T-LEVELS | Institute for Apprenticeships & Technical Education

T Level Technical Qualification in Maintenance, Installation and Repair for Engineering and Manufacturing (8712-33)

Maintenance Engineering Technologies: Electrical and Electronic (313)

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: Electrical & Electronic 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 the 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 section
This section includes detailed comments to demonstrate how the candidate evidence attests to the standard of minimal threshold competence 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 minimal threshold competence.

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 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 diagnosing components, assemblies and sub-assemblies to complete maintenance, installation and repair activities in line with the requirements of the brief, working systematically, logically and efficiently.

Demonstrate exemplary technical skills using tools and equipment for electrical and electronic 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 electrical and electronic systems, ensuring that all tolerances and calibrations 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 and prepare for 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 (components/tools/equipment) *The following will be needed to undertake the maintenance activities.*		
	Quantity	**Purpose and justification**
230 V supply	1	230 V supply is the mains supply voltage to the system that is to be stepped down by the transformer and converted to 5 V DC by the rectifier. This is mains voltage in the United Kingdom – any other voltage supply would not match the UK standard.
Step down transformer	2	This steps the voltage down from the mains supply to a lower AC voltage. Two spares have been included, dependent on the exact requirements of the system when inspected, and to reduce potential downtime, as this is a common failure point for this type of system.
Filter capacitors	2	These are to remove any large fluctuations from the rectifier and regulator output voltages. Spare components in case they need to be replaced.
Bridge rectifier diodes	6	Diodes for arranging in a bridge rectifier configuration, to convert the AC voltage into a DC voltage. Additional spares included in case of any issues with fitting and soldering, to reduce potential for system downtime.
Voltage regulators	2	Used to remove any remaining voltage ripples and produce the required 5 V DC voltage. Spare components in case they need to be replaced.
Soldering iron	1	Making permanent, soldered joints between wires and attaching components to PCBs when making repairs and replacing components.
Soldering iron stand and sponge	1	Safety device – for placing soldering iron in when not in use (stand) and cleaning the tip of the soldering iron after each use (sponge).
De-soldering pump	1	Removing solder from joints so components and wires can be removed and replaced.
Screwdriver (terminal)	1	Small screwdriver for removal and assembly of wires and components into block connectors.

Screwdriver (Philips and flathead)	2	Removal and assembly of casing and other assemblies/sub-assemblies, removal of PCB from mounting.
Wire cutters	1	Cutting wires to correct lengths and terminating wires that may need to be replaced.
Wire strippers	1	Removing insulation from the ends of wires, so they can be fitted and crimped/soldered in place.
Pliers and helping hand	1	Removal and replacing purposes. Holding components and wires in place when soldering.
Cable identification markers	6	Identifying wires and cables and their purpose/location within the system.
Crimping tool	1	Aid with crimping of any new cable terminations that are required.
Multimeter	1	To measure numerical electrical parameters such as signal voltage, current and resistance outputs from each system block. Checking continuity of wiring and PCB tracks. This is better to use than individual meters as it is smaller, more portable and can measure a range of different parameters.
Oscilloscope	1	To measure characteristics of signal waveforms and output as a graph of voltage against time. E.g. periodic time, amplitude and frequency. These will then be compared against expected norms for this circuit.
Materials and consumables *The following will be needed to undertake the maintenance activities.*		
Lead free solder reel	1	For making solder joints – e.g. joining components and wires to circuit board. Lead free to avoid dangerous fumes being inhaled.
Multi core wire/cable reel – live and ground	1	Connecting the 230 V power supply – live, neutral and ground connections.
Multi strand red wire reel	1	Connecting to the + 5 V output power.
Multi strand black wire reel	1	Connecting to the 0 V output power.
Block screw connectors	10	Making wire and cable connections that cannot be soldered or crimped.
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).*		
Portable extraction unit	1	For removing potentially dangerous solder fumes from the air. This must be switched on at all times during soldering or de-soldering activities.
Heat resistant gloves	1	To be worn when handling any components that are hot or overheating due to faults e.g. the PCB, the transformer or the voltage regulator.
Safety glasses	1	Work activities such as soldering and terminating wires can cause flying debris that may get into the eye. Safety glasses act as barrier between the eyes and this debris. Hot pieces of solder could cause severe eye injuries if not worn.
Overalls	1	Basic PPE requirement for engineering working areas and to protect clothes from dirt, solder flux residue and other contaminants that may result from the process. Protection of the body from hot liquid or hot parts/components.
Safety shoes/boots	1	Basic PPE requirement for engineering areas. Limit injuries from falling parts, instruments, tools and equipment that could cause 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 electrical supplies are isolated, informing others are in the area and mains voltage electrical work is taking place.

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**
Component datasheets/manufacturers' manuals	For the transformer, rectifier diodes, capacitors and voltage regulator. To provide technical information regarding intended functionality, tolerances and instructions for maintenance, repair and replacement.
Manual for the AC-DC converter system	Instructions and frequently asked questions for use, maintenance, disassembly, repair and installation of the complete system and individual sub-systems.
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 task to ensure brief requirements are being accurately met. To check correct layout of circuit and aid with testing of each block and sub-system.

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	Follow WEEE requirements to dispose of wiring, off cuts and faulty components.
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	
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 such as the transformer.
Input to output	This particular fault-finding method could be applied to a system like this because where there is a high voltage AC input, but an incorrect lower voltage DC output, then it is clear a problem has occurred. This could also be applied to individual sub-systems by looking at the expected output signal given the correct input signal.
Half split technique	This method will allow for the process to be broken down into sections/blocks/sub-systems, and the functionality of each section be checked. Eventually there will be one area left, which will narrow down where the fault is.
Sensory checks	Visually inspect the system to identify any obvious issues, such as loose wiring, frayed insulation or damaged solder joints on the PCB.

	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 humming, buzzing or rattling.

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 maintenance process and the 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 candidates knowledge and understanding of the process, in response to the brief, to be showcased. For example, recognising the likelihood of a faulty rectifier stage as a common fault on this type of system, and carrying additional spare diodes in case they are required, thus reducing the possibility of system downtime.

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, demonstrating 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.	2	1
Manual handling of tools and equipment needed for maintenance	Personal injury from items dropping, back injury from lifting.	When obtaining equipment and tools ensure awareness of maximum lifting weight. Ensure correct training has been provided.	2	1
Preparing soldering equipment for use	Burns, electric shock.	Inspect soldering iron flex cable and plug for damage before plugging into power outlet. Check iron heats up to correct temperature when powered on by touching against sponge. Tin the iron to prevent solder from 'spitting' when used. Follow relevant requirements of Electricity at Work Regulations (1989).	3	2
Preparation of general 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 of the working area throughout the maintenance of the power conversion system	Slips, trips and falls.	Ensure area is clean and tidy throughout maintenance and upon completion. Wear PPE at all times.	1	1
Manual handling or movement of equipment or components whilst undertaking maintenance	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
Working with stored electrical energy in the capacitors	Burns, electric shock.	Remove power from system. Ensure all capacitors are safely discharged prior to performing maintenance and repair activities.	3	2
Using soldering equipment to make joints between wires and attaching components to PCB during maintenance/ repairs	Burns, electric shock.	Keep hands away from hot tip of soldering iron when in use. Place soldering iron in stand when not use. Wear safety glasses to protect eyes from flying solder flux residue.	3	2
Using electrical measurement and test equipment for the maintenance and repair activities	Burns, electric shock.	Ensure correct selection and use of tools for the activity. Ensure sufficiently trained in the use of electrical test equipment. Ensure readings taken correctly and safely e.g. current in series, voltage in parallel and ensure power is off when measuring resistance.	2	4
Using general hand tools and equipment for maintenance and repair activities	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
Working with a system using live electricity (230 V mains and 5 V low voltage)	Electrocution.	Ensure safe isolation is carried out, including the use of LOTO procedures. Use voltage tester and proving unit to ensure system is dead. Follow requirements of Electricity at Work Regulations (1989) and IET regulations.	3	4

Fault finding				
Hazard	Risk	Control	Likelihood	Severity
Cleanliness of the working area around the power conversion system whilst fault finding	Slips, trips and falls.	Ensure area is clean and tidy throughout maintenance and upon completion. Wear PPE at all times.	1	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	System heating up when working on it	Isolate/power off the system before removing and replacing components and equipment.	3	2
Using electrical measurement and test equipment to investigate system faults	Burns, electric shock.	Ensure correct selection and use of tools for the activity. Ensure sufficiently trained in the use of electrical test equipment. Ensure readings taken correctly and safely e.g. current in series, voltage in parallel and ensure power is off when measuring resistance.	2	4
Using general hand tools and equipment to undertake fault finding and remedial repairs on the system	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 on a system with stored electrical energy in capacitors	Burns, electric shock.	Remove power from system. Ensure all capacitors are safely discharged prior to performing maintenance and repair activities.	3	2
Undertaking fault finding investigations with a system using live electricity (230 V mains and 5 V low voltage)	Electrocution.	Ensure safe isolation is carried out, including the use of LOTO procedures. Use voltage tester and proving unit to ensure system is dead. Follow requirements of the Electricity at Work Regulations (1989) and IET regulations.	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.

