



**Australian Government**

# **MARL6022A Demonstrate advanced knowledge of marine steam turbines and main boilers**

**Release 1**

## **MARL6022A Demonstrate advanced knowledge of marine steam turbines and main boilers**

### **Modification History**

Release 1

This is the first release of this unit.

This unit replaces and is equivalent to TDMMR5707A Manage the operation, monitoring and evaluation of the performance of steam propulsion plant on vessels of unlimited propulsion power.

### **Unit Descriptor**

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.

### **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

- |                                                                             |                                                                                                                                                                                                 |
|-----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1 Analyse methods of improving plant efficiency</b>                      | <b>1.1</b> Increase in Rankine efficiency of plant by increasing the pressure and temperature is analysed                                                                                       |
|                                                                             | <b>1.2</b> How regenerative feed heating and steam reheating increases overall plant efficiency is shown on an enthalpy/entropy diagram                                                         |
|                                                                             | <b>1.3</b> Efficiency calculations and performance evaluation for boilers, turbines, feed systems and total plant are performed                                                                 |
| <b>2 Analyse changes in feed system that occur during fluctuating loads</b> | <b>2.1</b> Changes that occur during fluctuating loads are identified, detailing how make up to system and dump from system are performed                                                       |
|                                                                             | <b>2.2</b> Condenser level control methods, how condenser is supported and how expansion stresses are avoided are explained                                                                     |
|                                                                             | <b>2.3</b> Loss of efficiency when heat transfer rate is interrupted is explained                                                                                                               |
|                                                                             | <b>2.4</b> Test procedure to identify leaks in a condenser is created                                                                                                                           |
|                                                                             | <b>2.5</b> Types, features, common defects and maintenance requirements of two-stage and super cavitating extraction pumps are compared and contrasted                                          |
|                                                                             | <b>2.6</b> Effects of air leaks in feed system and ineffective air removal in air ejector are explained                                                                                         |
|                                                                             | <b>2.7</b> Operation of a vacuum pump for air removal from a condenser is explained                                                                                                             |
|                                                                             | <b>2.8</b> Operation of a turbo feed pump differential pressure governor taking into account constant pressure, increasing pressure and decreasing pressure differential governing is explained |
|                                                                             | <b>2.9</b> Alarms, shutdowns, automatic cut-in arrangements and testing of over speed trips for a boiler feed pump are outlined                                                                 |

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|---------------------------------------------------------------------------------------------------------------------|------|--------------------------------------------------------------------------------------------------------------------|
| <b>3 Analyse design and construction of high-pressure water tube boilers and ancillary equipment</b>                | 3.1  | Temperature load relationships and temperature control of superheater are analysed                                 |
|                                                                                                                     | 3.2  | Operation of superheater with parallel, contra and cross flow of gas/steam flow is predicted                       |
|                                                                                                                     | 3.3  | Correct material for high temperature operation of superheater tubes and headers is identified                     |
|                                                                                                                     | 3.4  | Tube fixing and support arrangements for superheater elements are explained                                        |
|                                                                                                                     | 3.5  | Burner tip design and operation for steam atomising oil burners are compared                                       |
|                                                                                                                     | 3.6  | Features of a three-element water level control system and relationship with burner management system are outlined |
|                                                                                                                     | 3.7  | Operation of a combustion control system fitted with cross limits on air and fuel is explained                     |
| <b>4 Analyse operation, maintenance and performance of high-pressure water tube boilers and ancillary equipment</b> | 4.1  | Warm through procedure and checks to be carried out before connecting boiler to range are explained                |
|                                                                                                                     | 4.2  | How boiler is laid up for short and/or long periods is explained                                                   |
|                                                                                                                     | 4.3  | Actions required after oil or salt water contamination are detailed                                                |
|                                                                                                                     | 4.4  | Chemical cleaning procedure to remove scale and oil deposits from internal surfaces of a boiler is explained       |
|                                                                                                                     | 4.5  | Tube failures are identified and suitable methods of repair are selected                                           |
|                                                                                                                     | 4.6  | Defects that can occur in economisers and how they can be repaired are listed                                      |
|                                                                                                                     | 4.7  | Maintenance inspection procedures to prevent superheater and economise fires are produced                          |
|                                                                                                                     | 4.8  | Procedure to combat soot and steam/iron fires in generating banks, superheaters and economisers is outlined        |
|                                                                                                                     | 4.9  | Coordinate and congruent feed water treatment is illustrated on a caustic/phosphate graph                          |
|                                                                                                                     | 4.10 | Different feedwater tests, procedure for each test and appropriate chemical treatments are explained               |
|                                                                                                                     | 4.11 | 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
- 4.12 Procedure for setting lift, adjusting blow-down of safety valves and carrying out an accumulation test on a boiler is outlined
- 4.13 Operation, desired temperature range and correct cleaning and maintenance requirements for tube and regenerative air heaters are detailed
- 4.14 Preparation and procedure for conducting hydraulic testing of a high pressure water tube boiler is explained
- 5 Analyse turbine operation, maintenance and performance**
- 5.1 Relationship between sequential nozzle operation and bar lift in steam turbines is explained
- 5.2 Principle of operation of different ***trips and cut-outs*** is explained
- 5.3 Differentiation is made between resonance and critical speed, and their effect on the turbine operation is explained
- 5.4 Types of ***turbine vibration*** and where each type is found in a turbine is analysed
- 5.5 System torsional vibration and effect of operating at critical speeds and in-built design elements required to avoid critical speeds are explained
- 5.6 Back pressure and self condensing turbo alternators are compared
- 5.7 Governor system is explained
- 5.8 ***Turbine control systems*** are explained
- 5.9 Procedure for opening up turbine for survey, routine checks of blades, casings, rotors, bearings, glands, drains and the reassembly of turbine is explained
- 5.10 Procedure for straightening a bowed turbine rotor is outlined
- 6 Evaluate turbine-gearing performance**
- 6.1 Single and double reduction gearing systems are compared and contrasted
- 6.2 Features and applications of double helical involute gear teeth are outlined
- 6.3 Advantages and disadvantages of single and double locked train gearboxes are analysed
- 6.4 Construction and reason for installing flexible couplings in gearing

