

Unit 43: Service and Repair Electrical Systems on Land-based Equipment

Unit code: Y/600/3404

QCF Level 2: BTEC First

Credit value: 10

Guided learning hours: 60

● Aim and purpose

The aim of this unit is to provide the learner with the knowledge, understanding and skills required to carry out service and repair on electrical systems within land-based equipment. The learner will need to ensure they comply with current legislation and guidelines to complete this unit. This unit aims to introduce learners to skills and knowledge in the service and repair of electrical systems and how these can be applied in practice. It is designed for learners in centre-based settings looking to progress into the sector or onto further/higher education.

● Unit introduction

In this unit learners will develop an understanding of the fundamentals of electrical maintenance and the knowledge and skills required when carrying out electrical maintenance activities. In carrying out these activities learners will develop knowledge and skills in selecting fault-finding techniques and diagnose faults. Learners will also develop the skills needed to dismantling, reassemble and carry out routine maintenance on electrical equipment and circuits such as motors and control systems.

Learners will need to demonstrate an understanding of safe working practices when carrying out fault location and maintenance activities and take the necessary safeguards to protect their own safety and that of others in the workplace.

● Learning outcomes

On completion of this unit a learner should:

- 1 Be able to perform service and repair operations on electrical systems and their components used in land-based equipment
- 2 Know the construction, function and operation of electrical systems and circuits and their components.

Unit content

1 Be able to perform service and repair operations on electrical systems and their components used in land-based equipment

Electrical risks: welding, short circuit, battery open circuit, overcharging, reverse polarity

Dismantling and assembly: use of manufacturers' service manuals; parts lists and drawings; approved working procedures

Removal and replacement: eg damaged wires and cables, electrical units/components, termination and connection, soldering and de-soldering; appropriate tools and equipment; approved working procedures

Inspection and maintenance routines: maintenance routines eg power supplies and/or batteries, on electrical equipment and circuit components, devices and systems, wiring harnesses, connectors and connections, earthing; inspection and functional testing eg voltage, current, continuity, resistance, battery, condition, continuity, wear, overheating, missing or loose fittings, carrying out adjustments as necessary; recording of condition; the use of maintenance manuals and documentation

Types of instruments: eg multimeter, light meter, Power Probe

Fault diagnosis techniques: eg use of fault-finding aids, functional charts, diagrams, trouble shooting charts, six point (collect evidence, analyse evidence, locate fault, determine and remove cause, rectify fault, check system), half split, input/output, unit substitution, emergent sequence, component data sheets, operation and maintenance manuals, software-based records and data, visual examination, unit substitution, fault/repair reporting, final test handover procedures

Repairs to manufacturers' specifications: eg starting systems, charging systems, safety and/or circuit protection systems, ignition systems, spark ignition systems, lighting systems, instrumentation systems, ancillary systems

Problem: eg short circuit, open circuit, high resistance, intermittent, partial failure/out-of-specification output, complete breakdowns

Report findings: eg scheduled maintenance report, corrective maintenance report, other company-specific report, job cards, maintenance log

2 Know the construction, function and operation of electrical systems and circuits and their components

System components: electrical supply eg cables and connectors, batteries; lead acid, gel, maintenance free, dry cell; transformers, rectifiers, contactors; circuit components eg capacitors, circuit boards, switches, solenoids, thermistors, devices eg overload protection device, relays, sensors; use of maker's catalogue or database for selecting replacements

Identification of components and function: series and parallel connections, power supply and battery types, circuit protect devices, fixed and/or variable resistors, diodes, relays switches, wire types and sizes, electrical consumers

Identification and interpretation of circuit diagrams to include the following: electrical component symbols, colour coding, wire identification and sizing, series and parallel connections; alternating and direct current and the common voltages in use

Principles, construction and function of electrical circuits and their component types: starter circuits eg inertia, pre-engaged; cold start circuits eg heat start, safety start, ignition circuits; charging circuits eg alternators, rectifiers, lighting circuits eg indicators, brake lights, side, head, dip, marker lights, work lights; Instrumentation circuits eg fuel, temperature, tachometer, hour meter. spark ignition circuits eg spark generation; ancillary circuits eg wiper motors, stop circuits, ventilation, horn, switches, actuators; safety and/or circuit protection circuits eg battery isolation safety isolation, fuses and fuseable links, thermal switches, over – under voltage switching, relays, RCCB, earth bonding, double insulation