Hazards and risks are identified appropriately for each activity. In doing so, the candidate has demonstrated their awareness of the different types of hazards and risks, and the need to consider these throughout the entire maintenance process. The candidate has accurately labelled the likelihood and severity of 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, checking the condition of soldering equipment prior to use and tinning iron the tip to prevent flying/spitting solder, rather than simply protecting the body if this occurs. This demonstrates understanding of the hierarchy of control.

1c. Method statement

Maintenance

Initial pre-maintenance checks

Firstly, I will obtain the PPE (heat resistant gloves, safety glasses, overalls, safety shoes/boots) checking it over to ensure that there is no damage, and it is fit for purpose. 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 PPE, the working area can be entered. Once the work area has been entered, I will visually check the area initially to ensure the area is clean, safe and tidy. 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 the PPE regulations (Personal Protective Equipment at work Regulations 1992), the HASWA (Health and Safety at Work Act 1974), the Electricity at Work Regulations (1989) and with permits to work in place.

Undertaking the maintenance activity

Following the IET wiring regulations (BS 7671), HSE guidance and safe isolation procedures, I will lock off the supply with a tag out device (LOTO), remove the fuses and isolate the system. I will lock off the supply to ensure it cannot be re-energised by others whilst I am working on it. The system will then be tested for dead with an approved voltage indicator and proving unit following the prove-test-prove method. I will safely release stored electrical charge from the capacitors. There is subsequent risk of serious injury from mains electricity if these procedures are not completed correctly.

I will remove any circuit casings and perform an initial visual inspection of the system. This is to check for any obvious faults or problems, such as frayed insulation, loose wires or component damage from overheating. I will then perform a more detailed check of wiring connections and solder joints on the PCB, looking for evidence of dry joints or mechanical damage to the board itself. I will check the transformer for any obvious signs of overheating or damaged wiring/insulation.

I will then perform electrical tests to measure input and output parameters for each set of components for each sub-system block of the circuit. I will measure the current, voltage and resistance values for each, using a multimeter, and compare to expected outcomes. I will also use an oscilloscope to measure input and output waveforms from each sub-system block and compare to the expected results.

If any areas of concern are identified from the visual inspection and tests performed, I will apply the appropriate fault-finding techniques to investigate and diagnose the exact nature and causes of the faults. I will conduct any further testing that may be required and remove and replace any components or devices that may be faulty. If any components on the PCB require replacement, I will use a de-soldering tool to remove the solder joints, use pliers to remove the components and position and solder a new one in its place.

Once any faults are rectified, I will perform further visual checks, and take measurements to ensure the output values are now within reasonable tolerances. I will accurately write down the results of all tests conducted on a test record sheet. This is to ensure there is a clear paper trail of the work done, any issues found and how well the system is now operating. This will be needed for further maintenance and are a record for legal purposes.
Following the block diagram and schematic of the circuit, I will reassemble any remaining elements of the system and refit any casings. I will check these are secure before removing the lock and supplying power back to the system. I will then function check the system and ensure the full circuit and system 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 way the method statement is set out provides a comprehensive guide for the

candidate to follow to complete the maintenance activities. Steps are detailed without stages assumed and would allow the process to be easily followed correctly by a third party. For example, the detail provided relating to the specific steps needed to correctly remove and replace electrical components from the PCB.

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, and the need to comply with the requirements of the Electricity at Work Regulations. The candidate has used relevant and accurate technical terminology throughout their method statement. They have demonstrated understanding of the different elements of the system, processes and regulations that impact the work undertaken.

The candidate has provided detailed justifications most of for their proposed actions which shows thorough planning and preparation skills for the maintenance activities to meet the requirements of the brief. For example, explaining why it is important that all test results are accurately recorded.

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 (photograph 1)

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

- Photographic evidence showing faulty components prior to repair or replacement, clearly showing the cause of each fault - Illustrated in Task 2 photographic evidence section below (photographs 3, 4, 5 and 6)

- Photographic evidence showing replaced or repaired components in situ, including any solder joints or other connections made - Illustrated in Task 2 photographic evidence section below (photographs 7, 8, 9 and 10)

- Photographic evidence showing the re-instated work area – Illustrated in Task 2 photographic evidence section below (photograph 11)

Candidate evidence

2. Completed test record

Test record sheet - 03/04/2022

Testing the system

Measurements taken -
The table below shows the output signal values measured using a multimeter and oscilloscope. A multimeter was used as this provides accurate numerical measurements and outputs via an easy-to-read digital screen. It was also used to measure additional parameters during fault diagnosis. An oscilloscope was used because this allowed the output signals from each system block to be displayed as a graph of voltage against time.

Circuit/system block	Expected output V	Output V from initial tests	Output V following fault repairs
Transformer	12 V AC	12 V AC but with intermittent spikes	12 V AC
Rectifier	12 V DC with fluctuations	0 V	12 V DC with fluctuations
Filter	12 V DC without fluctuations	0 V	12 V DC without fluctuations
Regulator	Constant, ripple free 5 V DC	0 V when tested as part of system, 3.3 V when tested separately	Constant, ripple free 5 V DC

Fault diagnosis checks -
The initial measurements confirmed problems with the transformer, a rectifier diode, a filter capacitor and the regulator. The causes of each fault were confirmed using unit substitution, input to output, the half split technique and sensory checks. This fault diagnosis needed to be completed because voltage measurements simply showed 0 V across three of the four blocks circuitry, so the root causes of failure were not initially clear. Faults were subsequently diagnosed as follows:

Circuit/system block	Fault identified	Fault diagnosis techniques used	Actions taken to resolve faults
Transformer	Damaged insulation	Sensory checks, unit substitution, input to output	Transformer removed, replaced and retested
Rectifier	Shorted diode solder joints	Sensory checks, input to output	Solder joints repaired, diode retested
Filter	Failed filter capacitor	Half split technique	Filter capacitor removed, replaced and retested
Regulator	3.3 V voltage regulator fitted instead of 5 V	Half split technique	3.3 V voltage regulator IC removed, replaced with a 5 V regulator IC and retested

Additional functional tests completed -

Test	Reason for test	Outcome of test	Further actions needed/taken
Wiring continuity tests	To ensure accurate current flow through wires and cables	Current flowing as expected – test passed	None
Visual checks of circuit board solder joints	To ensure no dry joints or loose component connections	All joints secure – test passed	None
Transformer noise and vibration checks	To ensure the transformer is not moving or producing excessive noise	No vibration and noise within manufacturer's tolerances – test passed	None
Checks to casing	To ensure casing is securely fitted and providing adequate protection to the circuit	One loose connecting screw found	Screw tightened – issue resolved

Summary of actions completed

- Planned maintenance and inspection of system completed.
- Initial output voltage measurements taken for each block of components.
- Faults with the transformer, rectifier, filter and regulator stages of the circuit found and resolved.
- Final measurements taken confirming system functionality.
- Additional functional checks completed.

Testing of the AC-DC converter system is now complete, and the system can be handed back over to the supervisor. The next step is to complete the maintenance log with details of work completed and review control documents.

