

Unit 70: Aircraft Workshop Principles and Practice

NQF Level 3: BTEC National

Guided learning hours: 60

Unit abstract

In order to practice as an aircraft engineer a range of basic engineering skills are needed, regardless of where in the industry individuals wish to be employed. These skills will be beneficial to all personnel no matter whether they are in the field of aircraft structures, systems or component manufacture, fabrication, repair or maintenance.

This unit aims to provide learners with the key knowledge required to work in the aerospace engineering sector and will provide opportunities to practice these skills in a safe aircraft workshop environment. It 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.

The aircraft engineering industry is highly regulated and safety in all aspects of engineering practice is given the highest priority. The first part of this unit will provide learners with a thorough understanding of the safety issues associated with the care, control and use of the tools and equipment found in a typical aircraft workshop environment.

The range of skills that will be taught and practised in this unit fall into two broad areas. Those associated with typical mechanical and electrical bench fitting activities and those involving dismantling/assembly techniques for a variety of aircraft components and equipment. Learners therefore need to be able to read and interpret a range of engineering drawings and circuit diagrams so that they can successfully complete practical activities by following diagrammatic and written information to required standards.

Familiarity with the aircraft hardware associated with the practical activities is also emphasised in this unit. The unit also provides opportunities to put the theoretical aspects of workshop fitting and dismantling/assembly activities into practice.

Learning outcomes

On completion of this unit a learner should:

- 1 Understand the safe working practices associated with the care, control and use of aircraft workshop tools and equipment
- 2 Be able to read and interpret aircraft engineering drawings and diagrams
- 3 Understand the characteristics, identification methods and function of aircraft hardware
- 4 Be able to carry out workshop fitting, dismantling and assembly exercises.

Unit content

1 Understand the safe working practices associated with the care, control and use of aircraft workshop tools and equipment

Safe working practices: procedures and actions to be followed eg electricity (shock), high-pressure and low-pressure gases, oxygen and cryogenic substances, oils and chemicals in a workshop environment, fire, soldering irons; layout and nature of workshop firefighting equipment and first-aid provision

Care and use of tools and equipment: tool control methods eg shadow boards, portable servicing kits, toolboxes, tool tags, booking out/in systems; awareness and observation of safety procedures for the care and use of workshop tools and equipment eg

- marking out and work holding tools (engineer's rule, key seat rule, callipers, scribe, centre punch, dividers, fitters square, combination set, surface plate, surface gauge V- blocks, clamps, vices)
- cutting and metal removal tools (guillotines, hacksaws, files, pillar drills, electric and pneumatic drills, drill bits, taps and dies, reamers, grinding machines, countersinks)
- assembly/dismantling tools (hammers, pliers, crimping tools, screwdrivers, spanners, strap wrenches, torque wrenches, sockets, circlip pliers, soldering irons, hand riveting tools)
- precision measuring tools (calibration and control, bevel protractors, micrometers, Vernier callipers, Vernier height and depth gauges)
- soldering and welding equipment (gas bottles, regulators, welding torches, soldering irons, fluxes, solders)
- electrical test/measurement equipment (oscilloscopes, power supplies, wave generators, analogue and digital meters, continuity testers, bonding testers)

2 Be able to read and interpret aircraft engineering drawings and diagrams

Drawing types and conventions: types eg schematic diagrams, block diagrams, circuit diagrams, assembly and single-part diagrams, sketches, charts, tables; conventional methods of projection eg isometric, oblique, orthographic first or third angle, additional and auxiliary views; symbol conventions eg hydraulic, pneumatic British Standards (BS) 2917, International Standards Organisation (ISO) 1219, electrical BS 3939, BS 7845, BS EN 60617, limits and fits BS EN 20286, ISO 286, standard symbols and abbreviations (BS 8888); dimensioning and tolerances eg BS 8888

Read and interpret aircraft engineering drawings: key information from aircraft engineering drawings and circuit diagrams drawn to current national and international engineering standards eg BS 8888, BS 2917, ISO 1219, BS 3939, Air Transport Association (ATA) 100, Aerospace Industries Association (AIA), American National (AN), aircraft Air Publications (APs); retrieve key information from hardcopy or computer-based aircraft engineering publication drawings and diagrams

