Pearson BTEC Level 2 Diploma in Aerospace and Aviation Engineering (Foundation Competence)

Specification

New Apprenticeship Standards – Competence Qualification (England only)

First registration September 2015

Issue 2

Edexcel, BTEC and LCCI qualifications

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This specification is Issue 2. Key changes are listed in the summary table on the next page. We will inform centres of any changes to this issue. The latest issue can be found on the Pearson website: qualifications.pearson.com

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All information in this specification is correct at time of publication.

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Summary of Pearson BTEC Level 2 Diploma in Aerospace and Aviation Engineering (Foundation Competence) specification Issue 2 changes

Summary of changes made between previous issue and this current issue	Page/section number
Definition of TQT added	Section 2
Definition of sizes of qualifications aligned to TQT	Section 2
TQT value added	Section 3
GLH range removed and replaced with lowest GLH value for the shortest route through the qualification	Section 3
Guided learning definition updated	Section 12

Earlier issue(s) show(s) previous changes.

If you need further information on these changes or what they mean, contact us via our website at: qualifications.pearson.com/en/support/contact-us.html.

Contents

1 Introducing the New Apprenticeships in England

Background

The Government has produced an implementation plan[1] for the future of Apprenticeships in England, following the Richard Review (2012)[2]. The changes, which are in the implementation plan, move the design of Apprenticeships into the hands of employers to make them more rigorous and responsive to employers' needs. Employers will now undertake the design of an Apprenticeship for each occupation they identify as requiring apprentices.

From 2017/2018, it is intended that all Apprenticeships, in England, will use the new Apprenticeship Standards and Assessment Plans designed by employers and approved by the Department for Business, Innovation and Skills (BIS).

All new employer-designed Apprenticeships will:

- be based on the required level of skills, knowledge and competency to undertake a specific occupation well and operate confidently within a sector. This forms the standard for the Apprenticeship. The assessment of an apprentice will be against this standard. Apprentices will be awarded a certificate of completion only when they have demonstrated their ability in all areas of the standard
- use a single approach to assessment against the standard. This should include a range of assessment methods that covers the theoretical and practical elements of the Apprenticeship
- have a synoptic end-point assessment that requires the apprentice to use their skills, knowledge and behaviours effectively in an integrated way. Apprentices will be assessed largely at the end of an apprenticeship programme – with an expectation that, in most cases, at least two thirds of the assessment must take place at the end of the Apprenticeship
- have grading applied to the full Apprenticeship standard, with apprentices who successfully complete awarded a pass, merit or distinction. This will include a 'mastery mechanism' – apprentices will need to pass every aspect of their assessment in order to be successful, but not every aspect will necessarily be graded
- be of minimum 12-month duration to ensure that Apprenticeships provide sustained and substantial training
- include a minimum of 20% off-the-job training, away from the day-to-day job
- have a stronger focus on English and mathematics – all apprentices working towards the new Apprenticeships must, if they have not achieved them already, achieve Level 1 Mathematics and English qualifications as a part of their Apprenticeship. Over and above this, apprentices are, if not already achieved, required to work towards Level 2 Mathematics and English qualifications. For Apprenticeships at Level 3 and above, apprentices are required to achieve Level 2 Mathematics and English qualifications.

[1] The government's plans for implementing these reforms are set out in *The Future of Apprenticeships in England Implementation Plan,* published in October 2013.

[2] *The Richard Review of Apprenticeships*, November 2012.

2 The Aerospace Manufacturing Fitter Apprenticeship

Overview

The qualification in this specification relates to the Aerospace Manufacturing Fitter Apprenticeship.

This Apprenticeship is designed for those intending to work in the role of Aerospace Manufacturing Fitter. People in these roles are predominantly involved in highly-skilled, complex and specialist detailed work, assembling aircraft systems according to specific work instructions and using relevant hand and machine tools, jigs and measuring equipment.

The Apprenticeship Standard requires that people working in this job role must be able to:

- use and interpret engineering data and documentation such as engineering drawings and computer-generated printouts
- test and adjust the systems they have installed, ensuring individual components and assemblies meet the required specification
- comply with statutory regulations and organisational safety requirements
- work both individually and as part of a manufacturing team and with minimum supervision, taking responsibility for the quality and accuracy of the work they undertake
- be proactive in finding solutions to problems and identifying areas for improving the business.

The Apprenticeship is recognised by the Institution of Engineering and Technology (IET), The Royal Aeronautical Society (RAeS), and the Institution of Mechanical Engineers (IMechE) at 'Engineering Technician' Level.

The Apprenticeship programme is structured in two phases; Phase one being the Foundation Phase, equivalent to Level 2, and Phase two the Development Phase, equivalent to Level 3.

In line with the Apprenticeship Assessment Plan, new knowledge and competence qualifications have been developed at Level 2 and 3 to meet the requirements of these two phases.

Collectively, these qualifications contribute a percentage towards the overarching Apprenticeship, which is at Level 3. Please see the table overleaf for details of the contributing qualifications.

Phase	Type of qualification	Qualification	Contribution % to the Apprenticeship
Foundation Phase	Competence (Pass only)	Pearson Level 2 Competence qualification in Aerospace and Aviation Engineering	20%
Foundation Phase	Technical knowledge (Pass/Merit/Distinction)	Pearson Level 2 Specialist qualification in Aerospace and Aviation Engineering	10%
Development Phase	Competence (Pass only)	Pearson Level 3 Competence qualification in Aerospace and Aviation Engineering	30%
Development Phase	Technical knowledge (Pass/Merit/Distinction)	Pearson Level 3 Specialist qualification in Aerospace and Aviation Engineering	15%

In addition, other requirements of the Apprenticeship include:

- assessment of behaviours – at Level 2 these are incorporated in the competence and knowledge qualifications, while at Level 3 they are linked directly to the requirements of Eng Tech registration. Behaviours contribute 15% to the overall standard, 5% at Level 2 and 10% at Level 3
- Foundation Phase Gateway Assessment – this is a formal 'gate review' at the end of the Foundation phase to ensure that apprentices have a strong foundation of basic skills before progressing to the Development Phase. On completing of all the Foundation Phase requirements and passing the Foundation Gateway Assessment, apprentices can progress to the Level 3 Development Phase of the Apprenticeship
- employer endorsement – brings together all the evidence within the Apprenticeship to date, through a synoptic *viva* interview and completion of Eng Tech reporting form. This contributes 5% to the overall standard
- professional body assessment – independent assessment of evidence by the professional body. This contributes 5% to the overall standard.

The Apprenticeship is a minimum of 36 months, with an expectation of an average of 42 months.

The full apprenticeship is certificated by the Federation for Industry Sector Skills and Standards (FISSS).

Pearson offers and certificates the qualification components of the Apprenticeship and this particular specification is for the Level 2 competence qualification listed in the table above. Centres should familiarise themselves with the requirements for all components of the Apprenticeship programme and communicate these clearly to learners.

The published Aerospace Manufacturing Fitter Standard and Assessment Plan can be found at www.gov.uk/government/publications/apprenticeship-standard-aerospace-manufacturing-fitter

Qualification size

For all regulated qualifications, Pearson specify a total number of hours that it is estimated learners will require to complete and show achievement for the qualification – this is the Total Qualification Time (TQT). The TQT value indicates the size of a qualification.

Within the TQT, Pearson identifies the number of Guided Learning Hours (GLH) that we estimate a centre delivering the qualification might provide. Guided learning means activities, such as lessons, tutorials, online instruction, supervised study and giving feedback on performance, that directly involve tutors and assessors in teaching, supervising and invigilating learners. Guided learning includes the time required for learners to complete external assessment under examination or supervised conditions.

In addition to guided learning, other required learning directed by tutors or assessors will include private study, preparation for assessment and undertaking assessment when not under supervision, such as preparatory reading, revision and independent research.

TQT and credit values are assigned after consultation with users of the qualifications.

Qualifications for the new Apprenticeships Standards are generally available in the following sizes:

- Award – a qualification with a TQT value of 120 or less
- Certificate – a qualification with a TQT value in the range of 121–369
- Diploma – a qualification with a TQT value of 370 or more.

3 Qualification key information

Qualification title	Pearson BTEC Level 2 Diploma in Aerospace and Aviation Engineering (Foundation Competence)
Qualification Number (QN)	601/7165/0
Regulation start date	14/08/2105
Operational start date	01/09/2015
Approved age ranges	16–18 19+ Please note that sector-specific requirements or regulations may prevent learners of a particular age from embarking on this qualification. Please refer to the Apprenticeship Assessment Plan and Assessment Strategy
Assessment	Portfolio of Evidence (internal assessment)
Guided learning hours	439
Total Qualification Time	439
Grading information	The qualification and units are graded pass/fail
Entry requirements	There are no entry requirements required for this qualification other than any legal requirements of the process or the environment in which the learner is working. Assessment is open to any learner who has the potential to reach the assessment requirements set out in the relevant units Centres must also follow the Pearson Access and recruitment policy (see *Section 8 Access and Recruitment*)
Funding	The Trailblazer Apprenticeship funding rules can be found on the Skills Funding Agency's website at: www.gov.uk/government/collections/sfa-funding-rules

Centres should use the Qualification Number (QN) when seeking funding for their learners.

The qualification title, units and QN will appear on each learner's qualification certificate. You should tell your learners this when your centre recruits them and registers them with Pearson, along with any other qualification and other requirements. Further information about qualification certification is in the *UK Information Manual,* available on our website at: qualifications.pearson.com/en/support/support-topics/centre-administration/information-manual.html

4 Qualification purpose

Qualification objective

The Pearson BTEC Level 2 Diploma in Aerospace and Aviation Engineering (Foundation Competence) has been developed through close collaboration with the Aerospace and Aviation Apprenticeship Employer Group, professional bodies and other awarding organisations.

The qualification is for learners employed as an apprentice in the role of Aerospace Manufacturing Fitter.

It gives learners the opportunity to:

- develop the fundamental technical skills and the underpinning knowledge and understanding required to become competent in the job role. For details of the units included in this qualification, please see *Section 5 Qualification structure*
- develop appropriate professional attitudes and behaviours that will support personal success in their job role and the long-term success of their organisation. These attitudes and behaviours are embedded in the units
- develop a range of inter- and intrapersonal skills to support progression to, and success in, further study and career advancement
- achieve a nationally-recognised Level 2 qualification.

The units in the qualification are based on the Employer Units of Competence (EUCs) that set out the skills, technical knowledge and understanding, and the behaviours needed in employment in the role of Manufacturing Fitter in the Aerospace sector.

Progression opportunities

Learners who achieve the Pearson BTEC Level 2 Diploma in Aerospace and Aviation Engineering (Foundation Competence) will have achieved 20% of the overarching Apprenticeship requirements. On completion of the other Foundation Phase requirements, learners can progress to the Level 3 Development Phase of the Apprenticeship, and ultimately receive their Apprenticeship certification and recognition by professional engineering institutions at 'Engineering Technician' level. In addition, learners who have achieved the qualification and not completed the full Apprenticeship could progress to Engineering Operative or Semi-skilled Fitter job roles within the Engineering industry or to other qualifications such as the Pearson Edexcel Level 3 NVQ Diploma in Engineering Maintenance or the Pearson BTEC Level 3 Foundation Diploma in Engineering.

Industry support and recognition

This qualification is supported by:

- the Aerospace and Aviation Apprenticeship Employer Group, which includes: BAE Systems, Airbus, MSM Aerospace Fabricators, Rolls-Royce, GKN Aerospace, Marshall Aerospace and Defence Group, Magellan Aerospace UK Ltd, GTA England
- professional engineering institutions, which include: the Institution of Engineering and Technology (IET), the Institution of Mechanical Engineering (IMechE) and the Royal Aeronautical Society (RAeS)
- SEMTA, the Skills Council for the Engineering sector
- the National Forum of Engineering Centres (NFEC).

5 Qualification structure

Pearson BTEC Level 2 Diploma in Aerospace and Aviation Engineering (Foundation Competence)

The learner will need to meet the requirements outlined in the table below before the qualification is awarded.

Minimum number of GLH that must be achieved	439
Number of mandatory units that must be achieved	4
Minimum number of optional units that must be achieved	4

Unit No.	Mandatory units	Level	Guided learning hours
Group A: Learners must complete all three mandatory units in this group.			
1	Complying with Statutory Regulations and Organisational Safety Requirements	2	18
2	Working Efficiently and Effectively in an Engineering Environment	2	18
3	Using and Communicating Technical Information	2	18
Group B: Learners must complete one unit in this group.			
4	Conducting Business Improvement Activities	2	70
5	Demonstrating Personal Accountability in an Aircraft Maintenance Environment	2	70

Unit No.	Optional units	Level	Guided learning hours
Group C: Learners must complete a minimum of four units in this group.			
6	Producing Mechanical Engineering Drawings using a CAD System	2	140
7	Producing Components using Hand Fitting Techniques	2	175
8	Producing Mechanical Assemblies – *cannot be taken with* ***Unit 26***	2	140
9	Forming and Assembling Pipework Systems	2	140
10	Carrying out Aircraft Detail Fitting Activities – *cannot be taken with* ***Unit 20***	2	175
11	Installing Aircraft Mechanical Fasteners	2	105
12	Producing Aircraft Detail Assemblies	2	140
13	Preparing and using Lathes for Turning Operations	2	140
14	Preparing and using Milling Machines	2	140
15	Preparing and Proving CNC Machine Tool Programs	2	140
16	Preparing and using CNC Turning Machines	2	140
17	Preparing and using CNC Milling Machines	2	140
18	Maintaining Mechanical Devices and Equipment – *cannot be taken with* ***Unit 27***	2	175
19	Assembling and Testing Fluid Power Systems	2	105
20	Producing Sheet Metal Components and Assemblies – *cannot be taken with* ***Unit 10***	2	140
21	Preparing and using Manual TIG or Plasma-arc Welding Equipment	2	140
22	Preparing and using Semi-automatic MIG, MAG and Flux Cored Arc Welding Equipment	2	140
23	Producing Composite Mouldings using Wet Lay-up Techniques	2	140
24	Producing Composite Mouldings using Pre-Preg Techniques	2	140
25	General Electrical and Electronic Engineering Applications	2	140
26	Dressing Aircraft Engines – *cannot be taken with* ***Unit 8***	2	175
27	Maintaining Aircraft Mechanical Devices and Equipment – *cannot be taken with* ***Unit 18***	2	175
28	Maintaining Fluid Power Equipment	2	105

Unit No.	Optional units	Level	Guided learning hours
29	General Turning, Milling and Welding Applications*	2	140
30	Checking for Defects in Composite Mouldings	2	35
31	Carrying out Repairs on Composite Mouldings	2	105
32	Lifting and Trestling/Shoring Aircraft for Maintenance and Repair Activities	2	70

*If any of the units listed below are selected as one of the four optional units, then ***Unit 29:*** *General Turning, Milling and Welding Applications* **cannot** be taken:

Unit 13: Preparing and Using Lathes for Turning Operations

Unit 14: Preparing and Using Milling Machines

Unit 16: Preparing and Using CNC Turning Machines

Unit 17: Preparing and Using CNC Milling Machines

Unit 22: Preparing and Using Semi-automatic MIG, MAG and Flux Cored Arc Welding Equipment

Where units are barred, learners cannot take them as part of rule of combination, however, they can be taken as additional units if required by the employer.

6 Programme delivery

To support the wider application of the qualification throughout the aerospace and aviation sector, this qualification will be delivered and assessed in a sheltered but realistic working environment such as a training centre or college. This approach ensures that the minimum safe level of skills, knowledge and understanding will be achieved and demonstrated by the learner before they are exposed to the hazards of the industrial environment (during the Development Phase), thus minimising the risk of injury to themselves and other employees. For further guidance on the delivery and assessment environment for the Foundation Phase of the Apprenticeship, please see the Assessment Strategy (Employer Occupational Brief) in *Annexe A*.

Centres are free to offer this qualification using any mode of delivery that meets learners' and employers' needs.

Centres must make sure that learners have access to specified resources and to the sector specialists delivering and assessing the units. Centres must adhere to the Pearson policies that apply to the different models of delivery. Our policy *Collaborative arrangements for the delivery of vocational qualifications* can be found on our website at qualifications.pearson.com. There are various approaches to delivering a successful, competence-based qualification. The section below outlines elements of good practice that centres can adopt, as appropriate to the requirements of the Apprenticeship programme.

Elements of good practice

- Carrying out a thorough induction for learners to ensure that they completely understand the Apprenticeship programme and what is expected of them. The induction should include, for example, the requirements of the Apprenticeship programme, an initial assessment of current competency levels, assessment of individual learning styles, identification of training needs, an individual learning plan, details of training delivery and the assessment process. It is good practice to involve the employer in the induction process. This helps the employer to understand what will be taking place during the programme and enables them to start building a relationship with the centre/provider to support the effective delivery of the programme.
- Keeping in regular contact with the learner to keep them engaged and motivated, and ensuring that there are open lines of communication among the learner, the assessor, the employer and training staff.
- Offering flexible delivery and assessment to meet the needs of the employer and learner, through the use of a range of approaches, for example virtual learning environments (VLEs), online lectures, video, printable online resources, virtual visits, webcams for distance training, e-portfolios.
- Balancing on-the-job and off-the-job training to meet the requirements of the Apprenticeship. It is a mandatory requirement in the New Apprenticeship Standards that learners have a minimum of 20% or equivalent off-the-job training. Trainers need to use a range of teaching and learning methods to meet varying learner needs and deliver this training effectively.

Examples of methods include: demonstration, observation and imitation, practising ('trial and error'), feedback on performance from experts and peers, reflective practice, real-world problem solving, enquiry-based learning, simulation and role play, peer learning, virtual environments, questioning and discussions. Trainers also need to work closely with employers to plan opportunities for the development and practising of skills on the job. The on-the-job element of the programme offers opportunities for assessment and plays an important role in developing the learner's routine expertise, resourcefulness, craftspersonship and business-like attitude. It is important that there is intentional structuring of practice and guidance to supplement the learning and development provided through engagement in everyday work activities. Teaching and learning methods, such as coaching, mentoring, shadowing, reflective practice, collaboration and consultation, could be used in this structured on-the-job learning.

- Developing an holistic approach to assessment by matching evidence to the required competencies, as appropriate and, wherever possible, to reduce the assessment burden on learners and assessors. It is good practice to draw up an assessment plan that aligns the competencies to be achieved with the learning process and that indicates how and when assessment will take place.
- Discussing and agreeing with the learner and employer suitable times, dates and work areas where assessment will take place. Learners and employers should be given regular and relevant feedback on performance and progress.
- Working with the employer to ensure that learners are allocated a mentor in the workplace to assist them in the day-to-day working environment and to act as a contact for the assessor/trainer.
- Helping the employer to better understand their role in the delivery of the programme. It is important that employers understand that sufficient and relevant work must be given to learners in order to allow them to gain the wider employment experience required by the Apprenticeship standard and that they are able to complete all elements of the Apprenticeship within their contracted working hours.

  Please refer to *The Trailblazer Apprenticeship Funding Rules* for further information on the delivery and assessment of the new Apprenticeships. These can be found at: www.gov.uk/government/collections/sfa-funding-rules

7 Centre resource requirements

As part of the approval process, centres must make sure that the resource requirements below are in place before offering the qualification.

