T-LEVELS | Institute for Apprenticeships & Technical Education

T Level Technical Qualification in Maintenance, Installation and Repair for Engineering and Manufacturing (8712-32)

Maintenance Engineering Technologies: Mechatronic (312)

Guide standard exemplification material

Distinction – Sample 2022

First teaching from September 2022
Version 1.1

City & Guilds | eal

Version and date	Change detail	Section
1.1 Jan 2023	Minor typographical amendments	Through document

Contents

Introduction

The sample assessment materials within this document refer to the Maintenance engineering technologies: Mechatronic sample occupational specialism assignment. The aim of these materials is to provide centres with examples of knowledge, skills and understanding that attest to a distinction grade. The examples provided do not reflect all evidence from the sample assignment as the focus of this material is the quality and standards that need to be achieved rather than the volume of exemplar evidence provided. However, the examples provide a representative example of all tasks in the sample assignment. The evidence presented here has been developed to reflect a distinction grade within each task but is not necessarily intended to reflect the work of a single candidate. It is important to note that in live assessments a candidate's performance is very likely to exhibit a spikey profile and the standard of performance will vary across tasks. A distinction grade will be based on a synoptic mark across all tasks.

The materials in this Guide Standard Exemplification Material (GSEM) are separated into three sections as described below. Materials are presented against a number of tasks from the assignment.

Task

This section details the tasks that the candidate has been asked to carry out, what needs to be submitted for marking and any additional evidence required including any photographic evidence. Also referenced in this section are the assessment themes the candidates will be marked against when completing the tasks within it. In addition, candidate evidence that has been included or not been included in this GSEM has been identified within this section.

In this GSEM there is candidate evidence from:

- Task 1
- Task 2
- Task 3
- Task 4

Candidate evidence

This section includes exemplars of candidate work, photographs of the work in production (or completed) and practical observation records of the assessment completed by centre assessors. This will be exemplar evidence that was captured as part of the assessment and then internally marked by the centre assessor.

Commentary

This section includes detailed comments to demonstrate how the candidate evidence attests to the standard of distinction by directly correlating to the grade descriptors for this occupational area. Centres can compare the evidence against the performance indicators in the marking grid descriptors within the assessor packs, to provide guidance on the standard of knowledge, skills and understanding that need to be met for distinction.

It is important to note that the commentary section is not part of the evidence or assessment but are evaluative statements on how and why that piece of evidence meets a particular standard.

Grade descriptors

To achieve a distinction, a candidate will typically be able to:

Competently and thoroughly interpret technical information, applying technical skills to plan, assess risk and follow safe working methods to practical tasks and procedures to an exemplary standard in response to the requirements of the brief, working systematically, logically and efficiently producing an excellent quality of work that meets regulations and standards.

Thoroughly prepare working area, mitigating potential risks prior to commencing tasks and consistently apply exemplary housekeeping techniques during tasks that allow safe and efficient working.

Demonstrate comprehensive technical skills for maintaining, installing, repairing and diagnosing components, assemblies and sub-assemblies in line with the requirements of the brief working systematically, logically and efficiently.

Demonstrate exemplary technical skills using tools and equipment for mechatronic maintenance, installation and repair, ensuring safe isolation, removal and replacement of components, working systematically, logically and efficiently.

Demonstrate comprehensive knowledge and understanding of the principles and processes required for disassembly, repair, configuration and re-assembly of mechatronic systems, ensuring that all tolerances and tightening torques are in-line with specification.

Work safely and make well founded and informed decisions on the selection and appropriate use of tools, materials and equipment within the working environments for maintenance, installation and repair activities.

Consistently and accurately use industry and technical terminology across different communication methods with full consideration of technical and non-technical audiences.

Task 1 – Plan the maintenance activities

(Assessment themes: Health and safety, Planning and preparation, Systems and components)

For task 1 candidates need to produce the following pieces of evidence:

a) list of requirements and resources, including justifications for the selections
b) completed risk assessment
c) method statement.

Candidate evidence

1a. List of requirements and resources, including justifications for the selections

Resources The following resources will be required to undertake the required maintenance activities.		
Physical resources (tools/equipment) *The following will be needed to undertake the maintenance activities.*		
	Quantity	**Purpose and justification**
Power supply and pneumatics	1	To power the system, supply voltage 230 V and supply pneumatics for the robot to work/operate.
Replacement motor/sensor due to intermittent fault being notified prior to work	1 or more as required	This is needed due to intermittent fault being notified prior to work, and that the motor/sensor may be the issue of the fault. Will be used to replace the potential faulty motor, with the fault identified and diagnosed before request for a new motor – as motors are costly to buy if not needed.
Replacement parts and fixtures/fixings	10	To repair/replace any faulty or excessively worn parts, fixtures/fixings, including fuses, wire.
Networked system	1	Wired network required to control the system and for PLC communications.
Spanner set	1	To remove and reassemble nuts/bolts fixings/fastenings.
Driver set	1	Different types of drivers (Allen, torx, secure etc) for different fixtures and fixings.
Pliers	3	To hold items or help with removal.
Magnetic tray	1	To safely store removed fixings and fastenings.
Storage tray/box	2	To safely place the larger items/covers removed during the servicing.
Torque wrench	1	To check torque settings.
Belt tensioner	1	To confirm the tension on the belt.
Socket set	1	To use on the torque wrench or other appropriate components/fixings/fastenings.
Multimeter	1	To conduct various electrical/electronic tests and to aid fault finding.
Laptop	1	Required to control, adjust, and diagnose the system.
Materials and consumables *The following will be needed to undertake the maintenance activities.*		
Clean cloths and rags	6	To control any spillages or residue that may leak or be spilled from the robot. Will also be used to complete the cleaning post and pre job.

Oil (appropriate grade for task)	1	For lubricating moving parts as per the instruction manual.
Grease	1	To lubricate all joints/moving parts as appropriate.
Protective equipment *The following PPE are required to support safety during the maintenance activities, and to meet requirements of the Health and Safety at Work Act (HASAWA).*		
Gloves (disposable)	1	To reduce chances of injury/contamination to hands, also to provide extra grip. Worn throughout the whole process.
Goggles	1	To use when using spray lubricants and at other times when there may be a risk of eye injury present. Used to prevent ingress or eye damage.
Overalls	1	Basic PPE requirements meeting HASAWA. To protect clothes from dirt, water and other contaminants that may result from the process. Protection of the body from hot objects.
Safety shoes/boots	1	Basic PPE requirements meeting HASAWA. Limit injuries from instruments, tools and equipment causing damage to feet.
Electrostatic discharge mat	1	Extra precaution when dealing with the removal and replacing of electronic components.
Warning signs and notices		To indicate that air and electrical supplies are isolated, informing other in the area.
Technical Information *The following technical information and documentation will be required to refer to during the maintenance activities to support accurate application of equipment, and to ensure the brief requirements are met.*		
Requirement	**Purpose and justification**	
Manuals	For the SCARA robot and PLC equipment. Used for technical information.	
PLC and hardware manual	Guidance on the use, setting up and programming of the system. Will be used as a troubleshooting guide should any issues arise.	
MSDS for lubricants	To provide preventative and other COSHH related information when lubricating the joints etc.	
Risk assessment	To complete before beginning the task. The risk assessment will ensure that all hazards have been identified and control measures are implemented to mitigate any risks.	
Method statement	To refer to during maintenance activities to ensure logical order can be easily followed.	
Assignment brief, specification and diagrams	To aid with understanding the engineering process and to refer to during to ensure brief requirements are being accurately met.	
Other key requirements The following additional requirements are areas that I need to consider in detail in order to support the safe, efficient and effective deployment of the maintenance activities.		
Requirement	**Purpose and justification**	
Waste disposal	Wiring and general waste separated following legal requirements (WEEE Reg's etc).	
Time needed	Prepare the work area 1 hour Decommission and inspect system 2 hours Fault finding and diagnose 3 hours Repair 2 hours Calibrate 30 mins Recommission 1 hour	

	Recording 1 hour Re-instate work area 30 mins
Access requirements	Check location of system and need for ladder or appropriate steps, follow working at height regulations.
Fault finding/diagnostic techniques and methods	
Sensory checks	Using my senses to detect noise, vibration or unusual sounds/scents. Visually inspect the system to identify any obvious issues, such as a fault being displayed on the control console, loose wiring etc. Smell to ensure there is no burning of wires or components. Listen to the system for any unusual noises that may indicate an issue such as buzzing or rattling. Touching the system could indicate whether the process is too hot, cold or any vibration.
Test run the system	Running the system through a pre-existing program to check datum points and accuracy of the robot functions, this can lead to further fault finding.
Interrogate system	Connect a PC to the PLC to read error log in full, compare to system manual to confirm and error codes, which should indicate fault location and supports diagnosis.
Unit substitution	This fault-finding method would apply to the system should any components become faulty, they can then be replaced with known working parts. This is not a preferred method due to the cost implications but is part of the rectification process.
Input to output	Checking that what is required of the robot is happening to the expected values/accuracies. Using the handheld controller to check that what you request for the robot operation is happening.
Half split technique	Check pneumatic system and operations, electric system and operations. Splitting the fault location down to a specific location (half split).

