



Australian Government

MARL6019A Demonstrate advanced knowledge of marine control systems and automation

Release 1

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Modification History

Release 1

This is the first release of this unit.

Unit Descriptor

This unit involves the skills and knowledge required to operate control systems on board a commercial vessel. It includes basic knowledge of control theory and knowledge required to analyse the operation and performance of signal transmissions systems, electronic transmitters, final control element arrangements, electronic temperature sensors and transmitters, governors, PID electronic controllers, machinery space monitoring alarm and control systems.

It also includes knowledge of fault finding techniques for control systems, measurement and test equipment used for fault finding electronic apparatus, operational applications of analogue and digital programmable logic controllers, and procedures for programming, operating, and maintaining PLC controlled systems.

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

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|--|---|
| 1 Explain control theory | <ul style="list-style-type: none">1.1 Time lag is distinguished from time constant1.2 How resistance and capacitance affect control and process system response is shown1.3 Transfer function is defined1.4 Effect of variations in undamped natural frequency on control systems is illustrated |
| 2 Analyse signal transmissions systems used for monitoring, controlling and shutting down machinery | <ul style="list-style-type: none">2.1 Methods and limitations of different signal transmissions systems are compared2.2 Standard pneumatic system and standard analogue 4-20 mA system of signal transmission are compared and contrasted2.3 System of a communications bus using digital signal transmission with optical and electronic systems is explained2.4 Limitations and advantages of a communications bus system are analysed |
| 3 Analyse electronic transmitters | <ul style="list-style-type: none">3.1 Principles of operation of a typical 4-20 mA transmitter are explained3.2 Application of strain gauges and changes in capacitance as sensors for pressure and differential pressure transmitters are outlined3.3 Methods of testing transmitter outputs are explained3.4 Application of differential pressure transmitters to liquid level sensing is analysed3.5 Use of a differential pressure transmitter to measure flow is analysed and compared with |

- non-restrictive electronic systems
- 4 Evaluate final control element arrangements**
- 4.1 Pneumatic, electric and hydraulic actuation are compared and contrasted
 - 4.2 Arrangements for locking pneumatic control valves in their last position on air failure are outlined
 - 4.3 Control valve trim characteristics are explained
 - 4.4 Control valve selection for machinery space duties are analysed
- 5 Evaluate electronic temperature sensors and transmitters**
- 5.1 Colour coding of tails and compensating cables for thermo couple types are identified
 - 5.2 Temperature/mV outputs and application of common thermo couple types are illustrated
 - 5.3 Relationship between resistance and temperature for PT100 resistance temperature device and method of testing three wire arrangements is explained
 - 5.4 Arrangements of interfacing thermo couples and RTDs with 4-20ma systems and 1-5 volt interface cards are analysed
- 6 Analyse PID electronic controllers**
- 6.1 Principle of operation of an electronic analogue 3-term controller and how adjustments are made is explained
 - 6.2 Open loop response and PID controller testing and calibration is demonstrated
 - 6.3 Application of modern single loop digital controller is explained
 - 6.4 Programming requirements for manual and auto tuning when adjusting digital controllers are demonstrated
- 7 Evaluate performance of machinery space monitoring alarm and control systems**
- 7.1 Capacitance sensing and float level monitoring systems are compared
 - 7.2 Single, two and three element boiler water level control systems involving feedwater and cascade systems are analysed

- 7.3 Requirements and systems to provide advanced combustion control systems and sequential control for burner management are outlined
- 7.4 Concepts and arrangements for central cooling and load dependent cooling control systems are explained
- 7.5 Main engine control arrangements for fixed pitch propeller and CPP systems requiring sequential control are analysed
- 7.6 Tests and procedures to meet UMS requirements are explained, and alarm and monitoring systems involving data loggers, alarm print outers, and trend analysis are evaluated
- 8 Explain fault-finding techniques for control systems**
 - 8.1 Governor adjustments are demonstrated and effect of incorrect adjustments is explained
 - 8.2 Common defects in mechanical and electronic governors are listed
 - 8.3 Indication of *faults* and procedures of fault finding in 4-20mA loops are explained
 - 8.4 Fault-finding techniques in pneumatic control systems and their respective components are analysed
 - 8.5 Fault-finding flow diagram is illustrated
 - 8.6 Off limit performance, fault detection and principles of rectifications for common engine room control systems are evaluated
- 9 Analyse measurement and test equipment used for fault-finding electronic apparatus**
 - 9.1 Principles of operation of cathode ray oscilloscope are explained
 - 9.2 Need for pulse shaping in electronics is examined
 - 9.3 Different methods of testing common alarms systems are compared
 - 9.4 Methods used in stabilisation, surveillance and monitoring of control power supplies are demonstrated