General resource requirements

- Centres must have the appropriate physical resources to support delivery and assessment of the qualification(s). In line with the Assessment Strategy, any machinery, tools, materials, equipment and resources used in delivery and assessment must be representative of industry standards and there must be sufficient equipment and resources available for each learner to demonstrate their competence on an individual basis.
- The Realistic Work Environment used for the delivery and assessment of the qualification must replicate that expected in industry. Centres need to consider environmental factors such as lighting conditions, noise levels and the presence of hazards, work pressures such as time constraints and repetitive activities and the consequences of mistakes and their impact on customers, suppliers and departmental relationships.
- Centres must meet any specific human and physical resource requirements outlined in the Assessment Strategy in *Annexe A*. Staff assessing learners must meet the occupational competence requirements in the Assessment Strategy.
- There must be systems in place to ensure continuing professional development for staff delivering the qualification(s).
- Centres must have appropriate health and safety policies, procedures and practices in place for the delivery and assessment of the qualification(s).
- Centres must deliver the qualification(s) in accordance with current equality legislation. For further details on Pearson's commitment to the Equality Act 2010, please see *Section 8, Access and recruitment*. For full details on the Equality Act 2010, please go to www.legislation.gov.uk

8 Access and recruitment

Our policy on access to our qualifications is that:

- they should be available to everyone who is capable of reaching the required standards
- they should be free from barriers that restrict access and progression
- there should be equal opportunities for all wishing to access the qualifications.

Centres must ensure that their learner recruitment process is conducted with integrity. This includes ensuring that applicants have appropriate information and advice about the qualification to ensure that it will meet their needs.

Centres should review applicants' prior qualifications and/or experience, considering whether this profile shows that they have the potential to achieve the qualification.

All learners undertaking an Apprenticeship standard must be employed and have a contract of employment at the start of the first day of their Apprenticeship.

Prior knowledge, skills and understanding

There are no entry requirements required for the qualification other than legal requirements of the process or the environment in which the learner will be working.

Access to qualifications for learners with disabilities or specific needs

Equality and fairness are central to our work. Pearson's Equality Policy requires all learners to have equal opportunity to access our qualifications and assessments and requires that our qualifications are awarded in a way that is fair to every learner.

We are committed to making sure that:

- learners with a protected characteristic (as defined by the Equality Act 2010) are not, when they are undertaking one of our qualifications, disadvantaged in comparison to learners who do not share that characteristic
- all learners achieve the recognition they deserve from undertaking a qualification and that this achievement can be compared fairly to the achievement of their peers.

For learners with disabilities and specific needs, the assessment of their potential to achieve the qualification must identify, where appropriate, the support that will be made available to them during delivery and assessment of the qualification. Please see the information regarding reasonable adjustments and special consideration in *Section 9 Assessment*.

Learners taking a qualification may be assessed in British sign language or Irish sign language where it is permitted for the purpose of reasonable adjustments.

9 Assessment

To achieve a pass for the full qualification, the learner must achieve all the units required in the stated qualification structure.

Language of assessment

Assessment of the internally assessed units may be in English, Welsh or Irish. If assessment is to be carried out in either Welsh or Irish then centres must inform Pearson at the point of learner registration.

A learner taking the qualification(s) may be assessed in British or Irish Sign Language where it is permitted for the purpose of reasonable adjustment.

Further information on the use of language in qualifications is available in our policy document *Use of languages in qualifications policy,* available on our website at: qualifications.pearson.com

Internal assessment

The units in this qualification are assessed through an internally and externally quality assured Portfolio of Evidence made up of evidence gathered during the course of the learner's work in the training environment.

Each unit has specified standards in terms of the performance, skills and knowledge and understanding required to achieve the unit. To pass each unit the learner must:

- satisfy **all** the specified performance requirements by providing sufficient and valid evidence for each, and prove that the evidence is their own
- satisfy **all** the underpinning skills and knowledge and understanding requirements by providing sufficient and valid evidence for each and prove that the evidence is their own.

The learner must have an assessment record that identifies the performance, skills and knowledge and understanding requirements that have been met. The assessment record should be cross-referenced to the evidence provided and include details of the types of evidence collected and the date of assessment. Suitable centre documentation should be used to form an assessment record.

It is important that the evidence provided to meet the performance, skills and knowledge and understanding requirements for the unit is:

Valid	relevant to the standards for which competence is claimed
Authentic	produced by the learner
Current	sufficiently recent to create confidence that the same skill, understanding or knowledge persist at the time of the claim
Reliable	indicates that the learner can consistently perform at this level
Sufficient	fully meets the requirements of the standards.

Recognition of Prior Learning (RPL) – where a learner can demonstrate that they can meet a unit's requirements through knowledge, understanding or skills they already possess without undertaking a course of development. They must submit sufficient, reliable, authentic and valid evidence for assessment. Evidence submitted that is based on RPL should give the centre confidence that the same level of skill, understanding and knowledge exists at the time of claim as existed at the time the evidence was produced. RPL is acceptable for accrediting a unit, several units, or a whole qualification.

Further guidance is available in our policy document *Recognition of Prior Learning Policy and Process*, available on our website, qualifications.pearson.com

Assessment Strategy

The Assessment Strategy for this qualification is included in *Annexe A*. It sets out the overarching assessment requirements and the framework for assessing the units to ensure that the qualification remains valid and reliable. It has been developed by employers in the aerospace and aviation sectors.

Types of evidence

To achieve a unit, the learner must gather evidence that shows that they have met the required standard specified in the unit, Pearson's quality assurance arrangements (please see *Section 11 Quality assurance*) and the requirements of the Assessment Strategy given in *Annexe A*.

In line with the Assessment Strategy, evidence for the units can take a variety of forms as indicated below:

- direct observation of the learner's performance by their assessor (O)
- outcomes from oral or written questioning (Q&A)
- products of the learner's work (P)
- personal statements and/or reflective accounts (RA)
- professional discussion (PD)
- authentic statements/witness testimony (WT)
- expert witness testimony (EWT) – please refer to the Assessment Strategy for guidance on the use of witness testimony
- evidence of Recognition of Prior Learning (RPL).

Learners can use the abbreviations above in their portfolios for cross-referencing purposes.

Learners can also use one piece of evidence to prove their knowledge, skills and understanding across different assessment requirements and/or across different units. It is not necessary for learners to have each requirement assessed separately. They should be encouraged to reference evidence to the relevant assessment requirements. However, the evidence provided for each unit must clearly reference the unit that is being assessed. Evidence must be available to the assessor, the Internal Verifier and the Pearson Standards Verifier.

Further guidance on the requirements for centre quality assurance and internal verification processes is available on our website. Please see *Section 13 Further information and useful publications* for details.

Assessment of knowledge and understanding requirements

Knowledge and understanding are key components of competent performance, but it is unlikely that performance evidence alone will provide enough evidence in this area. Where the learner's knowledge and understanding is not apparent from performance evidence, it must be assessed by other means and be supported by suitable evidence.

Knowledge and understanding can be demonstrated in a number of different ways. It is recommended that oral questioning and practical demonstrations are used as they are considered the most appropriate for these units, they could take place perhaps while learners are observed undertaking specific tasks. Assessors should ask enough questions to make sure that learners have the appropriate level of knowledge and understanding required by each unit.

Achievement of the specific knowledge and understanding requirements in the units may not simply be inferred by the results of tests, exams or assignments from other units, such as in the technical knowledge qualifications or other training programmes. Where learner evidence from the above sources is being used, the assessor must, as with any assessment, make sure the evidence is valid, reliable, authentic, directly attributable to the learner, and that it meets the full knowledge and understanding requirements of the unit.

Where oral questioning is used, the assessor must retain a record of the questions asked, together with the learner's answers.

Appeals

Centres must have a policy for dealing with appeals from learners. Appeals may relate to incorrect assessment decisions or unfairly conducted assessment. The first step in such a policy is a consideration of the evidence by a Lead Internal Verifier or other member of the programme team. The centre's assessment plan should allow time for potential appeals after learners have been given assessment decisions.

Centres must document all learners' appeals and their resolutions. Further information on the appeals process can be found in the document *Enquiries and appeals about Pearson vocational qualifications policy,* which is available on our website.

Dealing with malpractice

Malpractice means acts that undermine the integrity and validity of assessment, the certification of qualifications and/or may damage the authority of those responsible for delivering the assessment and certification.

Pearson does not tolerate actions (or attempted actions) of malpractice by learners, centre staff or centres in connection with Pearson qualifications. Pearson may impose penalties and/or sanctions on learners, centre staff or centres where incidents (or attempted incidents) of malpractice have been proven.

Malpractice may arise or be suspected in relation to any unit or type of assessment within the qualification. For further details on malpractice and advice on preventing malpractice by learners please see *Pearson's Centre Guidance: Dealing with Malpractice*, available on our website.

The procedures we ask you to adopt vary between units that are internally assessed and those that are externally assessed.

Internal assessment

Centres are required to take steps to prevent malpractice and to investigate instances of suspected malpractice. Learners must be given information that explains what malpractice is for internal assessment and how suspected incidents will be dealt with by the centre. The *Centre Guidance: Dealing with Mal*practice document gives full information on the actions we expect you to take.

Pearson may conduct investigations if we believe that a centre is failing to conduct internal assessment according to our policies. The above document gives further information and examples, and details the penalties and sanctions that may be imposed.

In the interests of learners and centre staff, centres need to respond effectively and openly to all requests relating to an investigation into an incident of suspected malpractice.

External assessment

External assessment means all aspects of units that are designated as external in this specification, including preparation for tasks and performance. For these assessments, centres must follow the JCQ procedures set out in the latest version of the document *JCQ Suspected Malpractice in Examinations and Assessments Policies and Procedures* (available on the JCQ website, www.jcq.org.uk).

In the interests of learners and centre staff, centres need to respond effectively and openly to all requests relating to an investigation into an incident of suspected malpractice.

Learner malpractice

The head of centre is required to report incidents of suspected learner malpractice that occur during Pearson examinations. We ask centres to complete JCQ Form M1 (www.jcq.org.uk/malpractice) and email it with any accompanying documents (signed statements from the learner, invigilator, copies of evidence, etc.) to the Investigations Team at pqsmalpractice@pearson.com. The responsibility for determining appropriate sanctions or penalties to be imposed on learners lies with Pearson.

Learners must be informed at the earliest opportunity of the specific allegation and the centre's malpractice policy, including the right of appeal. Learners found guilty of malpractice may be disqualified from the qualification for which they have been entered with Pearson.

Teacher/centre malpractice

The head of centre is required to inform Pearson's Investigations Team of any incident of suspected malpractice by centre staff, before any investigation is undertaken. The head of centre is requested to inform the Investigations Team by submitting a JCQ M2(a) form (downloadable from www.jcq.org.uk/malpractice) with supporting documentation to pqsmalpractice@pearson.com. Where Pearson receives allegations of malpractice from other sources (for example Pearson staff, anonymous informants), the Investigations Team will conduct the investigation directly or may ask the head of centre to assist.

Incidents of maladministration (accidental errors in the delivery of Pearson qualifications that may affect the assessment of learners) should also be reported to the Investigations Team using the same method.

Heads of Centres/Principals/Chief Executive Officers or their nominees are required to inform learners and centre staff suspected of malpractice of their responsibilities and rights, please see *6.15 of JCQ Suspected Malpractice in Examinations and Assessments Policies and Procedures*.

Pearson reserves the right in cases of suspected malpractice to withhold the issuing of results/certificates while an investigation is in progress. Depending on the outcome of the investigation, results and/or certificates may not be released or they may be withheld.

We reserve the right to withhold certification when undertaking investigations, audits and quality assurances processes. You will be notified within a reasonable period of time if this occurs.

Sanctions and appeals

Where malpractice is proven, we may impose sanctions or penalties.

Where learner malpractice is evidenced, penalties may be imposed such as:

- mark reduction for affected external assessments
- disqualification from the qualification
- debarment from registration for Pearson qualifications for a period of time.

If we are concerned about your centre's quality procedures we may impose sanctions such as:

- working with you to create an improvement action plan
- requiring staff members to receive further training
- placing temporary blocks on your certificates
- placing temporary blocks on registration of learners
- debarring staff members or the centre from delivering Pearson qualifications
- suspending or withdrawing centre approval status.

The centre will be notified if any of these apply.

Pearson has established procedures for centres that are considering appeals against penalties and sanctions arising from malpractice. Appeals against a decision made by Pearson will normally be accepted only from the head of centres (on behalf of learners and/or members or staff) and from individual members (in respect of a decision taken against them personally). Further information on appeals can be found in our Enquiries and Appeals policy, on our website. In the initial stage of any aspect of malpractice, please notify the Investigations Team (via pqsmalpractice@pearson.com) who will inform you of the next steps.

Reasonable adjustments to assessment

Centres are able to make adjustments to assessments to take account of the needs of individual learners in line with the guidance given in the document *Pearson Supplementary Guidance for Reasonable Adjustment and Special Consideration in Vocational Internally Assessed Units*. In most instances, adjustments can be achieved by following the guidance; for example allowing the use of assistive technology or adjusting the format of the evidence. We can advise you if you are uncertain as to whether an adjustment is fair and reasonable. Any reasonable adjustment must reflect the normal learning or working practice of a learner in a centre or working within the occupational area.

Further information on access arrangements can be found in the Joint Council for Qualifications (JCQ) document *Access Arrangements, Reasonable Adjustments and Special Consideration for General and Vocational qualifications*.

Both documents are on our website at: qualifications.pearson.com

Special consideration

Centres must operate special consideration in line with the guidance given in the document *Pearson Supplementary Guidance for Reasonable Adjustment and Special Consideration in Vocational Internally Assessed Units*. Special consideration may not be applicable in instances where:

- assessment requires the demonstration of practical competence
- criteria have to be met fully
- units/qualifications confer licence to practice.

Centres cannot apply their own special consideration; applications for special consideration must be made to Pearson and can be made only on a case-by-case basis. A separate application must be made for each learner and certification claims must not be made until the outcome of the application has been received.

Further information on special consideration can be found in the Joint Council for Qualifications (JCQ) document *Access Arrangements, Reasonable Adjustments and Special Consideration for General and Vocational qualifications*.

Both of the documents mentioned above are on our website at: qualifications.pearson.com

10 Centre recognition and approval

Centre recognition

Centres offering New Apprenticeship Standards qualifications must be listed on the Skills Funding Agency's Register of Training Organisations and have a contract to deliver the New Apprenticeship Standards qualifications.

Centres that have not previously offered Pearson competence-based qualifications need to apply for and be granted centre recognition and approval to offer individual qualifications.

Existing Pearson centres seeking approval to offer New Apprenticeship Standards qualifications, will be required to submit supplementary evidence for approval, aligned with the associated New Apprenticeship Standards and Assessment Strategies.

Guidance on seeking approval to deliver Pearson vocational qualifications is available at qualifications.pearson.com/en/support/support-for-you/work-based-learning.html

Approvals agreement

All centres are required to enter into an approval agreement with Pearson, in which the head of centre or principal agrees to meet all the requirements of the qualification specification and to comply with the policies, procedures, codes of practice and regulations of Pearson and relevant regulatory bodies. If centres do not comply with the agreement, this could result in the suspension of certification or withdrawal of centre or qualification approval.

11 Quality assurance

Quality assurance is at the heart of vocational qualifications and apprenticeships. Centres are required to declare their commitment to ensuring quality and to giving learners appropriate opportunities that lead to valid and accurate assessment outcomes.

Pearson uses external quality assurance processes to verify that assessment, internal quality assurance and evidence of achievement meet nationally defined standards. Our processes enable us to recognise good practice, effectively manage risk, and support centres to safeguard certification and quality standards.

Our Standards Verifiers provide advice and guidance to enable centres to hold accurate assessment records and assess learners appropriately, consistently and fairly. Centres offering competence-based qualifications will usually receive two standards verification visits per year (a total of two days per year). The exact frequency and duration of Standards Verifier visits will reflect the level of risk associated with a programme, taking account of the:

- number of assessment sites
- number and throughput of learners
- number and turnover of assessors
- number and turnover of internal verifiers
- amount of previous experience of delivery.

If a centre is offering both the competence-based qualification and knowledge qualification within a New Apprenticeship Standard, wherever possible we will allocate the same Standards Verifier for both qualifications. We will work closely with centres offering New Apprenticeship Standards qualifications, so we can monitor and continuously improve our associated quality assurance arrangements.

Further guidance can be found in the New Apprenticeship Standard Quality Assurance Handbook and Delivery Guidance at qualifications.pearson.com/en/about-us/qualification-brands/btec.html

12 Unit format

Each unit has the following sections.

Unit title

This is the formal title of the unit that will appear on the learner's certificate.

Level

All units and qualifications have a level assigned to them. The level assigned is informed by the level descriptors defined by Ofqual.

Guided learning hours

Guided Learning Hours (GLH) is the number of hours that a centre delivering the qualification needs to provide. Guided learning means activities that directly or immediately involve tutors and assessors in teaching, supervising, and invigilating learners, for example lectures, tutorials, online instruction and supervised study.

Unit overview

Details the purpose of the unit and the competence, knowledge and behaviours expected of the learner.

Specific unit requirements

Details any specific additional assessment requirements the learner must meet in the unit and should be read in conjunction with the Assessment Strategy section *'Performance Evidence Requirements of the Occupational Competence Qualifications'* (see *Annexe A*). Learners must provide evidence according to each of the requirements stated.

Assessment requirements

Outlines the assessment requirements for each unit.

Additional information

Gives any additional information on the unit.

Performance requirements

The standard of performance that the learner has to demonstrate to confirm competence.

Skills

The skills the learner needs to demonstrate to meet the performance requirements.

Knowledge and understanding

The knowledge and understanding that the learner has to demonstrate to meet the performance requirements.

Unit 1: Complying with Statutory Regulations and Organisational Safety Requirements

Level: 2

Guided learning hours: 18

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to deal with statutory regulations and organisational safety requirements, in accordance with approved procedures. They will be required to comply with all relevant regulations that apply to their area of work as well as their general responsibilities as defined in the Health and Safety at Work Act. They will also need to be able to identify the relevant qualified first aiders or appointed person, and must know the location of the first aid facilities. They will have an understanding of the procedures to be adopted in the case of accidents involving injury, and in situations where there are dangerous occurrences or hazardous malfunctions of equipment, processes or machinery. They will also need to be fully conversant with the organisation's procedures for fire alerts and the evacuation of premises.

They will be required to identify the hazards and risks that are associated with their job. Typically, these will focus on their working environment, the tools and equipment that they use, materials and substances that they use, working practices that do not follow laid-down procedures, and manual lifting and carrying techniques.

Their responsibilities will require them to comply with organisational policy and procedures for the statutory regulations and organisational safety activities undertaken, and to report any problems with the safety activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. They will be expected to work with minimum supervision, taking personal responsibility for their own actions and for the way in which they carry out the required engineering activities.

Their underpinning knowledge will provide a good understanding of their work, and will provide an informed approach to applying statutory regulations and organisational safety requirements and procedures. They will understand the safety requirements and their application, in adequate depth to provide a sound basis for carrying out the activities safely and correctly.