Commentary

The candidate has interpreted the requirements of the brief well, creating a comprehensive list of resources that demonstrate an excellent knowledge and understanding for the system, maintenance process and task requirements. The structure and presentation of the resources list is clearly broken down into specific areas reflective of the task to be undertaken.

The candidate has identified system components, resources, tools and equipment correctly, including accurate identification of the quantities of each that would be required to successfully undertake the task. The justifications provided are detailed, allowing the candidate's knowledge and understanding of the process in response to the brief to be showcased. For example, the candidate shows that they have pre-empted potential issues and have planned efficiently for different scenarios to reduce system downtime, whilst balancing both cost and need, such as considerations for sourcing a replacement motor.

The candidate has gathered and analysed appropriate technical information and listed the relevant documentation to be obtained and completed, justifying the application of the documents and their relevance to the task. They have interpreted the technical information and identified appropriate fault diagnosis methods to be used to correctly diagnose faults and inform the appropriate resolution methods. For example, recognising that using the half

split technique will allow the system to be broken down and checked sub-system by sub-system or component by component within a structured framework, narrowing down where faults are located and the causes of them.

The candidate has accurately listed all appropriate elements of PPE required for the task, demonstrated exemplary understanding of safe working practices and of the Health and Safety at Work Act, which have been used to inform the planning for the tasks to be undertaken.

1b. Risk assessment

Preparation				
Hazard	Risk	Control	Likelihood	Severity
Working area when undertaking pre-preparation checks	Slips, trips and falls, personal injury.	Analyse working area before entering. Ensure no equipment or tools are on the floor and that walkways are clear. Ensure area is clean and tidy throughout preparation, maintenance and upon completion.	2	1
Manual handling of tools and equipment needed for maintenance	Personal injury.	Ensure awareness of maximum lifting weights when obtaining equipment and tools. Check size/weight of equipment and the load to be moved before moving. Consider lifting position and posture and whether support is needed from others to safely move. Check the area around the SCARA robot before moving. Ensure correct training has been undertaken.	2	1
Preparation of hand tools and equipment for the maintenance to be carried out	Cuts, abrasions, general hand injury.	Take care when selecting and organising tools and equipment. Check the condition of tools before obtaining them. Follow PUWER regulations.	2	1

Maintenance				
Hazard	Risk	Control	Likelihood	Severity
Cleanliness and safety of the working area throughout the maintenance of the SCARA robot	Slips, trips and falls, personal injury.	Ensure no equipment or tools are on the floor and that walkways are clear. Ensure area is clean and tidy throughout preparation, maintenance and upon completion. Store removed parts and components appropriately.	2	1
Manual handling or movement of equipment or components when undertaking maintenance	Personal injury from items dropping, back injury from lifting.	Check weight of tools, equipment or system components before lifting to ensure not to lift over maximum lifting limit. Ensure correct training has been received.	1	1
Working with stored energy (mechanical, electrical pneumatic)	Impact injuries, potential crush, burns, electrical shock, static, ingress.	Remove power from the robotic arm system. Slowly release potential mechanical energy, such as removing tension from the belt in a controlled manner. Ensure capacitors and other electrical components are discharged and given appropriate time to power down prior to maintenance taking place. Ensure correct training in appropriate pneumatic processes and isolation methods has been received.	3	2
Working within a system where high temperatures are present	Burns	Ensure system has cooled down before removing and replacing parts, observing appropriate cool down periods.	3	2
Use of hand tools and equipment when undertaking maintenance, such as removing and terminating wires	Cuts, abrasions, general hand injury.	Ensure correct selection and use of tools for the activity. Ensure proper use of tools and equipment, particularly wire cutters and crimpers. Ensure correct PPE is obtained and worn, such as gloves when working with hot components and safety glasses to protect from flying debris e.g. when snipping wires. Ensure sufficiently trained in the use of hand tools and electrical test equipment. Follow PUWER regulations.	2	1
Spilt liquid that may occur or residue that may leak from the robot	Slipping	If a spillage is to occur ensure correct procedures are followed to clean up, using cloths and rags. Follow MSDS.	2	1
Working with electricity within a live system	Electrocution	Ensure safe isolation is carried out, ensuring that electrical supplies are locked off where possible, following LOTO regulations. Use voltage tester and proving unit to ensure that there is no power coming into the system.	3	4

Fault finding				
Hazard	Risk	Control	Likelihood	Severity
Cleanliness of the working area around the SCARA robot when investigating faults	Slips, trips and falls, personal injury.	Ensure no equipment or tools are on the floor and that walkways are clear. Ensure area is clean and tidy throughout fault finding activities and during any remedial activities. Store removed parts and components appropriately.	2	1
Manual handling	Personal injury from items dropping, back injury from lifting.	Check weight of tools and equipment before lifting to ensure not to lift over maximum lifting limit. Ensure correct training has been received.	1	1
Equipment malfunction/ faulty components whilst investigating the live system, including moving machinery	Crushing / impact	Isolate/power off the system when removing and replacing components and equipment.	3	2
Using hand tools and equipment to undertake fault finding on the SCARA robot	Cuts, abrasions, general hand injury.	Ensure correct selection and use of tools for the activity. Ensure proper use of tools and equipment, particularly wire cutters and crimpers. Ensure correct PPE is obtained and worn, such as gloves when working with hot components and safety glasses to protect from flying debris e.g. when snipping wires. Ensure sufficiently trained in the use of hand tools and electrical test equipment. Follow PUWER regulations.	2	1
Undertaking fault finding activities where stored energy (temperature) is present	Scalding.	Ensure system has cooled down before removing and replacing parts from hot motors.	3	2
Undertaking fault finding activities where stored energy (mechanical, electrical pneumatic) is present	Impact injuries, potential crush, burns, electrical shock, static, ingress.	Remove power from the robotic arm system. Slowly release potential mechanical energy, such as removing tension from the belt in a controlled manner. Ensure capacitors and other electrical components are discharged and given appropriate time to power down prior to maintenance taking place. Trained in appropriate pneumatic processes and isolation methods.	3	2
Spilt liquid	Slipping	If a spillage is to occur ensure correct procedures are followed to clean up, using cloths and rags. MSDS sheets.	2	1

Fault finding within a system with live electricity	Electrocution	Ensure safe isolation is carried out, ensuring that electrical supplies are locked off where possible, following LOTO regulations. Use voltage tester and proving unit to ensure that there is no power coming into the system.	3	4

Likelihood		Severity	
1	Very unlikely to happen	1	Minor injury
2	Unlikely to happen	2	Major injury
3	Possible to happen	3	Loss of limb
4	Likely to happen	4	Death of an individual
5	Very likely to happen	5	Multiple death

Commentary

The candidate has structured the risk assessment logically by considering each of the key maintenance activities individually. In doing so they have shown understanding of the different hazards that can occur at each stage of the maintenance process.

The candidate has thoroughly considered and identified a comprehensive range of hazards and risks associated with the different stages of the maintenance activities on the system to ensure safe working is followed. They have categorised each element of the activities and identified each hazard for each element, showing a thorough understanding and awareness of health and safety working practices to ensure the safety of themselves and others. The candidate has accurately labelled the likelihood and severity for each risk and hazard. For example, correctly understanding the potential severity of hazards related to mains electricity, including when using measurement and test equipment.

Control measures are detailed, and the candidate has considered a wide variety of scenarios and situations that may arise, demonstrating thorough knowledge and understanding for the process and the activities to be completed. The candidate displays comprehensive knowledge for risk mitigation techniques. For example, the hazard of stored energy and preventing the associated risk of releasing potential mechanical energy rather than protecting from its damage if the risk occurs. This demonstrates understanding of the hierarchy of control.

1c. Method statement

Maintenance

Initial pre-maintenance checks

Firstly, I will obtain the required PPE (gloves, safety glasses, boots and overalls) for the task. I will check it over to ensure that there is no damage and that it is fit for purpose to ensure safety whilst undertaking the task. Should the PPE not be fit for purpose or found to be damaged, this will be reported to the appropriate people. Once checked and wearing the required and appropriate PPE the working area can be safely entered.

Once the work area has been entered, I will visually check the area initially to ensure the area is clean, safe and tidy. I will remove any objects, equipment or tools that may be on the floor to mitigate the chance of slips, trips and falls, then put signage in place indicating work is being carried out. All of the above will be in compliance with both the PPE regulations (Personal Protective Equipment at work Regulations 1992), the HASWA (Health and Safety at Work Act 1974) with permits to work in place.