10 Analyse governors

- 10.1 Governor faults are diagnosed and interpreted, identifying and evaluating appropriate adjustments and maintenance to be made
- 10.2 Specific governor applications requiring torque limitation, critical speed range avoidance are outlined
- 10.3 Typical electronic governors are explained using labelled diagrams to indicate major components and features
- 10.4 **Governor adjustments** to allow operation of propulsion and power generation diesels in both shared load and stand alone applications are specified
- 10.5 Response of a diesel engine governor on change in engine load using both feedback and feed forward control is explained using labelled diagrams to indicate major components and adjustments

11 Explain operational applications of analogue and digital programmable logic controllers

- 11.1 Methods of programming PLCs are assessed
- 11.2 Memory applications of PLCs are outlined
- 11.3 Input devices used with analogue PLCs are identified
- 11.4 Fibre optic data transmission systems are explained
- 11.5 Methods used for storing binary data and operating registers are explained

12 Document procedures for programming, operating and maintaining PLC controlled systems

- 12.1 Procedure for identifying required control system functions are explained
- 12.2 Procedure for connecting PLC to system control elements is outlined
- 12.3 System operating procedure is outlined
- 12.4 Procedure for modifying system and program as necessary to provide adequate and appropriate safety requirements, is outlined
- 12.5 Maintenance and fault-finding procedures are

outlined

12.6 Required documentation is prepared and accuracy is verified

Required Skills and Knowledge

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

Required Skills:

- Access information and sketch diagrams, and interpret and explain testing requirements related to control systems on commercial vessels
- Assess own work outcomes and maintain knowledge of current codes, standards, regulations and industry practices
- Explain advance principles of marine automation and process control and impart knowledge and ideas verbally, in writing and visually
- Identify and interpret numerical and graphical information, including schematic diagrams, relevant to control systems on commercial vessels
- Identify and suggest ways of rectifying faults and malfunctions in control systems on commercial vessels
- Identify methods, procedures and materials needed to operate and maintain control systems on commercial vessels
- Read and interpret written information related to operating control systems on commercial vessels

Required Knowledge:

- Analogue and digital programmable logic controllers
- Australian Standards for drawing symbols/layouts for schematic diagrams
- Characteristics and functions of temperature, pressure and viscosity of fuel
- Concept of 'fail safe' philosophy
- Concepts of unmanned machinery spaces (UMS), and automated monitoring and control of machinery
- Control and monitoring of ship machinery
- Control:
 - loops
 - theory
- Electronic:
 - temperature sensors and transmitters
 - transmitters
- Fault-finding techniques for control systems
- Final control element arrangements
- Governors
- Instrument process and control terms
- Machinery space monitoring alarm and control systems

- Measurement and test equipment used for fault-finding electronic apparatus
- Mechanical and electrical sensors
- Work health and safety (WHS)/occupational health and safety (OHS) legislation, policies and procedures
- PID electronic controllers
- Pneumatic and electrical instrumentation transmitters
- Principles of:
 - basic electronic circuits
 - basic pneumatic systems and action of pneumatic instruments
 - process control
- Safety devices, alarms and monitoring systems
- Sensing and transmitting elements
- Signal transmissions systems used for monitoring, controlling and shutting down machinery
- Tests and procedures required to meet UMS requirements

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:

- attention to detail when completing documentation
- providing accurate and reliable information
- providing appropriate level of detail in responses.

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 control systems and automation can be demonstrated
- technical reference library with current publications on automation and process control
- 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 control systems and automation

- 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.

Methods of testing transmitter outputs may include:

- MA test point
- MV test point
- No test points

Faults may include:

- Earths
- Electronic component failure
- High resistance joints
- Open circuits
- Power supply faults
- Short circuits

Governor adjustments may include:

- Mismatching between prime mover types and responses

Unit Sector(s)

Not applicable.

Competency Field

Marine Engineering