

Unit 84: Aircraft Electrical Systems

Unit code:	H/600/7276
QCF Level 3:	BTEC Nationals
Credit value:	10
Guided learning hours:	60

● Aim and purpose

This unit will give learners an understanding of typical aircraft airframe and propulsion electrical systems and will develop the skills needed to carry out maintenance on these systems.

● Unit introduction

This unit will familiarise learners with a range of typical electrical systems installed on modern aircraft. These systems include a variety of airframe and propulsion applications, such as centralised warning systems, flight data recording, and fire detection and overheat warning systems. The unit also addresses how to check, troubleshoot and maintain aircraft electrical components and systems.

The unit encourages learners to investigate the purpose of these systems and how they contribute to the overall effectiveness of aircraft operation. Emphasis is placed on the operation and maintenance of these systems in order to develop the learners' awareness of cockpit procedures. Learners will be given an appreciation of how electronic flight data recording systems can be utilised for the investigation of accidents and the scheduling of maintenance activities. A range of airframe and propulsion applications is studied including warning systems, control systems and actuation devices.

On completion of the unit, learners will have a broad understanding of how these electrical systems are operated and be able to identify their mechanical and electrical interfaces. Learners will also be capable of a range of maintenance activities on electrical systems and will gain experience in the use of aircraft documents including maintenance manuals and wiring diagram manuals.

This unit has been designed to provide some of the knowledge required for learners wishing to progress on to the European Aviation Safety Agency (EASA) Part 66 licensing requirements. It will also benefit those seeking employment within the armed forces or the aircraft manufacturing industry.

● Learning outcomes

On completion of this unit a learner should:

- 1 Know the function and operation of aircraft electronic systems
- 2 Know the function and operation of airframe electrical systems
- 3 Know the function and operation of aircraft propulsion electrical systems
- 4 Be able to carry out real or simulated aircraft electrical system maintenance activities.

Unit content

1 Know the function and operation of aircraft electronic systems

Typical electronic systems: accident data recording systems eg flight data recorders, data acquisition systems, mandatory parameters, optional parameters, interpretation of data for the purposes of scheduled inspections and maintenance; engine health monitoring systems eg temperature and pressure recording, interpretation of data for the purposes of scheduling inspections and maintenance activities

2 Know the function and operation of airframe electrical systems

Typical airframe systems: warning systems eg centralised warning, configuration warning, bleed air overheat detection; safety and actuation eg ice and rain protection, landing lights, anti-collision lights, navigation lights, cabin, cockpit and cargo lights, emergency lights, landing gear retraction, flying controls actuation

3 Know the function and operation of aircraft propulsion electrical systems

Typical propulsion systems: emergency systems eg thermal fire detection, optical fire detection, fire suppression; electrical control eg ignition systems, engine starting

4 Be able to carry out real or simulated aircraft electrical system maintenance activities

Practical activities: functional tests on aircraft electrical systems eg centralised warning systems, airframe electrical systems, propulsion electrical systems; serviceability of electrical components eg wiring loom integrity, electrical continuity and insulation checks, inspection of fibre optic cable assemblies and associated components; electrical component replacement eg lamps, fuses, circuit breakers, antennas, electronic modules, micro-switches, proximity detectors, actuation devices

Documentation: use and application of real or simulated documentation eg maintenance manuals, illustrated parts catalogues, wiring diagram manuals, electrical schematics, technical log

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 describe the operation of an aircraft data recording system	M1 analyse the operation of an airframe warning system	D1 evaluate how centralised warning systems contribute to the overall safety of an aircraft
P2 describe the operation of an engine health monitoring system	M2 compare the different methods used for engine fire detection	D2 explain the importance of coordinating maintenance activities when carrying out functional checks on actuation devices.
P3 describe the electrical operation of a given airframe warning system	M3 explain how a given electrical system problem could be assessed to ascertain its serviceability.	
P4 describe the electrical operation of a given airframe safety and actuation system		
P5 describe the electrical operation of a given propulsion emergency system		
P6 describe the electrical operation of a given propulsion control system		
P7 carry out practical activities to determine the serviceability of a given electrical system [SM3]		
P8 identify the documentation required to test and replace an electrical component [IE4].		

