



**Australian Government**

**Department of Education, Employment and Workplace Relations**

# **MEM18061B Maintain/calibrate complex control systems**

**Release: 1**

## **MEM18061B Maintain/calibrate complex control systems**

### **Modification History**

Not Applicable

## Unit Descriptor

<b>Unit descriptor</b>	This unit covers determining system specification and control loop characteristics, and testing, monitoring and recording system operation.
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## Application of the Unit

<b>Application of the unit</b>	<p>This unit applies to localising the fault condition; repairing or replacing faulty condition; calibrating, configuring and adjusting complex control systems; and recommissioning the system.</p> <p>It extends to the use of pneumatic analog and digital test and recording equipment for the calibration, configuration and testing of multiple loop control systems including pneumatic, analog electronics, distributed PLC and computer-based control systems which include supervisory mode.</p> <p>Work is to be undertaken autonomously or in a team environment in consultation with appropriate personnel, using predetermined standards of quality, safety and workshop procedures.</p> <p>Tasks are to be undertaken in workshop or on-site environments and involve the interpretation of manuals, specifications and diagrams, including pneumatic, electrical, electronic and logic diagrams, as well as program listings and configuration data for control system devices.</p> <p>Control strategies include: ratio, cascade, selector, duplex, feed forward, adaptive, dynamic compensations, computations, energy management and environmental control/systems.</p> <p>Unit MEM05002B (Perform high reliability soldering and desoldering) must also be selected if soldering of components is required to advanced or military specifications, where the reliability of electrical connections is critical, or where surface mounted devices are being soldered/de-soldered.</p> <p><b>Band: B</b></p> <p><b>Unit Weight: 8</b></p>
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## Licensing/Regulatory Information

Not Applicable

## Pre-Requisites

Prerequisite units		
<b>Path 1</b>	MEM05001B	Perform manual soldering/desoldering - electrical/electronic components
	MEM09002B	Interpret technical drawing
	MEM12004B	Perform precision electrical/electronic measurement
	MEM12023A	Perform engineering measurements
	MEM18001C	Use hand tools
	MEM18002B	Use power tools/hand held operations
	MEM18054B	Fault find, test and calibrate instrumentation systems and equipment
	MEM18055B	Dismantle, replace and assemble engineering components
	MEM18057B	Maintain/service analog/digital electronic equipment
	MEM18062B	Install, maintain and calibrate instrumentation sensors, transmitters and final control elements
	MEM18069B	Maintain, repair instrumentation process control analysers
<b>Path 2</b>	MEM09002B	Interpret technical drawing
	MEM12002B	Perform electrical/electronic

<b>Prerequisite units</b>		
		measurement
	MEM12023A	Perform engineering measurements
	MEM18001C	Use hand tools
	MEM18002B	Use power tools/hand held operations
	MEM18054B	Fault find, test and calibrate instrumentation systems and equipment
	MEM18055B	Dismantle, replace and assemble engineering components
	MEM18064B	Maintain instrumentation system components
	MEM18069B	Maintain, repair instrumentation process control analysers
<b>Path 3</b>	MEM05001B	Perform manual soldering/desoldering - electrical/electronic components
	MEM09002B	Interpret technical drawing
	MEM12004B	Perform precision electrical/electronic measurement
	MEM12023A	Perform engineering measurements
	MEM18001C	Use hand tools
	MEM18002B	Use power tools/hand held operations
	MEM18054B	Fault find, test and calibrate instrumentation systems and equipment
	MEM18055B	Dismantle, replace and assemble engineering components
	MEM18057B	Maintain/service analog/digital electronic equipment

<b>Prerequisite units</b>		
	MEM18060B	Maintain, repair control instrumentation - single and multiple loop control systems
	MEM18062B	Install, maintain and calibrate instrumentation sensors, transmitters and final control elements
	MEM18067B	Tune control loops - multi controller or multi element systems
<b>Path 4</b>	MEM09002B	Interpret technical drawing
	MEM12002B	Perform electrical/electronic measurement
	MEM12023A	Perform engineering measurements
	MEM18001C	Use hand tools
	MEM18002B	Use power tools/hand held operations
	MEM18054B	Fault find, test and calibrate instrumentation systems and equipment
	MEM18055B	Dismantle, replace and assemble engineering components
	MEM18060B	Maintain, repair control instrumentation - single and multiple loop control systems
	MEM18062B	Install, maintain and calibrate instrumentation sensors, transmitters and final control elements
	MEM18064B	Maintain instrumentation system components
	MEM18067B	Tune control loops - multi controller or multi element systems