Undertaking the maintenance activity

The first thing I will do in terms of the maintenance activity is visually inspect and function check the system. This is to ensure that it is in operational condition and a healthy state. I will start by running a program to see in what 'state' it currently runs in and check the control console for indication of any fault/s. Depending on what is displayed depends on the process I follow.

It has been indicated to me that there is an intermittent fault therefore I will be conducting fault finding processes, using more than one style to locate, identify and diagnose the issues with success.

If any faults should arise, I will apply the appropriate fault-finding techniques to investigate and diagnose any potential causes. For example, if error codes are displayed in the error log, then I will refer to the manual for guidance of the fault. I will then investigate to find the fault/s and prove which items/components are faulty before replacing/repairing. I will conduct any testing that may be required, remove and replace any equipment and components that may be faulty. Once the fault has been rectified, I will commence with the maintenance activity.

If diagnosis is not appropriate, then I will proceed to follow the maintenance schedule as listed in the manual and record my findings and diagnose as I go. I will use appropriate testing methods for different sensor signal type, this could include 4-20mA, voltage or modern digital communications (profibus, profinet, ethernet ASi etc). This is mainly a multimeter on the appropriate settings to test for different signal types.

I will proceed to clean down the system as part of maintenance to prevent any settled dust or debris from getting into the system when the sub-assemblies / covers are removed. Once I am happy the system is cleaned, I will remove any sub-assemblies to gain access to the components. I will visually inspect the components and wiring of the robot to ensure all connections are electrically sound and that no damage or wear and tear is visible. I will also check all joints for wear, tear and lubrication, lubricating with the appropriate grease or oil (as per the specification).

Once I am satisfied following the IET guidance I will switch off the supply and remove the fuses. I will lock off the supply to ensure it cannot be re-energised whilst I am working on it, ensuring LOTO procedures are followed.

I will check the entire system, assemblies and sub-assemblies for security and tightness. If any fastenings/fixing are showing signs of wear and tear then these will be replaced as appropriate. During this maintenance I will need to check the running of and replace the belt. To do this I need to disassemble the robot arm from the main motor and gain the appropriate access. Once this has been done and safely stored, I can proceed to remove, inspect and replace the belt. This will then need to be assembled and tightened in accordance with the manual. To check the correct tension on the belt I will use the belt tensioning tool and check the tension in the slackened part of the belt, rotating it to double check. Once I am happy, I will reassemble the robot in the correct order, torquing up the main fixings to the appropriate torque. The sub-assemblies are mainly fixings, and these will be tightened as per the required spec. During the reassembly process there are alignment markings that need to be checked and set to the appropriate datum so that the robot preforms 'true' and with precision. These alignment / datum settings are described in the manual and will be followed to ensure final correct operation. Another very important process to be followed is to ensure all greased components are cleaned off and re-greased. The same applies to the oiled surfaces. It is important to clean and reapply the oil and grease as it likely contains debris and carbon deposits from general use of the machine. As it is high temperature grease, it can become hard/waxy over time, which could cause seizing of important components if not refreshed.

I will then function check the system and ensure the process is operating correctly.

Post-maintenance

Once I am satisfied that the maintenance has been completed, I will tidy up my area and ensure that all tools and equipment are free from damage before returning to dedicated storage. I will clean my area and dispose of waste correctly, ensuring any disposal and regulatory requirements such as WEEE are followed. I will then handover the system to the assessor, demonstrating the system functionality and condition as part of the handover agreement. I will complete any necessary paperwork and amend any documentation that may need amending, before handing this over to the assessor.

Commentary

The candidate has set out a detailed method statement, demonstrating logical thinking and planning. The method statement has been developed following a defined and accurate process and in a sequence that provides a comprehensive guide for the candidate to follow to complete the maintenance activities. For example, applying and understanding of alignment markings and datum settings and when they need to be considered during reassembly. The response could have been developed further with greater detail, such as communicating with others working in the area that they are about to start work.

The candidate has considered and referred to a range of regulatory requirements showing their knowledge and understanding of compliance with workplace practices, such as checking the condition of tools, equipment and PPE before beginning the task. The response could have been developed further by acknowledging the need to allow the system to cool down before calibration can be completed.

The candidate has provided detailed justifications for most of their proposed actions which shows thorough planning and preparation skills for the maintenance activities to meet the requirements of the brief. For example, the highlighting of components needing to be cleaned and then regreased before reassembling the system, why this is important to do and ensuring that this step is part of their planning.

Task 2 – Perform the maintenance activities

(Assessment themes: Health and safety, Systems and components, Working with faults, Reviewing and reporting)

For task 2 candidates need to produce the following pieces of evidence from completing the maintenance activities:

- completed test record sheets
- updated maintenance records and control documents
- annotated method statement, including any recommendations for further investigation if required.

For task 2, assessors will need to produce the following pieces of supporting evidence from the maintenance activities:

- assessor observations of:
    - work area preparation
    - the maintenance activities.

Photographic evidence required:

- Photographic evidence showing the prepared work area - Illustrated in Task 2 photographic evidence section below (photographs 1 and 2)

- Photographic evidence showing the working area after disassembly - Illustrated in Task 2 photographic evidence section below (photograph 3 and 4)

- Photographic evidence showing the refitted belt showing the correct fitment to the pulleys – Illustrated in Task 2 photographic evidence section below (photograph 5 and 6)

- Photographic evidence showing the re-instated work area – Illustrated in Task 2 photographic evidence section below (photograph 7)

Candidate evidence

2. Completed test record sheets

Procedure	Inspection item (details)	Remedies	Actions taken
Make sure robot is off – follow LOTO			
1	Are any of the bolts or screws on the robot arm loose?	Tighten to the correct torque rating using the manual for the specifications.	All bolts and screws were checked and tightened to the correct torque. Once removed they were organised for correct replacement and tightened correctly on replacement/reassembly.
2	Are any of the connector fixing screws or terminal block terminal screws loose?	Tighten to the correct torque rating using the manual for the specifications.	One terminal block found to be loose (next to J1 axis actuator) – Monitor in next maintenance.
3	Remove the cover at each section and check the cables for wear damage and adherence of foreign matter.	Check and eliminate the cause. If the cables are severely damaged, contact the Mitsubishi Service Department.	All covers were thoroughly cleaned down. The housing around the belt was the worse. Monitor.
4	Is the timing belt tension abnormal?	If the timing belt is loose or too tense, adjust it.	Belt replaced and tensioned by following the manual.
5	It runs out of grease on the shaft.	Wipe the old grease off, and lubricate	J2 axis showing signs of seepage of grease. All joints lubricated with grease and gears.
6	Is the friction at the timing belt teeth severe?	If the teeth are missing or severe friction is found, replace the timing belt.	Belt excessively worn, monitor.
7	Replace the backup battery in the robot arm.	Exchange it referring to the manual.	Battery replaced following the correct procedure.
8	Lubricate the grease at the harmonic reduction gears for J1 and J2 axis.	Lubricate it referring to the manual.	Done.
9	Replace the bellows (J3 axis) (only for clean and protection specification)	Exchange it referring to the manual.	Bellows replaced – small nick found.
10	Is the power supply cable securely connected?		Yes, transformer replaced (suspected faulty part).
11	Is the machine cable between the robot arm and controller securely connected?		All machine cables are securely mounted and fixed without causing damage.
12	Are there any cracks, foreign contamination or obstacles on the robot and controller cover?	Replace with a new part or take remedial measures.	Debris wiped off.
13	Is there any abnormality in the pneumatic system? Are there any air leaks, drain clogging or hose	Drain the drainage, and remedy the air leaks (replace the part)	All pneumatic pipes seemed fit for purpose – monitor about J2 axis. Drain bowl checked and cleaned.

	damage? Is the air source normal?		
With Robot ON (powered)			
1	Is there any abnormal motion or abnormal noise when the power is turned ON?	Use manual as appropriate	Abnormal noise was excessively worn belt – replaced.
During operation (run program)			
1	Check whether the movement points are deviated?	Set points according to the manual.	After maintenance I ran the system and checked the datum points on assembly. All seems to be working within tolerance.
2	Check for any abnormal motion or abnormal noise?	Investigate.	No abnormal noise after the robot ran through test program.

Commentary

The candidate has completed a comprehensive test record which provides a clear overview of each of the steps taken when testing during the maintenance activity. For each step, the candidate has detailed clearly each of the actions that they undertook in response to the inspection stage. The candidate explored and used a wide range of testing techniques to measure the function of each sub-assembly before and after repairs, as well as the system as a whole. This demonstrated a comprehensive understanding and application of testing methods from the scope of options available. Where testing did not identify an issue, the candidate has demonstrated what they would have done if this had occurred, for example the procedure for dealing with severely damaged cables).