Aircraft engineering standards and presentation: relevant civil or military standards eg ATA 100, APs, BS, ISO, AN, Military Specifications (MS), AIA; presentation methods, eg printed manuals, microfilm, microfiche, posters, wall charts, tables, computerised methods; drawing amendment and control actions

3 Understand the characteristics, identification methods and function of aircraft hardware

Aircraft general hardware: characteristics and function of fasteners eg screws, nuts, bolts, studs (type, thread form, identification codes, dimensions); locking devices eg spring and tab washers, lock nuts, wire locking, friction devices, adhesives; other fasteners eg wing nuts, quick release fasteners, toggle fasteners, bayonet fasteners

Aircraft specialist hardware: characteristics and functions of specialist applications eg

- fluid plumbing hardware (solid and flexible pipes, unions, fittings and connectors, fitting procedures)
- transmission and motion hardware (springs, bearings, belts, chains, pulleys, sprockets, flexible control cables, bowden cables, teleflex cables, end fittings, handling, specific functions)
- rivets (types, materials, identification codes and numbers, dimensions, fitting tolerances, allowances and handling)
- electrical cables (types, materials, construction, limitations, securing devices, cable connectors, swaged end fittings, swaging methods, correct swaging identification methods, cable protection, insulation, bonding methods, cable handling)

4 Be able to carry out aircraft workshop fitting, dismantling and assembly exercises

Aircraft workshop fitting principles and practice: correct procedures for carrying out a range of mechanical fitting exercises eg rivet fit and removal, precision measuring and marking out, metal removal, metal joining by riveting and bolting, sheet metal bending, thread tapping, thread die cutting, panel fastener replacement, solid and rigid pipe removal and fit, lock wiring, cleaning and repacking bearings; correct procedures for carrying out a range of electrical fitting exercises eg removing and fitting flexible control cables, cable tensioning and adjustment, electrical cable crimping, fitting and removing electrical terminations, plugs and sockets, cable sheathing and looming, soldering joints, de-soldering, use of fluxes and heat sinks, bonding checks, earthing checks and continuity checks; associated safety precautions eg equipment pre-use checks, correct care and handling of cutting tools, welding equipment, metallic materials, measuring instruments, crimping tools, soldering irons, heat sinks, electrostatic hazards

Aircraft component dismantling and assembly principles and practice: dismantling, inspection and assembly observing correct procedures eg hydraulic and pneumatic pumps, motors, linear actuators, wheel and brake assemblies, accumulators, reservoirs, aircraft engine components, electric motors, electric pumps, electrical actuators, solenoids, switches, basic instruments; associated safety precautions eg care with fluids under pressure, ensure cleanliness, care with seals and seals handling, use of barrier creams, protective clothing, prevention of electric shock hazard, use of correct tools

Grading grid

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, 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 describe the different procedures to be followed in the event of a workshop fire, an electric shock to human operator and a chemical spillage</p> <p>P2 explain the precautions that must be observed for the control, care and use of tools needed for two different workshop fitting activities</p> <p>P3 use drawing types and conventions to read and interpret key information from a basic engineering drawing and a circuit diagram that conform to relevant standards and presentation</p> <p>P4 retrieve appropriate information from a hardcopy or computer-based aircraft engineering publication</p>	<p>M1 carry out a detailed fitting exercise observing all relevant safety precautions, using a range of aircraft specialist hardware, in accordance with laid down aircraft industry standards.</p> <p>M2 use appropriate precision measurement or test equipment on a mechanical or electrical assembly to establish whether dimensional accuracy or output characteristics conform to laid down aircraft industry standards.</p>	<p>D1 prepare a serviceability report having interpreted and used appropriate maintenance information to dismantle, inspect, assess for serviceability and reassemble a complex aircraft component or assembly, in accordance with laid down industry standards.</p>

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>P5 describe the characteristics and functions of aircraft general and specialist hardware</p> <p>P6 use aircraft workshop fitting principles and practices to carry out four different fitting exercises observing all relevant safety precautions</p> <p>P7 use aircraft component dismantling and assembly procedures and practice to carry out two dismantling, inspection and assembly exercises observing all relevant safety precautions.</p>		

Essential guidance for tutors

Delivery

This unit is essential for a full understanding of the health and safety issues associated with aircraft workshop practice and acts as an introduction to the health and safety requirements throughout other aerospace units. For this reason, it should be delivered early in the qualification.