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
<p>P1 identify electrical circuits and components and their functions from wiring diagrams and visual recognition [IE, CT]</p>	<p>M1 explain the relationship between component faults and the malfunction of a given electrical system</p>	<p>D1 compare and contrast two fault diagnosis techniques when carrying out maintenance work on an electrical system.</p>
<p>P2 perform tests using equipment and practices to measure and verify the correct operation of electrical systems and their components [SM, IE, TW]</p>		
<p>P3 identify and rectify faults in electrical systems and components [RL, EP]</p>		
<p>P4 maintain the integrity of electrical systems [EP, IE]</p>		
<p>P5 remove, dismantle, rectify faults, repair and reinstate electrical components and circuits to manufacturer's specifications and standards [EP, IE, TW]</p>		

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
P6 identify and interpret electrical circuit diagrams [IE]	M2 explain the importance of applying safe working practices when carrying out maintenance on an electrical system.	
P7 summarise Ohm's law, its application and principles [IE]		
P8 compare the specification, safe maintenance and charging of different types of battery [RL, IE, TW, CT]		
P9 describe the principles, construction and function of electrical circuits and their components [CT]		
P10 describe how to remove, dismantle, test, verify, repair and reinstate electrical circuits and their components [CT, RL]		
P11 outline risks posed to electrical systems and components by other activities or incidents. [IE, RL, SM, EP CT]		

PLTS: This summary references where applicable in the pass criteria, in the square brackets, the elements of the personal, learning and thinking skills. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers CT – creative thinkers	RL – reflective learners TW – team workers	SM – self-managers EP – effective participators
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Essential guidance for tutors

Delivery

All centres must comply with the requirements of relevant, current legislation and codes of practice the *Prevention of Accidents to Children in Agriculture Regulations 1998*. Learners must be made aware of, and have access to, relevant health and safety legislation and know the importance of the use of risk assessments appropriate to each situation. Appropriate risk assessments must precede all practical machinery activities and learners must work in a safe manner at all times when using equipment or working with machinery. Learners must be supervised at all times and tutors must not ask learners to undertake tasks that are beyond their physical capabilities.

Delivery of this unit will involve practical assessments, written assessment, visits to suitable collections and will link to industrial experience placements.

The unit provides an opportunity for learners to work in teams or groups when diagnosing component or system faults. Delivery of this unit should focus on learners developing diagnostic and practical skills, together with an understanding of electrical components and systems maintenance.

The learning outcomes are ordered logically and it would be reasonable to develop them sequentially throughout the unit. In this way, learners will be able to apply health and safety system and component operation to diagnostic, testing and maintenance techniques. All learning outcomes suit a practical approach rather than too much time spent in theory lessons. For example, a short introduction to a component (or range of components), the function of the component within the larger system, the tools necessary to carry out the maintenance task together with any safety considerations, followed by practice. Learners need a broad overview of the different electrical components and systems so they can select and apply the correct maintenance, diagnostic and testing techniques

Learners will need to ensure they comply with current legislation and guidelines to complete this unit.

Evidence may be collected from well-planned investigative assignments or reports of workshop activities. Evidence can be accumulated through learners building up a portfolio from investigations, case studies and maintenance operations through a tutor-led series of assignments, realistic maintenance exercises and tests.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan gives **an indication of the volume of learning it would take the average learner** to achieve the learning outcomes. It is **indicative and is one way of achieving the credit value**.

Learning time should address all learning (including assessment) relevant to the learning outcomes, regardless of where, when and how the learning has taken place.

Topic and suggested assignments/activities and/assessment

Electrical basics: include Ohm's law, what is needed in a circuit, series and parallel circuits.

Assignment 1: Electrical Health and Safety (P10, P11, M2)

Assignment 2: Maintenance of Electrical Equipment (P1, P2, P4, P5)

practical activities to cover unit content as required.

Topic and suggested assignments/activities and/assessment

Assignment 3: Electrical Theory (P6, P7, P9)

recognising components, working with circuit diagrams, understanding ohm's law and its application.

Assignment 4: Batteries (P8)

how batteries work, types of battery, battery application, the future of battery technology.

Assignment 5: Electrical Fault Finding (P3, M1, D1)

practical assessment activities that capture evident as described in unit content.

Unit review.

Assessment

For P1, P2, P3, P4 and P5 learners are required to demonstrate practices and use of equipment to identify, measure and rectify faults in electrical systems and their components/circuits. All practical tasks and tutor feedback needs to be recorded using appropriate documentation.

