

Unit: **Aircraft Electrical Machines, Cables and Connectors**

Learning hours: 60

NQF level 3: BTEC Nationals

Description of unit

This unit has been designed to provide prospective Avionic Air Electrical Technicians with an introduction to the theory of electrical machines used in aircraft systems. The unit also provides learners with an introduction to the types and uses of cables and connectors and the importance of correct handling of these components. The unit will enable learners to understand the principles and purpose of the machines and their control, methods of connection and the importance of cable husbandry when working in an aircraft environment. This unit also provides some of the underpinning knowledge and skills necessary for maintaining associated electrical systems.

This unit covers some of the avionics knowledge and understanding associated with the National Occupational Standards in Aircraft Engineering Competencies and the new European Directive, Joint Aviation Requirement (JAR 66) category A, in module 13.

A further aim of this unit is to cover the necessary underpinning knowledge and skills needed to meet the Armed Forces initial training requirements for those undergoing basic training as Air Electrical Technicians.

This unit is to be internally assessed, with methods that will include both written and practical assignments. The use of multiple-choice questions would be of benefit to learners as this is the preferred approach of the Regulatory Authorities for the JAR 66 Licence and the Armed Forces trade examinations.

The unit presents opportunities to demonstrate key skills in application of number, communication and improving own learning and performance.

This is an internally assessed unit.

Summary of learning outcomes

To achieve this unit a learner must:

- 1 Explain the needs and requirements of **ac and dc aircraft power supply systems**
- 2 Describe the construction, operation and control of aircraft **ac and dc generators**
- 3 Describe the construction and explain the operation of aircraft **dc motors and ac motors**
- 4 Identify, explain the function and carry out associated maintenance on typical aircraft **cables and connectors.**

Content

1 ac and dc aircraft power supply systems

Requirements, arrangement and operation of: dc single generator system, multiple generator systems, starter systems, secondary power supplies, auxiliary airborne power units, ac generator drive systems, non-paralleling ac generator system, paralleling ac generator system

2 ac and dc generators

Fundamentals: underpinning principles and constructional detail of dc and ac generators

Operation and control: machine characteristics and operation of dc and single/3-phase ac generators; generator control parameters and methods of achievement of these parameters; generator internal circuitry and control circuitry

3 dc motors and ac motors

Principles and control: motor principle and constructional detail, simple dc motors and their characteristics, methods of automatic control, parallel operation, aircraft dc, ac and 3-phase motor performance

Synchronous and induction motors: construction, performance and aircraft application of synchronous and induction motors; control of synchronous and induction motors

4 Cables and connectors

Fundamentals: cable types and construction, cable limitations and uses, construction of cable looms, types of securing devices and their use, the importance of cable husbandry

Associated maintenance: carry out maintenance operations in accordance with related procedures and documentation, eg actions to be taken on discovery of damaged cables, cable protection, types of connectors in common use, correct handling of connectors during connection/disconnection, common methods of connecting cables to connectors; continuity and insulation checks, connection/disconnection, associated safety requirements

Assessment guidance

This unit is internally assessed

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

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 the learner is able to:	To achieve a distinction grade the evidence must show that the learner is able to:
<ul style="list-style-type: none"> describe the construction and explain the principle of operation of typical dc and ac generators describe the function and operation of generator systems used in modern aircraft explain the methods used to maintain dc and ac electrical supplies in the event of main generator failure explain the methods used for automatic control (including operation in parallel) of modern aircraft generators currently employed in aircraft generation systems describe the construction, operation, use and performance characteristics of typical dc motors 	<ul style="list-style-type: none"> evaluate the function of modern ac generator control and protection circuitry in providing power to aircraft systems analyse the performance and application in aircraft for dc and ac electric motors plan a maintenance schedule to confirm the operation of cable loom connectors/fittings and to ascertain cable loom serviceability. 	<ul style="list-style-type: none"> appraise the performance of a modern integrated drive ac generator system or constant speed drive unit and ac generator, when interfaced with the engine throttle system justify, with the aid of appropriate circuit diagrams, the required rectification action for a range of given defects in an aircraft generator or aircraft motor system.

