

Unit 94: Operation and Maintenance of Aircraft Weapons' Electrical Systems

Unit code:	L/600/9071
QCF Level 3:	BTEC Nationals
Credit value:	10
Guided learning hours:	60

● Aim and purpose

This unit will provide prospective aircraft weapons' technicians with the underpinning knowledge and practical skills associated with the function, operation and maintenance of the weapons electrical systems fitted to modern military aircraft.

● Unit introduction

In this unit learners will apply direct current (DC) and alternating current (AC) theory to weapons' electrical circuits and systems. They will also gain an understanding of weapons' system cables and connectors, the components of weapons' electrical systems and the application of weapons' electrical systems in aircraft armament systems.

Although this unit has a strong theoretical base, it has also been designed to provide ample scope for centres to provide the learner with relevant 'hands-on' practical work on weapons' electrical equipment in an aeronautical engineering environment.

This unit, together with *Unit 93: Aircraft Explosive Devices and Regulations* and *Unit 95: Operation and Maintenance of Aircraft Assisted Escape Systems*, provides the underpinning knowledge needed to meet the requirements of the armed forces initial training requirements for those undergoing basic training as a weapons technician.

● Learning outcomes

On completion of this unit a learner should:

- 1 Be able to apply electrical theory to weapons' electrical circuits and systems
- 2 Know the applications of weapon systems' electrical cables and connectors
- 3 Know the electrical circuit components of a weapons system
- 4 Understand weapons' electrical systems armament applications.

Unit content

1 Be able to apply electrical theory to weapons' electrical circuits and systems

Direct current (DC) circuit theory: electromotive force (EMF) and voltage difference eg definitions of EMF/potential difference/voltage, sources of EMF/voltage, units, electric field; current eg current flow, units; resistance; use of Ohm's law ($V=IR$); material properties eg conductors, insulators, factors affecting a material's electrical resistance; static electricity eg cause and impact on weapons' electrical circuits and components; electrical earth/ground eg meaning, earth return circuits, earthing applications in weapons' electrical circuits; use of multimeters for DC measurements; electrical safety eg checks before and during the use of DC weapons' electrical circuits

Alternating current (AC) circuit theory: alternating current, AC generation, measurement – peak, peak-to-peak, root mean square (rms); use of measuring instruments eg multimeters, oscilloscope; electrical safety eg checks before and during the use of AC weapons' electrical circuits

2 Know the applications of weapon systems' electrical cables and connectors

Weapons' electrical systems cables: types of armament system cables/conductors eg Tersil, Kapton, Nyvin, equipment wire and co-axial; external markings; cable/conductor appearance and identification methods, eg cause and nature of cable/conductor damage/deterioration

Weapons' electrical systems connectors: types, identification, function and use of electrical connectors in armament systems eg Pattern, Plessey, breakdown of manufacturer's part number for use on aircraft guns, connection/disconnection of release equipment and armament ground equipment; connector location and locking methods; cause and nature of connector damage/deterioration; recording and documentation procedures – correct use of technical publications

3 Know the electrical circuit components of a weapon's system

Weapons' electrical systems circuit components: resistors eg fixed, variable – potentiometer, rheostat; resistor characteristics eg size, rating, colour coding; capacitors – safe working voltage, capacitor rating using identification markings; operation and use of semi-conductor diodes and simple bridge rectifiers; weapons electrical circuit protection eg fuses, circuit breakers – types, current rating, dummy fuses, circuit not in use fuses, fuse holders, manually operated thermal circuit breakers, warning lamps, electromagnetic indicators; identification and rectification of blown fuses and tripped circuit breakers

4 Understand weapons electrical systems armament applications

Armament systems: differing weapons roles of RAF aircraft eg air defence, ground attack, reconnaissance, maritime, search and rescue (SAR); weapons eg aircraft guns, rockets, chaff and flare, missiles, (air-to-air, air-to-surface); weapons delivery systems eg freefall, ejection, launched, fired

Armament system electrical components: battery/generator, switches and associated hardware; prevention of inadvertent operation of armament electrical installation eg weight-on-wheels (WOW) switch, armament circuit breaker isolation, fuel probe micro switch, bomb-bay doors micro switch, master arm switch, gun vent actuator micro switches