The candidate has described a logical approach to the fault finding and the maintenance by restoring the overall connectivity to the system. This demonstrates the candidate's knowledge and understanding for the process and how the process is expected to operate.

2. Updated maintenance records and control documents

Maintenance log							
			System type:	Mitsubishi RH-5AH series SCARA robot			
			System TAG number:	1A2B3C			
			Department responsible for equipment:	Maintenance engineering department			
Date:	**Maintenance performed by:**	**Maintenance description:**	**Work completed outside the scope of the maintenance:**	**Are any problems identified rectified? Y/N**	**Validation performed by:**	**Next maintenance due date:**	**Comments:**
03/04/2022	Candidate.A	Scheduled maintenance and intermittent fault diagnosis.	Yes, the system was indicating various error codes. Both the power supply transformer and one of the motors were faulty. Each of these issues were rectified, ensuring the connections were electrically, pneumatically and mechanically sound. The maintenance tasks were completed to include a belt change and correctly tensioned.	Y		03/04/2022	The job has been completed however it is advised the maintenance schedule is revisited. More regular maintenance will ensure sources of potential faults can be identified earlier and before they become a problem for the operation.

Controlling of documentation log				
Date:	**Checking of documentation performed by:**	**Are diagrams and specifications up to date?**	**Are risk assessments in date and applicable to the task?**	**Any issues with diagrams and specifications to report:**
03/04/2022	Candidate.B	Yes, most up to date diagrams and specifications are being used. V2.1	Yes. Area risk assessment has been checked and is in date. Risk assessment produced in task 1 is for the working activity.	All documents are complete, valid and in date. Should any problems have been found this would be relayed to the supervisor who would then contact the document controllers as per chain of command.

Commentary

The candidate has completed the maintenance log accurately, noting the four faults that were found outside of the planned routine maintenance, the actions needed to repair them, and that testing confirmed these were fully rectified. The candidate has demonstrated an awareness of the need to revisit the maintenance schedule in order to support future preventative action.

The candidate has completed the control documentation accurately and with clear and relevant detail, including diagram and specification version number currently in use.

2. Annotated method statement

Maintenance

Initial pre-maintenance checks

Firstly, I will obtain the required PPE (gloves, safety glasses, boots and overalls) for the task. I will check it over to ensure that there is no damage and that it is fit for purpose to ensure safety whilst undertaking the task. Should the PPE not be fit for purpose or found to be damaged, this will be reported to the appropriate people. Once checked and wearing the required and appropriate PPE the working area can be safely entered.

Once the work area has been entered, I will visually check the area initially to ensure the area is clean, safe and tidy. I will remove any objects, equipment or tools that may be on the floor to mitigate the chance of slips, trips and falls, then put signage in place indicating work is being carried out. All of the above will be in compliance with both the PPE regulations (Personal Protective Equipment at work Regulations 1992), the HASWA (Health and Safety at Work Act 1974) and with permits to work in place.

Undertaking the maintenance activity

The first thing I will do in terms of the maintenance activity is visually inspect and function check the system. This is to ensure that it is in operational condition and a healthy state. I will start by running a program to see in what 'state' it currently runs in and check the control console for indication of any fault/s. Depending on what is displayed depends on the process I follow.

It has been indicated to me that there is an intermittent fault therefore I will be conducting fault finding processes, using more than one style to locate, identify and diagnose the issues with success.

If any faults should arise, I will apply the appropriate fault-finding techniques to investigate and diagnose any potential causes. For example, if error codes are displayed in the error log, then I will refer to the manual for guidance of the fault. I will then investigate to find the fault/s and prove which items/components are faulty before replacing/repairing. I will conduct any testing that may be required, remove and replace any equipment and components that may be faulty. Once the fault has been rectified, I will commence with the maintenance activity.

If diagnosis is not appropriate, then I will proceed to follow the maintenance schedule as listed in the manual and record my findings and diagnose as I go.

***Update - approach to fault finding**:*

Upon checking the system, I found the control console to be indicating that the motor was creating an overheating fault (error log). I checked for power supply to the motor to discover that the supply was faulty (too low). This required the supply transformer to be replaced as the supply voltage from the wall was correct but the supply voltage to the robot was incorrect. Once this was done, I went on to check the motors in the robot. Using a multimeter I discovered that the resistance values on the motor indicated that there was high resistance – creating excess heat. This confirmed the intermittent faults to me. Whilst completing the repair the system was deenergised and I followed LOTO to prevent accidental electrocution.

I gained and replaced the faulty motor and ran the system to confirm my rectification process worked. I could continue with the maintenance.

I will proceed to clean down the system as part of maintenance to prevent any settled dust or debris from getting into the system when the sub-assemblies / covers are removed. Once I am happy the system is cleaned, I will remove any sub-assemblies to gain access to the components. I will visually inspect the components and wiring of the robot to ensure all connections are electrically sound and that no damage or wear and tear is visible. I will also check all joints for wear tear and lubrication, lubricating with the appropriate grease or oil (as per the specification).

Once I am satisfied following the IET guidance I will switch off the supply and remove the fuses. I will lock off the supply to ensure it cannot be re-energised whilst I am working on it, ensuring LOTO procedures are followed.

I will check the entire system, assemblies and sub-assemblies for security and tightness. If any fastenings/fixing are showing signs of wear and tear then these will be replaced as appropriate. During this maintenance I will need to check the running of and replace the belt. To do this I need to disassemble the robot arm from the main motor and gain the appropriate access. Once this has been done and safely stored, I can proceed to remove, inspect and replace the belt. This will then need to be assembled and tightened in accordance with the manual. To check the correct tension on the belt I will use the belt tensioning tool and check the tension in the slackened part of the belt, rotating it to double check.

Update - approach to fault finding

Once I gained access to the belt, I discovered that it was excessively worn, this would have led to incorrect operation of the robot and prevent accurate operation of the robot. Where the belt had worn there was excessive carbon/rubber compound particles in the housing. This required cleaning with the appropriate cleaning solvent (observing and using MSDS for the solvent). I made sure sufficient ventilation was available to avoid the inhalation of the solvent (I opened a window).

Once I am happy, I will reassemble the robot in the correct order, torquing up the main fixings to the appropriate torque. The sub-assemblies are mainly fixings, and these will be tightened as per the required spec. During the reassembly process there are alignment markings that need to be checked and set to the appropriate datum so that the robot preforms ‘true’ and with precision. These alignment / datum settings are described in the manual and will be followed to ensure final correct operation. Another very important process to be followed is to ensure all greased components are cleaned off and re-greased. The same applies to the oiled surfaces. It is important to clean and reapply the oil and grease as it likely contains debris and carbon deposits from general use of the machine. As it is high temperature grease, it can become hard/waxy over time, which could cause seizing of important components if not refreshed.

I will then function check the system and ensure the process is operating correctly.

Post-maintenance

Once I am satisfied that the maintenance has been completed, I will tidy up my area and ensure that all tools and equipment are free from damage before returning to dedicated storage. I will clean my area and dispose of waste correctly, ensuring any disposal and regulatory requirements such as WEEE are followed. I will then handover the system to the assessor, demonstrating the system functionality and condition as part of the handover

agreement. I will complete any necessary paperwork and amend any documentation that may need amending, before handing this over to the assessor.

Commentary

The candidate has clearly annotated their method statement at the intervals when the scope of work needed to change from the planned method statement. The annotations provided are very detailed, and specifically identify the steps taken and the reasons for taking these. This shows the candidate's ability to recognise where changes needed to be made to the planned maintenance from interpretation of fault detection results and to react appropriately to unplanned situations encountered. For example, confirming their initial fault diagnosis with the transformer using measurements of electrical parameters to confirm the fault code read.

The candidate has shown understanding of how both visual checks and measurement-based testing can result in discovery of unexpected issues and has shown how their planning has changed as a result. They have demonstrated logical thinking by realising that they needed to repair the transformer first, as subsequent faults would be difficult to diagnose without this component working correctly in the first instance.

2. Practical observation form – work area preparation

Assessment ID	Qualification number
8712-312	8712-32
Candidate name	**Candidate number**
Candidate.B	CG23456
Centre name	**Assessment theme**
City & Guilds	Health and safety Planning and preparation

Complete the table below referring to the relevant marking grid, found in the assessment pack. **Do not** allocate marks at this stage.

Task	**Notes –** *detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.*
Work area preparation	The candidate gathered the tools, equipment and PPE listed in their resource list, including clean cloths, spill kit and drain trays. Each piece of equipment was checked to confirm its condition and calibration dates. They were placed in their working area within reach and methodical order of use. Technical information, including risk assessment, were placed to hand in the work area with the relevant information located prior to starting work. Waste bins were placed close to the working area with consideration of slips, trips and fall hazards. Visual inspection of working area and PPE, moving an obstruction out of the walkway, ensuring all health and safety requirements were followed before the maintenance activities began. Appropriate warning signs were used with an extendable barrier positioned to extend across the entire work area.