## Employability Skills Information

<b>Employability skills</b>	This unit contains employability skills.
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## Elements and Performance Criteria Pre-Content

Elements describe the essential outcomes of a unit of competency.	Performance criteria describe the performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge section and the range statement. Assessment of performance is to be consistent with the evidence guide.
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## Elements and Performance Criteria

ELEMENT	PERFORMANCE CRITERIA
<p>1. Determine system specifications and control loop characteristics</p>	<p>1.1. Engineering specifications, technical information and historical records and trends are examined and relevant data is documented.</p> <p>1.2. System specifications and operational data including those for multiple loop control systems and devices are obtained, read and interpreted.</p> <p>1.3. Circuit and logic diagrams and configuration data are obtained, read and interpreted.</p> <p>1.4. Consultation with system operators and other relevant plant personnel is carried out, and relevant data is extracted and documented by appropriate means.</p> <p>1.5. Appropriate work clearances are obtained for monitoring and testing the system.</p>
<p>2. Test, monitor and record system operation</p>	<p>2.1. Relevant data is collected by appropriate means from all sources including maintenance records, chart recorders, data loggers, fault indicators, error codes, operational symptoms, tests and observation monitoring.</p> <p>2.2. Fault detection and diagnostic data are analysed against predetermined operational specifications, and conclusions are documented.</p> <p>2.3. System operation is observed using knowledge of all individual/multiple element loop device characteristics, controller mode principles, testing, calibration and adjustment methods.</p> <p>2.4. Appropriate test equipment is set up and used correctly.</p> <p>2.5. Appropriate tests are undertaken using standard operating procedures.</p> <p>2.6. Signal transmission test equipment is set up and used where applicable.</p> <p>2.7. Adjustment/maintenance needs are determined through interpretation and analysis of pneumatic, electrical, electronic, logic diagrams and configuration data for all control system devices.</p> <p>2.8. Appropriate field instrumentation is connected to test system configuration.</p> <p>2.9. Field instrumentation is connected and tested for selected control operation, and performance is monitored against specifications.</p>



ELEMENT	PERFORMANCE CRITERIA
	<p>2.10. Diagnostics checks are carried out to ensure correct operation.</p> <p>2.11. Fault finding and diagnostic tests are undertaken using correct equipment, techniques and procedures to detect faulty control system components or elements.</p>
3. Localise fault condition	<p>3.1. System is tested to the level necessary to detect and localise fault condition.</p> <p>3.2. Fault condition is localised and verified using appropriate test equipment, principles and processes.</p> <p>3.3. Fault condition is analysed, evaluated and corrective action is planned.</p>
4. Replace faulty items or repair faulty condition	<p>4.1. Faulty items are dismantled for repair or replacement using appropriate tools, equipment and procedures according to manufacturers' recommendations.</p> <p>4.2. Replaceable items are selected from manufacturers' catalogues, spare parts lists, or data sheets.</p> <p>4.3. Using manufacturers' handbooks, correct maintenance procedures for faulty items are established.</p> <p>4.4. Faulty items and/or condition are repaired using correct maintenance procedures and equipment.</p> <p>4.5. Repaired and replaceable items are reassembled using appropriate principles, tools, equipment, techniques and test procedures.</p>
5. Calibrate, configure, adjust complex control systems	<p>5.1. Diagnostic checks are carried out to ensure correct operation of system, taking appropriate corrective action as necessary.</p> <p>5.2. Correct calibration and test equipment is selected/set up to enable calibration to manufacturers' specifications.</p> <p>5.3. Mechanical alignment of control devices is undertaken where applicable.</p> <p>5.4. System is configured using appropriate programming tools and techniques.</p> <p>5.5. Relevant alignment procedures are performed for optimum control and in accordance with specifications.</p> <p>5.6. Correct sequence of alignment is used on multiple control loops and multi-element systems.</p> <p>5.7. Correct recording equipment is set up for adjustment and monitoring during alignment.</p>

