



Unit title	Maintaining Electrical Equipment/Systems
SQA code	HC3G 04
SCQF level	5
SCQF credit points	34

History of changes

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Title	Maintaining Electrical Equipment/Systems	
Level	5	
Credit value	34	
Learning Outcomes	Assessment Criteria	
The learner will:	The learner can:	
1 Maintain electrical equipment/systems.	1.1	Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines.
	1.2	Carry out all of the following during the electrical maintenance activities: <ul style="list-style-type: none"> ◆ adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations ◆ ensure the safe isolation of equipment (such as electrical, mechanical, gas, air or fluids), where appropriate ◆ follow job instructions, maintenance drawings and procedures ◆ check that the tools and test instruments are within calibration date and are in a safe, PAT tested and usable condition ◆ ensure that the system is kept free from foreign objects, dirt or other contamination ◆ return all tools and equipment to the correct location on completion of the maintenance activities
	1.3	Carry out maintenance/repair activities on two of the following types of electrical equipment: <ul style="list-style-type: none"> ◆ electrical plant ◆ wiring enclosures ◆ portable appliances ◆ generators ◆ alternators ◆ motors and starters ◆ heaters ◆ luminaires ◆ switchgear

Learning Outcomes	Assessment Criteria
The learner will:	The learner can:
	<ul style="list-style-type: none"> ◆ distribution panels ◆ transformers ◆ pumps ◆ fans/blowers ◆ other specific electrical equipment <p>1.4 Plan the maintenance activities before they start them.</p> <p>1.5 Obtain all the information they need for the safe removal and replacement of the equipment/system components.</p> <p>1.6 Obtain and prepare the appropriate tools and equipment.</p> <p>1.7 Apply appropriate maintenance diagnostic techniques and procedures.</p> <p>1.8 Use four of the following maintenance diagnostic techniques, tools and aids:</p> <ul style="list-style-type: none"> ◆ fault finding techniques (such as six point, half-split, input/output, Unit substitution) ◆ diagnostic aids (such as manuals, flow charts, troubleshooting guides, maintenance records) ◆ information gathered from fault reports ◆ visual checks (such as signs of damage, overheating, missing parts, wear/deterioration) ◆ movement checks (such as loose fittings and connections) ◆ monitoring equipment or gauges ◆ test instrumentation measurement (such as voltage, resistance, current) <p>1.9 Use the appropriate methods and techniques to remove and replace the required components.</p>

Learning Outcomes	Assessment Criteria
<p>The learner will:</p>	<p>The learner can:</p> <p>1.10 Carry out maintenance/repair activities on three of the following electrical systems:</p> <ul style="list-style-type: none"> ◆ single-phase lighting circuits ◆ single-phase power circuits ◆ three-phase power supplies ◆ direct current power supplies ◆ motor start and control ◆ vehicle heating or ventilating ◆ vehicle lighting ◆ vehicle starting and ignition ◆ instrumentation and control circuits ◆ alarm systems (such as fire, intruder, process control) ◆ electro-pneumatic or electro-hydraulic control circuits ◆ air conditioning control circuits ◆ refrigeration control circuits ◆ heating/boiler control circuits ◆ aircraft lighting circuits ◆ power generation and control circuits ◆ avionic circuits and systems ◆ emergency lighting systems ◆ communication systems ◆ computer systems ◆ other control systems ◆ other specific electrical systems <p>1.11 Carry out all of the following maintenance activities:</p> <ul style="list-style-type: none"> ◆ removing excessive dirt and grime ◆ dismantling/disconnecting equipment to the required level ◆ disconnecting and reconnecting wires and cables ◆ stripping cable insulation/protection ◆ attaching suitable cable identification markers ◆ removing electrical Units/components ◆ removing/replacing cable end fittings

Learning Outcomes	Assessment Criteria
The learner will:	The learner can:
	<ul style="list-style-type: none"> ◆ checking components for serviceability ◆ making mechanical/screwed/clamped connections ◆ soldering and de-soldering ◆ crimping (such as tags and pins) ◆ replacing damaged/defective components ◆ removing and replacing damaged wires and cables ◆ setting and adjusting replaced components ◆ making de-energised checks before reconnecting power supply <p>1.12 Replace/refit a range of electrical components, to include six of the following:</p> <ul style="list-style-type: none"> ◆ cables and connectors ◆ locking and retaining devices ◆ overload protection devices ◆ inverter and servo controllers ◆ relay components ◆ rectifiers ◆ capacitors ◆ circuit boards ◆ luminaires ◆ switches or sensors ◆ contactors ◆ encoders or resolvers ◆ batteries ◆ transformers ◆ solenoids ◆ thermistors or thermocouples ◆ other specific components <p>1.13 Carry out tests on the maintained equipment, in accordance with the test schedule/defined test procedures.</p>