Assessor signature	Date
Assessor.1	02/04/2022

Commentary

The candidate prepared the working area with all listed resources from Task 1, and all tools and equipment were checked for condition and calibration dates. This demonstrates a comprehensive understanding of the importance of preparatory checks to ensure efficient and accurate maintenance can be carried out, mitigating issues arising if an incorrectly calibrated multimeter was used, for example.

Resources were placed in the working area with consideration of the prepared method statement, demonstrating exemplary understanding of work area preparation and how this

can ensure safe and efficient working throughout. For example, placing tools in a logical sequence for starting work.

2. Practical observation form – maintenance activities

Assessment ID	**Qualification number**
8712-312	8712-32
Candidate name	**Candidate number**
Candidate.B	CG23456
Centre name	**Assessment theme**
City & Guilds	Health and safety Systems and components Working with faults Reviewing and reporting

Complete the table below referring to the relevant marking grid, found in the assessment pack. **Do not** allocate marks at this stage.

Task	**Notes –** *detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.*
Decommissioning, disassembly and inspection	The candidate correctly followed all steps of isolation procedures before starting work on the system and obtained permission to start work. The candidate completed a test run the robot with the current installed program to inform them of the current 'state' of operation. The candidate performed the maintenance correctly, checking their method statement and technical information as appropriate. The candidate completed this through visual and physical inspections and checked the control console, followed by connecting a PC to the PLC connection point and reading stored error codes. They then dismantled the sub-assemblies and lubricated with both grease and oil to the appropriate grade and to the correctly identified components (joints, gears and moving parts). The candidate was observed wearing the correct PPE needed for each task at all times. When disassembled the candidate observed good health and safety techniques relating to storage of removed components. The candidate made sure the location was not an obstruction to them or others surrounding them.
Fault detection and diagnosis	The candidate approached the fault finding logically, checking the control console and PLC first to gain any information displayed before moving onto other areas of the system. The candidate accurately identified and considered potential causes before effectively diagnosing a faulty motor. The candidate understood this was the issue, so removed and refitted the motor. The candidate continued working on the robot and discovered the

Task	Notes – *detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.*
Reassembly and recommissioning	source of strange noise – the belt was incorrectly tensioned and worn. After reassembling the system, the candidate then re-energised the system to discover that there was an inefficiency with operation, this led to further fault-finding methods. At this point the candidate correctly diagnosed a faulty power supply transformer. They followed the correct health and safety procedures and using the appropriate equipment (multimeter) to safely complete this task. The candidate then gained a power supply from the center store using comprehensive communication techniques. This was simply plugged into the system and powered up. The candidate went onto clear error codes using a PC. This is the logical process to follow to prevent stored error logs for future maintenance. A test run program was then followed and completed with the necessary checks to ensure that operational condition had been achieved. The candidate then followed the correct and logical process to remove and replace the drive belt. To do this, the candidate first disassembled the surrounding components, before reassembling these. The correct tooling and equipment (belt tensioner) was used throughout. The candidate went on to logically reassemble the robot using the technical information to reassemble to the correct datum points for the gears/drivers (so the robot operates within the 'true' required locations for any program/operation). Torque settings were observed and followed by the candidate using a torque wrench for the required motor assembly bolts. The candidate checked the connections to ensure that they were electrically sound and ensured that everything was replaced correctly. The pneumatic lines were also checked for kinks, wear and tear and traps.
Working area	The candidate worked safely and neatly throughout all activities, following all workshop and health and safety requirements. Disconnected wires and components were placed into organised containers which mitigated any trip hazards, kept them tidy and prepared for appropriate waste disposal. All tools and equipment were cleaned and returned to correct storage. Waste was disposed of in correct separate bins and the working area was left safe, clean, and tidy.

Assessor signature	Date
Assessor.1	03/04/2022

Commentary

The candidate demonstrated the ability to follow a logical methodology to the maintenance activity and fault-finding, ensuring this was undertaken effectively and efficiently. For example, checking the control console to gain any further fault diagnosis information before conducting any other inspection or testing techniques.

The candidate was able to demonstrate maintenance techniques showing excellent hand skills and correct use of tools and equipment, ensuring the maintenance was completed to a

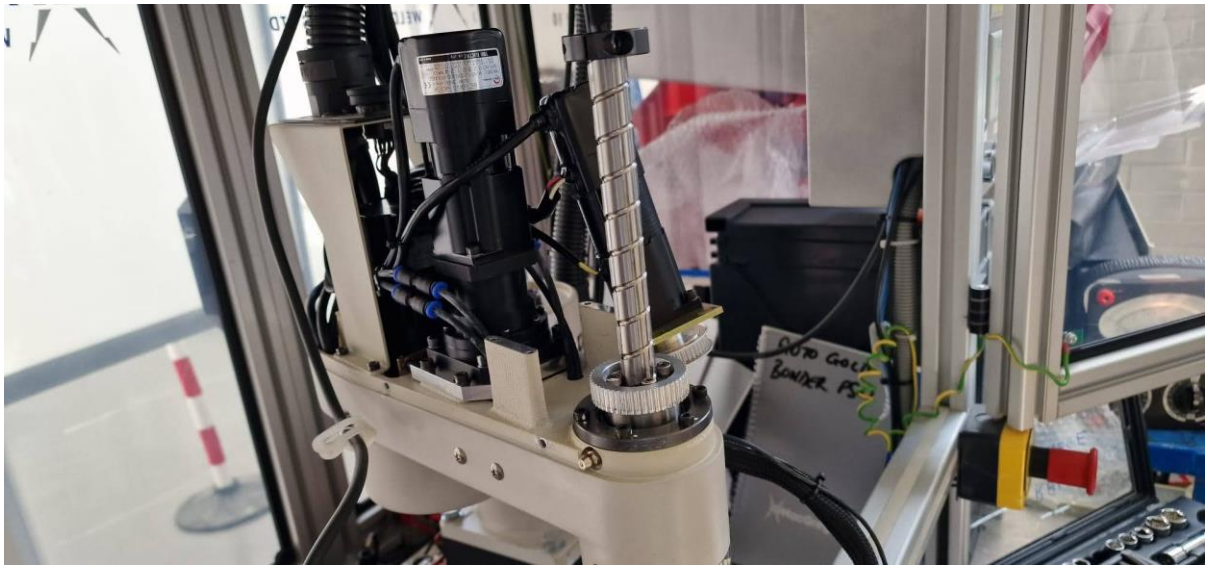
high standard. For example, the candidate ensured to disassemble the components and sub-assemblies surrounding the belt which needed to be replaced and using the correct tooling of a belt tensioner when performing the replacement.

The candidate demonstrated efficient use and application of test equipment to complete the calibration correctly, demonstrating ability to interpret the calibration requirements and documentation which resulted in system accuracy. The candidate paid special attention to the datum marks when reassembling which demonstrates attention to precision, along with running a final function test to confirm full functionality had been restored to the system.

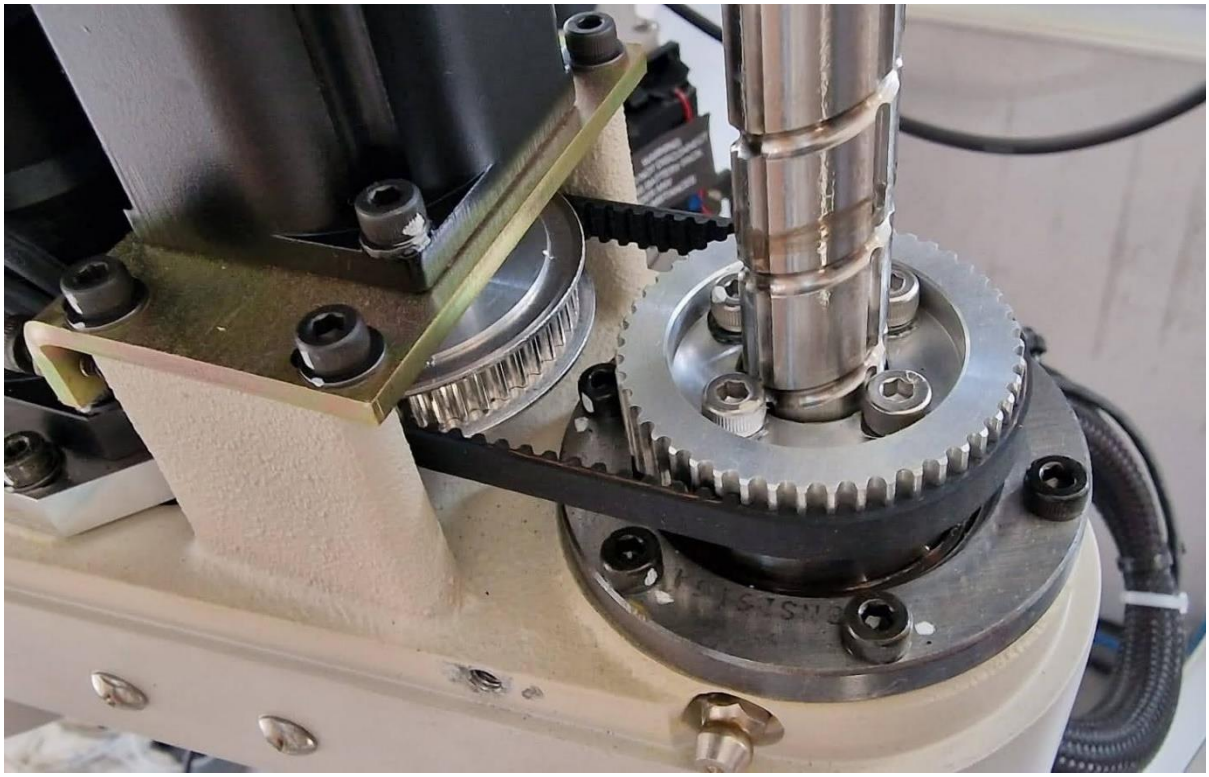
2. Photographic evidence.