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 the learner is able to:	To achieve a distinction grade the evidence must show that the learner is able to:
<ul style="list-style-type: none"> state the need for correct cable husbandry and describe how this is achieved carry out the assembly/disassembly, connection and disconnection of typical aircraft cable connectors, fixtures and fittings. 		

Essential information for teachers

Delivery strategies

This unit is designed to provide prospective Avionic/Air Electrical Technicians with the necessary knowledge of aircraft electrical machines, cabling and connectors to enable them to work safely and efficiently in an aircraft environment. This unit will involve strong delivery of sound underpinning knowledge and skills in a classroom, workshop or possibly an aircraft hangar environment.

This unit will enable learners to gain a full understanding of the special health and safety issues associated with aircraft electrical power systems equipment. This unit may be delivered as a stand-alone unit or in tandem with the other avionics units within the Aerospace Engineering scheme.

Adopting a hands-on approach will enhance learning. The amount of practical input will be largely dependent on centre resources but the learner experience should include an element of practical work. Where centre resources are limited or no suitable partnership with industry can be arranged to perform practical work, computer simulation packages may offer an appropriate alternative.

Although this subject requires substantial tutor input, learners should be encouraged to take responsibility for their own learning, whenever appropriate.

Assessment strategies

Evidence of outcomes can be collected from assignments and practical activities. The pass grade specifies the minimum acceptable level required by learners and the internal assessments comprising both theoretical and practical assignments will cover all the learning outcomes, but not necessarily all the topics included in the content. Achievement of a merit or distinction grade will require answers that demonstrate additional depth of knowledge of the theoretical and practical aspects of the subject matter.

The following amplification is intended to assist in the interpretation of the grading criteria found in the assessment grid.

Grade descriptions

Pass

This grade specifies the minimum level of learning required. Learners must be able to give a clear and accurate explanation of health and safety issues associated with the subject and observe all relevant safety precautions when undertaking practical activities.

Learners should be able to describe a variety of commonly used electrical machines, cables, cabling methods and connectors and explain their function. They should also possess an overall understanding of electrical machine theory and be able to identify the associated aircraft system hardware.

Merit

To achieve a merit, learners must possess a detailed knowledge of the theoretical and practical aspects of the subject. They must be able to qualitatively analyse the performance and application of dc, ac and 3-phase machine systems. Learners will be able to determine the serviceability of aircraft electrical machines, cables, cable looms, connectors and their associated equipment, eg cable lacing, locking devices and tie wraps and detail the necessary procedures and related safety issues, when working on aircraft electrical power systems and associated equipment. They will be able to evaluate the function of modern ac generator control and protection circuitry in providing power to aircraft systems.

Distinction

To achieve a distinction, learners must have an in-depth understanding of the subject matter and be able to read and analyse appropriate circuit diagrams in order to determine the likely cause of system/equipment defects on modern aircraft electrical systems.

Links

This unit has strong links with the units *Aircraft Electrical Systems* and *Aircraft Instruments and Indicating Systems*. This unit also requires knowledge contained in *Science for Technicians* which should be treated as a prerequisite.

Links also exist with parts of the JAR 66 syllabi, particularly in respect of the knowledge required by Maintenance Certifying Mechanics and Air Electrical Tradesmen, undergoing initial technical training in the Armed Forces.

One further link exists between this unit and some of the fundamental electrical systems knowledge required for the existing NVQ in Aircraft Maintenance Engineering.

This unit presents opportunities to demonstrate key skills in application of number, communication and improving own learning and performance.

Resources

This unit has been designed to provide the theoretical knowledge base and underlying principles, as well as some practical aspects of Aircraft Machines, Cables and Connectors, for those wishing to become Aircraft Engineering Avionics/Air Electrical specialists. Access is required to a variety of facilities to successfully complete the unit.