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:
P1 use DC circuit theory to describe the performance of a weapon's electrical circuit	M1 use a given maintenance procedure to determine the serviceability of an armament electrical circuit	D1 use appropriate system circuit diagrams and test equipment to evaluate the operational performance of an aircraft armament electrical system.
P2 use AC circuit theory to describe the performance of a weapon's electrical circuit	M2 explain the safety precautions that must be adhered to when working on a given armament system electrical circuit.	
P3 use electrical measuring instruments to take weapons' electrical circuit measurements		
P4 carry out electrical insulation and continuity checks on a weapons' electrical circuit [SM3, SM4]		
P5 identify and describe the applications of two different types of weapons' electrical cables		
P6 identify and describe the applications of two different types of weapons' electrical connectors		
P7 identify and describe the purpose of three different weapons' electrical system components		
P8 carry out a rectification process for a blown weapon's electrical circuit protection system		

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>P9 explain the function and application of two different aircraft armament systems and their related armament system electrical components.</p>		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. 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

The delivery strategy for this unit is likely to consist of a series of planned lectures, demonstrations and practical tasks. These should be designed to provide the learner with as much experience as possible of a range of weapons' electrical systems relating to aircraft armament systems. Emphasis should be placed on the identification, care and use of electrical systems and their components.

The nature of the practical work will very much depend upon the resources available to the centre. However delivery must include the handling, care and associated maintenance of aircraft armament electrical systems, their components and associated equipment and safety devices. Some elements of the delivery may be achieved by incorporating industrial visits reinforced by suitable weapons' electrical workshop/laboratory experience. It is essential that learners have access to information on all necessary safety procedures and regulations at all times.

Delivery of the unit content is likely to be highly integrative. For example, learners could be working on the theory of direct current (DC) and then applying it to relevant weapons' electrical circuits and armament applications before moving on to the theory of alternating current (AC) and doing the same. The nature of the weapons' electrical systems means that at some point the learner may be dealing with both DC and AC circuits within a particular application.

The primary aim of delivery should be to cover the specific requirements of the unit content but set within a relevant industry context that reflects the type of work that the learner may experience in the field.

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 demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment

Whole-class teaching:

- introduction to unit content, scheme of work and assessment strategy
- explain the safety precautions that must be followed when working with electrical circuits and systems
- explain the principles of EMF, voltage difference, current and the use of Ohm's law
- explain the material properties of conductors and insulators
- explain the causes and impact of static electricity and the purpose and methods of earthing/grounding
- explain the theory of alternating current, generation and measurement
- explanation/demonstration of the use of measuring instruments for DC and AC measurements.

Practical workshop activities:

- investigation of weapons' electrical circuits, use of multimeters and carrying out insulation and continuity checks.

Prepare for and carry out **Assignment 1: Aircraft Weapon Electrical Circuits** (P1, P2, P3, P4, M1, M2, D1)

Topic and suggested assignments/activities and/assessment

Whole-class teaching:

- explain the applications of different types of armament system cables and conductors
- explain the methods of identification and the external markings for each type
- explain the function and use of different types of armament system electrical connectors
- explain the connector location and locking methods
- explain the causes of connector damage/deterioration
- explain the correct use of recording and documentation procedures

Practical workshop activities:

- investigation of weapons electrical cables and connectors

Prepare for and carry out **Assignment 2: Weapon System Electrical Cables and Connectors** (P5, P6)

Whole-class teaching:

- explain the types and characteristics of resistors
- explain the function of capacitors and rating using identification markings
- explain the operation and use of semi-conductor diodes and bridge rectifiers
- explain the methods of electrical circuit protection and methods for identifying and rectifying blown fuses and tripped circuit breakers.

Practical workshop activities:

- investigation of weapons' electrical systems circuit components including identification and rectification of blown fuses and tripped circuit breakers.

Prepare for and carry out **Assignment 3: Electrical Circuit Components** (P7, P8)

Whole-class teaching:

- explain the roles of different types of aircraft, the different weapons involved and their delivery systems
- explain the function and operation of armament system electrical components and methods of preventing inadvertent operation.