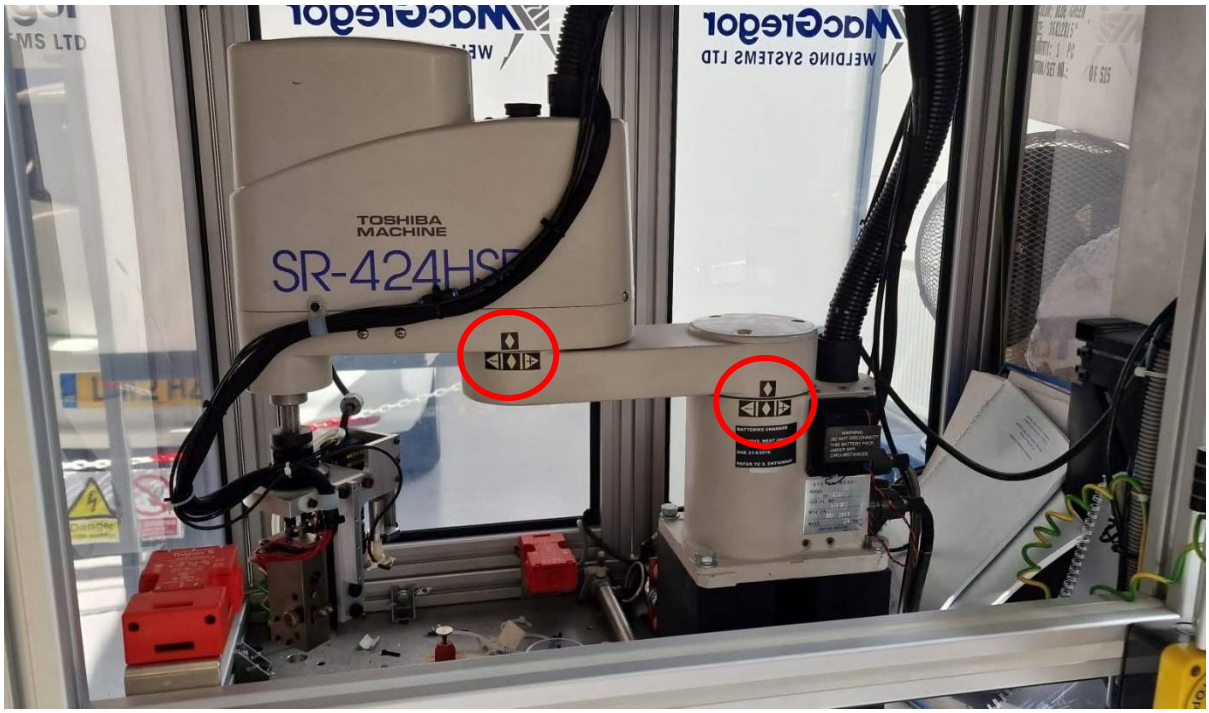
Photographs 1 and 2: Photographic evidence shows the well-organised work area with tools, equipment and technical documentation placed in the prepared working area within reach and arranged in a methodical order of use. Technical documentation has been placed at the specific pages needed for the task. No obstacles are evident. An extendable barrier has been positioned that can be used to seal off the entire working area and spill kit within the toolbox.

Photographs 3 and 4: Photographic evidence shows the working area after disassembly. Components and sub-assemblies have been neatly placed into separated containers.



Photographs 5 and 6: Photographic evidence shows the refitted belt and correct fitment to the pulleys and robot alignment markings.





Photograph 7: Photographic evidence shows the re-instated working area including the secured system. All tools and equipment have been tidied away out of the area, leaving only the technical data with the system.

Task 3a - Review and report the maintenance activities

(Assessment themes: Health and safety, Systems and components, Reviewing and reporting)

For task 3a candidates need to produce the following pieces of evidence:

- technical report
- revised maintenance schedule, including justifications.

Candidate evidence

3a. Technical report

Mitsubishi RH-5AH series SCARA robot	04/04/2022

The scheduled maintenance of the SCARA robot has been fully completed. The maintenance included the inspecting, testing and diagnosing and repairing of any faults found within the system. The inspection techniques completed included sensory checks that included visual and smell, fault diagnostic tests, measurement of key electrical parameters and finally operational and functional checks of each block of circuitry within the system. The maintenance completed allowed all the circuitry to be accurately inspected and effectively maintained, however it is to be recommended that the maintenance is conducted on a more regular basis as the issues that were found may not have occurred if the length of time during the scheduled maintenance was not as long, in effect reducing downtime. I ensured that the system had power to it and that the control console was indicating correctly.
Upon examination the control console indicated faults (flashing light) and through interrogation I gained error log codes. The codes indicated a motor overheating I identified and dealt with the fault before proceeding with the maintenance.

During the scheduled maintenance, four faults were discovered, investigated, diagnosed and rectified. These were:

- faulty transformer, not enough voltage supply – transformer replaced.
- an excessively worn belt – belt replaced
- the idle tensioner being set incorrectly – tension set and double checked for operation.
- a failed motor (windings) – replaced with new motor of same model and value.

I followed the method statement completed in task 2, but made deviations as noted on the modified version when unexpected faults or issues were discovered. This will require a new version to be created to ensure these changes are reflected in future maintenance. I followed safety precautions at all times including obtaining permit to work, fully isolating the system and using LOTO (lock out, tag out) procedures to ensure nobody could be harmed by the system whilst work was being carried out.

To carry out the maintenance, I first checked the main power supply with a multimeter. I discovered that the supply was lower than expected 0.5VDC. I checked supply from the mains 230 V AC and to the robot either side of the transformer. This diagnosed that the transformer was faulty, this would also create error logs that would not necessarily be true to the actual faults. I replaced this with a new one. The transformer did not seem to be exposed to any environmental impact to cause this, so I conclude that the transformer had reached its end of life or became faulty. Due to this being a sealed unit I could not diagnose any further.

I then proceeded to test each motor for voltage supply and resistance values of the windings. I found one on the motor's windings resistance to be too high – this would conclude the overheating error log. This motor overheating could be due to poor ventilation or poor motor design, there was no real indication of the cause of this fault. This was then removed and a new one replaced the issues were rectified and the system performance checked to confirm correct rectification. As part of the maintenance examination of the belt was required, I discovered that it was excessively worn, this was expected to be worn due to the service life of this component. This was then removed, refitted and tensioned to the appropriate values using the belt tensioning tool and manual the whole robot was reassembled. There was indication as to what caused this fault, there is always the possibility of the motor windings causing the motor to seize and causing the other motor connected to the drive end of the belt, driving the belt over stationary toothed wheel. The actual cause was due to the tensioning idler not being set to the correct tension and allowing the belt to slip.

On reassembly the gears required precise assembly ensuring datum alignment was adhered to, failure to do so would lead to an in accurate operation of the robot. Worst case scenario could lead to the robot throwing/knocking objects and creating health and safety hazards.

Once complete, I ran a pre-programmed operation of the robotic arm, checks were made and results compared to ensure optimal operation and accuracy of the system, confirming precision assembly. This then deemed the system safe and operational; this is a method of diagnosis and rectification verification.

The system was then reassembled with wiring connections securely fitted, sub-assemblies put back together, and the casings re-attached. I ensured that the screw connections were flush with the casings as this provided a neat finish and to help to prevent any snags on clothing or skin during future maintenance.

