerical and graphical information, and perform advanced mathematical calculations related to marine engineering thermodynamics, such as calculation of power, isentropic efficiencies, thermal efficiency, work and fuel consumption for gas turbine cycles
- Identify, collate and process information required to perform advanced calculations related to marine engineering thermodynamics
- Impart knowledge and ideas through verbal, written and visual means
- Read and interpret written information needed to perform complex calculations related to marine engineering thermodynamics
- Use calculators to perform complex mathematical calculations

Required Knowledge:

- Atomic and molecular weights and the kilogram-mol
- Daltons Law of partial pressures
- Enthalpy
- Gas laws
- Gas turbines
- Heat transfer:
  - methods
  - principles
- Internal combustion engine cycles
- Laws of Thermodynamics
- Noise and vibration control:
  - fundamentals of sound
  - noise and vibration problems
  - methods of control
- Operating cycle of reciprocating air compressors
- Operating principles of two-stroke and four-stroke internal combustion engines
- Principles of refrigeration

- Rankine cycle
- System International (SI) units
- Thermal efficiency calculations
- Thermodynamic principles
- Work health and safety (WHS)/occupational health and safety (OHS) requirements and work practices

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:

- making accurate and reliable calculations
- solving problems using appropriate laws and principles.

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 principles of marine engineering thermodynamics can be applied
- diagrams, specifications and other information required for performing advanced calculations related to marine engineering thermodynamics
- technical reference library with current publications on marine thermodynamics
- 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 applying advanced

	principles of marine engineering thermodynamics • 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.

Tables and/or diagrams may include:	• Pressure–enthalpy • Pressure–specific volume • Specific enthalpy–specific entropy • Temperature–pressure • Temperature–specific enthalpy • Temperature–specific entropy
Thermodynamic processes may include:	• Adiabatic • Isobaric • Isochoric • Isothermal • Polytropic
Parameters may include:	• Adiabatic saturation or constant enthalpy • Humidifying or dehumidifying and • Latent heat • Sensible heat
Methods may include:	• Duct attenuators • Duct lining • Lined duct splitters • Lined plenums • Natural attenuation • Sound absorbing materials/placement • Vibration isolators • White noise

Unit Sector(s)

Not applicable.

Competency Field

Marine Engineering