The unit has been designed to give learners a thorough understanding of aircraft hardware and workshop practices appropriate for the mechanical and/or electrical specialisations. Delivery will need to ensure the sound underpinning of knowledge using both classroom and workshop environments as well as a strong emphasis being placed on the practical aspects of the unit. Health and safety issues should be emphasised throughout, in addition to the stand-alone delivery of health and safety via learning outcome 1. Delivery could include input from qualified first aiders, firefighters and other experienced staff, to reinforce these and other procedures.

Wherever possible a practical approach should be adopted. The range of practical work has been detailed in the unit content and delivery of part or all of this range will be dependent on the nature of the cohort (ie whether they are to be steered towards the mechanical, electrical or both skills areas). However, no matter what practical pathway has been chosen, all learners must be given a thorough understanding of the safe working practices detailed in learning outcome 1.

Choice has been given with respect to the care, control and use of tools and equipment. Where learners are following a mechanical option, they may concentrate on the cutting, marking out and measuring tools directly associated with aircraft sheet metal work. Alternatively, those following the electrical option might concentrate on the use of soldering and electrical test and measuring tools and equipment. Ideally, learners should be encouraged to carry out practical exercises that require the care, use and control of all these tools and equipment. The range and type of dismantling/assembly tools used will also be dependent on the nature of the equipment and assemblies being worked on.

When delivering learning outcome 2 all learners are expected to gain familiarity with drawing types, symbols and abbreviations as detailed in BS 8888. However, for those following the mechanical option emphasis may well be placed on fluid power circuits (BS 2917, ISO 1219), while for learners following the electrical option more emphasis might be placed on BS 3939, BS 7845 and other appropriate standards.

The standards to be followed with respect to aircraft engineering manuals and documentation will again depend on the nature of the cohort. For example, military learners would be introduced to their Air Publication (AP) series, while those concerned with civil aviation might concentrate on the Air Transport Association ATA 100 series of manuals. Learners would then be able to use these to read and interpret engineering drawings and extract key information.

In learning outcome 3 learners are expected to gain familiarity with aircraft general hardware but have a choice in the type of specialist hardware they wish to study.

Finally, in learning outcome 4 a broad range of fitting and dismantling/assembly exercises are detailed that are typically carried out in an aircraft engineering workshop environment. The time dedicated to these exercises will vary from centre to centre, as indeed will the skill level achieved by learners. However, to gain any meaningful practical competence a substantial amount of time should be given over to their delivery, with the remainder being used to deliver the theory that underpins these practical activities. Some of the time needed to deliver aspects of the practical work may be found during other work, for example during the delivery of appropriate NVQs if applicable and appropriate.

Since the practical elements of the unit have been designed to utilise typical workshop facilities that are commonly found in most centres, delivering the practical content should pose few problems. However, it is expected that the hardware and materials used are those typically found on aircraft, for example light alloy sheet metal and rivets, aircraft structure and electrical cables and aircraft hydraulic, pneumatic and electrical components.

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.

Assessment

Pass criterion P1 could be assessed through written or oral questioning, with role play and/or practical demonstrations. P2 could also be assessed by written and/or oral questioning. Evidence of what learners say in response to oral questions or do in role play must be obtained and recorded as assessment evidence (witness statement/observation record).

P3 and P4 could be assessed through an assignment or short formal test. For P3, learners might be given a BS 8888 drawing of a relatively simple assembly and a circuit diagram and asked questions that demonstrate their ability to read and interpret information from the drawing. For P4, an aircraft parts or maintenance manual in hard copy or electronic form could be made available and an exercise given that requires learners to interpret and retrieve key information.

P5 requires learners to describe the characteristics and functions of two sets of hardware. Appropriate hardware can be given to learners and their competence assessed through oral questioning. Alternatively, drawings of appropriate hardware could be given to learners who would then identify and describe the characteristics in writing. Again, a witness statement/observation record may be needed to record answers to oral questions.