Learners will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full, employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements *The learner must be able to:*	
P1	Comply with their duties and obligations as defined in the Health and Safety at Work Act
P2	Demonstrate the required behaviours in line with the job role and company objectives
P3	Present themselves in the workplace suitably prepared for the activities to be undertaken
P4	Follow organisational accident and emergency procedures
P5	Recognise and control hazards in the workplace
P6	Use correct manual lifting and carrying techniques
P7	Apply safe working practices and procedures

Skills

The learner must be able to:

1. Demonstrate their duties and obligations to health and safety by carrying out **all** of the following:
   - 1.1 applying, in principle, their duties and responsibilities as an individual under the Health and Safety at Work Act and other relevant current legislation
   - 1.2 identifying, within their working environment, appropriate sources of information and guidance on health and safety issues, to include eye protection and personal protective equipment (PPE), COSHH regulations and risk assessments
   - 1.3 identifying the warning signs and labels of the main groups of hazardous or dangerous substances
   - 1.4 complying with the appropriate statutory regulations at all times and specified regulations to their work

2. Comply with **all** emergency requirements, to include:
   - 2.1 identifying the appropriate qualified first aiders or appointed person and the location of first aid facilities
   - 2.2 identifying the procedures to be followed in the event of injury to themselves or others
   - 2.3 following organisational procedures in the event of fire/fire drills and the evacuation of premises/work area
   - 2.4 identifying the procedures to be followed in the event of dangerous occurrences or hazardous malfunctions of equipment, processes or machinery

Skills

The learner must be able to:

3. Identify the hazards and risks that are associated with **all** of the following:
   - 3.1 their working environment (such as working at heights, confined spaces, environmental conditions)
   - 3.2 the tools and equipment that they use (such as machine tools, power tools, cutting tools)
   - 3.3 the materials and substances that they use (such as fluids, oils, fluxes)
   - 3.4 using working practices that do not follow laid-down procedures

4. Demonstrate the following method of manual lifting and carrying techniques:
   - 4.1 lifting alone

   Plus **one** from:
   - 4.2 with assistance of others
   - 4.3 with mechanical assistance

5. Apply safe working practices in an industrial environment, to include **all** of the following:
   - 5.1 maintaining a tidy workplace with exits and gangways free from obstructions
   - 5.2 using tools and equipment safely and only for the purpose intended
   - 5.3 observing organisational safety rules, signs and hazard warnings
   - 5.4 taking measures to protect others from harm resulting from any work they are carrying out
   - 5.5 observe personal protection and hygiene procedures at all times

Knowledge and understanding

The learner must:

K1 Describe the roles and responsibilities of themselves and others under the Health and Safety at Work Act 1974 and other current legislation (e.g. The Management of Health and Safety at Work Regulations; Workplace Health and Safety and Welfare Regulations; Personal Protection at Work Regulations; Manual Handling Operations Regulations; Provision and Use of Work Equipment Regulations; Display Screen at Work Regulations)

K2 Describe the specific regulations and safe working practices and procedures that apply to their work activities

K3 Describe the importance of applying the appropriate behaviours in the workplace and the implications for both the learner and the business if these are not adhered to

Knowledge and understanding *The learner must:*	
K4	Identify the warning signs for the seven main groups of hazardous substances defined by Classification, Labelling and Packaging of Dangerous Substances and Mixtures Regulations
K5	State the location of relevant health and safety information for their tasks; the sources of expert assistance when help is needed
K6	Explain what constitutes a hazard in the workplace (e.g. moving parts of machinery, electricity, slippery and uneven surfaces, dust and fumes, handling and transporting, contaminants and irritants, material ejection, fire, working at height, environment, pressure/stored energy systems, volatile or toxic materials, unshielded processes)
K7	Describe their responsibilities for dealing with hazards and reducing risks in the workplace (e.g. hazard spotting and safety inspections; the use of hazard checklists, carrying out risk assessments, COSHH assessments and safe systems of working)
K8	Describe the risks associated with their working environment (e.g. the tools, materials and equipment that they use, spillages of oil and chemicals, not reporting accidental breakages of tools or equipment and not following laid-down working practices and procedures)
K9	Outline the processes and procedures that are used to identify and rate the level of risk (e.g. safety inspections, the use of hazard checklists, carrying out risk and COSHH assessments)
K10	Explain the control measures that can be used to eliminate/reduce the hazard (e.g. lock-off and permit top work procedures, provision of safe access and egress, use of guards and fume extraction equipment, use of personal protective equipment)
K11	Identify the first aid facilities that exist within their work area and within the organisation in general, and the procedures to be followed in the case of accidents involving injury
K12	State what constitutes dangerous occurrences and hazardous malfunctions, and why these must be reported even when no one was injured
K13	Outline procedures for sounding the emergency alarms, evacuation procedures and escape routes to be used, and the need to report their presence at the appropriate assembly point
K14	Outline the organisational policy with regard to firefighting procedures; the common causes of fire and what they can do to help prevent them
K15	State the protective clothing and equipment that is required for their areas of activity and the importance of wearing appropriate clothing and equipment
K16	Explain the need to observe personal protection and hygiene procedures at all times (e.g. skincare (barrier creams, gloves), eye protection (safety glasses, goggles, full face helmets), hearing protection (earplugs, ear defenders), respiratory protection (fume extraction, face masks, breathing apparatus), head protection (caps with hair restraints, protective helmets), foot protection (safety footwear), dangers of ingestion and the importance of washing hands)

Knowledge and understanding *The learner must:*
K17 Explain the importance of acting responsibly within the working environment; Including: using tools responsibly for purpose intended, observing restricted area notices, complying with warning signs, walking not running, using equipment only for its intended purpose, not interfering with equipment or processes that are not within their job role, following approved safety procedures at all times
K18 Outline the procedure for lifting and carrying loads safely and identify the manual and mechanical aids available
K19 Describe how to prepare and maintain safe working areas; standards and procedures to ensure good housekeeping
K20 Explain the importance of safe storage of tools, equipment, materials and products
K21 Describe the extent of their own authority and who they should report to in the event of problems that they cannot resolve

Unit 2: Working Efficiently and Effectively in an Engineering Environment

Level: 2

Guided learning hours: 18

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to carry out all necessary preparations; within the scope of their responsibility prior to undertaking the engineering activity. This will include preparing the work area and ensuring that it is in a safe condition to carry out the intended activities, obtaining the appropriate job documentation, work instructions, tools, equipment and materials required for the work activities undertaken, and to check they are in a safe and usable condition. Planning their work activities before they start them will also form part of this unit.

On completion of the engineering activity, they will be required to return their immediate work area to an acceptable condition before undertaking further work. This may involve placing part-completed or completed work in the correct location, returning and/or storing any tools and equipment in the correct area, removing any waste and/or scrapped materials, and reporting any defects or damage to the tools and equipment used.

In order to be efficient and effective in the workplace, they will also be required to demonstrate that they can create and maintain effective working relationships with colleagues and supervisors. They will be expected to review objectives and targets for their personal development and to contribute to, and communicate any opportunities for, improvements that could be made to working practices and procedures.

Fundamental to this unit is the learner's ability to be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Their responsibilities will require them to comply with health and safety requirements, environmental and organisational policy and procedures for the activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the activities, and to seek appropriate help and advice in determining and implementing a suitable solution.

They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide a good understanding of their work, and will provide an informed approach to working efficiently and effectively in an engineering environment. They will understand the need to work efficiently and effectively, and will know about the areas they need to consider when preparing and tidying up the work area. They will know how to contribute to improvements, deal with problems, maintain effective working relationships, understand the behaviours that are required in the workplace and agree their development objectives and targets, in adequate depth to provide a sound basis for carrying out the activities safely and correctly.

They will understand the safety precautions required when carrying out the specific engineering activities and will be required to demonstrate safe working practices throughout, and will understand the responsibility that they owe to themselves and others in the workplace.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full, employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst and, at the same time, ensuring that the overall generic content is to a high standard in terms of depth and breadth, to enable progression and/or transferability to other employers.

Performance requirements

The learner must be able to:

P1 Work safely at all times, complying with health and safety and environmental legislation, regulations and other relevant guidelines

P2 Demonstrate the required behaviours in line with the job role and company objectives/values

P3 Plan the engineering activities before they start them

P4 Prepare the work area for carrying out the engineering activity

P5 Obtain all necessary tools and equipment and check that they are in a safe and usable condition

P6 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

P7 Maintain effective working relationships with colleagues and supervisors

P8 Review personal training and development, as appropriate to the job role

P9 Clean, tidy up and restore the work area on completion of the engineering activity

Skills

The learner must be able to:

1. Ensure that they apply all of the following checks and practices at **all** times during the engineering activities:
   - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
   - 1.2 wear the appropriate personal protective equipment for the work area and specific activity being carried out
   - 1.3 use all tools and equipment safely and correctly, and only for their intended purpose including adherence to the Control of Vibration at Work Regulations (Hand and Arm)
   - 1.4 ensure that the work area is maintained and left in a safe and tidy condition

2. Create and maintain effective working relationships and behaviours, to include carrying out and demonstrating **all** of the following during the foundation phase of the apprenticeship:
   - 2.1 maintains a consistently good record of punctuality and attendance in accordance with company policy
   - 2.2 always suitably dressed for the activities to be undertaken
   - 2.3 follows both verbal and written instructions provided, seeking additional information, clarification or assistance where necessary in a courteous and polite manner.

Skills

The learner must be able to:

2.4 able take advice from others in a positive way

2.5 makes a positive contribution to any discussions

2.6 flexible in their approach to work, responding positively to any agreed amendments or changes

2.7 communicates with others using clear, accurate and appropriate language

2.8 demonstrates an open and honest approach, showing respect for the views, rights and property of others including the values of diversity and equality

2.9 demonstrates a willingness to help others when working towards a common team objective.

3. Prepare for the specific engineering activity, by producing work plans which includes **all** of the following:

3.1 documentation required (such as drawings, technical/reference documents - such as tapping drill sizes, imperial to metric conversion books, component specifications, quality documentation)

3.2 materials required (such as stock material, components, part-machined components, cables/wire, welding consumables)

3.3 equipment required (such as machine tools to be used, lifting and handling equipment, bending and forming equipment, anti-static equipment, test equipment)

3.4 workholding methods and equipment (such as machine or bench vice, clamps, special workholding arrangements), where appropriate

3.5 tools required (such as hand tools, portable power tools, cutting tools, soldering irons)

3.6 measuring equipment required (such as mechanical, electrical, pressure, flow, level, speed, sound)

3.7 the operating sequence to be followed

3.8 timescale required to complete the engineering operations

4. Prepare to carry out the engineering activity, ensuring **all** of the following, as applicable to the work to be undertaken:

4.1 the work area is free from hazards and is suitably prepared for the activities to be undertaken

4.2 any required safety procedures are implemented

4.3 any necessary personal protection equipment is obtained, and is in a usable condition

4.4 all necessary drawings, specifications and associated documents are obtained

Skills

The learner must be able to:

4.5 job instructions are obtained and understood

4.6 the correct materials or components are obtained

4.7 appropriate authorisation to carry out the work is obtained

5. Complete the work activities, to include **all** of the following:

5.1 returning tools and equipment to the designated location

5.2 returning drawings and work instructions

5.3 disposing of waste materials, in line with organisational and environmental requirements

5.4 completing all necessary documentation accurately and legibly

5.5 identifying, where appropriate, any damaged or unusable tools or equipment

6. Deal with problems affecting the engineering activity, to include two of the following:

6.1 materials

6.2 job specification

6.3 timescales

6.4 tools and equipment

6.5 quality

6.6 safety

6.7 drawings

6.8 people

6.9 work activities or procedures

7. Contribute to developing their own engineering competence, to include all of the following:

7.1 describing the levels of skill, knowledge and understanding needed for competence in the areas of work expected of them

7.2 describing their development objectives/program, and how these were identified

7.3 providing information on their expectations and progress towards their identified objectives

7.4 using feedback and advice to improve their personal performance

Knowledge and understanding *The learner must:*	
K1	Explain the importance of applying the appropriate behaviours in the workplace and the implications for both the learner and the business if these are not adhered to
K2	Explain the importance of reporting to work on time and returning from breaks on time and the potential consequences if this is not adhered to
K3	Explain the benefits of team working and understanding of team objectives
K4	Outline the roles of individual team members and how they contribute to the team
K5	Describe the importance of clear communication both oral and written, using appropriate language and format
K6	Identify the need to change communication styles to meet the needs of the target audience
K7	Describe the need to adhere to timescales set for work, whilst maintaining appropriate quality standards and the implications if these are not adhered to
K8	Explain the importance of seeking additional support and guidance when required
K9	Explain why it is important to be open and honest and admit to any errors and/or mistakes
K10	Explain the importance of being flexible and taking an active and positive part in the implementation of any amendments or changes to work requirements
K11	Describe their individual responsibility to work in an ethical manner and the organisation's policies relating to ethical working and behaviours
K12	Explain the importance of respecting others, including an awareness of diversity and inclusion
K13	Explain the importance of ensuring that all documentation relating to the work being carried out is available, prior to starting the activity
K14	Explain the importance of ensuring that all tools and equipment are available prior to undertaking the activity
K15	Outline the checks to be carried out to ensure that tools and equipment are in full working order, prior to undertaking the activity
K16	Outline the checks to be carried out to ensure that all materials required are correct and complete, prior to undertaking the activity
K17	Define the actions that should be taken if documentation, tools and equipment or materials are incomplete or do not meet the requirements of the activity
K18	Outline their role in helping to develop their own skills and knowledge (e.g. checking with their supervisor about the work they are expected to carry out and the standard they need to achieve; the safety points to be aware of and the skills and knowledge they will need to develop)
K19	Describe the benefits of continuous personal development, and the training opportunities that are available in the workplace

Knowledge and understanding *The learner must:*
K20 Explain the importance of reviewing their training and development with trainers and supervisors, of comparing the skills, setting objectives to overcome any shortfall or address any development needs
K21 Outline their responsibilities for providing evidence of their performance and progress (e.g. submitting work for assessment or the completion of assignments or tests)
K22 Explain the importance of maintaining effective working relationships within the workplace (e.g. listening attentively to instructions from their supervisor, making sure they ask for help and advice in a polite and courteous manner, responding positively to requests for help from others)
K23 Explain the reason for informing others of their activities which may have impact on their work (e.g. the need to temporarily disconnect a shared resource like electricity or compressed air supply; making undue noise or creating sparks, fumes or arc flashes from welding)
K24 Describe how to deal with difficulties and disagreements in working relationships in a way which will help to resolve them and maintain long-term working relationships
K25 Outline the organisational procedures to deal with and report any problems that can affect working relationships
K26 Identify the regulations that affect how individuals should be treated at work (e.g. Equal Opportunities and Equal Pay, Race Relations and Sex Discrimination, Working Time Directive, Disabled Persons Acts)
K27 Explain the need to dispose of waste materials and consumables (e.g. oils and chemicals) in a safe and environmentally friendly way
K28 Identify where tools and equipment should be stored and located, and state the importance of returning all tools and documentation to their designated area on completion of their work activities
K29 Explain when to act on their own initiative and when to seek help and advice from others
K30 Explain the importance of leaving the work area in a safe condition on completion of their activities (e.g. equipment correctly isolated, cleaning the work area and removing and disposing of waste)

Unit 3: Using and Communicating Technical Information

Level: 2

Guided learning hours: 18

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to make full use of text, numeric and graphical information, by interpreting and using technical information extracted from a range of documentation such as, engineering drawings, technical manuals, technical specifications, reference tables and charts, electronic displays, planning and quality control documentation. This will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or will act as a basis for the development of additional skills and occupational competences in the working environment.

They will be required to extract the necessary data from the various specifications and related documentation, in order to establish and carry out the work requirements, and to make valid decisions about the quality and accuracy of the work carried out. They will also need to be able to communicate and record technical information, using a range of different methods such as producing detailed sketches, preparing work planning documentation, producing technical reports and recording data from testing activities.

Their responsibilities will require them to comply with organisational policy and procedures for obtaining, using and communicating the technical information applicable to the activity. They will need to take account of any potential difficulties or problems that may arise with the activities, and to seek appropriate help and advice in determining and implementing a suitable solution. They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide a good understanding of the types of documentation available for use, and will provide an informed approach to applying and communicating engineering instructions and procedures. They will be able to read and interpret the documentation available, and will know about the conventions, symbols and abbreviations to the required depth to provide a sound basis for carrying out the activities to the required specification.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A.* These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements *The learner must be able to:*
P1 Use the approved source to obtain the required data, documentation or specifications
P2 Demonstrate the required behaviours in line with the job role and company objectives
P3 Extract and interpret information from engineering drawings and other related documentation
P4 Report any inaccuracies or discrepancies in the drawings and specifications
P5 Use the information obtained to establish work requirements
P6 Record and communicate the technical information by appropriate means
P7 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

Skills *The learner must be able to:*
1. Use approved sources to obtain the necessary data and related specifications, and carry out **all** of the following: 1.1 check the currency and validity of the data and documentation used 1.2 exercise care and control over the documents at all times 1.3 correctly extract all necessary data in order to carry out the required tasks 1.4 seek out additional information where there are gaps or deficiencies in the information obtained 1.5 deal with or report any problems found with the data 1.6 make valid decisions based on the evaluation of the engineering information 1.7 return all documentation to the approved location on completion of the work 1.8 complete all necessary production documentation
2. Use information extracted from engineering documentation, to include **one** or more of the following: 2.1 detailed component drawings 2.2 illustrations 2.3 welding drawings 2.4 general assembly drawings 2.5 visual display screens

Skills

The learner must be able to:

2.6 casting drawings

2.7 repair drawings

2.8 modification drawings

2.9 operational diagrams

2.10 fluid power drawings

2.11 sub-assembly drawings

2.12 physical layouts

2.13 wiring/circuit diagrams

2.14 schematic diagrams

2.15 manufacturers' manuals/drawings

2.16 installation drawings

2.17 fabrication drawings

2.18 photographic representations

2.19 approved sketches

2.20 pattern drawings

2.21 contractual specifications

3. Use information extracted from related documentation, to include **two** from the following:

3.1 job instructions

3.2 material specifications

3.3 planning documentation

3.4 drawing instructions

3.5 finishing specifications

3.6 quality control documents

3.7 test schedules

3.8 reference tables/charts

3.9 operation sheets

3.10 manufacturers' instructions

3.11 national, international and organisational standards

3.12 process specifications

3.13 welding procedure specifications

Skills

The learner must be able to:

4. Extract information that includes **three** of the following:
   - 4.1 materials or components required
   - 4.2 surface texture requirements
   - 4.3 surface finish required
   - 4.4 dimensions
   - 4.5 location/orientation of parts
   - 4.6 weld type and size
   - 4.7 tolerances
   - 4.8 process or treatments required
   - 4.9 operations required
   - 4.10 build quality
   - 4.11 assembly sequence
   - 4.12 shape or profiles
   - 4.13 installation requirements
   - 4.14 inspection requirements
   - 4.15 test points to be used
   - 4.16 connections to be made
   - 4.17 part numbers for replacement parts
   - 4.18 circuit characteristics (such as pressure, flow, current, voltage, speed)

5. Record and communicate technical information, using **three** of the following methods:
   - 5.1 producing fully detailed sketches of work/circuits completed or required
   - 5.2 preparing work planning documentation
   - 5.3 recording data from testing activities
   - 5.4 producing technical reports on activities they have completed
   - 5.5 completing material and tool requisition documentation
   - 5.6 producing a list of replacement parts required for a maintenance activity
   - 5.7 completing training records or portfolio references

Knowledge and understanding *The learner must:*	
K1	Describe the information sources used for the data and documentation that they use in their work activities (e.g. verbal, written, electronic)
K2	Explain why technical information is presented in different forms (e.g. drawings, data sheets, and national and international standards)
K3	State where to obtain the various documents that they will be using (e.g. safety handouts, drawings, planning documentation, work instructions, maintenance records, technical manuals and reference tables/charts)
K4	Outline the types of engineering drawings used and describe how they interrelate (e.g. isometric and orthographic drawings; assembly, sub-assembly and general arrangement drawings; circuit and wiring diagrams, block and schematic diagrams; fluid power and instrumentation and control diagrams)
K5	Describe how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards), in relation to work undertaken
K6	Describe how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
K7	State the meaning of the different symbols and abbreviations found on the documents that they use (e.g. surface finish to be achieved, linear and geometric tolerances, electronic components, weld symbols and profiles, pressure and flow characteristics, torque values, imperial and metric systems of measurement, tolerancing and fixed reference points)
K8	Explain the importance of using other sources of information to support the data in documentation (e.g. electronic component pin configuration specifications, standard reference charts for limits and fits, tapping drill reference charts, bend allowances required for material thickness, electrical conditions required for specific welding electrodes, mixing ratios for bonding and finishing materials, metal finishing specifications and inspection requirements)
K9	Outline the procedures for reporting discrepancies in the data or documents and for reporting lost or damaged drawings and documents
K10	Outline the care and control procedures for the documents
K11	State how damage or graffiti on drawings can lead to scrapped work
K12	State the importance of returning the documents/drawings to the designated location on completion of the work activities
K13	State typical ways of communicating technical information (e.g. sketches, test and inspection reports, work planning documents) and the amount of detail that should be included
K14	Explain the importance of ensuring that sketches are of a suitable size, use appropriate drawing conventions, are in proportion and are legible to others
K15	Explain the importance of using a fixed common reference point for dimensioning of drawings and sketches

Knowledge and understanding *The learner must:*
K16 State when to act on their own initiative to find, clarify and evaluate information and when to seek help and advice from others
K17 Explain why they should always seek clarification if they are in any doubt as to the validity or suitability of the information they have gathered
K18 Identify who they should report to in the event of problems that they cannot resolve

Unit 4: Conducting Business Improvement Activities

Level: 2

Guided learning hours: 70

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to conduct a business improvement activity using a systematic plan, do, check, act approach for an engineering operation or process. This will prepare them for entry into the engineering industry or engineering manufacturing sector, creating a progression between education and employment and acting as a basis for the development of additional skills and occupational competencies in the working environment. They will be expected to adopt a systematic approach to conducting business improvement activities on an engineering/manufacturing operation or process to identify opportunities for the elimination of waste.