Aside from the additional recommended checks stated earlier in this report, I also recommend that the maintenance schedule be revisited to include checks of the transformer and solder/wiring joints every 6 months. This is because these components are prone to failure due to mechanical stress on the system and could cause catastrophic full system failure if not diagnosed early. This in turn would result in a long period of downtime or even the whole system needing to be replaced in its entirety.

The stock used and recorded included:

- 1 step down transformer
- 1 drive belt
- 1 motor.

There was not much waste, however the removed transformer and the motor were disposed of in the electrical bin in accordance with Waste Electrical and Electronic Equipment Regulations. Any extra stock that was obtained as part of preparing for the task was returned to the correct location and recorded on the stock record sheet located in the stock room. This enables stock to be tracked and replenished when certain items are running low.

Overall, the maintenance is cost effective, only requiring hours of the engineer and some minor costing of components such as the replacement transformer and motor. During the procedure, it became obvious how errors flashing on the control console were ignored or not reported appropriately. I recommend that the customer checks staff training and to notify my company as a service provider with faults as soon as they arise due to the health and safety complications that could result from ignored faults displayed.

Commentary

The candidate has analysed and reviewed the maintenance and the issues that were found, providing a recommendation on how this can be improved through explaining that some issues may have been prevented had the system been inspected sooner.

The candidate has stated the fault finding and testing methods applied and explained how these were used to aid with the locating and diagnosing of the faults. For example, the candidate both identified and diagnosed one faulty motor through testing of its parameters and finding the winding resistance was too high. The candidate has explained clearly how the issues were then rectified showing a comprehensive knowledge of the maintenance and fault resolution processes.

The candidate has demonstrated a good understanding of test reports and their purpose by reviewing and analysing the actions taken, before completing the report with a conclusion and providing clear recommendations for future actions. For example, recommending staff training to prevent missed codes or flashing indication lamps.

3a. Revised maintenance schedule

System:	Findings during maintenance:	Recommendations to seniors:	Justification to seniors:	Recommended next planned maintenance due date:
SCARA Robot	Transformer faulty, providing inefficient supply to the robot. This can be caused by environmental factors or faulty parts. This may have led to a breakdown in the motor windings – which was also found to be faulty. Faults were indicated on the control console and logged internally. Pneumatic pipes – monitor about J2 axis. Terminal block found to be loose (next to J1 axis actuator) – Monitor in next maintenance. Worn belt, indicates jamming of the motor or poor operation of the robot – Monitor.	It is recommended that the maintenance schedule is addressed and altered from 12 monthly to 6 monthly. Due to the nature and constant use of the system, there is a high chance than mechanical stress and excessive wear and tear faults will occur more frequently. It is also recommended that the company check employee training and notify us of any faults as one fault could have created much bigger health and safety implications.	As well as rectifying faults, both recommendations will reduce system downtime and any further issues arising. This will save money as maintenance engineers will not need to spend as much time rectifying the issues that have arisen as well as preventing issues before they arise. By upskilling operators of the robot this can prevent premature wear and tear.	03/10/2022

Commentary

The revised maintenance schedule has been completed efficiently with a detailed explanation of the findings from the maintenance activities. The candidate has clearly identified and explained recommendations for the system that has been maintained to improve its maintenance schedule and reduce downtime by increasing the frequency of planned maintenance activities.

The candidate has provided a detailed justification for increasing the frequency of scheduled maintenance activities which considers the effects on potential downtime, cost of replacement and safety. For example, understanding that ensuring correct training and upskilling the operators of the system will ensure proper use and therefore reduce premature wear and tear.

Task 3b – Peer review

(Assessment themes: Reviewing and reporting)

For task 3b candidates will be asked to peer review two maintenance schedules and then be given two completed peer reviews to review and amend their proposed maintenance schedule. This is supporting evidence for assessors to see what suggestions have been given to each candidate in order to base their amendments on and will not be marked.

For task 3b candidates need to produce the following pieces of evidence:

- maintenance schedule amended from peer review feedback, including justifications

3b. Completed peer review forms

Candidate name	**Candidate number**
Candidate.C	34567
Centre name	**Centre number**
ABCDE	12345

Question	**Feedback**
How well does the schedule enable planned maintenance activities to be performed and recorded over time?	*The schedule enables planned maintenance to be completed at more regular intervals which will improve system efficiency. The documents produced allow for the maintenance to be recorded clearly.*
How appropriate are the recommended planned maintenance intervals and why?	*The alteration to the maintenance schedule that is proposed is appropriate for the system, its age and use.*
What are the implications to the business of the proposed maintenance schedule?	*The implications are mainly costs. More regular maintenance will mean additional costs for the customer and business, however with constant and precise use of the robot, more regular maintenance should mean reduced system downtime and a well-maintained robot can also extend its working life. Due to the increased initial cost implications, seniors may not approve the update.*
How can the maintenance schedule could be optimised/ improved?	*Where candidate.B has reduced from 12 monthly to 6 monthly, I feel that the maintenance should be completed on a 3 monthly system as to maintain full accuracy and efficiency of the system. I would also recommend replacing the belt each time planned maintenance is carried out to prevent excessive wear and tear faults before they happen.*

Candidate name	Candidate number
Candidate.D	45678
Centre name	**Centre number**
ABCDE	12345

Question	Feedback
How well does the schedule enable planned maintenance activities to be performed and recorded over time?	*The documentation that is in place allows the maintenance steps to be recorded and stored efficiently and can be referenced back to during future maintenance activities. The planned maintenance activities are comprehensive and the schedule is appropriate for the tasks to be completed.*
How appropriate are the recommended planned maintenance intervals and why?	*After reviewing the issues that the system presented during the maintenance, the recommended planned maintenance intervals are appropriate.*
What are the implications to the business of the proposed maintenance schedule?	*The new maintenance schedule will mean that more time is being spent on the fault rectification(s) which may have a cost implication, however, overall will reduce costs as the system will be functioning more accurately and downtime will be reduced. This will ultimately lead to prevention of serious health and safety risks.*
How can the maintenance schedule could be optimised/ improved?	*A revision to the schedule requires it to be read every 6 months. The purpose of having a service engineer onsite with this robot every 6 months is to prevent severe failure and malfunction which could lead to health and safety implications.*

Candidate evidence

3b. Maintenance schedule amended form peer review feedback

System:	Findings during maintenance:	Recommendations to seniors:	Justification to seniors:	Recommended next planned maintenance due date:
SCARA Robot	Transformer faulty, providing inefficient supply to the robot. This can be caused by environmental factors or faulty parts. This may have led to a breakdown in the motor windings – which was also found to be faulty. Faults were indicated on the control console and logged internally. Pneumatic pipes – monitor about J2 axis. Terminal block found to be loose (next to J1 axis actuator) – Monitor in next maintenance. Worn belt, indicates jamming of the motor or poor operation of the robot – Monitor.	It is recommended that the maintenance schedule is addressed and altered from 12 monthly to ~~6 monthly~~ 3 monthly. Due to the nature and constant use of the system, there is a high chance than mechanical stress and excessive wear and tear faults will occur more frequently. It is also recommended that the company check employee training and notify us of any faults as one fault could have created much bigger health and safety implications.	As well as rectifying faults, both recommendations will reduce system downtime and any further issues arising. This will save money as maintenance engineers will not need to spend as much time rectifying the issues that have arisen as well as preventing issues before they arise. By upskilling operators of the robot this can prevent premature wear and tear.	03/07/2022

Justification for changes:

From the peer review feedback, it was highlighted that 6 months is still a long time for the accuracy of the system due to the constant use and nature of the working environment. With consideration of the feedback, it has been decided that the proposed changes to the maintenance will go from 6 monthly to 3 monthly. This will improve system efficiency and reduce breakdown costs and time that could occur. Carrying out planned maintenance on a more regular schedule will improve consistency in the maintenance process and identify smaller faults early before progressing into larger more serious and costly faults.

Commentary

The candidate has clearly amended the maintenance schedule and highlighted where the change was made for easy identification. The candidate has reviewed the date and amended it, considering the peer review feedback, which demonstrates their understanding of the system, and that prevention would be more cost efficient for this system than reactive maintenance.

The candidate has taken on board the peer review feedback and implemented changes where they agreed it was appropriate to further improve safety and reduce the possibility of downtime. The candidate has provided clear justifications for the changes made, giving detailed reasoning for their decision and recommendations.

Task 4 – Complete handover

(Assessment themes: Health and safety, Reviewing and reporting)

For task 4 candidates need to produce the following pieces of evidence:

- handover documentation.

For task 4, assessors will need to produce the following pieces of supporting evidence from the maintenance activities:

- assessor observations of the handover meeting.

The following task 4 supporting evidence has not been included for this version of the guide standard exemplification materials:

- video evidence showing the handover meeting.