For P6, P7, P8, P9, P10 and P11, learners must provide information relating to operational task procedures relating to the service and repair of electrical systems. Evidence may be a by way of project assignment, observed practical test or pictorial presentation with notes using appropriate software, slides or OHPs.

For M1, M2 and D1, learners must provide detailed information on electrical fault diagnosis, malfunctions and safe working practices. Evidence could be in the form of a report, test or presentation.

Programme of suggested assignments

The following table shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P10, P11, M2	Electrical Health and Safety	Electrics can be dangerous and working on vehicle electrics can damage the components beyond repair. Look at the risks involved with electrical system maintenance and repair.	Assignment.
P1, P2, P4, P5	Maintenance of Electrical Equipment	As with other systems, electrical systems need maintenance and repair. Carry out tests, maintenance and repairs to electrical systems and components.	Portfolio of evidence.
P6, P7, P9	Electrical Theory	Electrical systems can become very complex. It is essential that you understand circuit diagrams and the theory of electric systems.	Open book test.
P8	Batteries	Though vehicle electrics have change drastically over a short period of time, the same cannot be said for the humble battery. Investigate the different types of vehicle battery with a view to the future.	Investigative report.
P3, M1, D1	Electrical Fault Finding	Quick fault diagnosis will save considerable time, effort and expense. Use fault-finding techniques to identify system faults and rectify them.	Practical assessment.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC land-based sector suite. This unit has particular links with:

Level 2	Level 3
LEO22 Service and Repair Electrical Systems on Land-based Equipment	Undertake and Review Work-related Experience in the land-based Industries

Essential resources

Centres delivering this unit must have access to land-based vehicle standard components and systems, testing instruments and rigs. This unit relies heavily on the learner being able to investigate the manufactured specification of components and service manuals.

Employer engagement and vocational contexts

Visits to vehicle electric specialist firms in relation to fault finding would be of benefit to learners as well as visits to manufacturing organisations or similar with a focus on electrical components, their installation and service requirements. Learners will be made aware of the vast range and scope of electrical components and sensors used in the land-based engineering sector.

Indicative reading for learners

Textbooks

Health and Safety Executive – *Essentials of Health & Safety at Work* (HSE, 1995) ISBN 071760716X

Adams J – *Electrical Safety: A Guide to the Causes and Prevention of Electrical Hazards* (Institution of Electrical Engineers, 1994) ISBN 085296806X

Websites

uk.rs-online.com

RS is Europe's leading distributor of electronic, electrical and industrial components.

www.ehow.com

eHow.com is an online community dedicated to providing visitors the ability to research, share, and discuss solutions and tips for completing day-to-day tasks and projects.

www.hse.gov.uk

Health and Safety Executive

Delivery of personal, learning and thinking skills (PLTS)

The following table identifies the PLTS opportunities that have been included within the assessment criteria of this unit:

Skill	When learners are ...
Independent enquirers	carrying out fault finding electrical systems
Creative thinkers	carrying out fault finding on electrical systems
Reflective learners	making comparisons between components and systems
Team workers	gathering test data
Self-managers	investigating faults
Effective participators	gathering test data.

Although PLTS opportunities are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Independent enquirers	planning and carrying out research activities related to the unit evaluating and carrying out extended thinking
Creative thinkers	asking questions to extend their thinking during lectures and practical sessions trying out alternatives or new solutions
Reflective learners	identifying opportunities for their own achievements
Team workers	assisting in group activities
Self-managers	setting own targets for accurate completion of work asking for assistance
Effective participators	encouraging debate.

● Functional Skills – Level 2

Skill	When learners are ...
ICT – Use ICT systems	
Select, interact with and use ICT systems independently for a complex task to meet a variety of needs	using ICT-based systems to define component functionality
Use ICT to effectively plan work and evaluate the effectiveness of the ICT system they have used	
Manage information storage to enable efficient retrieval	
Follow and understand the need for safety and security practices	
Troubleshoot	
Select and use ICT to communicate and exchange information safely, responsibly and effectively including storage of messages and contact lists	
Mathematics	
Understand routine and non-routine problems in a wide range of familiar and unfamiliar contexts and situations	describing Ohm's law and its application
Identify the situation or problem and the mathematical methods needed to tackle it	
Select and apply a range of skills to find solutions	using electrical fault-finding techniques
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	discussing fault-finding techniques.
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	