It is accepted that apart from JAR 147 approved organisations and specialist training organisations, access to modern electrical/electronic aircraft systems and equipment will be severely limited. Nevertheless it is suggested that a basic minimum for successful completion of key practical activities should include examples of electrical machines, cables and connectors eg generators, motors, cable types and commonly used connectors, plus a selection of examples of aircraft hardware, eg cable looms and cable loom securing devices.

The unit also contributes towards the knowledge and understanding for ECS units at level 3:

- 1.02 Identify solutions to meet technical requirements
- 1.05 Identify factors that impact on engineering design briefs
- 1.12 Interpret detailed information from technical sources
- 1.13 Read and extract information from engineering drawings and specifications

- 1.14 Provide technical information in required formats
- 6.02 Conduct specified testing of engineering products or assets
- 6.03 Analyse and interpret the results of engineering tests.

Access to training aircraft or industrial visits would be of tremendous benefit to learners in order to carry out recognition exercises of modern aircraft electrical systems and components. Such links would also allow learners to engage in simple maintenance activities on mock-ups or training aircraft.

Suggested reading

Textbooks

- *Avionic* Technician Textbooks from Jeppesen Publishing – Aircraft Technician Series

Specialist texts

- *Aircraft* Publications – 101 Series (Military)
- ATA-100 Series specialist Textbooks (Civil Aviation)

Key skills

Highlighted here are the key skills that have already been identified in the *Description* section. Achievement of key skills is not a requirement of this qualification but it is encouraged. Suggestions of opportunities for the generation of level 3 key skills evidence are given here. Staff should check that learners have produced all the evidence required by part B of the key skills specifications when assessing this evidence. Learners may need to develop additional evidence elsewhere to fully meet the requirements of the key skills specifications.

Application of number level 3	
When learners are:	They should be able to develop the following key skills evidence:
<ul style="list-style-type: none"> selecting and accessing data for electrical machine experiments carrying out calculations during experiments on dc, ac and 3-phase machines investigating electrical machines and machine theory 	<p>N3.1 Plan and interpret information from two different types of sources, including a large data set.</p> <p>N3.2 Carry out multi stage calculations to do with:</p> <ol style="list-style-type: none"> amounts and sizes scales and proportion handling statistics rearranging and using formulae. <p>You should work with a large data set on at least one occasion.</p> <p>N3.3 Interpret results of your calculations, present your findings and justify your methods. You must use at least one graph, one chart and one diagram.</p>
Communication level 3	
When learners are:	They should be able to develop the following key skills evidence:
<ul style="list-style-type: none"> discussing issues relating to integration and operation of aircraft electrical machines and cabling researching issues relating to faults on aircraft machines and cabling, including connections reporting on assignments carried out to investigate electrical machines 	<p>C3.1a Contribute to a group discussion about a complex subject.</p> <p>C3.2 Read and synthesise information from two extended documents about a complex subject. One of these documents should contain at least one image.</p> <p>C3.3 Write two different types of documents about complex subjects. One piece of writing should be an extended document and include at least one image.</p>

Improving own learning and performance level 3	
When learners are:	They should be able to develop the following key skills evidence:
<ul style="list-style-type: none"> • action planning an investigation • managing action plan • evaluating action planning 	<p>LP3.1 Agree targets and plan how these will be met over an extended period of time, using support from appropriate people.</p> <p>LP3.2 Take responsibility for your learning by using your plan, and seeking feedback and support from relevant sources, to help meet targets.</p> <p>Improve your performance by:</p> <ul style="list-style-type: none"> a studying a complex subject b learning through a complex practical activity c further study or practical activity that involves independent learning. <p>LP3.3 Review progress on two occasions and establish evidence of achievements, including how you have used learning from other tasks to meet new demands.</p>