Candidate evidence

4. Handover documentation

Maintenance log							
System type: **System TAG number:** **Department responsible for equipment:**				Mitsubishi RH-5AH series SCARA robot 1A2B3C Maintenance engineering department			
Date:	**Maintenance performed by:**	**Maintenance description:**	**Work completed outside the scope of the maintenance:**	**Are any problems identified rectified? Y/N**	**Validation performed by:**	**Next maintenance due date:**	**Comments:**
03/04/2022	Candidate.B	Scheduled maintenance and intermittent fault diagnosis.	Yes, the system was indicating various error codes. Both the power supply transformer and one of the motors were faulty. Each of these issues were rectified, ensuring the connections were electrically, pneumatically and mechanically sound. The maintenance tasks were completed to include a belt change.	Y	Assessor.1	03/07/2022	Maintenance schedule has been updated and approved by seniors, planned maintenance will now be carried out 3 monthly instead of 12 monthly.

Controlling of documentation log				
Date:	**Checking of documentation performed by:**	**Are diagrams and specifications up to date?**	**Are risk assessments in date and applicable to the task?**	**Any issues with diagrams and specifications to report:**
03/04/2022	Candidate.B	Yes, most up to date diagrams and specifications are being used. V2.1	Yes. Area risk assessment has been checked and is in date. Risk assessment produced in task 1 is for the working activity.	All documents are complete, valid and in date. Should any problems have been found, they would have been relayed to the supervisor who would then contact the document controllers as per chain of command.

Completed test record - Mitsubishi RH-5AH series SCARA robot – 03/04/2022			
Procedure	**Inspection item (details)**	**Remedies**	**Actions taken**
Make sure robot is off – follow LOTO			
1	Are any of the bolts or screws on the robot arm loose?	Tighten to the correct torque rating using the manual for the specifications.	All bolts and screws were checked and tightened to the correct torque. Once removed they were organised for correct replacement and tightened correctly on replacement/reassembly.
2	Are any of the connector fixing screws or terminal block terminal screws loose?	Tighten to the correct torque rating using the manual for the specifications.	One terminal block found to be loose (next to J1 axis actuator) – Monitor in next maintenance.
3	Remove the cover at each section and check the cables for wear damage and adherence of foreign matter.	Check and eliminate the cause. If the cables are severely damaged, contact the Mitsubishi Service Department.	All covers were thoroughly cleaned down. The housing around the belt was the worse. Monitor.
4	Is the timing belt tension abnormal?	If the timing belt is loose or too tense, adjust it.	Belt replaced and tensioned by following the manual.
5	It runs out of grease on the shaft.	Wipe the old grease off, and lubricate	J2 axis showing signs of seepage of grease. All joints lubricated with grease and gears.
6	Is the friction at the timing belt teeth severe?	If the teeth are missing or severe friction is found, replace the timing belt.	Belt excessively worn, monitor.
7	Replace the backup battery in the robot arm.	Exchange it referring to the manual.	Battery replaced following the correct procedure.
8	Lubricate the grease at the harmonic reduction gears for J1 and J2 axis.	Lubricate it referring to the manual.	Done.
9	Replace the bellows (J3 axis) (only for clean and protection specification)	Exchange it referring to the manual.	Bellows replaced – small nick found.
10	Is the power supply cable securely connected?		Yes, transformer replaced (suspected faulty part).
11	Is the machine cable between the robot arm and controller securely connected?		All machine cables are securely mounted and fixed without causing damage.
12	Are there any cracks, foreign contamination or obstacles on the robot and controller cover?	Replace with a new part or take remedial measures.	Debris wiped off.
13	Is there any abnormality in the pneumatic system? Are there any air leaks, drain clogging or hose damage? Is the air source normal?	Drain the drainage, and remedy the air leaks (replace the part)	All pneumatic pipes seemed fit for purpose – monitor about J2 axis. Drain bowl checked and cleaned.

With Robot ON (powered)			
1	Is there any abnormal motion or abnormal noise when the power is turned ON?	Use manual as appropriate	Abnormal noise was excessively worn belt – replaced.
During operation (run program)			
1	Check whether the movement points are deviated?	Set points according to the manual.	After maintenance I ran the system and checked the datum points on assembly. All seems to be working within tolerance.
2	Check for any abnormal motion or abnormal noise?	Investigate.	No abnormal noise after the robot ran through test program.

Updated Maintenance Schedule				
System:	**Findings during maintenance:**	**Recommendations to seniors:**	**Justification to seniors:**	**Recommended next planned maintenance due date:**
SCARA Robot	Transformer faulty, providing inefficient supply to the robot. This can be caused by environmental factors or faulty parts. This may have led to a breakdown in the motor windings – which was also found to be faulty. Faults were indicated on the control console and logged internally. Pneumatic pipes – monitor about J2 axis Terminal block found to be loose (next to J1 axis actuator) – Monitor in next maintenance. Worn belt, indicates jamming of the motor or poor operation of the robot - Monitor	It is recommended that the maintenance schedule is addressed and altered from 12 monthly to ~~6 monthly~~ 3 monthly. Due to the nature and constant use of the system, there is a high chance than mechanical stress and excessive wear and tear faults will occur more frequently. It is also recommended that the company check employee training and notify us of any faults as one fault could have created much bigger health and safety implications.	As well as rectifying faults, both recommendations will reduce system downtime and any further issues arising. This will save money as maintenance engineers will not need to spend as much time rectifying the issues that have arisen as well as preventing issues before they arise. By upskilling operators of the robot this can prevent premature wear and tear.	03/07/2022

Justification for changes:

From the peer review feedback, it was highlighted that 6 months is still a long time for the accuracy of the system due to the constant use and nature of the working environment. With consideration of the feedback, it has been decided that the proposed changes to the maintenance will go from 6 monthly to 3 monthly. This will improve system efficiency and reduce breakdown costs and time that could occur. Carrying out planned maintenance on a more regular schedule will improve consistency in the maintenance process and identify smaller faults early before progressing into larger more serious and costly faults.

Commentary

The candidate has ensured to hand over all relevant documentation required, including the completed test record, maintenance log, controlling of documents log and updated maintenance schedule, and ensuring to obtain a signature on the maintenance log confirming that work has been completed. This shows comprehensive understanding of the importance of thorough documentation and recording procedures as well as the requirements of handover procedures.

4. Practical observation form – handover meeting

Assessment ID	Qualification number
8712-312	8712-32
Candidate name	**Candidate number**
Candidate.B	CG23456
Centre name	**Assessment theme**
City & Guilds	Reviewing and reporting

Complete the table below referring to the relevant marking grid, found in the assessment pack. **Do not** allocate marks at this stage.

Task	**Notes –** *detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.*
Handover	The candidate accurately explained in detail the actions that were taken to complete the maintenance and thoroughly justified actions. System functionality was demonstrated clearly using the correct technical terminology for each area of the system. No error messages displayed on the control console showing the original fault has been rectified and all outputs were reading correctly. The candidate demonstrated excellent communication skills using accurate technical terminology appropriate to the technical audience. The candidate explained the revision of the maintenance schedule, providing the supervisor with an overview of the peer feedback they received, including the difference of opinion from the two sets about the time of planned maintenance intervals. The candidate then explained the decision to amend the revised maintenance schedule. One peer was concerned about cost implications and the candidate explained they chose to dismiss this concern as in the long run as increasing the maintenance intervals and fault prevention would be less costly than reactive maintenance. They also explained their decision to not make any changes from the suggestion of changing the belt each time planned maintenance is carried out being unnecessary due to it only needing to be changed when showing signs of wear and changing every time would be wasteful of components still fully working and this would add unnecessary costs. The candidate ensured all the documentation had been completed correctly and asked the supervisor to confirm they were happy with the information and findings presented, signing the completed documentation. Overall, the handover was complete, comprehensive and used excellent communication skills.

Assessor signature	Date
Assessor.1	05/04/2022

Commentary

The observation report identifies the different areas of the handover process and how the candidate met the requirements. They shared all correct documentation and obtained the supervisor's signature to confirm they were satisfied with the work completed, demonstrating they understand the handover processes and how to correctly follow them for quality assurance.

The candidate provided a technically detailed functional overview of the system in use and verbally explained the faults found, using correct terminology throughout, and the rectification processes followed. They shared all key documentation and explained these in an appropriate level of technical detail to the assessor.

The candidate clearly addressed the revised maintenance schedule and the peer review feedback received, explaining some feedback they chose to dismiss as it was unnecessary. For example, dismissing the suggestion to change the belt at each planned maintenance interval instead of waiting for it to fail, the candidate understood and justified that this was unnecessary because it could be wasteful if the belt did not have enough wear and tear to justify changing, causing additional and potentially unnecessary costs to the business.

The T Level is a qualification approved and managed by the Institute for Apprenticeships and Technical Education.