They will be required to conduct a 5S/5C audit and identify wasteful or non-added value activities in the operation or process. They will need to produce a new Standard Operating Procedure (SOP) or contribute to improving an existing SOP. These activities will include creating the appropriate visual management systems required, calculating key performance indicators required and the quality control requirements and presenting records of the business improvement activities and how they will meet their aims.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the business improvement activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the business improvement activities and to seek appropriate help and advice in determining and implementing a suitable solution. They will work under a high level of supervision whilst taking responsibility for their own actions and the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, in order to safely apply appropriate engineering principles to business improvement activities. They will understand the tools and techniques used in business improvement activities and procedures used, and their application, and will know about the process, materials and consumables, to the required depth to provide a sound basis for carrying out the improvement activities and producing project plans that will lead to a successful project outcome.

They will understand the safety precautions required when carrying out the business improvement activities for the agreed operations and processes. They will be required to demonstrate safe working practices throughout, and will understand their responsibility for taking the necessary safeguards to protect themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements *The learner must be able to:*	
P1	Work safely at all times, complying with health and safety and other relevant regulations and guidelines
P2	Demonstrate the required behaviours in line with the job role and company objectives
P3	Apply and document a systematic plan, do, check, act (PDCA) approach to problems/improvement activities
P4	Apply the principles of workplace organisation to an operation or process using a 5S/5C audit and a 'red tag' exercise
P5	Identify where information, and/or resources are missing and where improvement can be made to increase the 5S/5C score
P6	Apply the principle and processes of visual management to an operation or process using a variety of visual management techniques
P7	Identify appropriate parts of the operation or process that will have visual controls
P8	Identify key performance indicators that will be displayed in the work area
P9	Produce or update a Standard Operating Procedure (SOP) and visual controls for the operation or process
P10	Deal promptly and effectively with problems within their control and seek help and guidance from the relevant people when they have problems they cannot resolve

Skills *The learner must be able to:*		
1.	Identify improvements within the operation or process for **three** of the following:	
	1.1	reduced product cost
	1.2	improved quality
	1.3	improved safety
	1.4	improvements to working practices
	1.5	improvement in delivery performance
	1.6	reduction in waste and/or energy usage
	1.7	reduction in lead times
	1.8	resource utilisation
	1.9	improvement in customer satisfaction

Skills

The learner must be able to:

2. Produce/contribute to improvements in existing Standard Operating Procedures (SOPs) for **three** of the following:
   - 2.1 customer service
   - 2.2 health and safety practices
   - 2.3 product quality
   - 2.4 cleaning of equipment/work area
   - 2.5 process procedures
   - 2.6 maintenance of equipment
   - 2.7 manufacturing operations
   - 2.8 staff development

3. Create and/or update visual controls that promote **six** of the following:
   - 3.1 producing shadow boards to standardise the storage and location of area equipment
   - 3.2 colour coding of equipment
   - 3.3 safety
   - 3.4 performance measures
   - 3.5 parts control system
   - 3.6 zero defects
   - 3.7 process control boards
   - 3.8 skills matrices
   - 3.9 process concerns or corrective actions
   - 3.10 workplace organisation
   - 3.11 work in progress locations and quantities (WIP)
   - 3.12 problem resolution (such as Kaizen boards)
   - 3.13 Standard Operating Procedures (SOPs)
   - 3.14 autonomous maintenance worksheets

4. Determine and calculate **both** of the following:
   - 4.1 not right first time
   - 4.2 delivery schedule achievement

   Plus **one** more of the following:
   - 4.3 parts per operator hour (PPOH)
   - 4.4 overall equipment effectiveness (OEE)
   - 4.5 value added per person (VAPP)

Skills

The learner must be able to:

4.6 stock turns

4.7 cost breakdown in term of labour, material and overhead

4.8 floor space utilisation (FSU)

5. Record and present the records from business improvement activities to the appropriate people using:

5.1 verbal report using visual aids such as flipcharts and white boards

Plus **one** more method from the following:

5.2 written or typed report

5.3 computer-based presentation

5.4 specific company documentation

Knowledge and understanding

The learner must:

K1 Describe the health and safety requirements of the area in which they are carrying out the business improvement activities

K2 Explain the importance of following a systematic Plan, Do, Check, Act (PDCA) approach to problem solving and business improvement

K3 Outline the implications of not taking account of legislation, regulations, standards and guidelines when conducting business improvement activities

K4 Explain the importance of applying the appropriate behaviours in the workplace and the implications for both the learner and the business if these are not adhered to

K5 Describe what is meant by business improvement and how continuous improvement activities can benefit a company

K6 Outline the application of the seven key measures of competitiveness (delivered right first time, delivery schedule achievement, people productivity, stock turns, overall equipment effectiveness, value added per person, floor space utilisation)

K7 Describe how to obtain and interpret information on the engineering/manufacturing operation or process requirements (e.g. customer specifications and instructions, quality control requirements, product drawings/specification, methods and techniques to be used)

K8 Explain the eight wastes (over production, inventory, transport, over-processing, waiting time, operator motion, bad quality, failure to exploit human potential) and how to eliminate these forms of waste in a process or operation

K9 Explain the steps in a 5S/5C audit and a `red tag' exercise and describe how to carry them out

K10 Explain how to score and audit the 5S/5C exercise

Knowledge and understanding *The learner must:*
K11 Explain the importance of arranging and labelling the necessary equipment for rapid identification and access
K12 Describe how to use 'root cause' problem-solving analysis using the 5 whys/how technique
K13 Describe methods of evaluating improvement ideas in order to select those that are to be pursued
K14 Describe how improvements to the process could be achieved by engaging the knowledge and experience of the people working on the process
K15 Explain the importance of creating Standard Operating Procedures (SOPs) and of relating work activities to them
K16 Describe the methods that can be used to communicate information using visual control systems (e.g. Kanban systems, card systems, colour coding, floor footprints, graphs, team boards, tool/equipment shadow boards)
K17 Describe how information can be displayed differently depending on various work applications

Unit 5: Demonstrating Personal Accountability in an Aircraft Maintenance Environment

Level: 2

Guided learning hours: 70

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to demonstrate personal accountability in an aircraft maintenance environment using a systematic plan, do, check, act approach for an engineering operation or process. This will prepare them for entry into the engineering industry or engineering manufacturing sector, creating a progression between education and employment and acting as a basis for the development of additional skills and occupational competencies in the working environment.

These activities will include creating the appropriate visual management systems required, calculating key performance indicators required and the quality control requirements and presenting records of the improvement activities and how they will meet their aims.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the improvement activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the improvement activities and to seek appropriate help and advice in determining and implementing a suitable solution. They will work under a high level of supervision whilst taking responsibility for their own actions and the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, in order to safely apply appropriate engineering principles to improvement activities. They will understand the tools and techniques used in improvement activities and procedures used, and their application, and will know about the process, materials and consumables, to the required depth to provide a sound basis for carrying out the improvement activities and producing project plans that will lead to a successful project outcome.

They will understand the safety precautions required when carrying out the improvement activities for the agreed operations and processes. They will be required to demonstrate safe working practices throughout, and will understand their responsibility for taking the necessary safeguards to protect themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity motivation and commitment.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements

The learner must be able to:

P1 Work safely at all times, complying with health and safety and other relevant regulations and guidelines

P2 Demonstrate the required behaviours in line with the job role and company objectives

P3 Apply and document a systematic plan, do, check, act (PDCA) approach to problems/improvement activities

P4 Apply basic principles of auditing techniques, process and recording

P5 Apply the principle and processes of visual management to an operation or process using a variety of visual management techniques

P6 Identify appropriate parts of the operation or process that will have visual controls

P7 Identify key performance indicators that will be displayed in the work area

P8 Produce or update a Standard Operating Procedure (SOP) and visual controls for the operation or process

P9 Deal promptly and effectively with problems within their control and seek help and guidance from the relevant people when they have problems they cannot resolve

Skills

The learner must be able to:

1. Identify improvements within the operation or process for three of the following:
   - 1.1 improved quality
   - 1.2 improved safety
   - 1.3 improvements to working practices
   - 1.4 reduction in waste and/or energy usage
   - 1.5 improvement in customer satisfaction

2. Produce/contribute to improvements in existing standard operating procedures for three of the following:
   - 2.1 customer service
   - 2.2 health and safety practices
   - 2.3 product quality
   - 2.4 cleaning of equipment/work area
   - 2.5 process procedures

Skills

The learner must be able to:

3. Create and/or update visual controls that promote three of the following:
   - 3.1 producing shadow boards to standardise the storage and location of area equipment
   - 3.2 colour coding of equipment
   - 3.3 safety
   - 3.4 process concerns or corrective actions
   - 3.5 workplace organisation
   - 3.6 work in progress locations and quantities (WIP)
   - 3.7 problem resolution (such as Kaizen boards)
   - 3.8 standard operating procedures

4. Carry out an audit of a process or work area and provide a written report which has considered three of the following:
   - 4.1 organisational procedures
   - 4.2 regulatory standards
   - 4.3 health and safety requirements
   - 4.4 operational standards
   - 4.5 company procedures
   - 4.6 customer standards
   - 4.7 manufacturers standards

5. Record and present the records from business improvement activities to the appropriate people using:
   - 5.1 verbal report using visual aids such as. flipcharts and white boards

   Plus **one** more method from the following:
   - 5.2 written or typed report
   - 5.3 computer based presentation
   - 5.4 specific company documentation

Knowledge and understanding *The learner must:*	
K1	Describe the health and safety requirements of the area in which they are carrying out the business improvement activities
K2	Explain the importance of following a systematic Plan, Do, Check Act (PDCA) approach to problem-solving and business improvement
K3	Outline the implications of not taking account of legislation, regulations, standards and guidelines when conducting business improvement activities
K4	Explain the importance of applying the appropriate behaviours in the workplace and the implications for both the learner and the business if these are not adhered to
K5	Describe what is meant by business improvement and how continuous improvement activities can benefit a company
K6	Outline the application of the seven key measures of competitiveness (delivered right first time, delivery schedule achievement, people productivity, stock turns, overall equipment effectiveness, value added per person, floor space utilisation)
K7	Describe how to obtain and interpret information on the engineering/manufacturing operation or process requirements (e.g. customer specifications and instructions, quality control requirements, product drawings/specification, methods and techniques to be used)
K8	Explain the eight wastes (over-production, inventory, transport, over-processing, waiting time, operator motion, bad quality, failure to exploit human potential) and how to eliminate these forms of waste in a process or operation
K9	Explain the importance of arranging and labelling the necessary equipment for rapid identification and access
K10	Describe how to use "root cause" problem solving analysis using the 5 whys/how technique
K11	Describe methods of evaluating improvement ideas in order to select those that are to be pursued
K12	Describe how improvements to the process could be achieved by engaging the knowledge and experience of the people working on the process
K13	Explain the importance of creating Standard Operating Procedures (SOPs) and of relating work activities to them
K14	Describe the methods that can be used to communicate information using visual control systems (e.g. Kanban systems, card systems, colour coding, floor footprints, graphs, team boards, tool/equipment shadow boards)
K15	Describe how information can be displayed differently depending on various work applications

Unit 6: Producing Mechanical Engineering Drawings using a CAD System

Level: 2

Guided learning hours: 140

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to set up and operate a computer aided drawing (CAD) system to produce detailed drawings for mechanical engineering activities. The type of drawings produced could include detailed component drawings for manufacturing, assembly and sub-assembly drawings, installation drawings, fault location aids such as flow diagrams, and modification drawings.

They will be given a specific drawing brief or a request for a change/modification to a drawing, and they will be required to access these requirements and extract all necessary information in order to carry out the drawing operations. They will need to select the appropriate equipment and drawing software to use, based on the type and complexity of the drawing functions to be carried out. They will be expected to use current British, European, International and company standards to produce a drawing template for a range of paper sizes, that must include the drawing title, scale used, date of drawing, material to be used and other relevant information. They will then be expected to produce fully detailed drawings to enable the manufacture, assembly, installation or modification of the product to take place. On completion of the drawing activities, they will be expected to return all documentation, reference manuals or specifications to the designated location, to shut down the CAD system correctly and to leave the work area in a safe and tidy condition.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for working with the CAD equipment. They will need to take account of any potential difficulties or problems that may arise with the computer hardware, software or drawing procedures, and to seek appropriate help and advice in determining and implementing a suitable solution. They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate computer aided drawing procedures and techniques for generating mechanical engineering drawings. They will understand the computer system and software used, and its application, and will know about the various tools and techniques used to produce the drawings, to the required depth to provide a sound basis for carrying out the activities to the required specification.

They will understand the safety precautions required when working with the computer drawing system. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

In order to prove their ability to combine different drawing features, at least one of the drawings produced must be of a significant nature, and must have a minimum of **seven** of the features listed in paragraph 7 of the *Skills* section.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements *The learner must be able to:*	
P1	Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
P2	Demonstrate the required behaviours in line with the job role and company objectives
P3	Plan the drawing activities before they start them
P4	Use appropriate sources to obtain the required information for the drawing to be created
P5	Access and use the correct drawing software
P6	Use appropriate techniques to create drawings, in the required formats, that are sufficiently and clearly detailed
P7	Use codes and other references that follow the required conventions
P8	Make sure that drawings are checked and approved by the appropriate person
P9	Save the drawings in the appropriate medium and location
P10	Produce hard copies of the finished drawings
P11	Deal promptly and effectively with problems within their control and seek help and guidance from the relevant people if they have problems that they cannot resolve
P12	Shut down the CAD system to a safe condition on completion of the drawing activities

Skills *The learner must be able to:*		
1.	Prepare the CAD system for operation by carrying out **all** of the following:	
	1.1	check that all the equipment is correctly connected and in a safe and usable working condition (such as cables undamaged, correctly connected, safely routed, PAT tested)
	1.2	power up the equipment and activate the appropriate drawing software
	1.3	set up the drawing system to be able to produce the drawing to the appropriate scale
	1.4	set up and check that all peripheral devices are connected and correctly operating (such as keyboard, mouse, light pen, digitiser/tablet, scanner, printer, plotter)
	1.5	set the drawing datum at a convenient point (where applicable)
	1.6	set up drawing parameters (to include layers, line types, colour, text styles) to company procedures or to suit the drawing produced
	1.7	create a drawing template to the required standards, which includes all necessary detail (such as title, drawing number, scale, material, date, etc.)

Skills

The learner must be able to:

2. Use **three** of the following to obtain the necessary data to produce the required drawings:
   - 2.1 drawing brief
   - 2.2 specifications
   - 2.3 drawing change or modification request
   - 2.4 regulations
   - 2.5 manuals
   - 2.6 sample component
   - 2.7 calculations
   - 2.8 existing drawings/designs
   - 2.9 sketches
   - 2.10 notes from meetings/discussions
   - 2.11 standards reference documents (such as limits and fits, tapping drill charts)
   - 2.12 other available data

3. Take into account **three** of the following design features, as appropriate to the drawing being produced:
   - 3.1 function
   - 3.2 materials
   - 3.3 clearance
   - 3.4 operating environment
   - 3.5 quality
   - 3.6 cost
   - 3.7 aesthetics
   - 3.8 interfaces
   - 3.9 manufacturing method
   - 3.10 life of the product
   - 3.11 physical space
   - 3.12 safety
   - 3.13 ergonomics
   - 3.14 tolerances

Skills

The learner must be able to:

4. Carry out **all** of the following before producing the engineering drawing:
   - 4.1 ensure that the data and information they have is complete and accurate
   - 4.2 review the data and information to identify the drawing requirements
   - 4.3 recognise and deal with problems (such as information-based and technical)

5. Interpret and produce drawings, using **two** of the following methods of projection:
   - 5.1 first angle orthographic projections
   - 5.2 isometric/oblique projections
   - 5.3 third angle orthographic projections

6. Produce **two** of the following types of drawing:
   - 6.1 detail drawings
   - 6.2 sub-assembly drawings
   - 6.3 general arrangement drawings
   - 6.4 installation drawings

7. Produce mechanical drawings which include **ten** of the following:
   - 7.1 straight lines
   - 7.2 symbols and abbreviations
   - 7.3 hidden detail
   - 7.4 dimensions
   - 7.5 curved/contour lines
   - 7.6 sectional detail
   - 7.7 angled lines
   - 7.8 circles or ellipses
   - 7.9 parts lists
   - 7.10 text
   - 7.11 geometrical tolerancing
   - 7.12 insertion of standard components
   - 7.13 other specific detail

Skills

The learner must be able to:

8. Save and store drawings in appropriate locations, to include carrying out **all** of the following:
   - 8.1 ensure that their drawing has been checked and approved by their supervisor
   - 8.2 check that the drawing is correctly titled and referenced
   - 8.3 save the drawing to an appropriate storage medium (such as hard drive or other external storage device)
   - 8.4 create a separate backup copy and place it in safe storage
   - 8.5 produce a hard copy printout of the drawing for file purposes
   - 8.6 register and store the drawings in the appropriate company information system (where appropriate)
   - 8.7 record and store any changes to the drawings in the company information system (where appropriate)

9. Produce drawings which comply with the following:
   - 9.1 BS and ISO standards

   Plus **one** more from the following:
   - 9.2 organisational guidelines
   - 9.3 statutory regulations and codes of practice
   - 9.4 CAD software standards
   - 9.5 other international standard

Knowledge and understanding

The learner must:

K1 Explain the specific safety precautions to be taken when working with computer systems (to include safety guidance relating to the use of visual display unit (VDU) equipment and work station environment (such as lighting, seating, positioning of equipment), repetitive strain injury (RSI); the dangers of trailing leads and cables; how to spot faulty or dangerous electrical leads, plugs and connections)

K2 Describe the methods and procedures used to minimise the chances of infecting a computer with a virus

K3 Explain the implications if the computer they are using does become infected with a virus and who to contact if it does occur

K4 Describe the basic principles of engineering manufacturing operations, assembly and installation methods, and limitations of the equipment/processes that are used to produce the drawn item (such as machining methods, joining processes, fabrication, casting and forging), and how these can influence the way they present the drawing

Knowledge and understanding *The learner must:*	
K5	Define the functionality of the component being drawn and describe its interrelationship with other components and assemblies
K6	Describe the correct start-up and shutdown procedures to be used for the computer systems
K7	Explain the importance of using software manuals and related documents to aid efficient operation of the relevant drawing system
K8	Describe the process for dealing with system problems (such as error messages received, peripherals which do not respond as expected, obvious faults with the equipment or connecting leads)
K9	Define the types of drawings that may be produced by the software (such as first and third angle drawings, sectional elevations, isometric or oblique drawings)
K10	Describe the process for setting up the viewing screen to show multiple views of the drawing to help with drawing creation (to include isometric front and side elevations)
K11	Define the national, international and organisational standards and conventions that are used for the drawings
K12	Explain the importance of being able to access, recognise and use a wide range of standard components and symbol libraries from the CAD equipment
K13	Describe the need for document control (such as ensuring that completed drawings are approved, labelled and stored on a suitable storage medium)
K14	Explain the need to create backup copies, and to file them in a separate and safe location
K15	Explain the advantages and disadvantages of printers and plotters

Unit 7: Producing Components using Hand Fitting Techniques

Level: 2

Guided learning hours: 175

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to produce components using hand fitting techniques. This will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or will provide a basis for the development of additional skills and occupational competences in the working environment.