For P6 and P7 learners need to demonstrate practical competence and ability to understand and follow safety procedures relating to given practical tasks. Once learners have been guided through several fitting and assembly/dismantling exercises their competence could be assessed formally. This could be through learners completing a relatively simple fitting and assembly/dismantling test, appropriate for either the mechanical or electrical options or both. A marking guide could be produced for each piece of assessed practical work that indicates the standards set for the exercise in order to achieve P6 and P7 criteria.

Assessment of M1 and M2 could be conducted in a similar manner to P6 and P7. For the mechanical option, M1 will involve learners using a range of specialist hardware such as rivets, bolts, fasteners, wire inserts, pulleys, bearings etc, to execute a repair, or a similar fitting exercise, to aircraft panels, structure or airframe components. Such exercises would involve learners in taking precision measurements (M2) and correctly interpreting tolerances and allowances from engineering drawings, in order to produce a piece of work to laid down industry standards.

For those following the electrical option, a cable crimping and looming exercise could be developed involving the correct use of electrical hardware such as cable, cable end fittings, crimps, looming tap and cable ties (M1). Learners would need to follow an engineering drawing to achieve dimensional accuracy, correct cable rating and successful cable crimps to laid down industry standards. They would then carry out tests on the cable circuit for continuity, insulation and resistance using appropriate test equipment (M2).

To meet D1 learners are not only required to read and interpret engineering drawings but also to determine the correct information source, correct procedure/s and establish the industry standards for wear, unservicability and dimensional tolerances of component parts of a complex assembly. This could be an aircraft generator, oleo strut assembly, electric or hydraulic motor or pump, powered flying control unit, air cycle cooling machine, aircraft instruments or engine gearbox assembly. Meaningful measurements will need to be taken to check geometric tolerances and allowances of assembly components. Learners could also be involved in writing a serviceability report of the assembly component parts, then after reassembly (if possible) check correct output parameters. The choice of component needs to be made with care to ensure that all relevant documentation is available to the learner, when requested.

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

This unit provides the opportunity to practice some of the skills and understanding associated with SEMTA Level 3 National Occupational Standards in Aeronautical Engineering, particularly:

- Unit 39: Drilling and Finishing Holes in Aircraft Structure or Components
- Unit 62: Installing Aircraft Cable Forms/Looms
- Unit 76: Testing Aircraft Cable Forms/Looms.

Some of the skills used in this unit may also be practiced by completing appropriate units from the level 2 NVQ in Performing Engineering Operations, including the units on measuring and marking out, shaping engineering products by material removal using hand tools, assemble components to meet specifications, soldered joints etc. Many of these units could act as precursor skills development units or be taught in tandem with the skills developed in this unit. However, the emphasis in the Level 2 NVQ in Performing Engineering Operations is towards general engineering and therefore the materials and standards differ.

This unit has also been designed to act as a prerequisite for *Unit 76: Aircraft Maintenance Practices* and is linked to *Unit 74: Metallic Aircraft Materials, Structures and Repair* and *Unit 75: Non-metallic Aircraft Materials, Manufacture and Repair*. Together these units cover the knowledge content of modules 6 and 7 of the EASA Part 66 licence syllabus.

Essential resources

Those institutions currently offering mechanical, electrical and/or aeronautical engineering programmes, will already have appropriately equipped workshops. A selection of aircraft materials and parts (hardware) should be available, sufficient to meet the needs of the practical exercises and the requirements of learning outcome 3.

The equipment and components used for assembly/dismantling exercises should be real aircraft components. For the purposes of assessment these components should preferably be operational and must at least be accompanied by the appropriate manuals and other documentation so that learners can follow procedures and adhere to industry standards.

Indicative reading for learners

Textbooks

Black B – *Workshop Processes, Practices and Materials* (Newnes, 2004)
ISBN 0750660732

Dingle L and Tooley M – *Aircraft Maintenance Practice* (Elsevier, 2007)
ISBN 9780750650168

Simmons C and Maguire D – *Manual of Engineering Drawing: To British and International Standards* (Newnes, 2004) ISBN 0750651202

Key skills

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 skill 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.

Communication Level 3	
When learners are:	They should be able to develop the following key skills evidence:
<ul style="list-style-type: none"> reading and interpreting key information from engineering drawings and retrieving and interpreting information from aircraft engineering publications. 	<p>C3.2 Read and synthesise information from at least two documents about the same subject.</p> <p>Each document must be a minimum of 1000 words long.</p>