Learning Outcomes	Assessment Criteria
<p>The learner will:</p>	<p>The learner can:</p> <p>1.14 Carry out checks and tests on the maintained equipment, to include:</p> <ul style="list-style-type: none"> ◆ making visual checks for completeness and freedom from damage <p>Plus three more from the following:</p> <ul style="list-style-type: none"> ◆ protective conductor resistance values ◆ insulation resistance values ◆ continuity ◆ voltage levels ◆ load current ◆ polarity ◆ resistance ◆ capacitance ◆ power rating ◆ frequency values ◆ inductance ◆ RCD disconnection time ◆ specialised tests (such as speed, sound, light, temperature) <p>1.15 Maintain electrical equipment, in accordance with one or more of the following quality and accuracy standards:</p> <ul style="list-style-type: none"> ◆ BS 7671/IET wiring regulations ◆ other BS and/or ISO standards ◆ company standards and procedures ◆ equipment manufacturer's requirements <p>1.16 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve.</p> <p>1.17 Leave the work area in a safe and tidy condition on completion of the maintenance activities.</p>

Learning Outcomes	Assessment Criteria
<p>The learner will:</p> <p>2 Know how to maintain electrical equipment/systems.</p>	<p>The learner can:</p> <p>2.1 Describe the health and safety requirements, and safe working practices and procedures required for the electrical maintenance activities undertaken.</p> <p>2.2 Describe the isolation and lock-off procedure or permit-to-work procedure that applies to electrical maintenance activities (to include electrical isolation, locking off switchgear, removal of fuses, placing of maintenance warning notices, proving that isolation has been achieved and secured).</p> <p>2.3 Describe the hazards associated with carrying out electrical maintenance activities (such as dangers of electric shock, capacitor discharge, misuse of tools, using damaged or badly maintained tools and equipment, not following laid-down maintenance procedures), and how to minimise them.</p> <p>2.4 Explain what constitutes a hazardous voltage and how to recognise and deal with victims of electric shock (to include methods of safely removing the victim from the power source, isolating the power source, and how to obtain first aid assistance).</p> <p>2.5 Describe the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy.</p> <p>2.6 Describe the procedure for obtaining drawings, job instructions, related specifications, replacement parts, materials and other consumables necessary for the maintenance activities.</p>

Learning Outcomes	Assessment Criteria
<p>The learner will:</p>	<p>The learner can:</p> <p>2.7 Explain how to obtain and interpret information from job instructions and other documentation used in the maintenance activities (such as drawings, specifications, manufacturers' manuals, BS and ISO wiring regulations, symbols and terminology).</p> <p>2.8 Describe the basic principles of how the equipment functions, and the working purpose of individual units/components.</p> <p>2.9 Describe the various maintenance diagnostic techniques and aids that can be used (such as fault reports, visual checks, measuring, movement and alignment checks, testing).</p> <p>2.10 Describe the various fault location techniques that can be used, and how they are applied (such as half-split, input-to-output, function testing, Unit substitution, and equipment self-diagnostics).</p> <p>2.11 Explain how to use a range of fault diagnostic equipment to investigate the problem.</p> <p>2.12 Describe the care, handling and application of electrical measuring instruments.</p> <p>2.13 Describe the different types of cabling used in the maintenance activities, and their methods of termination.</p> <p>2.14 Describe the techniques used to dismantle/assemble electrical equipment (such as unplugging, de-soldering, removal of screwed, clamped and crimped connections).</p> <p>2.15 Describe the methods of removing and replacing cables and wires in wiring enclosures without causing damage to existing cables.</p>