They will be expected to prepare for the hand fitting activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required fitting activities and the sequence of operations they intend to use. They will be required to select the appropriate equipment to use, based on the operations to be carried out and the accuracy required.

In producing the components, they will be expected to use appropriate tools and equipment to mark out the material for a range of features to be produced, and then to use hand tools, portable power tools, and shaping and fitting techniques appropriate to the type of material and operations being performed. These activities could include hand sawing, band sawing, filing, drilling, threading, scraping, lapping and off-hand grinding. The components produced could have features that include flat, square, parallel and angular faces, radii and curved profiles, drilled holes, internal and external threads, and sliding or mating parts.

During, and on completion of, the fitting operations, they will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and the tolerances to be achieved. They will need to be able to recognise fitting defects, to take appropriate action to remedy any faults that occur and to ensure that the finished workpiece is within the drawing requirements. On completion of the fitting activities, they will be expected to return all tools and equipment to the correct locations, and to leave the work area in a safe and tidy condition.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the fitting activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the fitting activities, and to seek appropriate help and advice in determining and implementing a suitable solution. They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate hand fitting techniques safely. They will understand the hand fitting process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

They will understand the safety precautions required when using hand fitting techniques, and when using hand and power tools. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

In order to prove their ability to combine different fitting operations, at least one of the components produced must be of a significant nature, and must have a minimum of **five** of the features listed in paragraph 7 of the *Skills* section.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements *The learner must be able to:*	
P1	Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
P2	Demonstrate the required behaviours in line with the job role and company objectives
P3	Plan the fitting activities before they start them
P4	Obtain the appropriate tools and equipment for the hand fitting operations, and check that they are in a safe and usable condition
P5	Mark out the components for the required operations, using appropriate tools and techniques
P6	Cut and shape the materials to the required specification, using appropriate tools and techniques
P7	Measure and check that all dimensional and geometrical aspects of the component are to the specification
P8	Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
P9	Leave the work area in a safe and tidy condition on completion of the fitting activities

Skills *The learner must be able to:*		
1.	Carry out **all** of the following during the hand fitting activities:	
	1.1	adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
	1.2	follow job instructions, assembly drawings and procedures
	1.3	ensure that all power tool cables, extension leads or air supply hoses are in a serviceable condition
	1.4	check that all measuring equipment is within calibration date
	1.5	ensure that the components used are free from foreign objects, dirt or other contamination
	1.6	return all tools and equipment to the correct location on completion of the fitting activities

Skills

The learner must be able to:

2. Mark out a range of material forms, to include **two** of the following:
   - 2.1 square/rectangular (such as bar stock, sheet material, machined components)
   - 2.2 circular/cylindrical (such as bar stock, tubes, turned components, flat discs)
   - 2.3 sections (such as angles, channel, tee section, joists, extrusions)
   - 2.4 irregular shapes (such as castings, forgings, odd shaped components)
3. Use marking out methods and techniques, to include:
   - 3.1 direct marking using instruments

   Plus **one** more of the following:
   - 3.2 use of templates
   - 3.3 tracing/transfer methods
4. Use a range of marking out equipment, to include **all** of the following:
   - 4.1 rules/tapes
   - 4.2 scribers
   - 4.3 scribing blocks
   - 4.4 protractor
   - 4.5 dividers/trammels
   - 4.6 punches
   - 4.7 squares
   - 4.8 vernier instruments
5. Mark out workpieces which include **all** of the following features:
   - 5.1 datum/centre lines
   - 5.2 circles
   - 5.3 linear hole positions
   - 5.4 square/rectangular profiles
   - 5.5 radial profiles

   Plus **one** more from the following:
   - 5.6 angles/angular profiles
   - 5.7 allowances for bending
   - 5.8 simple pattern development
   - 5.9 radial hole positions

Skills

The learner must be able to:

6. Use both of the following hand fitting activities:
   - 6.1 filing
   - 6.2 hand sawing

   Plus **one** more from the following:
   - 6.3 power sawing
   - 6.4 scraping 6.5 lapping
   - 6.6 off hand grinding
   - 6.7 other specific technique relevant to the aerospace sector

7. Produce components which combine different operations and have features that cover **all** of the following:
   - 7.1 flat datum faces
   - 7.2 drilled through holes
   - 7.3 internal threads
   - 7.4 faces which are square to each other
   - 7.5 reamed holes
   - 7.6 external threads
   - 7.7 curved profiles

   Plus **three** more from the following:
   - 7.8 faces that are parallel to each other
   - 7.9 chamfers and radii
   - 7.10 faces angled to each other
   - 7.11 counterbore, countersink, or spot face
   - 7.12 holes drilled to a depth
   - 7.13 sliding or mating parts

8. Cut and shape **two** different types of material from the following:
   - 8.1 low carbon/mild steel
   - 8.2 stainless steel
   - 8.3 plastic/nylon/synthetic
   - 8.4 high carbon steel
   - 8.5 aluminium/aluminium alloys
   - 8.6 composite
   - 8.7 cast iron
   - 8.8 brass/brass alloys
   - 8.9 other specific material

Skills

The learner must be able to:

9. Carry out the necessary checks for accuracy, to include **all** of the following:
   - 9.1 linear dimensions
   - 9.2 hole position
   - 9.3 flatness
   - 9.4 hole size/fit
   - 9.5 squareness
   - 9.6 depths
   - 9.7 angles
   - 9.8 thread size and fit
   - 9.9 profiles
   - 9.10 surface finish

10. Use **all** of the following measuring equipment during the hand fitting and checking activities:
   - 10.1 external micrometers
   - 10.2 surface finish equipment (such as comparison plates, machines)
   - 10.3 Vernier calliper

   Plus **four** more of the following:
   - 10.4 rules
   - 10.5 feeler gauges
   - 10.6 squares
   - 10.7 bore/hole gauges
   - 10.8 callipers
   - 10.9 slip gauges
   - 10.10 protractors
   - 10.11 radius/profile gauges
   - 10.12 micrometers (depth and internal)
   - 10.13 thread gauges
   - 10.14 depth verniers
   - 10.15 dial test indicators (DTI)
   - 10.16 coordinate measuring machine (CMM)

Skills

The learner must be able to:

11. Produce components to **all** of the following standards, as applicable to the process:

    11.1 components to be free from false tool cuts, burrs and sharp edges

    11.2 general dimensional tolerance +/- 0.25mm or +/- 0.010”

    11.3 there must be one or more specific dimensional tolerances within +/- 0.1mm or +/- 0.004”

    11.4 flatness and squareness 0.05mm per 25mm or 0.002” per inch

    11.5 angles within +/- 1 degree

    11.6 screw threads to BS Medium fit

    11.7 reamed and bored holes within H8

    11.8 surface finish 63 µin or 1.6 µm

Knowledge and understanding

The learner must:

K1 Describe the hazards associated with the hand fitting activities (e.g. use of power tools, trailing leads or hoses, damaged or badly maintained tools and equipment, using files with damaged or poor fitting handles), and how they can be minimised

K2 Describe how to prepare the materials in readiness for the marking out activities, in order to enhance clarity, accuracy and safety (e.g. visually checking for defects, cleaning the materials, removing burrs and sharp edges, applying a marking out medium)

K3 Describe the importance of ensuring that marking out is undertaken from the selected datum, and the possible effects of working from a different datum

K4 Describe the methods of holding and supporting the workpiece during the marking out activities, and equipment that can be used (e.g. surface plates, angle plates, vee blocks and clamps, parallel bars, screw jacks)

K5 Explain the importance of using marking out conventions when marking out the workpiece (including datum lines, cutting guidelines, square and rectangular profiles, circular and radial profiles, angles, holes which are linearly positioned, boxed and on pitch circles)

K6 Explain the importance of laying out the marking-out shapes or patterns to maximise use of materials

K7 Explain the importance of clear and dimensional accuracy in marking out to specification and drawing requirements

K8 Explain the importance of setting and adjusting tools (e.g. squares, protractors and verniers)

K9 Describe the various types of file that are available, and the cut of files for different applications the importance of ensuring that file handles are secure and free from embedded foreign bodies or splits

Knowledge and understanding *The learner must:*
K10 Explain the importance of preparing the components for the filing operations (cleaning, de-burring, marking out)
K11 Explain the importance of vice jaw plates to protect the workpiece from damage
K12 Explain saw blade selection for different applications and materials; methods of setting saw blades for cutting externally and internally (e.g. hand saws, mechanical saws, band saws)
K13 Describe the method of fixing and adjusting the dies to give the correct thread fit
K14 Explain how to determine the drill size for tapped holes and the importance of using the taps in the correct sequence
K15 Explain how to prepare drilling machines for operations and the importance of preparing them correctly (e.g. adjustment of table height and position; mounting and securing drills, reamers, countersink and counterbore tools in chucks or morse taper sockets; setting and adjusting spindle speeds; setting and adjusting guards/safety devices)
K16 Describe how to mount the workpiece (e.g. in a machine vice, clamped to table, clamped to angle brackets); techniques of positioning drills to marking out, use of centre drills and taking trial cuts and checking accuracy, and how to correct holes which are off centre
K17 Explain how to produce a sliding or mating fit using filing, scraping and lapping techniques
K18 Describe the problems that can occur with the hand fitting activities, and how these can be overcome (e.g. defects caused by incorrectly ground drills, inappropriate speeds, damage by workholding devices)

Unit 8: Producing Mechanical Assemblies

Level: 2

Guided learning hours: 140

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to produce mechanical assemblies. This will prepare them for entry into the engineering or manufacturing sector, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competencies in the working environment.

They will be expected to prepare for the assembly activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required assembly activities and the sequence of operations they intend to use. They will be required to select the appropriate equipment to use, based on the operations to be carried out and the type of components to be assembled.

In carrying out the assembly operations, they will be required to follow specified assembly techniques, in order to produce the required mechanical assembly. The assembly activities will also include making all necessary checks and adjustments, to ensure that components are correctly orientated, positioned and aligned, that moving parts have the correct working clearances, that all fasteners are tightened to the correct torque, and that the assembled parts are checked for completeness and they function as per the specification.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the assembly activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the assembly activities, and to seek appropriate help and advice in determining and implementing a suitable solution. They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate assembly techniques safely. They will understand the assembly process, and its application, and will know about the mechanical equipment being assembled, the components, tools and consumables used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

They will understand the safety precautions required when carrying out the assembly activities, and when using assembly tools and equipment. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

In order to prove their ability to combine different assembly operations, at least one of the assemblies produced must be of a significant nature, and must contain a minimum of **six** of the components listed in paragraph 3 of the *Skills* section.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements *The learner must be able to:*	
P1	Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
P2	Demonstrate the required behaviours in line with the job role and company objectives
P3	Plan the assembly activities before they start them
P4	Obtain and prepare the appropriate components, tools and equipment
P5	Use the appropriate methods and techniques to assemble the components in their correct positions
P6	Secure the components using the specified connectors and securing devices
P7	Check the completed assembly to ensure that all operations have been completed and that the finished assembly meets the required specification
P8	Deal promptly and effectively with problems within their control and seek help and guidance from the relevant people if they have problems that they cannot resolve
P9	Leave the work area in a safe and tidy condition on completion of the assembly activities

Skills *The learner must be able to:*		
1.	Carry out **all** of the following during the assembly activities:	
	1.1	adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
	1.2	follow job instructions, assembly drawings and procedures
	1.3	ensure that all power tool cables, extension leads or air supply hoses are in a safe and serviceable condition
	1.4	check that tools and measuring instruments to be used are within calibration date
	1.5	use lifting and slinging equipment in accordance with health and safety guidelines and procedures (where appropriate)
	1.6	ensure that the components used are free from foreign objects, dirt or other contamination
	1.7	return all tools and equipment to the correct locations on completion of the assembly activities

Skills

The learner must be able to:

2. Produce assemblies using **six** of the following methods and techniques:
   - 2.1 assembling of components by expansion/contraction
   - 2.2 applying sealants/adhesives
   - 2.3 fitting (such as filing, scraping, lapping or polishing)
   - 2.4 electrical bonding of components
   - 2.5 securing by using mechanical fasteners/threaded devices
   - 2.6 assembling of products by pressure
   - 2.7 setting and adjusting
   - 2.8 applying bolt locking methods
   - 2.9 aligning components
   - 2.10 drilling
   - 2.11 shimming and packing
   - 2.12 riveting
   - 2.13 pinning
   - 2.14 reaming
   - 2.15 blue-bedding of components
   - 2.16 torque setting
   - 2.17 balancing components

3. Assemble products to meet the required specification, using **nine** of the following types of component:
   - 3.1 assembly structure (framework, support, casings, panels)
   - 3.2 pre-machined components
   - 3.3 shafts
   - 3.4 levers/linkages
   - 3.5 springs
   - 3.6 fabricated components
   - 3.7 chains
   - 3.8 keys
   - 3.9 belts
   - 3.10 bearings
   - 3.11 couplings

Skills

The learner must be able to:

3.12 pulleys

3.13 gaskets

3.14 seals

3.15 sprockets

3.16 gears

3.17 pipework/hoses

3.18 bushes

3.19 cams and followers

3.20 other specific component

4. Secure the components using **both** of the following categories of fastening devices:

4.1 threaded fasteners (such as nuts, bolts, machine screws, cap screws)

4.2 locking and retaining devices (such as tab washers, locking nuts, wire locks, special purpose types)

Plus **one** more from the following:

4.3 pins (such as parallel/dowels, hollow/roll, tapered, split)

4.4 spring clips (such as external circlips, internal circlips, special clips)

4.5 rivets (such as countersunk, roundhead, blind, special purpose types)

5. Assemble products using **two** of the following assembly aids and equipment:

5.1 workholding devices

5.2 shims and packing

5.3 lifting and moving equipment

5.4 rollers or wedges

5.5 specialised assembly tools/equipment

5.6 supporting equipment

5.7 jigs and fixtures

6. Carry out the required quality checks, to include **eight** from the following, using appropriate equipment:

6.1 positional accuracy

6.2 alignment

6.3 sense/direction

6.4 freedom of movement

Skills *The learner must be able to:*
6.5 function 6.6 component security/locking 6.7 bearing/shaft end float 6.8 completeness 6.9 operating/working clearances 6.10 dimensions 6.11 freedom from damage or foreign objects 6.12 orientation 6.13 torque settings 7. Produce mechanical assemblies which comply with **all** of the following: 7.1 all components are correctly assembled and aligned in accordance with the specification 7.2 moving parts are correctly adjusted and have appropriate clearances 7.3 where appropriate, assemblies meet required geometric tolerances (such as square, straight, angles free from twists) 7.4 all fastenings have appropriate washers and are tightened to the required torque 7.5 where appropriate, bolt locking methods are applied

Knowledge and understanding *The learner must:*
K1 Describe the hazards associated with the assembly activities (e.g. use of power tools, trailing leads or air hoses, damaged or badly maintained tools and equipment, lifting and handling heavy items), and how they can be minimised K2 Explain the importance of preparing the components in readiness for the assembly activities (e.g. visually checking for defects, cleaning the components, removing burrs and sharp edges) K3 Describe the general principles of mechanical assembly, and the purpose and function of the components and materials used (including component identification systems such as codes and component orientation indicators) K4 Explain the importance of adhering to the assembly/joining procedures K5 Describe the methods for aligning, adjusting and positioning components prior to securing and the tools and equipment to be used for this K6 Detail the various mechanical fastening devices that are used (e.g. nuts, bolts, machine screws, cap screws, clips, pins, locking and retaining devices) K7 Explain the importance of using the specified components and joining devices for the assembly, and why they must not use substitutes

Knowledge and understanding *The learner must:*	
K8	Describe where appropriate, the application of sealants and adhesives within the assembly activities, and the precautions that must be taken when working with them
K9	Explain the importance of conducting the necessary checks to ensure the accuracy, position, security, function and completeness of the assembly (e.g. checking for correct operation where the assembly has moving parts, checking the torque figures to which critical fastenings have been tightened, checking the end float on shafts, checking operating clearance on actuating mechanisms)
K10	Explain how to detect assembly defects, and what to do to rectify them (e.g. ineffective joining techniques, foreign objects, component damage)
K11	Describe problems that could occur with the assembly operations, and the importance of informing appropriate people of non-conformances

Unit 9: Forming and Assembling Pipework Systems

Level: 2

Guided learning hours: 140

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to form and assemble pipework systems. This will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment.

They will be expected to prepare for the pipe fitting activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required pipe fitting activities and the sequence of operations they intend to use. They will be expected to select the appropriate equipment to use, based on the operations to be carried out and the accuracy required.

In producing the pipework systems, they will be expected to select and use a range of hand tools, pipe bending and forming equipment and pipe assembly techniques, appropriate to the type of material and operations being performed. Activities will include cutting the pipes to the required lengths using hand saws, power saws or pipe cutters; bending pipes using hand bending machines, springs, fillers or heating techniques; and the use of templates or set wires to check bend profiles which will include angular bends, offsets, bridge sets and expansion loops. They will then be expected to assemble the pipes, using a range of different connectors such as straight connectors, elbows, tee pieces, reducers, tank connectors and valves.