Commentary

The candidate has completed a comprehensive test record showing the results of measurements, fault diagnosis checks and additional functional tests. The candidate has detailed the purpose of each test and justified the use of measurement and test equipment used. For example, explaining why they used a multimeter and oscilloscope to take numerical measurements. 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 the measurements did not clearly identify the root cause of a fault, the candidate has showed how further tests and fault diagnosis checks were undertaken, which resulted in the faults being found and resolved.

2. Updated maintenance records and control documents

Maintenance log							
			System type:	AC-DC converter system			
			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.B	Scheduled maintenance and intermittent fault diagnosis.	When tested the system was showing intermittent faults on the transformer (replace and rewire) and further inspection revealed a shorted rectifier diode (solder joints repaired), failed filter capacitor (replaced) and 3.3 V voltage regulator incorrectly fitted instead of a 5 V regulator (replaced with regulator of correct value). All four faults were rectified by replacement or repair, and final testing showed the system now functioning as per the specification (see test record sheet).	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 cause the system to become non-functional.

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. Recommend update to risk assessment to place greater emphasis on releasing stored energy from the transformer for future, requiring new version to be created (V2.2).	All documents are complete, valid and in date. Should any problems have been found this would be relayed to 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. The candidate has recommended to update the risk assessment version including greater emphasis on releasing stored energy from the transformer for future, demonstrating comprehensive understanding of the purpose of control documentation being used over time.

2. Annotated method statement

Maintenance

Initial pre-maintenance checks

Firstly, I will obtain the PPE (heat resistant gloves, safety glasses, overalls, safety shoes/boots) checking it over to ensure that there is no damage, and it is fit for purpose. 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 PPE the working area can be 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, and will then put signage in place to indicate that 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), the Electricity at Work Regulations (1989) and with permits to work in place.

Undertaking the maintenance activity

Following the IET wiring regulations (BS 7671) HSE guidance and safe isolation procedures, I will lock off the supply with a tag out device (LOTO), remove the fuses and isolate the system. I will lock off the supply to ensure it cannot be re-energised by others whilst I am working on it. The system will then be tested for dead with an approved voltage indicator and proving unit following the prove-test-prove method. I will safely release stored electrical charge from the capacitors. There is subsequent risk of serious injury from mains electricity if these procedures are not completed correctly.

I will remove any circuit casings and perform an initial visual inspection of the system. This is to check for any obvious faults or problems, such as frayed insulation, loose wires or component damage from overheating. I will then perform a more detailed check of wiring connections and solder joints on the PCB, looking for evidence of dry joints or mechanical damage to the board itself. I will check the transformer for any obvious signs of overheating or damaged wiring/insulation.

***Update - approach to fault finding**:*
Two potential faults were found during the initial and more detailed visual checks of the system. There was clear damage to the insulation of the transformer and further testing confirmed this was causing an intermittent fault and voltage spikes, so a potential safety issue. I decided to replace the transformer with a new step-down model. I checked the printed circuit board which showed that one of the four rectifier diodes was shorting due to poor solder joints. This was also confirmed by taking measurements of the output voltage signal using a multimeter and oscilloscope. I decided to repair the solder joints, so these were re-soldered and solder was reapplied. Further testing confirmed this had solved the problem and the diode was now functioning as expected. Safety procedures were followed at all times including ensuring the system was still isolated (including LOTO) during repair and using a portable fume extractor during soldering activities. Once repairs were complete, I continued with the maintenance.

I will then perform electrical tests to measure input and output parameters for each set of components for each sub-system block of the circuit. I will measure the current, voltage and resistance values for each, using a multimeter, and compare to expected outcomes. I will

also use an oscilloscope to measure input and output waveforms from each sub-system block and compare to the expected results.

***Update - approach to fault finding**:*
As well as confirming the faults with the transformer and rectifier diode, test measurements showed that there were additional problems with the filter capacitor and voltage regulator IC. This necessitated the use of fault diagnosis techniques to investigate the root causes. I used the half split technique to narrow down these issues to a failed filter capacitor, which was replaced with a new capacitor, and an issue with the voltage regulator IC. This was tested outside of the system and I found that this was in fact a 3.3 V regulator instead of the 5 V regulator required. I therefore installed a 5 V voltage regulator, which solved the problem, and continued to perform final functional checks and reassembly.

If any areas of concern are identified from the visual inspection and tests performed, I will apply the appropriate fault-finding techniques to investigate and diagnose the exact nature and causes of the faults. I will conduct any further testing that may be required and remove and replace any components or devices that may be faulty. If any components on the PCB require replacement, I will use a de-soldering tool to remove the solder joints, use pliers to remove the components and position and solder a new one in its place.

Once any faults are rectified, I will perform further visual checks, and take measurements to ensure the output values are now within reasonable tolerances. I will accurately write down the results of all tests conducted on a test record sheet. This is to ensure there is a clear paper trail of the work done, record of any issues found and information on how well the system is now operating. This will be needed for further maintenance and is required as a record for legal purposes.

Following the block diagram and schematic of the circuit, I will reassemble any remaining elements of the system and refit any casings. I will check these are secure before removing the lock and supplying power back to the system. I will then function check the system and ensure the full circuit and system is operating correctly.

Post-maintenance

Once I am satisfied that the maintenance has been completed, I will tidy up my work 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. This shows the candidate's ability to recognise where changes needed to be made to the planned maintenance and to react appropriately to unplanned situations encountered. For example, confirming their initial fault diagnosis with the transformer and rectifier using measurements of electrical parameters and these measurements identified further faults within the filter capacitor and voltage regulator. The level of detail provided in the annotation also demonstrates

comprehensive understanding of recording procedures, ensuring accuracy and quality of documentation.

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 and rectifier faults first, as subsequent faults would be difficult to diagnose without these two blocks of components working correctly in the first instance.

2. Practical observation form – work area preparation

Assessment ID	**Qualification number**
8712-313	8712-33
Candidate name	**Candidate number**
Candidate B	CG23456
Centre name	**Assessment theme/s**
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 and checked each piece for condition, test dates, calibration dates and that each was still accurately calibrated. They were placed in their working area within reach and methodical order of use. Technical information, including risk assessment, and waste bins were placed within the working area with consideration of potential slips, trips and fall hazards. Visual inspection of working area and PPE were performed, including moving an obstruction out of the walkway. Appropriate warning signs and barriers were used.

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 checked for condition, calibration dates and accuracy of calibration. 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 oscilloscope was used, for example.

Resources placed in the working area with consideration of the prepared method statement. This demonstrates exemplary understanding of work area preparation and how this can ensure safe and efficient working throughout.

2. Practical observation form – maintenance activities

Assessment ID	**Qualification number**
8712-313	8712-33
Candidate name	**Candidate number**
Candidate B	CG23456
Centre name	**Assessment theme/s**
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. They disassembled the system correctly and carefully, checking their method statement and technical information as appropriate. The candidate completed thorough visual and physical inspections, checking the transformer, all components and all wiring and soldered component connections. They used appropriate test equipment to perform accurate measurements to check the function of the system. A 10-minute cool down period was observed which was appropriate for the system. Correct sub-assemblies, casings, wiring and components were removed and placed into well organised containers.

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.*
Fault detection and diagnosis	The candidate approached the fault finding logically, using the results of both sensory checks and test measurements to identify all the faults within the system. They used a range of appropriate fault diagnosis techniques, as outlined in their method statement, to investigate and accurately diagnose the root causes of the faults; damaged transformer insulation, shorted rectifier diode, failed filter capacitor and a 3.3 V voltage regulator incorrectly fitted instead of a 5 V regulator. All results of testing and fault finding were accurately recorded.
Resolution and calibration	The candidate addressed each of the faults in a logical order, correctly recognising that it would be more difficult to assess the function of the filter and regulator stages of the circuit if the transformer and rectifier diodes were not repaired first. All wiring and cabling connections were made accurately and were appropriately tightened. Some waste wire was left over after a slight miscalculation in terms of the amount needed. Solder joints were produced with care, accuracy and precision. Final system calibration was performed accurately and effectively to manufacturer's specifications.
Reassembly and recommissioning	All soldered and wired joints were made to a high standard, with care and attention to detail observed throughout. Cable terminations were well fitted, with no exposed copper, and were electrically sound. Conductivity testing was used to confirm the flow of current through them. The candidate re-energised the system correctly and safely and completed the necessary checks to ensure that safe operational condition had been achieved. The casings and sub-assembles were accurately refitted to original specifications and all screw joints left flush for an aesthetically pleasing finish.
Working area	Worked safely and neatly throughout all activities, following all workshop and health and safety requirements. Disconnected wires and components placed into organised containers which mitigated any trip hazards, kept them tidy and prepared for appropriate waste disposal. All tools and equipment cleaned and returned to correct storage, waste disposed of in correct separate bins and working area left safe, clean and tidy.

