Australian Government

MARL5002A Apply basic principles of marine engineering thermodynamics

Release 1

INDUSTRY SKILLS COUNCILS
Creating Australia's Future

MARL5002A Apply basic 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 basic principles of marine engineering thermodynamics to perform calculations and to explain the operation of marine machinery, including engines, compressors, steam plants, refrigeration and air-conditioning units.

Application of the Unit

This unit applies to the work of Marine Engineering Watchkeepers on commercial vessels greater than 750 kW and forms part of the requirements for the Certificate of Competency Marine Engineer Watchkeeper 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 Explain common thermodynamic principles	1.1 Desired System International (SI) units applicable to thermodynamic calculations are developed
	1.2 Basic properties of fluids are outlined
	1.3 Gauge pressure is distinguished from absolute pressure
	1.4 Temperature is defined and temperature scales are outlined
	1.5 Calculations are performed by applying formulae for work, power and efficiency
2 Calculate properties of gas during expansion and compression	2.1 Calculations are performed by applying Boyle's, Charles's and combined gas law
	2.2 Gas equation is derived and applied to gas process calculations
	2.3 Specific heat of gases and the relationship between Cp, Cv, R and Gamma is defined
	2.4 Heat transfer is calculated for constant pressure and constant volume processes
	2.5 Isothermal, adiabatic and polytropic processes are outlined and properties of gases after expansion and compression including the effects of turbocharging are calculated
	2.6 Work required to compress gases is illustrated and calculated
3 Explain methods of heat transfer	3.1 Different forms of heat transfer and their application to marine systems are explained
	3.2 Heat transfer through flat layers is calculated
	3.3 Purpose of insulation is explained
4 Explain enthalpy and apply to mixture calculations	4.1 Heat energy is defined
	4.2 Fundamental formula for heat energy transfer is developed
	4.3 Specific heat and its application are identified
	4.4 Enthalpy and change of phase are outlined
	4.5 Heat mixture problems involving water equivalent, ice, water and steam are solved
	4.6 Specific heat of materials are calculated

	4.7	Latent heat and dryness fraction are identified
	4.8	Steam tables are used to find values of enthalpy for water, saturated and superheated steam and dryness fraction
	4.9	Temperature/enthalpy diagram is constructed from steam table data
5 Explain steam plants and calculate thermal efficiency	5.1	Basic steam plant cycles are sketched and function of each component is outlined
	5.2	Steam cycles on a temperature/enthalpy diagram are illustrated
	5.3	Effects of superheating and under cooling are clarified
	5.4	Calculations are performed for heat supplied, rejected, work and thermal efficiency of a steam plant
	5.5	Methods of improving cycle efficiency are outlined
6 Explain operation of internal combustion engine cycles	6.1	Operating principles of two stroke and four stroke internal combustion engines are outlined
	6.2	Differentiation is made, by use of a pressure/volume diagram, between Otto, Diesel and Dual combustion cycles
	6.3	Mean effective pressure is calculated from an indicator diagram
	6.4	Indicated power formula is developed and related calculations are solved
	6.5	Specific fuel consumption is defined and calculated
	6.6	Ideal cycle and air standard efficiency is defined
7 Explain operating cycle of reciprocating air compressors	7.1	Pressure/volume diagram is used to describe operating cycle of single stage reciprocating air compressors
	7.2	Mass of air delivered by single stage reciprocating air compressors is calculated
	7.3	Clearance volume and its effect on volumetric efficiency is outlined, and volumetric efficiency is calculated
	7.4	Work per cycle for isothermal and polytropic processes is calculated
8 Explain operating cycle of refrigeration and air conditioning	8.1	Principle of refrigeration is outlined
	8.2	Temperature/enthalpy and pressure/enthalpy diagrams are compared
	8.3	Refrigerants used in refrigeration and air conditioning machines are

plant		identified
	8.4	Refrigeration effect and plant capacity are defined
	8.5	Refrigeration tables are used to calculate refrigeration effect and condition of vapour after expansion
	8.6	Operating cycle of self-contained and centralised air conditioning systems are outlined and compared
	8.7	Relative humidity is defined and key features of a psychrometric chart are outlined
9 Apply linear, superficial and volumetric expansion equations to calculate expansion of liquids and metals	9.1	Expansion processes for metals is defined
	9.2	Coefficient of linear expansion is outlined
	9.3	Linear expansion is applied to calculate machinery clearances and to shrink fit allowances
	9.4	Superficial and volumetric expansion of solids is calculated
	9.5	Apparent expansion of liquids in tanks is calculated

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 basic principles of marine engineering thermodynamics
- Identify and apply relevant mathematical formulas and techniques to solve basic problems related to marine engineering thermodynamics
- Identify and interpret numerical and graphical information, and perform basic mathematical calculations related to marine engineering thermodynamics, such as gas expansion and contraction, heat transfer, thermal efficiency, and the expansion of liquids and solids
- Identify, collate and process information required to perform basic calculations related to marine engineering thermodynamics
- Impart knowledge and ideas through verbal, written and visual means
- Read and interpret written information needed to perform basic calculations related to marine engineering thermodynamics
- Use calculators to perform mathematical calculations

Required Knowledge:

- Enthalpy
- Expansion processes for metals (conduction, convection, radiation)
- Forms of heat transfer (conduction, convection, radiation)
- Gas laws
- Internal combustion engine cycles
- Methods of heat transfer
- Operating cycle of reciprocating air compressors
- Operating principles of two stroke and four stroke internal combustion engines
- Principles of refrigeration
- Properties of fluids (density, mass, pressure, specific volume, temperature)
- SI units
- Steam plants
- Thermodynamic principles
- Thermal efficiency calculations
- 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:

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

Not applicable.

Unit Sector(s)

Not applicable.

Competency Field

Marine Engineering