During, and on completion of, the pipe fitting operations, they will be expected to check the quality of the work, using measuring equipment appropriate to the aspects being checked and the tolerances to be achieved. They will need to be able to recognise pipe bending and fitting defects, to take appropriate action to remedy any faults that occur and to ensure that the finished system is within the drawing requirements. On completion of the pipe fitting activities, they will be expected to return all tools and equipment to the correct locations, and to leave the work area in a safe and tidy condition.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the pipe bending, forming and fitting activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the activities, and to seek appropriate help and advice in determining and implementing a suitable solution. They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate pipe bending, forming and fitting techniques safely. They will understand the pipe bending, forming and fitting equipment and techniques, and their application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

They will understand the safety precautions required when carrying out the pipe bending, forming and fitting activities, and when using the associated tools and equipment. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

In order to prove their ability to combine different pipe assembly operations, at least one of the pipe assemblies produced must be of a significant nature, and must have a minimum of **five** of the fittings listed in paragraph 9 of the *Skills* section.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements *The learner must be able to:*	
P1	Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
P2	Demonstrate the required behaviours in line with the job role and company objectives
P3	Plan the pipe fitting activities before they start them
P4	Cut the pipes to the appropriate lengths making allowances for bending and attachment of fittings
P5	Bend and form the pipes using the appropriate tools and equipment for the types and sizes of pipe
P6	Assemble and secure the pipework, using the correct fittings and joining techniques
P7	Check the completed assembly to ensure that all operations have been completed and that the finished pipe assembly meets the required specification
P8	Test the completed pipe assembly, using the appropriate techniques, tools and equipment
P9	Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
P10	Leave the work area in a safe and tidy condition on completion of the assembly activities

Skills *The learner must be able to:*		
1.	Carry out **all** of the following during the pipe bending, forming and fitting activities:	
	1.1	adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
	1.2	follow job instructions, assembly drawings and procedures
	1.3	check that the bending and forming equipment is in a safe and usable condition
	1.4	return all tools and equipment to the correct location on completion of the pipe fitting activities
	1.5	apply safe working practices at all times

Skills

The learner must be able to:

2. Produce pipework assemblies using **two** of the following types of pipe:
   - 2.1 carbon steel
   - 2.2 copper
   - 2.3 aluminium
   - 2.4 stainless steel
   - 2.5 brass
   - 2.6 plastic

3. Mark out pipework, using the following method:
   - 3.1 direct marking using tapes and markers

   Plus **one** more from the following:
   - 3.2 set-outs of pipework using templates
   - 3.3 producing set wires
   - 3.4 set-outs of pipework onto floor

4. Cut and prepare the pipes for forming and assembly, to include carrying out **all** of the following:
   - 4.1 cutting pipes to length with appropriate allowance for fittings
   - 4.2 removing all external and internal burrs
   - 4.3 cleaning pipe ends for soldering or cementing (where appropriate)
   - 4.4 cutting threads on pipe ends to the appropriate length (where appropriate)
   - 4.5 checking that prepared pipes are the correct length

5. Cut and prepare pipework using the following:
   - 5.1 saws (hand or power)

   Plus **two** more from the following:
   - 5.2 pipe/tube cutter
   - 5.3 de-burring reamers
   - 5.4 abrasive cloth
   - 5.5 wire pipe cleaners

Skills *The learner must be able to:*
6. Bend and form pipe using the following method: 6.1 hand operated pipe bender Plus **one** more of the following 6.2 bending springs 6.3 pipe expander 6.4 swaging kit 6.5 hydraulic pipe bending equipment 6.6 heating methods 6.7 fillers 7. Produce pipework bends/forms that include **both** of the following: 7.1 angular bends 7.2 offsets Plus **one** more from the following: 7.3 bridge sets 7.4 radii 7.5 internal swaged ends 7.6 expansion loops 7.7 external swaged ends 8. Assemble pipes using **three** of the following methods: 8.1 compression fittings 8.2 soldered fittings 8.3 cemented fittings 8.4 snap-on/push fittings 8.5 brazed fittings 8.6 welded joints 8.7 screwed connections

Skills

The learner must be able to:

9. Produce pipework assemblies which combine a range of different fittings, covering **all** of the following:
   - 9.1 straight couplings
   - 9.2 elbows
   - 9.3 tee pieces

   Plus **three** more from the following:
   - 9.4 flanges
   - 9.5 reduction pieces
   - 9.6 drain/bleeding devices
   - 9.7 unions
   - 9.8 valves
   - 9.9 blanking caps
   - 9.10 screwed fittings (such as tank, tap, pump, gauges)

10. Assemble pipework using **all** of the following methods and techniques:
   - 10.1 securing pipework supports to structures
   - 10.2 connecting pipe-to-equipment
   - 10.3 fitting pipework supports
   - 10.4 using gaskets, seals/sealing tapes or jointing compounds
   - 10.5 connecting pipe-to-pipe
   - 10.6 alignment/levelling equipment

11. Carry out tests on the assembled pipework, to include **one** of the following:
   - 11.1 hydraulic pressure testing
   - 11.2 gas/air leakage test
   - 11.3 water leakage testing

12. Produce pipework assemblies which comply with **all** of the following:
   - 12.1 pipes are bent to the appropriate shape/form and position
   - 12.2 all pipe bends are free from buckling or deformation
   - 12.3 appropriate fittings are used, and are secure and leak free
   - 12.4 soldered and cemented fittings are free from excessive residues
   - 12.5 the completed assembly meets the specific system requirements

Knowledge and understanding *The learner must:*	
K1	Describe the hazards associated with the pipe fitting activities (e.g. handling long pipe lengths, using damaged or badly maintained tools and equipment, using pipe bending equipment, using heating and soldering equipment, using adhesives), and how they can be minimised
K2	Explain the importance of using the correct principles, methods and equipment for marking out pipework
K3	Explain the importance of preparing the pipes in readiness for the marking out activities (e.g. visually checking for defects, cleaning the materials, removing burrs and sharp edges)
K4	Define the characteristics of the various materials that are to be used with regard to the bending operations, and why some materials may require the addition of heat/hot air to aid the bending process
K5	Give positive and negative points of the different methods used to hand bend and form the pipe; including the use of bending springs, hand bending machines, fillers, heating methods
K6	Explain the reasons for incorporating expansion loops in a system, and where they should be positioned
K7	Explain the importance of preparing pipework and fittings for the assembly operation (e.g. checking for damage, removing foreign objects, dirt and swarf from bore of pipe, removing burrs)
K8	Describe the range of pipe fittings that can be used, and how to identify them (such as straight connectors, elbows, tee pieces, reduction pieces, flanged fittings, valves, blanking pieces/cap ends)
K9	Define the different types of fittings available (e.g. screwed fittings, soldered fittings, compression fittings, push fit fittings and glued/cemented fittings)
K10	Describe the methods used to seal screwed joints (e.g. tapes and sealing compounds)
K11	Describe the advantages and disadvantages of using flanges to connect pipes
K12	Explain the importance of using gaskets; and torque loading of flange bolts
K13	Describe the methods used to prepare pipe ends and fittings for soldering or brazing and explain why it is necessary to ensure that these preparations are carried out
K14	Describe the various types of soldered connectors available (e.g. solder ring types and capillary fittings)
K15	Describe the methods used to solder the joints, and how to recognise when the fitting is correctly soldered
K16	Explain the precautions to be taken when using gas torches to form the joint, and the effect of overheating the joint
K17	Describe the methods used to prepare pipe ends and fittings when using adhesives and explain why it is necessary to ensure that these preparations are carried out
K18	Describe the methods used to cement the joints and how to recognise when the fitting is correctly secured

Knowledge and understanding *The learner must:*
K19 Describe the various adhesives and sealing compounds that are used on non-metallic pipework
K20 Explain the precautions to be taken when using the adhesives, cements and sealing compounds (e.g. adequate ventilation, fume extraction, away from naked flames, avoiding skin contact)
K21 Describe the advantages and disadvantages of using compression fittings
K22 State how the pipes are sealed and the effects of over tightening the fittings
K23 Describe the benefits of using push-fit connectors
K24 Describe the process for identifying the correct orientation of fittings with regard to flow, and the consequences of incorrect orientation
K25 Define the supporting methods that are used when assembling pipework, and the type of fittings that are used
K26 Describe the different methods of testing pipework systems for leaks (using air, water or hydraulic testing methods)

Unit 10: Carrying out Aircraft Detail Fitting Activities

Level: 2

Guided learning hours: 175

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to carry out aircraft detail fitting assemblies. This will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment.

They will be expected to prepare for the detail fitting activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required detail fitting activities and the sequence of operations they intend to use. They will be expected to select the appropriate equipment to use, based on the operations to be carried out and the accuracy required.

They will be expected to use a range of different materials, ensuring efficient use of them and, when applicable, ensure that grain flow is taken into account. In carrying out the detail fitting activities, they will need to use a range of hand tools, portable power tools and simple machines to produce a variety of shapes and profiles.

During, and on completion of, the detail fitting operations, they will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and tolerances to be achieved. They will need to be able to recognise fitting defects, to take appropriate action to remedy any faults that occur and to ensure that the finished workpiece is within the drawing requirements. On completion of the detail fitting activities, they will be expected to return all tools and equipment used to its correct location and to leave the work area in a safe and tidy condition.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the detail fitting activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the detail fitting activities, and to seek appropriate help and advice in determining and implementing a suitable solution. They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate aircraft detail fitting techniques safely. They will understand the aircraft detail fitting process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

They will understand the safety precautions required when using aircraft detail fitting techniques, and when using hand tools, power tools and machines. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

In order to prove their ability to combine different aircraft detail fitting operations, at least one of the components produced must be of a significant nature, and must contain a minimum of **five** of the features listed in paragraph 8 of the *Skills* section.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements *The learner must be able to:*	
P1	Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
P2	Demonstrate the required behaviours in line with the job role and company objectives
P3	Plan the aircraft detail fitting activities before they start them
P4	Obtain the appropriate tools and equipment for the aircraft detail fitting operations, and check that they are in a safe and usable condition
P5	Mark out the components for the required operations, using appropriate tools and techniques
P6	Cut and shape the materials to the required specification, using appropriate tools and techniques
P7	Bend and form the materials, using the appropriate tools and equipment
P8	Assemble and secure the components, using the correct fastening devices and joining techniques
P9	Measure and check that all dimensional and geometrical aspects of the component are to the specification
P10	Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
P11	Leave the work area in a safe and tidy condition on completion of the fitting activities

Skills *The learner must be able to:*		
1.	Carry out **all** of the following during the aircraft detail fitting activities:	
	1.1	adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
	1.2	check that all measuring equipment is within calibration date
	1.3	ensure that all power tool cables, extension leads or air supply hoses are in a serviceable condition and PAT tested
	1.4	return all tools and equipment to the correct location on completion of the detail fitting activities
2.	Mark out a range of material forms, to include **three** from:	
	2.1	square/rectangular (such as bar stock, sheet material, machined components)
	2.2	circular/cylindrical (such as bar stock, tubes, turned components, flat discs, rolled cylinders/cones)
	2.3	sections (such as angle, channel, tee section, joists, extrusions)

Skills

The learner must be able to:

2.4 irregular shapes (such as castings, forgings, odd shaped components)

2.5 detail assemblies

3. Use **both** the following types of material:

3.1 metallic material relevant to the aerospace sector

3.2 composite material relevant to the aerospace sector

4. Use marking out methods and techniques which include the following:

4.1 direct marking using instruments

Plus **one** more from the following:

4.2 use of templates

4.3 tracing/transfer methods

4.4 other specific method

5. Use a range of marking out equipment, to include **all** of the following:

5.1 marking tools

5.2 squares

5.3 vernier instruments

5.4 rules/tapes

5.5 protractors

5.6 dividers/compass

6. Mark out workpieces, to include **all** of the following features:

6.1 datum/centre lines

6.2 circles and radial profiles

6.3 square/rectangular profiles

6.4 linear hole positions

Plus **two** more from the following:

6.5 angles/angular profiles

6.6 allowances for bending

6.7 radial hole positions

6.8 simple pattern development

Skills

The learner must be able to:

7. Cut and shape the materials, using **four** of the following:
   - 7.1 saws (hand or mechanical)
   - 7.2 tin snips
   - 7.3 cropping machines
   - 7.4 guillotines
   - 7.5 drills and hole saws
   - 7.6 files
   - 7.7 bench knives
   - 7.8 nibblers
   - 7.9 abrasive discs

8. Produce components which combine different operations and have features that cover **all** of the following:
   - 8.1 edges/faces that are square to each other
   - 8.2 curved or circular forms
   - 8.3 edges/faces that are parallel
   - 8.4 holes linearly pitched

   Plus **two** more of the following:
   - 8.5 edges/faces that are angled
   - 8.6 external profiles
   - 8.7 internal profiles
   - 8.8 holes radially pitched

9. Bend and form materials using **four** of the following:
   - 9.1 bench folding machines
   - 9.2 hand tools
   - 9.3 box pan folding machines
   - 9.4 heating techniques
   - 9.5 pinch or pyramid rolling machines
   - 9.6 shrinking techniques
   - 9.7 presses
   - 9.8 stretching techniques

Skills

The learner must be able to:

10. Produce a range of components with features that cover **five** of the following:
    - 10.1 right-angled bends
    - 10.2 curved profile
    - 10.3 angled bends
    - 10.4 cylindrical shape
    - 10.5 square flanges
    - 10.6 conical shape
    - 10.7 tray sections and channels
    - 10.8 dished profile
    - 10.9 curved/circular flanges

11. Use **both** of the following types of measuring equipment during the detail fitting and checking activities:
    - 11.1 external micrometers
    - 11.2 vernier calliper

    Plus **four** more of the following:
    - 11.3 rules
    - 11.4 feeler gauges
    - 11.5 squares
    - 11.6 bore/hole gauges
    - 11.7 callipers (external and internal)
    - 11.8 radius/profile gauges
    - 11.9 vernier protractors
    - 11.10 thread gauges
    - 11.11 micrometers (internal and external)
    - 11.12 dial test indicators (DTI)
    - 11.13 depth Verniers
    - 11.14 surface finish equipment (such as comparison plates, machines)
    - 11.15 slip gauges
    - 11.16 coordinate measuring machine (CMM)

Skills

The learner must be able to:

12. Produce components to **all** of the following standards, as applicable to the process:
    - 12.1 components to be free from false tool cuts, burrs and sharp edges
    - 12.2 finished components meet the required shape/geometry (to the template profile)
    - 12.3 completed components are free from excessive tooling marks, deformation including from heat sources or cracking
    - 12.4 dimensional tolerance +/- 0.25mm or +/- 0.010”
    - 12.5 flatness and squareness 0.05mm per 25mm or 0.002” per inch
    - 12.6 angles within +/- 0.5 degree
    - 12.7 screw threads to BS Medium fit
    - 12.8 reamed and bored holes within H8
    - 12.9 surface finish 63 µin or 1.6 µm

Knowledge and understanding

The learner must:

K1 Describe the hazards associated with the aircraft detail fitting activities (e.g. use of power tools, trailing leads or hoses, damaged or badly maintained tools and equipment, use of forming and bending equipment, using hand shears and guillotines), and how they can be minimised

K2 Explain material selection for different applications (including material identification systems, codes used and grain flow indicators)

K3 Explain the principles of marking out, and the equipment used in the aerospace industry

K4 Describe the importance of cleaning and preparing the surfaces to be marked out, ensuring that grain flow is taken into account where appropriate

K5 Describe the process for calculating bending allowances when marking out

K6 Describe the importance of ensuring that marking out is undertaken from the selected datums, and the possible effects of working from different datums

K7 Describe the various methods of pattern development that can be used (e.g. parallel line; radial line; triangulation), and typical applications of each method

K8 Describe the importance of laying out the marking-out shapes or patterns to maximise use of materials

K9 Describe the need for clear and dimensional accuracy in marking out to specification and drawing requirements

K10 Describe the shaping methods and techniques that can be used to produce a range of shapes/profiles on the various section materials (e.g. sawing, shearing, drilling, filing, abrading), and the sequence in which the operations will need to be carried out

Knowledge and understanding *The learner must:*
K11 Explain saw blade selection for different applications and materials; methods of setting saw blades for cutting externally and internally (e.g. hand saws, mechanical saws, band saws)
K12 Describe the various shearing methods that can be used (e.g. tin snips, bench shears, guillotines, cropping machines and nibbling machines)
K13 Describe the range of hand tools and associated equipment that is used to produce a variety of shapes, bends, curved surfaces, dished profiles
K14 Describe the range of bending and forming machines to be used (e.g. fly presses, bending machines, rolling machines, flanging machines)
K15 Describe the importance of setting up a bending machine to produce a range of forms (e.g. right-angled bends, angled bends, tray sections, channel sections)
K16 Describe the importance of setting up pinch/pyramid forming rolls to produce a variety of forms (e.g. curved profiles, cylinders, cones) – *this knowledge criteria only applies if learner has chosen skill 9.5*
K17 Describe the importance of producing flanges on curved/cylindrical components – *this knowledge criteria only applies if learner has chosen skill 10.9*
K18 Describe the methods of drilling and finishing holes in sheet and stock materials (e.g. drills, reamers, countersinks, hole saws)
K19 Describe the various types of files that are available; the cut of files for different applications; the importance of ensuring that file handles are safe and free from embedded foreign bodies
K20 Describe the preparations and/or treatments that may need to be carried out on the materials before and after the cutting and shaping operations
K21 Describe the purpose and use of joint sealing agents and anti-electrolysis barriers, and the precautions to be taken when using them
K22 Describe the problems that can occur with the cutting, shaping and forming operations, and how these can be overcome

Unit 11: Installing Aircraft Mechanical Fasteners

Level: 2

Guided learning hours: 105

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to install aircraft mechanical fasteners. This will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment.

They will be expected to prepare for the installation activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required installation activities and the sequence of operations they intend to use. They will be expected to select the appropriate equipment to use, based on the types of fastener to be installed and the accuracy required.

The mechanical fasteners to be installed will include devices such as hollow and solid rivets, threaded fasteners, anchor nuts, pins and other locking devices. They will need to use a range of different techniques to prepare, install and check that the mechanical fasteners are installed to the required specification.

During, and on completion of, the installation operations, they will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and tolerances to be achieved. They will need to be able to recognise installation defects, to take appropriate action to remedy any faults that occur and to ensure that the finished installation meets the drawing requirements. On completion of the installation activities, they will be expected to return all tools and equipment used to the correct locations, and to leave the work area in a safe and tidy condition.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the installation activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the installation activities, and to seek appropriate help and advice in determining and implementing a suitable solution. They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate techniques, for the installation of the aircraft mechanical fasteners, safely. They will understand the fastener installation process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

They will understand the safety precautions required when using aircraft mechanical fastener installation techniques, and when using hand and power tools. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

In order to prove their ability to combine different aircraft fastener installation operations, at least one of the assemblies produced must be of a significant nature, and must contain a minimum of **four** types of the fasteners listed in paragraph 2 of the *Skills* section.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements

The learner must be able to:

P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines

P2 Demonstrate the required behaviours in line with the job role and company objectives

P3 Plan the installation of the mechanical fasteners before they start the activity

P4 Obtain the appropriate tools and equipment for the installation operations, and check that they are in a safe and usable condition

P5 Assemble and secure the components, using the correct fastening devices and joining techniques

P6 Measure and check that all dimensional and geometrical aspects of the component are to the specification

P7 Check that the installation is complete, and that all components are free from damage

P8 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

P9 Leave the work area in a safe and tidy condition on completion of the fitting activities

Skills

The learner must be able to:

1. Carry out **all** of the following activities during the installation of the mechanical fasteners:

   1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations

   1.2 check that all measuring equipment is within calibration date

   1.3 ensure that all power tool cables, extension leads or air supply hoses are in a serviceable condition and PAT tested

   1.4 return all tools and equipment to the correct location on completion of the installation activities

2. Install a range of mechanical fasteners, to include **all** of the following:

   2.1 hollow rivets

   2.2 solid rivets

   2.3 threaded fasteners

   2.4 quick release fasteners

   Plus **two** more from the following:

   2.5 collared fasteners

Skills

The learner must be able to:

2.6 split pins

2.7 pin clips

2.8 wire locks

2.9 anchor nuts

2.10 Rivnuts

2.11 NAPPY pins

2.12 PIP/PIT pins

2.13 other locking devices

3. Use **both** of the following types of equipment:

3.1 riveting guns (appropriate to rivet type)

3.2 gripping pins and location dowels

Plus **two** more from the following:

3.3 gauges (such as for intrusions)

3.4 redline templates

3.5 clamps

3.6 drills and tools with attachments

3.7 jigs

4. Use **all** of the following installation methods and techniques:

4.1 countersinking

4.2 solid riveting (single and double handed)

4.3 through-hole

4.4 milling rivets

4.5 wire locking

4.6 blind riveting

5. Make **three** types of connection from:

5.1 wet assembly

5.2 panels

5.3 structures

5.4 dry assembly

5.5 skins

5.6 repairs

Skills

The learner must be able to:

6. Use **four** of the following to carry out appropriate checks during, and on completion of, the installation activities:
   - 6.1 rules
   - 6.2 feeler gauges
   - 6.3 squares
   - 6.4 bore/hole gauges
   - 6.5 callipers
   - 6.6 radius/profile gauges
   - 6.7 protractors
   - 6.8 dial test indicators (DTI)
   - 6.9 micrometers
   - 6.10 torque wrenches/gauges
   - 6.11 Verniers
   - 6.12 rivet intrusion gauges
   - 6.13 slip gauges

7. Install aircraft mechanical fasteners to comply with **all** of the following requirements:
   - 7.1 all components are correctly assembled and aligned, in accordance with the specification
   - 7.2 overall dimensions are within specification tolerances
   - 7.3 assemblies meet appropriate geometric tolerances (such as square, straight, angles free from twists)
   - 7.4 where appropriate, pitches of rivets/fasteners meet specification requirements
   - 7.5 completed assemblies have secure and firm joints, and are clean and free from burrs/flash, deformation or cracking

Knowledge and understanding

The learner must:

K1 Describe the hazards associated with installing aircraft mechanical fasteners, and with the tools and equipment used (e.g. use of power tools, trailing leads or hoses, damaged or badly maintained tools and equipment), and how they can be minimised

K2 Explain the importance of working to the installation instructions and appropriate specifications

K3 Explain the implications if the correct and specified fastener is not fitted to the component and the impact this could have on the business

Knowledge and understanding *The learner must:*	
K4	Describe the process for the control of materials, and the need for component control and quarantine
K5	Explain the methods of identifying the mechanical fasteners to be used (e.g. material identification systems, codes used and grain flow indicators)
K6	Explain why they must obtain design approval before removing and replacing faulty fasteners
K7	Describe the purpose and use of joint sealing agents and anti-electrolysis barriers, and the precautions to be taken when using them
K8	Explain the regulations concerning electrical bonding and anti-electrolysis barriers
K9	Explain the various types and range of screwed fasteners used on aircraft fittings, and the methods of installing them
K10	Explain the types and applications of aircraft rivets, and the advantages of hollow rivets over solid rivets
K11	Explain the reasons for using screw fastenings rather than rivets
K12	Describe the purpose and use of a countersink cage
K13	Describe the various locking devices used with fastenings
K14	Describe the purpose and use of locating dowels, gripping pins and gauges, when carrying out fastening operations
K15	Describe the procedures to be adopted when removing rivets and other fasteners
K16	Explain the term 'quilting', its occurrence and avoidance
K17	Describe bolt break-offs, and where they occur
K18	Explain how to check that riveting guns, power tools and attachments are in a safe and usable condition, and the action to be taken in the event of identifying defective equipment
K19	Describe the types of gauges used to measure angles, depths, countersinks and torque
K20	Describe how and why tools are calibrated, and how to check that the tools they are using are within calibration dates
K21	Explain the importance of conducting the necessary checks to ensure the accuracy and quality of the installations produced
K22	Describe the problems that can occur with the installation of the mechanical fasteners, and how these can be overcome

Unit 12: Producing Aircraft Detail Assemblies

Level: 2

Guided learning hours: 140

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to assemble components to produce aircraft detail assemblies. This will prepare them for entry into the engineering or manufacturing sector, creating a progression between education and employment, or will provide a basis for the development of additional skills and occupational competences in the working environment.