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	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

Although this unit assumes that learners have no prior knowledge of aircraft electrical systems, they must have an understanding of electrical and electronic fundamentals equivalent to *Unit 6: Electrical and Electronic Principles*. Before delivering this unit tutors will therefore need to ensure that learners have the relevant prerequisite knowledge.

To establish the context of aircraft electrical systems the unit should begin with an introduction to the types of systems that will be studied, eg warning systems, control systems and actuation systems. Learners should appreciate that these are typical systems employed in a variety of electronic, airframe and propulsion applications. It might be useful to give an overview of how electrical systems have developed over the last 25-30 years because of the increased complexity and integration of aircraft systems. Illustrations of these advances could be via comparisons of hardware using actual equipment, DVDs and/or videos.

The first three learning outcomes are not specifically linked, however, learning outcome 4 applies to all of the preceding outcomes.

On completion of this unit, learners will have a broad understanding of the operation of these typical electrical systems and how they are tested and maintained. This will include an understanding of the range of associated documents that are required for the operation of a modern aircraft. Examples of how electrical systems are used should focus on their operation in a commercial or military environment. Use can also be made of any first hand experience that learners may have gained through work experience and/or the Air Training Corp (ATC).

Learning outcome 1 covers the fundamental principles of electronic systems such as flight data recorders and engine health monitoring systems. In delivering this subject, there is an opportunity to broaden the scope of learners' attitude towards operating aircraft safely and efficiently. The subject of flight data recording will necessitate reference to the 'black box' flight recorder and the 'autopsy' approach used in investigating aircraft accidents. In contrast, engine health monitoring will introduce learners to the concept of trend monitoring and predictive maintenance.

To aid teaching of learning outcomes 2 and 3 it would be useful if learners are able to see a gas turbine engine that has been removed from an aircraft and have access to an aircraft flight deck or cockpit. In the context of this unit 'flight deck' is used to define the pilots' stations on a commercial aircraft and 'cockpit' is used for general aviation or military aircraft. It would also be of benefit for learners to be able to see inside an equipment bay. This could be achieved by using the centre's own aircraft and/or by carrying out a visit to an airline, repair organisation or military base. Because of the security associated with the aircraft industry, alternative arrangements could include viewing an aircraft simulator or aircraft museum. It would also be beneficial for learners to get their hands on equipment such as control panels or aircraft computers and take them apart to see how they are constructed.

The use of a 'given system' in the criteria relating to learning outcomes 2 and 3 allows centres to take advantage of the resources and expertise available.

Learning outcome 4 is focused on practical activities based in a workshop and/or hangar environment. When delivering learning outcome 4 learners only require the knowledge and skills for simple procedures relating to the testing, maintenance and faultfinding of systems. Task-based activities could be used and a checklist kept of what has been achieved. Learners should be given a range of tasks that require them to work both by themselves and in teams.

Note that the use of 'eg' in the content is to give an indication and illustration of the breadth and depth of the area or topic. As such, not all content that follows an 'eg' needs to be taught or assessed.

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 methods of assessment
- use of video resources and/or examples of electrical hardware to describe the development and integration of aircraft electrical systems over the last 30 years
- describe data recording systems and the methods of interpreting data for maintenance
- describe use of flight data recorder in investigating and determining causes of accidents
- explain the use of engine health monitoring systems and the interpretation the of data collected.

Individual learner activities:

- investigative task to research the use of data recording systems and engine health monitoring systems for scheduled and predictive maintenance
- quiz or multiple choice test on function and operation of aircraft electronic systems.

Prepare for and carry out **Assignment 1: Aircraft Electronic Systems** (P1, P2).

Whole-class teaching:

- describe the purpose, use, function and operation of different warning systems
- describe the purpose, use, function and operation of different safety and actuation systems.

Industrial visit:

- visit to airline or aircraft maintenance center to view aircraft flight deck or cockpit.

Individual learner activity:

- investigation of the construction and layout of airframe electrical systems.

Prepare for and carry out **Assignment 2: Airframe Electrical Systems** (P3, P4, M1, D1).

Whole-class teaching:

- describe the purpose, use, function and operation of emergency systems
- describe the purpose, use, function and operation of electrical control systems.

Practical workshop activity:

- practical investigation of propulsion electrical systems construction and layout
- quiz or multiple choice test on the operation of propulsion emergency and control systems.