Assessor signature	Date
Assessor.1	03/04/2022

Commentary

The candidate demonstrated their ability to interpret requirements and perform maintenance and fault-finding tasks in line with the requirements of the brief in a logical and methodical way. For example, addressing the faults with the transformer and rectifier blocks of the system before diagnosing issues with the filter and regulator stages. The candidate correctly and accurately diagnosed and resolved all four faults within the system.

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, high accuracy and precision was shown when producing soldered joints and wiring connections, consistently using the correct amount of solder and producing well shaped joints.

The candidate demonstrated efficient use and application of test equipment to complete both initial and final functional tests accurately. Appropriate measurements were accurately taken which supported the fault diagnosis and repair and confirmed the system was ready to be safely re-energised.

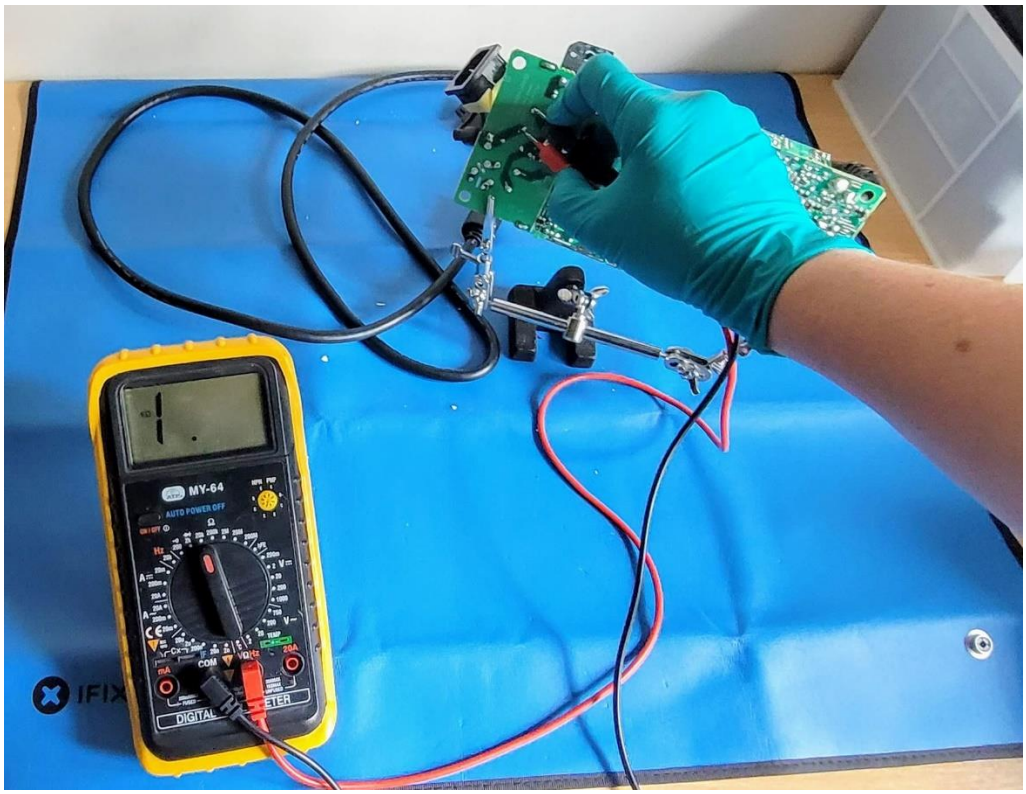
2. Photographic evidence

Photograph 1: Photographic evidence showing the tools and equipment neatly prepared, organised and placed in the working area within reach and methodical order of use.

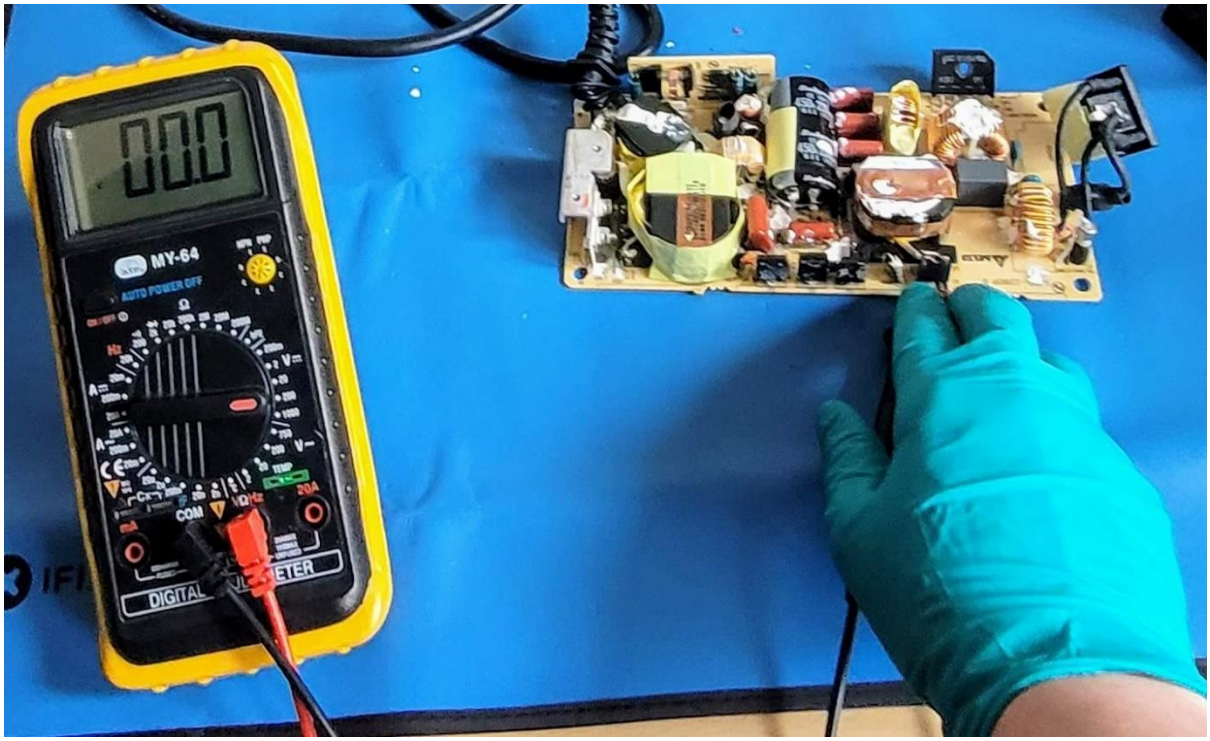
Photograph 2: Photographic evidence shows the working area after removal of casings and disassembly, with parts, components and sub-assemblies organised and placed in separate containers.

Photographs 3, 4, 5 and 6: Photographic evidence shows the correctly identified faulty components prior to repair or replacement, showing the cause of each fault where possible.