They will be expected to prepare for the assembly activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required assembly activities and the sequence of operations they intend to use. They will be expected to select the appropriate equipment to use, based on the assembly operations to be carried out and the accuracy required.

In carrying out the assembly operations, they will be required to follow laid-down procedures and specific assembly techniques, in order to assemble the various components into detail assemblies. They will need to produce a range of assemblies, which could include stringers, frames, panels, trays, skins, ribs, tanks and other small assemblies, as appropriate.

During, and on completion of, the assembly operations, they will be expected to check the quality of the assembly, using measuring equipment appropriate to the aspects being checked and tolerances to be achieved. They will need to be able to recognise assembly defects, to take appropriate action to remedy any faults that occur and to ensure that the finished assembly is within the drawing requirements. On completion of the assembly activities, they will be expected to return all tools and equipment used to the correct locations, and to leave the work area in a safe and tidy condition.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the aircraft detail assembly activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the assembly activities, and to seek appropriate help and advice in determining and implementing a suitable solution. They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate aircraft detail assembly techniques safely. They will understand the aircraft detail assembly process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

They will understand the safety precautions required when using aircraft detail assembly techniques, and when using hand tools, power tools and machines. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

In order to prove their ability to combine different aircraft detail assembly operations, at least one of the assemblies produced must be of a significant nature, and must contain a minimum of **four** of the components listed in paragraph 2 of the *Skills* section.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements *The learner must be able to:*	
P1	Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
P2	Demonstrate the required behaviours in line with the job role and company objectives
P3	Plan the aircraft detail assembly activities before they start them
P4	Obtain the appropriate tools and equipment for the aircraft detail assembly operations, and check that they are in a safe and usable condition
P5	Obtain the specified components and check that they are in a usable condition
P6	Use the appropriate methods and techniques to assemble the components in their correct positions
P7	Secure the components using the specified connectors and securing devices
P8	Measure and check that all dimensional and geometrical aspects of the component are to the specification
P9	Check the completed assembly to ensure that all operations have been completed and that the finished assembly meets the required specification
P10	Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
P11	Leave the work area in a safe and tidy condition on completion of the fitting activities

Skills *The learner must be able to:*		
1.	Carry out **all** of the following activities during assembly:	
	1.1	adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
	1.2	check that all tools, test and measuring equipment are within calibration date and PAT tested
	1.3	ensure that all power tool cables, extension leads or air supply hoses are in a serviceable condition
	1.4	return all tools and equipment to the correct location on completion of the assembly activities

Skills

The learner must be able to:

2. Produce aircraft detail assemblies, which includes **seven** of the following components:
   - 2.1 skins
   - 2.2 frames
   - 2.3 trays
   - 2.4 jumper braids, bonding clips, earthing straps
   - 2.5 stringers
   - 2.6 ribs
   - 2.7 angles
   - 2.8 cleats
   - 2.9 panels
   - 2.10 pipes, unions and joints
   - 2.11 aircraft general supplies
   - 2.12 tanks
   - 2.13 brackets
   - 2.14 other small assemblies, as applicable

3. Apply **all** of the following assembly methods and techniques:
   - 3.1 drilling and riveting
   - 3.2 ensuring that correct part numbers are used
   - 3.3 applying sealants/adhesives
   - 3.4 electrical bonding of components
   - 3.5 ensuring that correct hand of components is used (left or right handed)
   - 3.6 positioning and aligning components in line with drawing requirements
   - 3.7 securing components using mechanical fasteners and threaded devices
   - 3.8 applying bolt locking methods (such as split pins, wire locking, lock nuts, stiff nuts)

4. Carry out quality and accuracy checks which include **all** of the following:
   - 4.1 freedom from damage
   - 4.2 electrical bonding and continuity
   - 4.3 torque loading checks

Skills

The learner must be able to:

5. Produce assemblies which comply with **all** of the following:

   5.1 all components are correctly assembled, positioned and aligned in accordance with the specification

   5.2 overall dimensions are within specification tolerances

   5.3 assemblies meet appropriate geometric tolerances (such as square, straight, angles free from twists)

   5.4 where appropriate, pitches of rivets/fasteners meet specification requirements

   5.5 completed assemblies have secure and firm joints, and are clean and free from burrs/flash, deformation or cracking

Knowledge and understanding

The learner must:

K1 Describe the specific safety precautions to be taken whilst carrying out the detail assembly operations (including any specific legislation, regulations or codes of practice relating to the activities, equipment or materials)

K2 Describe the hazards associated with producing aircraft detail assemblies, and with the tools and equipment used (such as use of power tools, trailing leads or hoses, damaged or badly maintained tools and equipment), and how they can be minimised

K3 Explain the importance of working to the assembly instructions and appropriate specifications

K4 Explain the importance of identifying the components to be used (e.g. component identification systems, codes used and component orientation indicators)

K5 Describe the preparations to be undertaken on the components prior to fitting them into the assembly

K6 Describe the assembly methods and procedures to be used, and the importance of adhering to these procedures

K7 Describe the methods used to hold the components in their correct position prior to securing them with the appropriate fasteners

K8 Describe the various mechanical fasteners that will be used, and their method of installation (including open and blind rivets, threaded fasteners, special securing devices)

K9 Describe the importance of using the specified fasteners for the particular assembly, and why they must not use substitutes

K10 Explain what to do if the components or fastening devices are not assembled correctly, are damaged, or have other faults

K11 Explain why they must obtain design approval before removing and replacing faulty fasteners

Knowledge and understanding *The learner must:*
K12 Describe the application of sealants and adhesives within the assembly activities, and the precautions that must be taken when working with the various adhesives and sealants
K13 Describe the purpose and use of joint sealing agents and anti-electrolysis barriers, and the precautions to be taken when using them
K14 Describe the quality control procedures to be followed during the assembly operations
K15 Explain the importance of conducting the necessary checks to ensure the accuracy and quality of the assemblies produced
K16 Explain how and why tools are calibrated, and how to check that the tools they are using are within calibration dates
K17 Explain the importance of using all tools in the correct manner and within their permitted operating range
K18 Explain the importance of ensuring that the completed assembly is free from dirt, swarf and foreign objects
K19 Describe the problems that can occur with the detail assembly operations, and how these can be overcome

Unit 13: Preparing and using Lathes for Turning Operations

Level: 2

Guided learning hours: 140

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to prepare and use lathes for turning operations. This will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment.

The turning operations may be carried out on machines such as centre lathes, capstan or turret lathes, automatic or other specific turning machines. They will be expected to prepare for the turning activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required turning activities and the sequence of operations they intend to use.

They will be required to prepare for the turning activities by mounting, positioning and correctly setting a range of workholding devices, to mount the workpiece and cutting tools and to set and use cutting feeds/speeds and techniques appropriate to the type of material, tooling, workpiece rigidity and operations being performed. They will be expected to produce components that combine a number of different features, such as parallel, stepped and tapered diameters, drilled, bored and reamed holes, internal and external threads, and special forms/profiles.

During, and on completion of, the turning operations, they will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and the tolerances to be achieved. They will need to be able to recognise turning defects, to take appropriate action to remedy any faults that occur and to ensure that the finished workpiece is within the drawing requirements. On completion of the turning activities, they will be expected to remove all cutting tools and workholding devices, and to leave the machine and work area in a safe and tidy condition.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the turning activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the turning activities, and to seek appropriate help and advice in determining and implementing a suitable solution.

They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they produce.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate turning techniques safely. They will understand the turning process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

They will understand the safety precautions required when working with the lathe, and with its associated tools and equipment. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

In order to prove their ability to combine different turning operations, at least one of the machined components produced must be of a significant nature, and must have a minimum of **six** of the features listed in paragraph 5 of the *Skills* section.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements

The learner must be able to:

P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines

P2 Demonstrate the required behaviours in line with the job role and company objectives

P3 Plan the machining activities before they start them

P4 Obtain and prepare the appropriate materials, tools and equipment

P5 Mount and set the required workholding devices, workpiece and cutting tools

P6 Set and adjust the machine tool speeds and feeds to achieve the component specification

P7 Use the machine tool controls safely and correctly, in line with operational procedures

P8 Measure and check that all dimensional and geometrical aspects of the component are to the specification

P9 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

P10 Shut down the equipment to a safe condition on completion of the machining activities

Skills

The learner must be able to:

1. Ensure that they apply **all** of the following checks and practices at all times during the turning activities:
   - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
   - 1.2 machine guards are in place and are correctly adjusted
   - 1.3 components are held securely (without damage or distortion)
   - 1.4 cutting tools are maintained in a suitable/safe condition
   - 1.5 make sure the work area is maintained and left in a safe and tidy condition

2. Machine components made from **two** of the following types of material:
   - 2.1 low carbon/mild steel
   - 2.2 cast iron
   - 2.3 plastic/nylon/composite
   - 2.4 high carbon steel
   - 2.5 brass/brass alloys
   - 2.6 aluminium/aluminium alloys
   - 2.7 other specific material

Skills

The learner must be able to:

3. Mount, secure and machine components using **three** of the following workholding devices:
   - 3.1 three-jaw chucks with hard jaws
   - 3.2 drive plate and centres
   - 3.3 magnetic or pneumatic devices
   - 3.4 three-jaw chucks with soft jaws
   - 3.5 fixtures
   - 3.6 fixed steadies or travelling steadies
   - 3.7 four-jaw chucks
   - 3.8 faceplates
   - 3.9 special purpose workholding devices (such as wax chucks)
   - 3.10 collet chucks

4. Mount and use **eight** of the following types of tool:
   - 4.1 turning
   - 4.2 knurling
   - 4.3 recessing/grooving
   - 4.4 twist/core drills
   - 4.5 thread forming tools
   - 4.6 facing
   - 4.7 parting off
   - 4.8 chamfering
   - 4.9 reamer
   - 4.10 dies
   - 4.11 boring
   - 4.12 forming
   - 4.13 centre drills
   - 4.14 taps

5. Produce machined components which combine different operations and have features that cover **all** of the following:
   - 5.1 flat faces
   - 5.2 stepped diameters
   - 5.3 drilled holes

Skills *The learner must be able to:*
5.4 chamfers 5.5 parallel diameters 5.6 tapered diameters 5.7 reamed holes 5.8 grooves/undercuts Plus **four** more of the following: 5.9 bored holes 5.10 internal threads 5.11 eccentric diameters 5.12 knurls or special finishes 5.13 profile forms 5.14 external threads 5.15 parting off 6. Carry out the necessary checks for accuracy, to include **all** of the following: 6.1 external diameters 6.2 bore/hole size/fit 6.3 surface finish 6.4 parallelism 6.5 angle/taper 6.6 linear dimensions (such as lengths, depths) 6.7 grooves/undercuts (such as position, width, depth) Plus **two** more of the following: 6.8 internal diameters 6.9 concentricity 6.10 eccentricity 6.11 ovality 6.12 thread fit 7. Use **all** of the following measuring equipment during the machining and checking activities: 7.1 external micrometers 7.2 dial test indicators (DTI) 7.3 Vernier/digital/dial callipers 7.4 surface finish equipment (such as comparison plates, machines)

Skills

The learner must be able to:

Plus **four** more of the following

7.5 rules

7.6 bore/hole gauges

7.7 internal micrometers

7.8 thread gauges (such as ring, plug, profile)

7.9 depth micrometers

7.10 plug gauges

7.11 depth Verniers

7.12 radius/profile gauges

7.13 slip gauges

7.14 protractors

7.15 coordinate measuring machine (CMM)

8. Produce components to **all** of the following quality and accuracy standards, as applicable to the operation:

8.1 components to be free from false tool cuts, burrs and sharp edges

8.2 general dimensional tolerance +/- 0.25mm or +/- 0.010”

8.3 there must be one or more specific dimensional tolerances within +/- 0.1mm or +/- 0.004”

8.4 surface finish 63 µin or 1.6µm

8.5 reamed holes within H8

8.6 screw threads BS medium fit

8.7 angles within +/- 0.5 degree

Knowledge and understanding *The learner must:*
K1 Describe the hazards associated with the turning operations (e.g. revolving/moving parts of machinery, airborne and hot metal particles, sharp cutting tools and burrs and sharp edges on component), and how they can be minimised
K2 Define the safety mechanisms on the machine (e.g. emergency stop buttons, emergency treadle brakes), and the procedure for checking that they function correctly
K3 Explain the correct operation of the machine controls in both hand and power modes
K4 Describe how to stop the machine in both normal and emergency situations and the procedure for restarting after an emergency
K5 Describe the process for planning and preparing to carry out the machining operations (e.g. obtaining the component drawing, determining the machines required, selecting materials, selecting workholding methods and devices, selecting cutting tools, determining a suitable sequence of operations, determining quality checks to be made and equipment to be used)
K6 Define the main features of the lathe and the accessories that can be used (e.g. saddle, capstan/turret head, compound slide, tailstock, taper turning attachments, profile attachments, fixed and travelling steadies)
K7 Explain the importance of positioning and securing workholding devices to the machine spindle, and the checks to be made (e.g. ensuring that all seating/location faces are clean and undamaged, that (where appropriate) the workholding device location marks are lined up with those on the machine spindle, and checking that all bolts, cam locks or other securing devices are tightened securely)
K8 Describe the effects of clamping the workpiece in a chuck/workholding device, and how this can cause damage or distortion in the finished components
K9 Define the various turning operations that can be performed, and the shapes and types of tooling that can be used (such as solid high-speed tooling, brazed tip tooling, interchangeable tipped tooling)
K10 Describe different methods of mounting and securing the cutting tools in the tool holding devices (e.g. front or rear tools posts; mounting drills in chucks or by the use of morse taper sockets)
K11 Explain the importance of ensuring that the tool is at the correct centre height and that tool overhang is kept to a minimum
K12 Describe the process for checking that cutting tools are in a safe and usable condition and how to handle and store tools safely/correctly
K13 Define the effects of backlash in machine slides and screws, and how this can be overcome

Knowledge and understanding *The learner must:*	
K14	Describe the techniques of taking trial cuts and checking dimensional accuracy; the application of roughing and finishing cuts, and the effect on tool life, surface finish and dimensional accuracy
K15	Define the factors that affect the selection of cutting feeds and speeds, and the depth of cut that can be taken (e.g. type of material, type of tool used, size of material, operations being performed, workholding method/security of workpiece, condition of machine, finish and tolerance required)
K16	Explain the importance of the application of cutting fluids and compounds with regard to a range of different materials, and why some materials do not require cutting fluids to be used
K17	Define the checks to be carried out on the components before removing them from the machine, and the equipment that will need to be used (including micrometers, verniers and surface texture comparison methods)
K18	Describe the process for checking that the measuring equipment is within current calibration dates and that the instruments are correctly zeroed; measuring internal and external dimensions (e.g. lengths, diameters, depths, slots, hole positions, angles, profiles); measuring geometric features (e.g. flatness, squareness, parallelism, concentricity, ovality); how to check surface finish (e.g. by using comparison blocks or instruments)
K19	Describe the problems that can occur with the turning activities (e.g. defects caused by incorrectly ground tools, inappropriate feeds/speeds, damage by workholding devices), and how these can be overcome

Unit 14: Preparing and using Milling Machines

Level: 2

Guided learning hours: 140

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to prepare and use milling machines. This will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment.

The milling operations may be carried out on equipment such as horizontal, vertical or universal milling machines. They will be expected to prepare for the machining activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required milling activities and the sequence of operations they intend to use.

They will be required to prepare for the milling activities by mounting, positioning and correctly setting a range of workholding devices, to mount the workpiece and cutting tools and to set and use cutting feeds/speeds and techniques appropriate to the type of material, tooling, workpiece rigidity and operations being performed. They will be expected to produce components that combine a number of different features, such as flat faces, parallel faces, faces square to each other, angular faces, steps, open and enclosed slots, drilled, bored and reamed holes, internal threads, and special forms/profiles.

During, and on completion of, the milling operations, they will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and the tolerances to be achieved. They will need to be able to recognise milling defects, to take appropriate action to remedy any faults that occur and to ensure that the finished workpiece is within the drawing requirements. On completion of the machining activities, they will be expected to remove cutters and workholding devices, and to leave the milling machine and work area in a safe and tidy condition.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the milling activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the milling activities, and to seek appropriate help and advice in determining and implementing a suitable solution.