Prepare for and carry out **Assignment 4: Armament System Applications** (P9)

Feedback on assessment and unit review

Assessment

Much of the assessment evidence for this unit could be achieved through tutor observation and oral questioning during learners' practical work. It is important however, that such processes evidenced for assessment are planned and recorded appropriately. Any process evidence could be supplemented by additional written work through either open assignments or in the form of notes and records that have been prepared by the learner during the practical tasks.

For this unit, a limited amount of testing or practical exercises carried out under controlled conditions may be appropriate. Either way, it is important that the work is designed to enable the learner to meet the requirements of the grading criteria and related content. Whilst the evidence must only be that produced by each individual learner (group work would not be acceptable), it is expected that the learner will carry out any assessment tasks (particularly associated with aircraft weapons' electrical systems) with an appropriate level of supervision.

It should be noted that there are four pass criteria (P1 – P4) associated with learning outcome 1. Learning outcomes 2 and 3 each have two associated pass criteria (P5 and P6, P7 and P8, respectively) and learning outcome 4 has just one (P9). The first two criteria (P1 and P2) are likely to provide the basis for all the assessment activities. That is, the learner should be able to use DC circuit theory to describe the performance of a weapon's electrical circuit in terms of insulation and continuity check (P3) of a weapon's electrical cable (P5) and/or electrical connectors (P6), etc. Where two or more different 'types' are required (eg P5 - cables, P6 - connectors, P7 – system components and P9 – armament systems), it is expected that together these should cover both DC and AC (rather than all DC or all AC).

The criterion P3 requires the use of electrical measuring instruments to take weapons' electrical circuit measurements. The assessment evidence should include the use of multimeters on both DC and AC circuits. Oscilloscopes need only be used for measurement and observation of signal behaviour of AC circuits.

Whilst the assessment evidence for the pass criteria will focus on a specific aspect of a weapon's electrical circuit, the evidence for merit and distinction will require a more holistic approach to whole systems. In this way, learners achieving a merit or distinction are required to demonstrate a greater level of competence in the wider applications of DC and AC theory and also independence in their approach to working with circuits and systems.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and 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
P1, P2, P3, P4, M1, M2, D1	Aircraft Weapon Electrical Circuits	A technician needs to evaluate the performance of weapons' electrical circuits.	A written report based on practical activities supported by observation records.
P5, P6	Weapon System Electrical Cables and Connectors	A technician needs to choose the correct weapons' electrical cables and connectors for certain applications.	A written description or records of oral questioning.
P7, P8	Electrical Circuit Components	A technician needs to describe a rectification process for a blown weapon's electrical circuit protection system.	A written description or records of oral questioning.
P9	Armament System Applications	A technician needs to produce a report on aircraft armament systems.	A written report.

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

This unit forms part of the BTEC Engineering sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
		Aircraft Explosive Devices and Regulations
		Operation and Maintenance of Aircraft Assisted Escape Systems

Essential resources

Centre will need to provide learners with access to relevant weapons' electrical system data books, manuals and appropriate test and handling equipment.

Employer engagement and vocational contexts

Much of the work for this unit can be set in the context of learners' work placements or be based on case studies of local employers. Further information on employer engagement is available from the organisations listed below:

- Work Experience / Workplace learning frameworks — Centre for Education and Industry (CEI -University of Warwick) — www.warwick.ac.uk/wie/cei/
- Learning and Skills Network — www.vocationallearning.org.uk
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme — www.stemnet.org.uk
- National Education and Business Partnership Network — www.nebpn.org
- Local, regional Business links — www.businesslink.gov.uk
- Work-based learning guidance — www.aimhighersw.ac.uk/wbl.htm

Indicative reading for learners

Specialist manuals for relevant aircraft armament systems and devices, air publications and Statutory Regulations.

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Self-managers	organising time and resources, prioritising actions and anticipating and managing risks when carrying out insulation and continuity checks.

Although PLTS 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 ...
Reflective learners	setting goals with success criteria for their development and work

● Functional Skills — Level 2

Skill	When learners are ...
English	
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching information on the range of weapons electrical components and systems and their associated regulation, directives and publications
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	preparing reports on the practical work undertaken and presenting information on weapons electrical components and systems.