Photograph 3: faulty capacitor

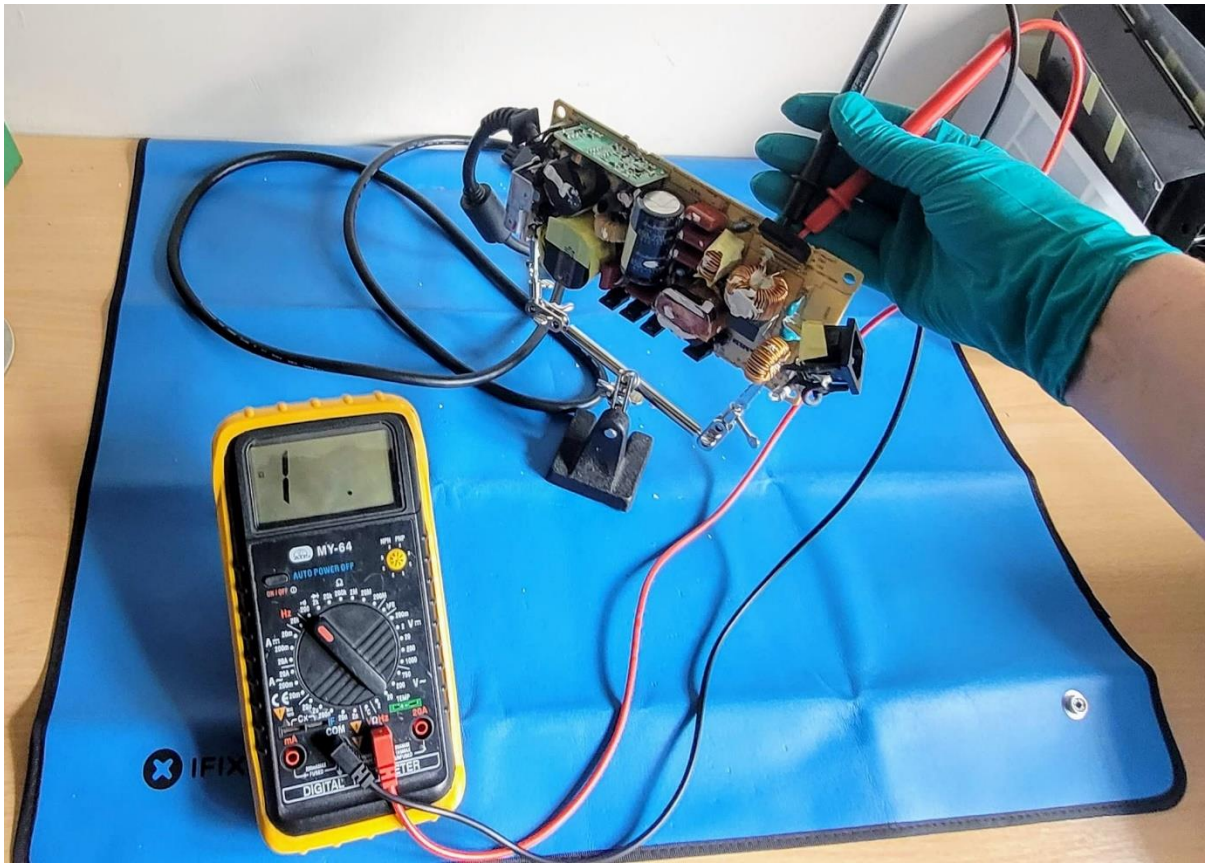


Photograph 4: faulty regulator



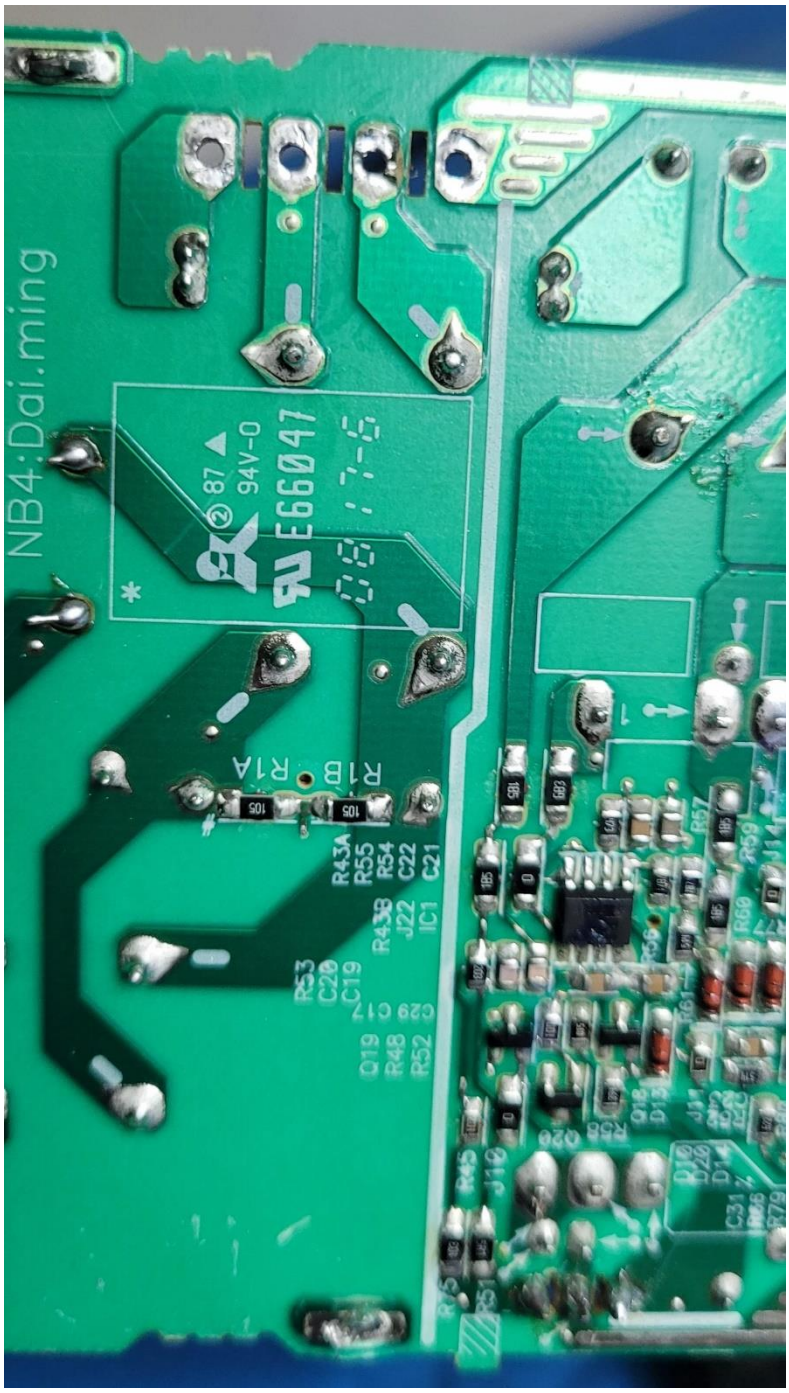
Photograph 5: faulty wire

Photograph 6: faulty rectifier

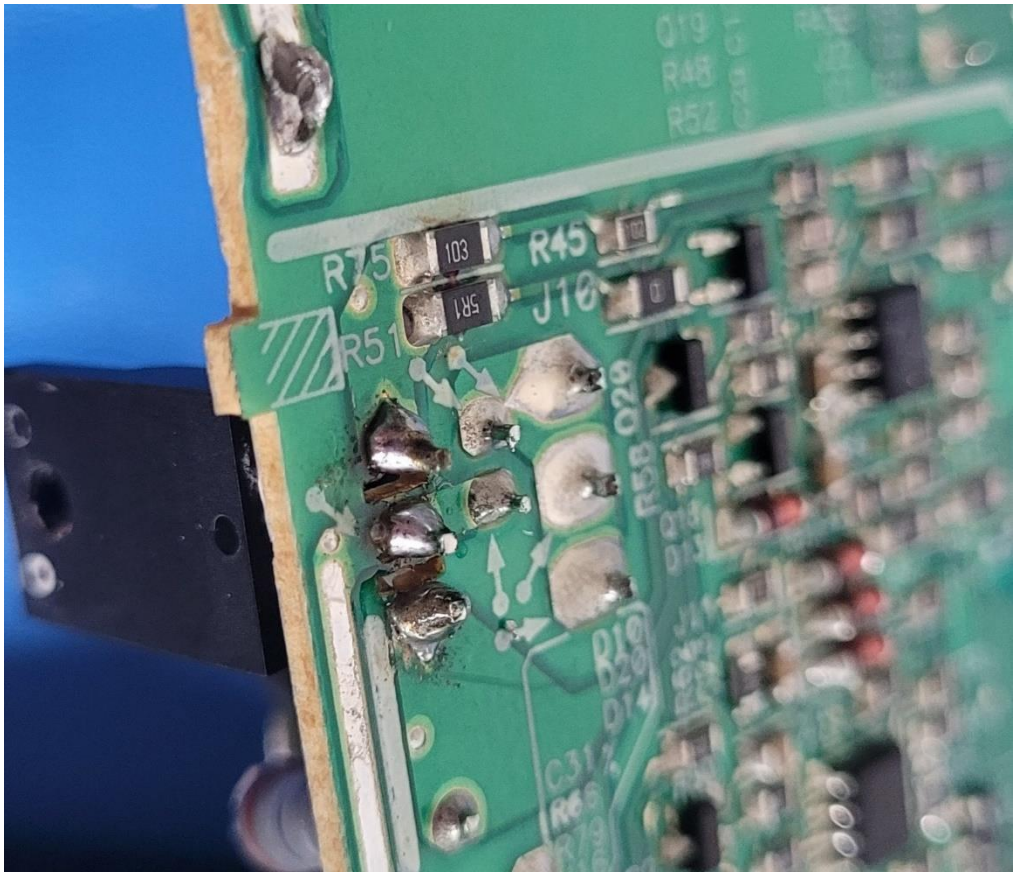


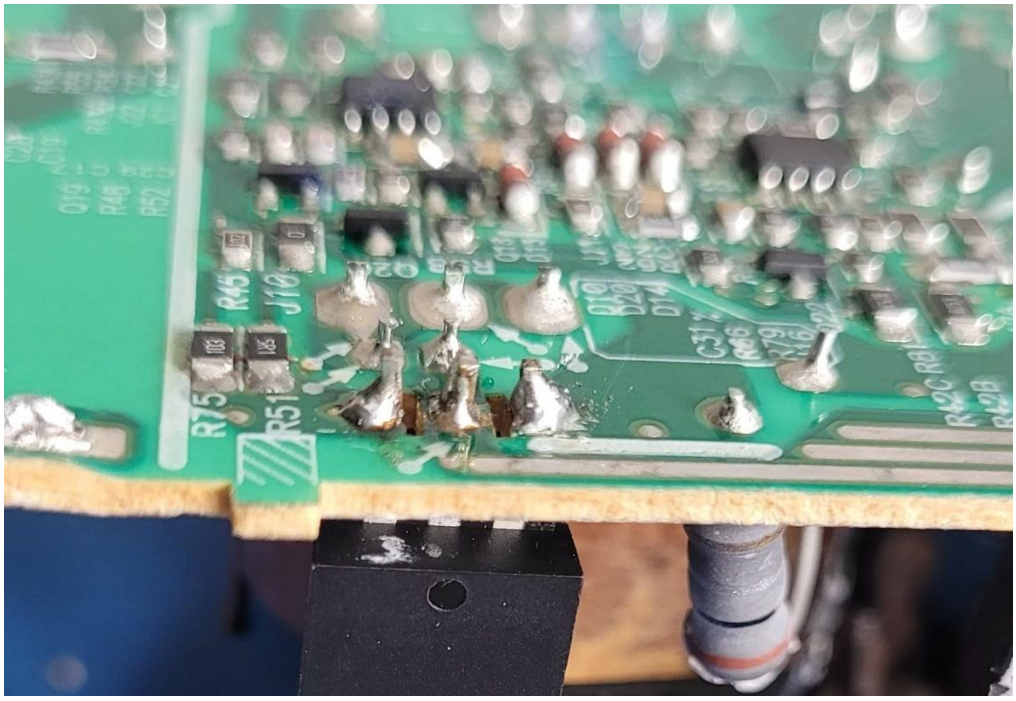
Photographs 7, 8, 9 and 10: Photographic evidence shows solder joints/connections of replaced/repaired components to the main circuit board. Condition and quality of solder joints are neat, accurate and precise, using the appropriate amount of solder.

