



Australian Government

MARL011 Apply basic principles of marine engineering thermodynamics

Release: 1

MARL011 Apply basic principles of marine engineering thermodynamics

Modification History

Release 1. New unit of competency.

Application

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.

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).

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 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

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| | 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 C_p , C_v , R and Γ 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 | 5.1 | Basic steam plant cycles are sketched and function of each |

and calculate thermal efficiency		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 plant	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 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 and recorded
	9.5	Apparent expansion of liquids in tanks is calculated and recorded

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.

Not applicable.

Unit Mapping Information

This unit replaces and is equivalent to MARL5002A Apply basic 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>

Assessment Requirements for MARL011 Apply basic principles of marine engineering thermodynamics

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Performance Evidence

Evidence required to demonstrate competence in this unit must be relevant to and satisfy all of the requirements of the elements, performance criteria and range of conditions on at least one occasion and include:

- applying relevant work health and safety/occupational health and safety (WHS/OHS) requirements and work practices
- assessing own work outcomes and maintaining knowledge of current codes, standards, regulations and industry practices
- identifying and applying relevant mathematical formulas and techniques to solve basic problems related to marine engineering thermodynamics
- identifying and interpreting 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
- identifying, collating and processing information required to perform basic calculations related to marine engineering thermodynamics
- reading and interpreting written information needed to perform basic calculations related to marine engineering thermodynamics
- performing accurate and reliable mathematical calculations using a calculator
- solving problems using appropriate laws and principles.

Knowledge Evidence

Evidence required to demonstrate competence in this unit must be relevant to and satisfy all of the requirements of the elements, performance criteria and range of conditions and include knowledge of:

- basic principles of marine engineering thermodynamics
- enthalpy
- effective verbal, written and visual communication strategies
- 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
- WHS/OHS requirements and work practices.

Assessment Conditions

Assessors must satisfy National Vocational Education and Training Regulator (NVR)/Australian Quality Training Framework (AQTF) assessor requirements.

Evidence required to demonstrate competence in this unit must be relevant to and satisfy all of the requirements of the elements, performance criteria and range of conditions on at least one occasion and include:

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.

Assessment must occur in workplace operational situations or where this is not available, in simulated workplace operational situations or an industry-approved marine operations site that replicate workplace conditions where basic principles of marine engineering thermodynamics can be applied.

Resources for assessment include access to:

- diagrams, specifications and other information required for performing basic calculations related to marine engineering thermodynamics
- regulations, codes of practice and operation manuals
- relevant and appropriate tools, equipment and personal protective equipment currently used in industry
- relevant documentation including workplace procedures,
- technical reference library with current publications on basic marine thermodynamics.

Performance should be demonstrated consistently over time and in a suitable range of contexts.

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