ELEMENT	PERFORMANCE CRITERIA
	<p>5.8. Calibration and adjustment function are performed on multi-loop devices, multi-element control loops, controller modes and actions according to operational specifications using correct principles and methods applicable to the type of control loop being serviced.</p> <p>5.9. On-line changes are made to parameters in the system to meet specified requirements.</p> <p>5.10. Field instrumentation is connected for selected control operation and system is operated to a satisfactory level of control.</p>
6. Return system to service	<p>6.1. Final adjustments to align system operation to operational specifications including process and optimum control efficiencies are undertaken.</p> <p>6.2. Correct procedures are applied in return to service including configuring, calibrating, adjusting, tuning and final validation of system performance in accordance with specifications.</p> <p>6.3. System is returned to service.</p> <p>6.4. Service reports are completed to standard operating procedures.</p>

## Required Skills and Knowledge

### REQUIRED SKILLS AND KNOWLEDGE

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

#### Required skills

Look for evidence that confirms skills in:

- obtaining and interpreting relevant engineering specifications, technical information, historical records and other reference documents
- obtaining specifications of system components and operational data
- obtaining relevant circuit and logic diagrams and configuration data
- planning and sequencing operations
- checking and clarifying task-related information
- undertake numerical operations, and engineering calculations/formulae within the scope of this unit
- consulting system operators and other relevant plant personnel with respect to the control loop characteristics

**REQUIRED SKILLS AND KNOWLEDGE**

- documenting information obtained from system operators and other relevant personnel
- obtaining necessary work clearances for the monitoring and testing of the system
- locating and interpreting in-built fault indicators and error codes
- comparing collated data with the operational specifications of the control system
- documenting results of the analysis of collated data and any conclusions reached
- observing operation of the system confirm function/ malfunction of the system and/or its components
- setting up and using test equipment
- performing tests
- measure signals using suitable test equipment and analysis techniques
- connecting field test instruments to the system
- testing and monitoring the operation of selected controls using field test instrumentation
- performing diagnostic checks on the system
- checking operational characteristics of control devices, signal conversion instruments and final control elements for conformance to specification
- testing system using fault finding techniques including continuity testing, fault isolation
- verifying faults
- documenting corrective action
- marking items for repair or replacement
- dismantling and assembling items
- obtaining manufacturers'/suppliers' catalogues, spare parts lists or data sheets
- repairing item(s) using appropriate tools and equipment
- performing diagnostic checks of the system
- taking corrective action to bring system operation into line with specifications
- setting up test and calibration equipment
- aligning control devices to specifications
- configuring the system
- aligning controllers for optimum performance
- aligning multiple control loops in the correct sequence
- setting up and monitoring recording equipment during the tuning process to identify the effects of adjustment made to the system
- calibrating and adjusting control system components
- changing system parameters on-line to meet specified requirements
- connecting field test instrumentation to selected control system
- operating the control system
- adjusting the control system
- validating system performance
- returning control systems to service

**REQUIRED SKILLS AND KNOWLEDGE**

- completing reports

**Required knowledge**

Look for evidence that confirms knowledge of:

- the specification of each system component
- relevant data and/or trends
- system components and their function
- procedures for:
  - documenting information
  - obtaining work clearances
  - documenting control system tests and analysis
  - using test equipment
  - testing system configuration, control system components/elements, testing circuits and control lines
  - testing and monitoring the operation of selected controls
  - carrying out diagnostic checks
  - isolating the control system and its components
  - marking serviceable items for repair or replacement
  - dismantling/disassembling items for repair or replacement
  - servicing item(s)
  - adjusting the system to conform to operational specifications
  - calibrating the control system components
  - aligning control devices
  - configuring the system
  - tuning controllers, multiple control loops and multi-element systems
  - recording signals and data during system tuning operations
  - changing parameters
  - operating and monitoring a control system
  - making final adjustments to ensure all control system components conform to specifications
  - assembling repaired and/or replacement items
  - returning to service
  - reporting/recording requirements associated with return to service of control systems
- reasons for:
  - observing the system in operation
  - selecting the chosen test equipment
  - identifying the adjustments/maintenance to be carried out