Photograph 7: de-soldered board

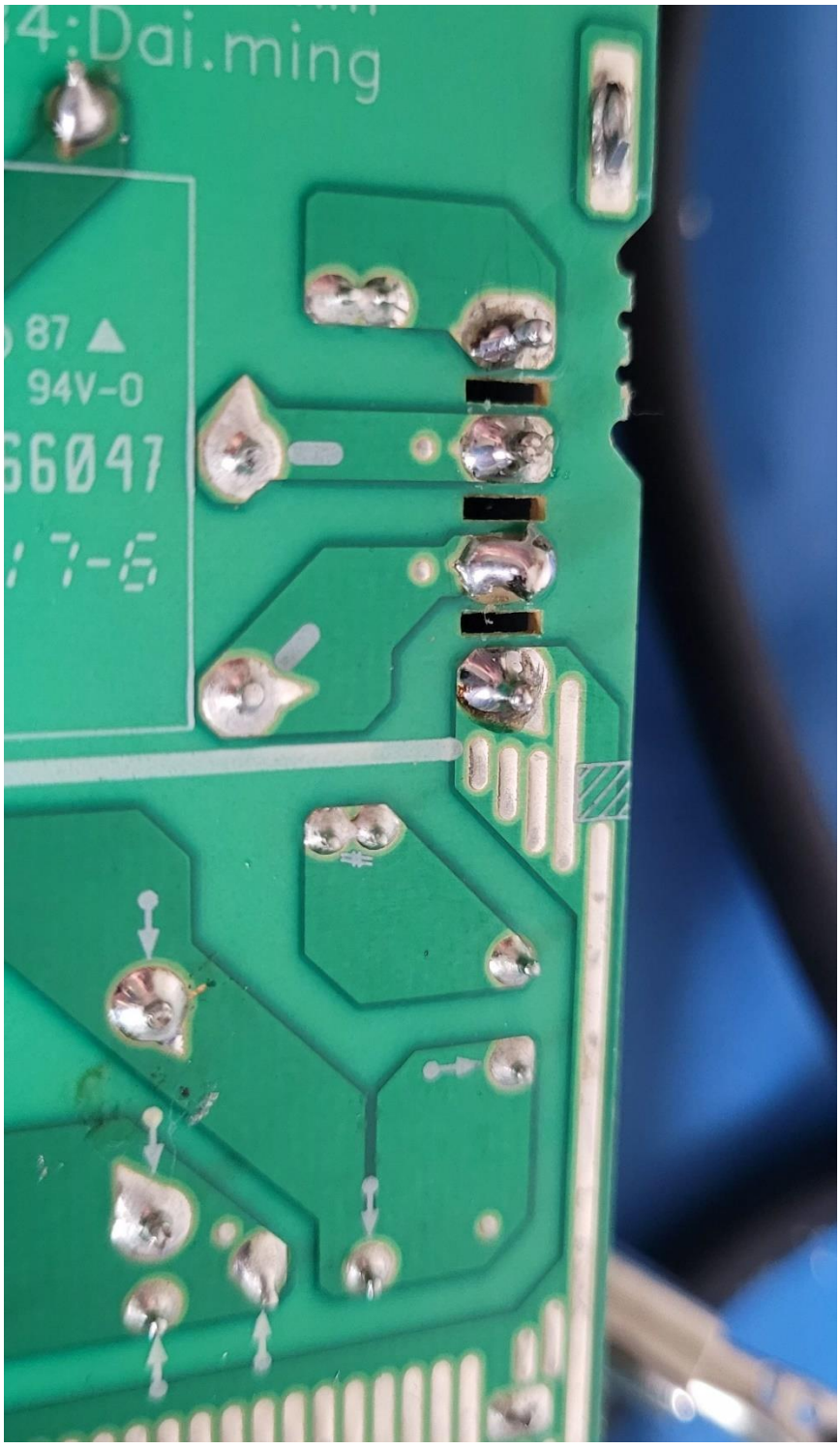


Photographs 8 and 9: soldered regulator

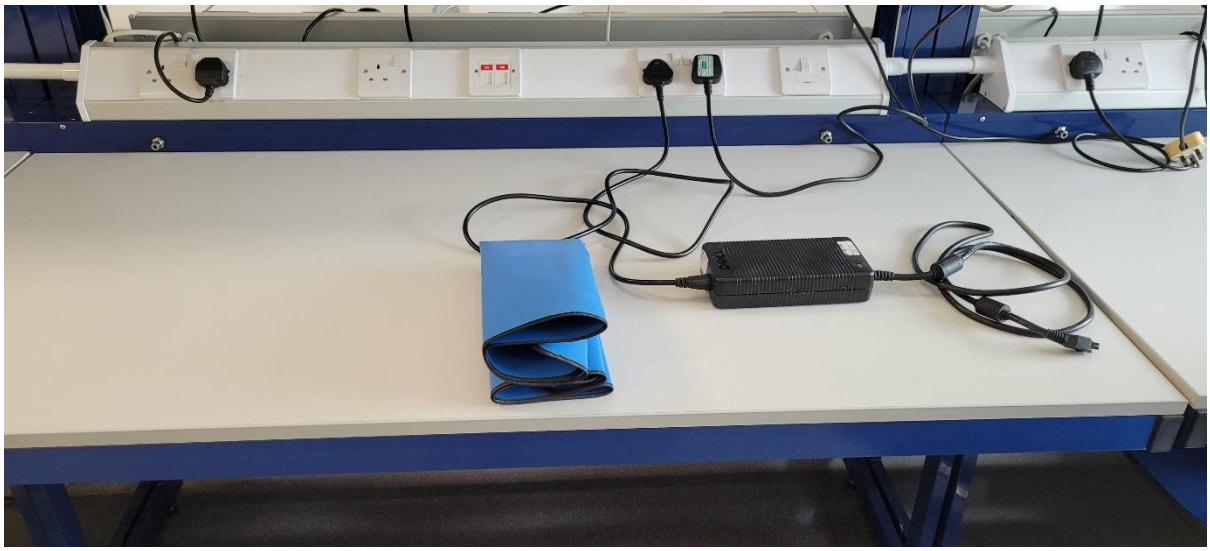




Photograph 10: soldered rectifier



Photograph 11: Photographic evidence shows the re-instated working area including the system showing overall condition and working area thoroughly cleaned.



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

Temperature system technical report	04/04/2022

The scheduled maintenance of the AC-DC converter system 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 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. I wore safety glasses and used a stand and sponge when completing soldering activities to ensure no damage to eyes and to minimise the risk of burns when the soldering iron was not in use. Portable fume extraction and lead-free solder were used to ensure no harmful fumes were inhaled. In future, I would recommend using a fixed extraction unit as this would provide a more powerful extraction method and further improve health and safety outcomes.

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

- damaged insulation on the step-down voltage transformer – transformer replaced.
- a shorted bridge rectifier diode due to poor soldering – joints de-soldered and then resoldered accurately.
- a failed filter capacitor – replaced with new capacitor of same model and value.
- a 3.3 V voltage regulator IC had been incorrectly fitted – replaced with 5 V voltage regulator IC.

Initial visual and sensory checks identified the issues with the transformer and rectifier diode, with test measurements confirming these faults. These faults were rectified first as any voltage spikes or shorts from these two blocks of circuitry would make any subsequent faults difficult to diagnose. As this was at the mains 230 V voltage section of

the system the potential for safety issues was greatly increased, so more urgency was needed at this stage.

Additional measurements showed 0 V across the capacitor and regulator system blocks, indicating issues with these components as well. The half split technique allowed the root causes to be narrowed down to the exact components and exact issues with them. In addition, the regulator was tested outside of the system, using a multimeter and oscilloscope, which confirmed this was producing 3.3 V DC instead of the 5 V DC signal output required. Once fault diagnosis and subsequent repairs had been completed functional testing confirmed each block of circuitry within the system, and the system as a whole, were working as expected from the specification requirements. Final calibration was carried out successfully. It is recommended that routine inspections are made to the transformer insulation and solder joints to avoid the possibility of closed or open circuit faults in the future.

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:

- 0.3 m single core wire
- 0.3 m multi core wire
- 0.25 m lead free solder
- 1 step down transformer
- 1 bridge rectifier diode
- 1 electrolytic filter capacitor.

There was not much waste, however all cut offs of wire, the removed transformer and the filter capacitor 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 diode. Cost effectiveness in the long term can also be improved by reducing the length of time between the planned maintenance and optimal efficiency and accuracy of the system can be achieved. There are no other outstanding issues left to report.

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 an incorrect output from the voltage regulator, using fault diagnosis methods to determine the root cause of the fault. 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 using a fixed extraction unit for future maintenance rather than the portable version used this time to further improve health and safety outcomes.

3a. Revised maintenance schedule

System:	Findings during maintenance:	Recommendations to seniors:	Justification to seniors:	Recommended next planned maintenance due date:
AC-DC converter	Transformer had damaged insulation caused by movement and mechanical stress. A rectifier diode had a shorted solder joint caused by poor installation combined with mechanical stress to the PCB. A filter capacitor had failed due to age and possibly due to spikes from the damaged transformer. A 3.3 V voltage regulator IC had been incorrectly fitted instead of a 5 V regulator.	It is recommended that the maintenance schedule is addressed and altered from 12 monthly to 6 monthly. As the system is running over 12 hours a day, and placed in a high traffic area, there is a high chance of movement which could cause mechanical stress on the system. This in turn could result in connections becoming loose over time, or damage to the insulation of the transformer as found during this maintenance job. In addition to more regular visual and sensory checks, it is recommended that additional test measurements are taken to spot any early signs of issues before they combine to form larger problems with the whole system.	Errors with the transformer and PCB could cause catastrophic full system failure. This would result in increased downtime and the possible need for full system replacement. As the transformer steps down a 230 V supply, failure of this component could cause safety issues.	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, showing understanding that a failing transformer could present electrical safety issues due its usage of a mains voltage input supply.