Prepare for and carry out **Assignment 3: Aircraft Propulsion Electrical Systems** (P5, P6, M2).

Whole-class teaching:

- describe the health and safety procedures that need to be followed when carrying out maintenance activities on aircraft electrical systems
- describe and demonstrate the processes and procedures relating to the testing, maintenance and faultfinding of aircraft electrical systems
- describe the documentation that is needed when carrying out maintenance on aircraft electrical systems.

Topic and suggested assignments/activities and/assessment

Practical workshop activities:

- learners to carry out functional tests on a range of aircraft electrical systems, check components for serviceability and replace where necessary, using all relevant documentation.

Prepare for and carry out **Assignment 4: Aircraft Electrical Systems Maintenance** (P7, P8, M3, D2).

Feedback on assessment and unit evaluation.

Assessment

Assessment of this unit could be through the use of four assignments, one assignment for each learning outcome. However the learning outcomes do not need to be assessed in order. Evidence of assessment could be collected in a variety of formats including short answer questions, observation of practical work and written assignments.

Learners are expected to use their own words when referring to systems and, while much of their research will be done using the internet, it is important that what they present is not just simply a cut-and-paste exercise.

For the first assignment, covering P1 and P2, evidence to support knowledge of flight data recording and engine health monitoring applications could be generated from written tasks asking learners to describe how these systems operate.

The second assignment could cover pass criteria P3 and P4 and include further written tasks giving learners an opportunity to analyse warning systems (M1) and evaluate their contribution to aircraft safety (D1).

A third assignment, covering P5 and P6, could include a task requiring learners to apply their knowledge of fire detection systems for the comparison needed to achieve M2.

The last assignment could cover pass criteria P7 and P8 and involve a given range of practical tasks. The learner could assume the role of a maintenance technician who has been tasked with investigating reports raised by their supervisor. These criteria should be met by learners providing evidence that they can test systems, investigate defects, replace components and use the appropriate aircraft documentation. The assignment could be extended with written tasks to cover criteria M3 and D2.

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	Aircraft Electronic Systems	A technician needs to describe the operation of data recording and engine health monitoring systems to a new apprentice.	An assignment consisting of a series of written tasks or a presentation supported by tutor observation and relevant handouts.
P3, P4, M1, D1	Airframe Electrical Systems	A technician has been asked to produce a report on the operation of airframe electrical systems.	A written report detailing systems' operation and analysing and evaluating airframe warning systems.
P5, P6, M2	Aircraft Propulsion Electrical Systems	A technician has been asked to produce a report on the electrical operation of propulsion systems.	A written report detailing systems' operation.
P7, P8, M3, D2	Aircraft Electrical Systems Maintenance	A technician needs to determine the serviceability of an aircraft electrical system.	A two part assignment consisting of a practical task supported by tutor observation and relevant documentation, and additional written tasks.

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
		Electrical and Electronic Principles
		Aircraft Instruments and Indicating System

This unit covers some of the knowledge and understanding associated with the SEMTA Level 3 National Occupational Standards in Aeronautical Engineering, particularly:

- Unit 76: Testing Aircraft Cableforms/Looms.

Essential resources

To meet the needs of this unit learners will need access to the following:

- an aircraft and/or simulator with functioning electrical systems
- representative electrical equipment (eg sensors, computers, displays and indicators)
- test equipment and measuring instruments
- relevant aircraft technical publications (eg maintenance manuals, system schematics, wiring diagram manuals).

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

Textbooks

Eismin T – *Aircraft Electricity and Electronics* (McGraw-Hill, 1994) ISBN 0071132864

Pallett E – *Aircraft Electrical Systems* (Longman, 1988) ISBN 0582988195

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 ...
Independent enquirers	analysing and evaluating information when using relevant documentation during aircraft electrical systems maintenance
Self-managers	organising time and resources when carrying out aircraft electrical systems maintenance.

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 reviewing progress during maintenance activities and acting on the outcomes
Team workers	collaborating with others when working in a small group to carry out maintenance activities on aircraft electrical systems.

● Functional Skills – Level 2

Skill	When learners are ...
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	describing the operation of electronic, airframe and propulsion systems
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching and investigating aircraft electrical systems
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	describing the operation of electronic, airframe and propulsion systems.