system is explained

- 6.5 Features, functions and applications of star, planetary and solar epicyclic gearing are compared and contrasted
- 6.6 Space savings resulting from use of epicyclic gearing are analysed

## Required Skills and Knowledge

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

### Required Skills:

- Access diagnostic information related to marine steam turbines
- Assess own work outcomes and maintain knowledge of current codes, standards, regulations and industry practices
- Explain operation of marine steam turbines and impart advanced knowledge and ideas verbally, in writing and visually
- Identify and apply relevant solutions to complex problems that can occur during operating steam propulsion plant and associated systems on a steam vessel
- Identify and interpret complex diagnostic information and perform complex mathematical calculations related to operating, repairing and maintaining marine steam turbines
- Identify methods, procedures and materials needed for operating, maintaining and repairing marine steam turbines
- Read and interpret complex manuals, technical specifications, safety data sheets (SDS)/material safety data sheets (MSDS) and manufacturer guides related to operating, repairing and maintaining marine steam turbines

### Required Knowledge:

- Boiler operation, maintenance and performance
- Changes in feed system that occur during fluctuating loads
- Established engineering practice and procedures for operating shipboard steam propulsion plant and associated systems in warm through, manoeuvring, start up, normal running, emergency and shut down situations
- Fundamental principles of steam propulsion systems and boilers
- Hazards and problems that can occur during operation of steam propulsion plant and associated systems, and appropriate preventative and remedial action
- High-pressure water tube boilers and ancillary equipment
- Methods of lubricating principal components of a marine steam propulsion turbine and its associated gearing, and evaluating common faults, including common lubrication faults, symptoms, causes, and actions to be taken with such faults
- Operational characteristics and performance specifications for different types of steam propulsion plant and associated systems on a steam vessel of unlimited propulsion power
- Principles of operation of main steam propulsion and auxiliary systems on a steam vessel, including:
  - construction and operation of main and auxiliary steam turbines
  - methods of turbine control, including safety devices
  - procedures for emergency operation of a steam turbine
  - symptoms, causes, effects, and actions to be taken of defects of auxiliary steam

#### turbines

- Procedures for reading and interpreting readings and indications of performance of steam propulsion plant and associated systems
- Turbine operation, maintenance and performance
- Turbine-gearing performance
- Types, properties, tests, applications and treatment of fuels, lubricants, and solvents/chemicals used on board a steam vessel, including a basic understanding of working principles, construction, maintenance and safe operation of centrifuges, filters and other treatment devices
- Typical operating precautions for steam propulsion plant and associated systems to ensure operational performance is in compliance with bridge orders, technical specifications, survey requirements and established safety and anti-pollution rules and regulations
- Units of measurement
- Ways of improving plant efficiency
- Work health and safety (WHS)/occupational health and safety (OHS) legislation and policies

## 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
- producing accurate and reliable information.

### **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 knowledge of marine steam turbines and main boilers can be demonstrated
- diagrams, specifications and other information required for performing complex calculations related to marine steam turbines
- technical reference library with current publications on marine steam turbines
- 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 demonstrating

advanced knowledge of marine steam turbines and main boilers

- 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.

Trips and cut-outs may include:

- Axial displacement
- Bearing high temperature
- High condenser level
- Loss of vacuum
- Over speed
- Vibration

Turbine vibration may include:

- Axial
- Torsional
- Transverse

Turbine control systems may include:

- Bridge control
- Emergency operation
- Hydraulic control
- Local control

## **Unit Sector(s)**

Not applicable.

## **Competency Field**

Marine Engineering