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. 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. Additional test measurements have been recommended but is not clear what these would be and how they would be recorded.*
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 new maintenance schedule will mean that more time is being spent on the maintenance and have a cost implication, so seniors may not approve the update because of this.*
How can the maintenance schedule could be optimised/ improved?	*I agree with candidate.B's recommendation to reduce planned maintenance from 12 monthly to 6 monthly, but the cost implications to the business will need to be more thoroughly considered. Additional test measurements recommended but should be clearly stated which tests to carry out. Because the filter capacitor has failed, it's likely that this a common issue for this system so I would*

	recommend replacing the filter capacitor each time planned maintenance is carried out.

Candidate name	**Candidate number**
Candidate.D	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 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, however a reduced schedule should be considered to implement preventative maintenance.*
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 may not be appropriate.*
What are the implications to the business of the proposed maintenance schedule?	*There is more chance for breakdown as the time between the maintenance is still quite lengthy at 6 months. This could effectively cause more downtime and fault investigation, costing the company more money over time.*
How can the maintenance schedule could be optimised/ improved?	*The maintenance schedule could be brought down to a 12-weekly maintenance checks or develop two maintenance intervals; a yearly scheduled check which consists of comprehensive maintenance checks, such as replacing of components, and a 12-weekly which includes the checking of the transformer, wiring connections and soldered joints.*

Candidate evidence

3b. Maintenance schedule amended from peer review feedback

System:	Findings during maintenance:	Recommendations to seniors:	Justification to seniors:	Recommended next planned maintenance due date:
AC-DC converter	Transformer had damaged insulation caused by movement and mechanical stress. A rectifier diode had a shorted solder joint caused by poor installation combined with mechanical stress t the PCB. A filter capacitor had failed due to age and possibly due to spikes from the damaged transformer. A 3.3 V voltage regulator IC had been incorrectly fitted instead of a 5 V regulator.	It is recommended that the maintenance schedule is addressed and altered from 12 monthly to ~~6 monthly~~ 3 monthly. As the system is running over 12 hours a day, and placed in a high traffic area, there is a high chance of movement which could cause mechanical stress on the system. This in turn could result in connections becoming loose over time, or damage to the insulation of the transformer as found during this maintenance job. In addition to more regular visual and sensory checks, it is recommended that additional test measurements (current output, signal waveform parameters, power output) are taken to spot any early signs of issues before they combine to form larger problems with the whole system.	Errors with the transformer and PCB could cause catastrophic full system failure. This would result in increased downtime and the possible need for full system replacement. As the transformer steps down a 230 V supply, failure of this component could cause safety issues.	03/07/2022

Justification for changes:

From the peer review feedback, it was highlighted that 6 months is still a long interval given the possibility of safety issues from a failing mains transformer because of high traffic placement and consistent use. With consideration of the feedback, it has been decided that the proposed changes to the maintenance should be increased further from my original recommended 6 monthly to 3 monthly. This will reduce the likelihood of complete and catastrophic full system failure caused by the transformer failing in use. The feedback was considered and actioned as the points that were made by peers were valid and correct.
In addition to the increased intervals, it was suggested to add additional detail around the further testing originally recommended which I agree is valid and appropriate, which will ensure the same parameters are tested each time planned maintenance is carried out and recorded over time as well. This 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 if a full catastrophic system failure were to occur.