**REQUIRED SKILLS AND KNOWLEDGE**

- selecting the chosen diagnostic checks
- selecting the chosen test and calibration equipment
- any deviations/variations from specification
- the errors indicated by in-built devices
- deviations/variations from specification
- the following for the given system: all individual/multiple element loop device characteristics; controller mode principles, testing methods; calibration methods; adjustment methods
- equipment:
  - to be used and reasons for selecting the chosen equipment
  - required to verify an apparent fault
  - used to test system configuration
  - required to undertake maintenance on item(s)
  - necessary to calibrate the control system components
  - necessary to carry out the alignment of the control devices
  - programming tools and techniques to be used
  - appropriate measuring techniques, tools and equipment
- adjustments/maintenance to be carried out
- diagnostic checks to be applied to the system to ensure correct operation of the system
- fault finding and performing diagnostic tests to be applied to control devices, signal conversion instruments and final control elements
- hazards associated with testing circuits and control lines
- causes of verified faults and the action to be taken to return the control system/component to specification
- appropriate replacement parts
- specifications of serviceable item(s)
- diagnostic checks to be carried out
- specifications of the equipment to be calibrated
- alignment specifications
- specifications of the controllers
- correct sequence of tuning
- recording equipment to be used
- adjustments that can be made to control system components
- effects of those adjustments on the calibration of the control system components
- requirements to be achieved by changing system parameters on-line
- the level of control to be achieved
- hazards and control measures associated with maintaining/calibrating complex control systems
- use and application of personal protective equipment

<b>REQUIRED SKILLS AND KNOWLEDGE</b>
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| <ul style="list-style-type: none"><li>• safe work practices and procedures</li></ul> |
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## Evidence Guide

<b>EVIDENCE GUIDE</b>	
<p>The evidence guide provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge, range statement and the Assessment Guidelines for the Training Package.</p>	
<p><b>Overview of assessment</b></p>	<p>A person who demonstrates competency in this unit must be able to maintain/calibrate complex control systems. Competency in this unit cannot be claimed until all prerequisites have been satisfied.</p>
<p><b>Critical aspects for assessment and evidence required to demonstrate competency in this unit</b></p>	<p>Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the criteria, including required knowledge, and be capable of applying the competency in new and different situations and contexts.</p>
<p><b>Context of and specific resources for assessment</b></p>	<p>This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is the candidate is not in productive work, then an appropriate simulation must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. The assessment environment should not disadvantage the candidate.</p> <p>This unit could be assessed in conjunction with any other units addressing the safety, quality, communication, materials handling, recording and reporting associated with maintaining/calibrating complex control systems, or other units requiring the exercise of the skills and knowledge covered by this unit.</p>
<p><b>Method of assessment</b></p>	<p>Assessors should gather a range of evidence that is valid, sufficient, current and authentic. Evidence can be gathered through a variety of ways including direct observation, supervisor's reports, project work, samples and questioning. Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency. The candidate must have access to all tools, equipment, materials and documentation required. The candidate must be permitted to refer to any relevant workplace procedures, product and manufacturing specifications, codes, standards, manuals and reference materials.</p>

**EVIDENCE GUIDE**

<b>Guidance information for assessment</b>	
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**Range Statement****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. Essential operating conditions that may be present with training and assessment (depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts) may also be included.

**Control loop**

<b>Control loop</b>	A process of documenting and recording measurements and variables within the process
<b>Test equipment</b>	Engineer level, laser alignments etc., and appropriate equipment for measurement of alignment, flatness, squareness, straightness, temperature, vibration, load deflection, noise level, RPM
<b>Tests</b>	Measuring and analysing to ensure correct operation
<b>Control system</b>	Control systems include pneumatic control, analog and/or digital electronics, distributed PLC, DCS, SCADA, and computer-based control systems. Computer-based control systems may include supervisory mode
<b>Field instrumentation</b>	Test and measuring equipment which could include specialised testing fixtures or equipment

**Test equipment****Tests****Control system****Field instrumentation****Unit Sector(s)**

<b>Unit sector</b>	
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## Co-requisite units

<b>Co-requisite units</b>		

## Competency field

<b>Competency field</b>	Maintenance and diagnostics
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