Learning Outcomes	Assessment Criteria
The learner will:	<p>The learner can:</p> <p>2.16 Describe the use of BS 7671/IET wiring, and other regulations, when selecting wires and cables and when carrying out tests on systems.</p> <p>2.17 Describe the methods of attaching identification markers/labels to removed components or cables, to assist with re-assembly.</p> <p>2.18 Describe the tools and equipment used in the maintenance activities (such as the use of cable stripping tools, crimping tools, soldering irons and torches, gland connecting tools).</p> <p>2.19 Describe the methods of checking that components are fit for purpose, and the need to replace 'lifer' items (such as seals and gaskets overload protection devices).</p> <p>2.20 Explain how to check that tools and equipment are free from damage or defects, and are in a safe and usable condition.</p> <p>2.21 Describe the importance of completing documentation and/or reports following the maintenance activity.</p> <p>2.22 Describe the importance of making 'off-load' checks before proving the equipment with the electrical supply on.</p> <p>2.23 Explain how to use appropriate lifting and handling equipment in the maintenance activity.</p> <p>2.24 Describe the problems that can occur during the electrical maintenance activity, and how they can be overcome.</p> <p>2.25 Explain when to act on their own initiative and when to seek help and advice from others.</p>

Learning Outcomes	Assessment Criteria
The learner will:	The learner can:
	2.26 Describe the importance of leaving the work area in a safe and clean condition on completion of the maintenance activities (such as returning hand tools and test equipment to its designated location, cleaning the work area, and removing and disposing of waste).

Additional information about the Unit

Unit purpose and aim(s)

This Unit covers the skills and knowledge needed to prove the competences required to cover a broad range of basic electrical maintenance activities that will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment.

The learner will be expected to prepare for the electrical maintenance activities by obtaining all necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required maintenance activities and the sequence of operations they intend to use.

The learner will be required to select the appropriate equipment to use, based on the maintenance operations to be carried out and the type of electrical equipment/systems being maintained. This will include electrical equipment that uses single, three-phase or direct current power supplies, and includes equipment such as control systems, motors and starters, switchgear and distribution panels, electrical plant, pumps, fans, alternators, generators, transformers, wiring enclosures and luminaires, portable appliances and other specific electrical equipment. The learner will be expected to use a variety of maintenance diagnostic techniques and procedures, such as gathering information from fault reports, using recognised fault finding techniques and diagnostic aids, measuring, inspecting and operating the equipment.

The learner will be expected to cover a range of maintenance activities, such as isolating and locking off, disconnecting, removing and reconnecting electrical components, wires and cables, attaching cable identification markers, replacing damaged or defective components, cables and wires, setting and adjusting components, and making 'off-load' checks before testing the equipment, using appropriate techniques and procedures.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the electrical maintenance activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the maintenance activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply appropriate electrical maintenance techniques and procedures safely. The learner will understand the electrical maintenance process, and its application, and will know about the electrical equipment and systems being maintained, the components, tools and consumables used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the maintenance activities (especially those for ensuring that the equipment is correctly isolated), and when using maintenance tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand their responsibility for taking the necessary safeguards to protect themselves and others in the workplace.

Details of the relationship between the Unit and relevant national occupational standards (if appropriate)

This Unit has been derived from national occupational standard Performing Engineering Operations Unit No. 37: Maintaining electrical equipment/systems (Suite 2).

Details of the relationship between the Unit and other standards or curricula (if appropriate)

C32 — Contribute to the maintenance of vessel electrical equipment
C33 — Carry out maintenance of vessel electrical machinery and systems

International Maritime Organisation (IMO) standards for training and certification for watchkeeping (stcw) requirements for an Electro-technical Officer at Operational Level.

Assessment requirements specified by a sector or regulatory body (if appropriate)

This Unit to be assessed in accordance with the Maritime Skills Alliance Assessment Strategy.

Unit specific additional assessment requirements:

In order to prove their ability to combine different electrical maintenance operations, at least one of the electrical maintenance activities carried out must be of a significant nature, and must cover a minimum of eight of the activities listed in Assessment Criteria 1.11.

Assessment (evidence) Requirements

The following evidence is required to demonstrate that learners have the appropriate level of knowledge to undertake Maintaining Electrical Equipment and Systems. All Learning Outcomes and Assessment Criteria must be achieved.

Written and/or recorded oral evidence produced either on or off-the-job is required for the following:

Learning Outcome 2

Performance evidence in the workplace or in an appropriate simulated environment is required for the following:

Learning Outcome 1

This could be achieved through the observation of learners undertaking practical exercises.

An approved Maritime Skills Alliance (MSA) approved Training Record Book (TRB) should be used to record evidence of achievement.

Guidance on Instruments of Assessment

Performance evidence can be generated using practical exercises in a simulated environment.

Short answer written questions and/or oral interview could be used for the other Learning Outcomes and Assessment Criteria.