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. For example, adding the additional detail of testing to complete each time ensuring the same parameters are tested and recorded each time, using this information to identify faults as early as possible.

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 handover:

- 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

Test record sheet - 03/04/2022

Testing the system

Measurements taken -
The table below shows the output signal values measured using a multimeter and oscilloscope. A multimeter was used as this provides accurate numerical measurements and outputs via an easy-to-read digital screen. It was also used to measure additional parameters during fault diagnosis. An oscilloscope was used because this allowed the output signals from each system block to be displayed as a graph of voltage against time.

Circuit/system block	Expected output V	Output V from initial tests	Output V following fault repairs
Transformer	12 V AC	12 V AC but with intermittent spikes	12 V AC
Rectifier	12 V DC with fluctuations	0 V	12 V DC with fluctuations
Filter	12 V DC without fluctuations	0 V	12 V DC without fluctuations
Regulator	Constant, ripple free 5 V DC	0 V when tested as part of system, 3.3 V when tested separately	Constant, ripple free 5 V DC

Fault diagnosis checks -
The initial measurements confirmed problems with the transformer, a rectifier diode, a filter capacitor and the regulator. The causes of each fault were confirmed using unit substitution, input to output, the half split technique and sensory checks. This fault diagnosis needed to be completed because voltage measurements simply showed 0 V across three of the four blocks circuitry, so the root causes of failure were not initially clear. Faults were subsequently diagnosed as follows:

Circuit/system block	Fault identified	Fault diagnosis techniques used	Actions taken to resolve faults
Transformer	Damaged insulation	Sensory checks, unit substitution, input to output	Transformer removed, replaced and retested
Rectifier	Shorted diode solder joints	Sensory checks, input to output	Solder joints repaired, diode retested
Filter	Failed filter capacitor	Half split technique	Filter capacitor removed, replaced and retested
Regulator	3.3 V voltage regulator fitted instead of 5 V	Half split technique	3.3 V voltage regulator IC removed, replaced with a 5 V regulator IC and retested

Additional functional tests completed -

Test	Reason for test	Outcome of test	Further actions needed/taken
Wiring continuity tests	To ensure accurate current flow through wires and cables	Current flowing as expected – test passed	None
Visual checks of circuit board solder joints	To ensure no dry joints or loose component connections	All joints secure – test passed	None
Transformer noise and vibration checks	To ensure the transformer is not moving or producing excessive noise	No vibration and noise within manufacturer's tolerances – test passed	None
Checks to casing	To ensure casing is securely fitted and providing adequate protection to the circuit	One loose connecting screw found	Screw tightened – issue resolved

Summary of actions completed

- Planned maintenance and inspection of system completed.
- Initial output voltage measurements taken for each block of components.
- Faults with the transformer, rectifier, filter and regulator stages of the circuit found and resolved.
- Final measurements taken confirming system functionality.
- Additional functional checks completed.

Testing of the AC-DC converter system is now complete, and the system can be handed back over to the supervisor. The next step is to complete the maintenance log with details of work completed and review control documents.

Updated Maintenance Schedule				
System:	**Findings during maintenance:**	**Recommendations to seniors:**	**Justification to seniors:**	**Recommended next planned maintenance due date:**
AC-DC converter	Transformer had damaged insulation caused by movement and mechanical stress. A rectifier diode had a shorted solder joint caused by poor installation combined with mechanical stress t the PCB. A filter capacitor had failed due to age and possibly due to spikes from the damaged transformer. A 3.3 V voltage regulator IC had been incorrectly fitted instead of a 5 V regulator.	It is recommended that the maintenance schedule is addressed and altered from 12 monthly to ~~6 monthly~~ 3 monthly. As the system is running over 12 hours a day, and placed in a high traffic area, there is a high chance of movement which could cause mechanical stress on the system. This in turn could result in connections becoming loose over time, or damage to the insulation of the transformer as found during this maintenance job. In addition to more regular visual and sensory checks, it is recommended that additional test measurements (current output, signal waveform parameters, power output) are taken to spot any early signs of issues before they combine to form larger problems with the whole system.	Errors with the transformer and PCB could cause catastrophic full system failure. This would result in increased downtime and the possible need for full system replacement. As the transformer steps down a 230 V supply, failure of this component could cause safety issues.	03/07/2022

Justification for changes:

From the peer review feedback, it was highlighted that 6 months is still a long interval given the possibility of safety issues from a failing mains transformer because of high traffic placement and consistent use. With consideration of the feedback, it has been decided that the proposed changes to the maintenance should be increased further from 6 monthly to 3 monthly. This will reduce the likelihood of complete and catastrophic full system failure caused by the transformer failing in use. The feedback was considered and actioned as the points that were made by peers were valid and correct.
In addition to the increased intervals, it was suggested to add additional detail around the further testing originally recommended which I agree is valid and appropriate, which will ensure the same parameters are tested each time planned maintenance is carried out and recorded over time as well. This will improve consistency in the maintenance process and identify smaller faults early before progressing into larger more serious and costly faults.

Maintenance log							
			System type:	AC-DC converter system			
			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.B	Scheduled maintenance and intermittent fault diagnosis.	When tested the system was showing intermittent faults on the transformer (replace and rewire) and further inspection revealed a shorted rectifier diode (solder joints repaired), failed filter capacitor (replaced) and 3.3 V voltage regulator incorrectly fitted instead of a 5 V regulator (replaced with regulator of correct value). All four faults were rectified by replacement or repair, and final testing showed the system now functioning as per the specification (see test record sheet).	Y	*Assessor.1*	03/07/2022	Planned maintenance has been completed. Maintenance schedule has been updated and approved by seniors, planned maintenance will now be carried out 3 monthly instead of 12 monthly, along with additional testing to complete (current output, signal waveform parameters, power output).

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. Recommend update to risk assessment to place greater emphasis on releasing stored energy from the transformer for future, requiring new version to be created (V2.2).	All documents are complete, valid and in date. Should any problems have been found this would be relayed to supervisor who would then contact the document controllers as per chain of command.

Commentary

The candidate has provided the correct documentation and obtained signatures from the supervisor to show that the work completed has been verified and handed over. This demonstrates a comprehensive understanding for the process of which documentation is required to handover, adhering to the best practice procedures and the requirements of the task. For example, the candidate has ensured to handover the co-signed maintenance log, controlling of documentation log, updated maintenance schedule for future use and the completed test record.

4. Practical observation form – handover meeting

Assessment ID	**Qualification number**
8712-313	8712-33
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 explained and justified the actions taken to rectify the faults found. System functionality was demonstrated clearly and in detail, using the correct technical terminology for each part of the system. They explained how testing showed that the system was now producing the required 5 V DC output from the input 230 V AC mains supply. 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 disregard 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.*
	suggestion of changing the filter capacitor each time planned maintenance is carried out being unnecessary due to unlikelihood of this being a regular failure and this would add additional unnecessary costs. The candidate demonstrated excellent communication skills using accurate and consistent technical terminology that was fully appropriate to the audience. 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	04/04/2022

Commentary

The observation report identifies the different areas of the handover process and how the candidate met the requirements. They shared the 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 filter capacitor at each planned maintenance interval instead of waiting for it to fail, the candidate understood and justified that this was unnecessary because it is not a common failure and would add additional costs to the business.

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