They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate milling techniques safely. They will understand the milling process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

They will understand the safety precautions required when working with the milling machine, and with its associated tools and equipment. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

In order to prove their ability to combine different milling features, at least one of the components produced must be of a significant nature, and must have a minimum of **five** of the features listed in paragraph 5 of the *Skills* section.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements

The learner must be able to:

P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines

P2 Demonstrate the required behaviours in line with the job role and company objectives

P3 Plan the machining activities before they start them

P4 Obtain and prepare the appropriate materials, tools and equipment

P5 Mount and set the required workholding devices, workpiece and cutting tools

P6 Set and adjust the machine tool speeds and feeds to achieve the component specification

P7 Use the machine tool controls safely and correctly, in line with operational procedures

P8 Measure and check that all dimensional and geometrical aspects of the component are to the specification

P9 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

P10 Shut down the equipment to a safe condition on completion of the machining activities

Skills

The learner must be able to:

1. Ensure that they apply **all** of the following checks and practices at all times during the machining activities:
   - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
   - 1.2 machine guards are in place and correctly adjusted
   - 1.3 components are held securely (without damage or distortion)
   - 1.4 cutting tools are maintained in a suitable/safe condition
   - 1.5 make sure the work area is maintained and left in a safe and tidy condition

2. Machine components made from **two** of the following types of material:
   - 2.1 low carbon/mild steel
   - 2.2 cast iron
   - 2.3 plastic/nylon/composite
   - 2.4 high carbon steel
   - 2.5 brass/brass alloys

Skills

The learner must be able to:

2.6 aluminium/aluminium alloys

2.7 other specific material

3. Mount, secure and machine components, using **two** of the following workholding devices:

3.1 fixed vice

3.2 direct clamping to machine table

3.3 magnetic or pneumatic devices

3.4 swivel or universal vice

3.5 angle plates

3.6 chucks

3.7 fixtures

3.8 vee block and clamps

3.9 indexing device

4. Mount and use **four** of the following types of milling cutters/tools:

4.1 face mills

4.2 slot cutters

4.3 twist/core drills

4.4 slab/cylindrical cutters

4.5 slitting saws

4.6 reamers

4.7 end mills

4.8 vee cutters

4.9 boring bars

4.10 slot drills

4.11 other form cutters

4.12 taps

4.13 side and face cutters

5. Produce machined components that combine different operations and have features that cover **all** of the following:

5.1 flat faces

5.2 parallel faces

5.3 open ended slots

Skills

The learner must be able to:

5.4 square faces

5.5 steps/shoulders

5.6 enclosed slots

Plus **two** more of the following:

5.7 angular faces

5.8 drilled holes

5.9 bored holes

5.10 indexed or rotated forms

5.11 recesses

5.12 tee slots

5.13 profile forms (such as vee, concave, convex, gear forms, serrations, special forms)

6. Carry out the necessary checks for accuracy, to include **all** of the following:

6.1 linear dimensions

6.2 surface finish

6.3 depths

6.4 slots (such as position, width, depth)

6.5 flatness

6.6 angles (where appropriate)

6.7 squareness

6.8 hole size/fit (where appropriate)

7. Use the following measuring equipment during the machining and checking activities:

7.1 external micrometers

7.2 dial test indicators (DTI)

7.3 Vernier/digital/dial callipers

7.4 surface finish equipment (such as comparison plates, machines)

Plus **four** more of the following

7.5 rules

7.6 feeler gauges

7.7 squares

7.8 bore/hole gauges

7.9 internal micrometers

Skills

The learner must be able to:

7.10 slip gauges

7.11 depth micrometers

7.12 radius/profile gauges

7.13 depth Verniers

7.14 protractors

7.15 coordinate measuring machine (CMM)

8. Produce components to **all** of the following quality and accuracy standards, as applicable to the operation:

8.1 components to be free from false tool cuts, burrs and sharp edges

8.2 general dimensional tolerance +/- 0.25mm or +/- 0.010”

8.3 there must be one or more specific dimensional tolerances within +/- 0.1mm or +/- 0.004”

8.4 flatness and squareness within 0.125mm per 25mm or 0.005” per inch

8.5 reamed holes within H8

8.6 surface finish 63 µin or 1.6µm

8.7 angles within +/- 1 degree

Knowledge and understanding

The learner must:

K1 Describe the hazards associated with the milling operations (e.g. revolving/moving parts of machinery, airborne and hot metal particles, sharp cutting tools and burrs and sharp edges on component), and how they can be minimised

K2 Define the safety mechanisms on the machine (e.g. emergency stop buttons, emergency brakes), and the procedure for checking that they function correctly

K3 Explain the correct operation of the machine controls in both hand and power modes

K4 Describe how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency

K5 Describe the process for planning and preparing to carry out the machining operations (e.g. obtaining the component drawing, determining the machines required, selecting materials, selecting workholding methods and devices, selecting cutting tools, determining a suitable sequence of operations, determining quality checks to be made and equipment to be used)

K6 Define the main features of the milling machine, and the accessories that can be used (such as vertical heads, indexing devices)

Knowledge and understanding *The learner must:*	
K7	Explain the importance of positioning and securing workholding devices to the machine table, and the checks to be made (e.g. ensuring all seating/location faces are clean and undamaged, ensuring that the device is suitably aligned using instruments or tenons, as appropriate, and checking that all bolts or other securing devices are tightened securely)
K8	Describe the effects of clamping the workpiece in a vice or other workholding device, and how this can cause damage or distortion in the finished components
K9	Define the various milling operations that can be performed, and the types of cutters that are used (e.g. face mills, slab/cylindrical cutters, side and face cutters, end mills, slot drills, form cutters, twist drills)
K10	Describe different methods of mounting and securing the cutting tools in the tool holding devices and to the machine spindle (e.g. face mills on stub arbors or direct to the machine spindle; slab mills/cylindrical cutters and side and face cutters on long arbors; end mills and slot drills in collet chucks; mounting drills in chucks or by the use of morse taper sockets)
K11	Explain how to position the workpiece in relation to the milling cutters to give conventional or climb milling conditions
K12	Describe the process for checking that the milling cutters are in a safe and usable condition, and how to handle and store cutters safely
K13	Define the effects of backlash in machine slides and screws, and how this can be overcome
K14	Describe the techniques of taking trial cuts and checking dimensional accuracy; the application of roughing and finishing cuts and the effect on tool life, surface finish and dimensional accuracy
K15	Define the factors that affect the selection of cutting feeds and speeds, and the depth of cut that can be taken (e.g. type of material, type of tool used, operations being performed, workholding method/security of workpiece, condition of machine, finish and tolerance required)
K16	Explain the importance of the application of cutting fluids and compounds with regard to a range of different materials, and why some materials do not require cutting fluids to be used
K17	Define the checks to be carried out on the components before removing them from the machine, and the equipment that will need to be used (including micrometers, verniers and surface texture comparison methods)
K18	Describe the process for checking that the measuring equipment is within current calibration dates and that the instruments are correctly zeroed; measuring linear dimensions (e.g. lengths, depths, slots, positions, angles, profiles); measuring geometric features (e.g. flatness, squareness, parallelism); how to check surface finish (e.g. by using comparison blocks or instruments)
K19	Describe the problems that can occur with the milling activities (such as defects caused by worn cutters, inappropriate feeds/speeds, damage by workholding devices), and how these can be overcome

Unit 15: Preparing and Proving CNC Machine Tool Programs

Level: 2

Guided learning hours: 140

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to prepare and prove CNC machine tool programs. This will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competencies in the working environment.

They will be required to produce the component program, using manual data input or by use of a remote computer, saving the prepared program on to a storage device or by downloading it into the machine controller from the computer.

They will be expected to prepare part programs, using operational sequences and machining techniques that avoid unnecessary tool/cutter movements or tool changes, and to use repetitive programs and canned cycles, to reduce program size and input time. They will prepare component programs that combine a number of different operations, such as parallel, stepped and tapered diameters, drilled, bored and reamed holes, internal and external threads, flat, square and parallel faces, angular faces, slots and recesses, special forms and profiles.

They will need to check the program using single block run and program edit facilities. They will also be required to adjust the machine tool equipment and program, following proving/editing procedures, to achieve component specification. They must ensure that any edited programs are saved safely and correctly.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the programming activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the programming activities, and to seek appropriate help and advice in determining and implementing a suitable solution. They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they produce.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate CNC programming and proving techniques safely. They will understand the CNC programming process, and its application, and will know about the machine operating programs and setting-up procedures, to the required depth to provide a sound basis for carrying out the programming activities to the required specification.

They will understand the safety precautions required when working with the CNC machines, and with their associated tools and equipment. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

In order to prove their ability to produce programs that combine different features, at least one of the programs produced must be of a significant nature, and must cover a minimum of **five** of the features listed in paragraph 5 of the *Skills* section.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements

The learner must be able to:

P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines

P2 Demonstrate the required behaviours in line with the job role and company objectives

P3 Plan the programming activities before they start them

P4 Determine an operational sequence that avoids wasted tool/cutter movements and tool changes

P5 Develop component programs using appropriate programming codes and techniques

P6 Specify positional information and machine axes that are consistent with the requirements of each stage/operation

P7 Load/input the program to the machine controller, and check/prove the program for errors using approved procedures

P8 Save and store the program in line with organisational procedures

P9 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

P10 Shut down the equipment to a safe condition on completion of the programming activities

Skills

The learner must be able to:

1. Ensure that they apply **all** of the following checks and practices at all times during the programming activities:

    1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations

    1.2 the correct component drawings are obtained and checked for currency and validity

    1.3 the appropriate reference manuals and programming codes are used to suit the machine controller

    1.4 the machine controller is prepared ready to accept the operating program

    1.5 the prepared program is input/loaded into the controller safely and correctly

    1.6 programs are stored safely and correctly in the appropriate format

    1.7 program media is stored safely and correctly, away from contaminants and corruption

Skills

The learner must be able to:

2. Prepare and prove programs for **one** of the following types of CNC machine tool:
   - 2.1 two axis machine
   - 2.2 multiple axis machines (5 or more)
   - 2.3 three axis machine
   - 2.4 machining centres

3. Produce CNC programs using **one** of the following methods:
   - 3.1 entered directly into the machine controller
   - 3.2 using computer software

4. Develop part programs which contain **all** of the following, as applicable to the machine type:
   - 4.1 all necessary positional information
   - 4.2 appropriate codes
   - 4.3 machine management commands (preparatory/auxiliary functions)
   - 4.4 repetitions within programs (using features such as subroutines, canned cycles, labels)
   - 4.5 absolute or incremental co-ordinates
   - 4.6 tool/cutter change positions
   - 4.7 tool information (such as lengths, offsets, radius compensation)

5. Develop programs to produce components which cover **eight** of the following features:
   - 5.1 parallel diameters
   - 5.2 angular faces
   - 5.3 enclosed slots/recesses
   - 5.4 stepped diameters
   - 5.5 internal profiles
   - 5.6 open ended slots
   - 5.7 tapered diameters
   - 5.8 external profiles
   - 5.9 eccentric diameters
   - 5.10 flat faces
   - 5.11 reamed holes

Skills

The learner must be able to:

5.12 external screw threads

5.13 internal undercuts

5.14 tapped holes

5.15 internal screw threads

5.16 external undercuts

5.17 drilled holes

5.18 chamfers and radii

5.19 steps/shoulders

5.20 holes on pitched circles

5.21 bored holes

5.22 parallel faces

5.23 holes linearly pitched

5.24 special forms (such as concave, convex)

5.25 faces that are square to each other

5.26 parting-off

6. Develop part programs to machine components made from **two** of the following types of material:

6.1 low carbon/mild steel

6.2 cast iron

6.3 plastic/nylon/composite

6.4 high carbon steel

6.5 brass/brass alloys

6.6 aluminium/aluminium alloys

6.7 other specific material

7. Prove the part program using **six** of the following:

7.1 single block mode

7.2 graphic displays/modelling

7.3 data input facilities

7.4 full dry run (in air)

7.5 search facilities

7.6 edit facilities

7.7 program override controls (spindle speed, feed rate, tool data)

7.8 program save/store facilities

Skills

The learner must be able to:

8. Confirm that the program operates safely and correctly, by checking **all** of the following:
   - 8.1 datums for each machine axis are set in relation to all equipment and tooling used
   - 8.2 all operations are carried out to the program co-ordinates
   - 8.3 tool change positions are safe and clear of the workpiece and machine equipment
   - 8.4 the correct tools are selected at the appropriate points in the program
   - 8.5 tool offsets are correctly entered into the machine controller
   - 8.6 tool cutter paths are executed safely and correctly
   - 8.7 auxiliary functions operate at the correct point in the program (cutter start/stop, coolant flow)
   - 8.8 programs have been saved in the appropriate format

Knowledge and understanding

The learner must:

K1 Describe the hazards associated with using CNC machine tools (e.g. automatic machine operations, power operated chucks, revolving/moving parts of machinery, airborne and hot metal particles, sharp cutting tools and burrs and sharp edges on component), and how they can be minimised

K2 Define the safety mechanisms on the machine (e.g. emergency stop buttons, emergency brakes), and describe the procedure for checking that they function correctly

K3 Explain the correct operation of the various hand and automatic modes of machine control (e.g. program operating and control buttons)

K4 Describe how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency

K5 Describe the computer coding language used in CNC programs (with regard to machine axes, positional information, machine management and auxiliary functions)

K6 Define the use of features that enable reductions in program size and input time (e.g. canned cycles, subroutines and labels)

K7 Define the function keys and operating system of the machine computer control system being operated

K8 Describe the process for setting the machine control system in the programming and editing mode, download (input) and upload (output) modes

K9 Explain how to deal with error messages and faults on the program or equipment

Knowledge and understanding *The learner must:*
K10 Describe the steps needed to access the program edit facility, in order to enter tooling data (e.g. tool datums, positions, lengths, offsets and radius compensation)
K11 Define the use of tool posts, magazines, carousels and turrets, and how to identify the tools in relationship to the operating program
K12 Explain the importance of conducting trial runs (using single block run, dry run and feed and spindle speed override controls)
K13 Define the factors that may affect the feeds and spindle speeds being used, and why they may need to be adjusted from the programmed values (e.g. condition of material, workholding method, tooling used, tolerance and finish to be achieved)
K14 Define the checks to be made before allowing the CNC machine to operate in full program run mode
K15 Describe the typical problems that can occur with the programming, loading and editing activities, and what to do if they occur
K16 Define the methods and procedures used to minimise the chances of infecting a computer with a virus
K17 Describe the implications if the computer they are using does become infected with a virus and who to contact if it does occur

Unit 16: Preparing and using CNC Turning Machines

Level: 2

Guided learning hours: 140

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to prepare and use CNC turning machines. This will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment.

In preparing the machine, they will be expected to select the appropriate workholding devices, and to mount and secure them to the machine spindle. They will be required to select the appropriate cutting tools, to mount and secure them to the appropriate tool holding devices, and to place the cutting tools in the relevant positions within the tool posts, turrets, slides or tool change magazine/carousel, where this is applicable.

They will need to ensure that all the tools have been allocated a relevant tool number, and that the relevant data on their co-ordinates and datum positions is entered into the operating program and machine. This will involve loading and checking component programs, checking for errors/faults, and editing and saving program changes. They will also be required to adjust the machine tool equipment and program, following editing procedures, to achieve component specification. They will be expected to produce components that combine a number of different features, such as parallel, stepped and tapered diameters, drilled, bored and reamed holes, internal and external threads, and special forms/profiles.

During, and on completion of, the turning operations, they will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and the tolerances to be achieved. On completion of the turning activities, they will be expected to remove all cutting tools and workholding devices, and to leave the machine and work area in a safe and tidy condition.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the CNC turning activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the turning activities, and to seek appropriate help and advice in determining and implementing a suitable solution. They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they produce.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate CNC setting and turning techniques safely. They will understand the CNC turning process, and its application, and will know about the equipment, workholding devices, tooling, machine operating programs and setting-up procedures, to the required depth to provide a sound basis for carrying out the turning activities to the required specification.

They will understand the safety precautions required when working with the CNC lathe, and with its associated tools and equipment. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

In order to prove their ability to combine different turning operations, at least one of the machined components produced must be of a significant nature, and must have a minimum of **five** of the features listed in paragraph 5 of the *Skills* section.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements

The learner must be able to:

P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines

P2 Demonstrate the required behaviours in line with the job role and company objectives

P3 Plan the CNC machining activities before they start them

P4 Load/input the program to the machine controller and check the program for errors using the approved procedures

P5 Mount and set the required workholding devices, workpiece and cutting tools

P6 Check that all safety mechanisms are in place, and that the equipment is set correctly for the required operations

P7 Run the operating program, and check and adjust the machine tool speeds, feeds and operating parameters to achieve the component specification

P8 Measure and check that all dimensional and geometrical aspects of the component are to the specification

P9 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

P10 Shut down the equipment to a safe condition on completion of the machining activities

Skills

The learner must be able to:

1. Ensure that they apply **all** of the following checks and practices at all times during the turning activities:
   - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
   - 1.2 machine guards are in place and correctly adjusted
   - 1.3 components are held securely (without damage or distortion)
   - 1.4 cutting tools are maintained in a suitable/safe condition
   - 1.5 the work area is maintained and left in a safe and tidy condition

2. Position and secure workpieces, using **two** of the following workholding methods and devices:
   - 2.1 chucks with hard jaws
   - 2.2 chucks with soft jaws
   - 2.3 fixtures
   - 2.4 drive centres

Skills *The learner must be able to:*
2.5 collet chucks 2.6 faceplates 2.7 magnetic/pneumatic devices 2.8 other workholding devices

Skills *The learner must be able to:*
3. Select and mount the appropriate tool holding device and **six** of the following types of cutting tool: 3.1 roughing tool 3.2 screw-thread tool 3.3 centre drills 3.4 reamers 3.5 finishing tool 3.6 profiling tools 3.7 twist/core drills 3.8 maxi-tipped drills 3.9 parting-off tool 3.10 form tools 3.11 boring tools 3.12 carbide insert drills 4. Prepare the tooling for operation by carrying out **all** the following activities, as applicable to the machine type: 4.1 positioning tools in the correct location in the tool posts, turrets, magazine or carousel 4.2 checking the tool numbers in relation to the CNC program 4.3 entering relevant tool data (such as tool lengths, tool offsets, radius compensation) into the CNC program or control system, as appropriate 4.4 pre-setting tooling using setting jigs/fixtures 4.5 setting tool datum 4.6 saving changes to the program

Skills

The learner must be able to:

5. Produce machined components that combine different operations and have features that cover **all** of the following:

   5.1 parallel diameters

   5.2 stepped diameters

   5.3 flat face

   5.4 drilled holes

   5.5 chamfers and radii

   Plus **four** more from the following

   5.6 tapered diameters

   5.7 external profiles

   5.8 parting-off

   5.9 internal screw threads

   5.10 undercuts

   5.11 reamed holes

   5.12 eccentric diameters

   5.13 bored holes

   5.14 internal profiles

   5.15 tapped holes

   5.16 external screw threads

6. Confirm that the machine and program operate safely and correctly, by checking **all** of the following:

   6.1 datums for each machine axis are set in relation to all equipment and tooling used

   6.2 the machining carried out meets the drawing specification

   6.3 tool change positions are safe and clear of the workpiece and machine equipment

   6.4 the correct tools are selected at the appropriate points in the program

   6.5 tool offsets are correctly entered

   6.6 tool cutter paths are executed safely and correctly

   6.7 auxiliary/miscellaneous functions operate at the correct point in the program (cutter start/stop, coolant flow)

   6.8 programs have been saved in the appropriate format

Skills

The learner must be able to:

7. Machine components made from **two** of the following types of material:
   - 7.1 low carbon/mild steel
   - 7.2 cast iron
   - 7.3 plastic or composite
   - 7.4 high carbon steel
   - 7.5 brass/brass alloys
   - 7.6 aluminium/aluminium alloys
   - 7.7 other specific material

8. Carry out the necessary checks for accuracy, to include **all** of the following:
   - 8.1 external diameters
   - 8.2 parallelism/cylindricity
   - 8.3 linear dimensions (such as lengths, depths)
   - 8.4 surface finish

   Plus **four** more from the following:
   - 8.5 internal diameters
   - 8.6 concentricity/coaxiality
   - 8.7 bore/hole size/fit
   - 8.8 grooves/undercuts (such as position, width, depth)
   - 8.9 angle/taper
   - 8.10 eccentricity
   - 8.11 thread fit
   - 8.12 ovality

9. Use **all** of the following measuring equipment during the machining and checking activities:
   - 9.1 external micrometers
   - 9.2 dial test indicators (DTI)
   - 9.3 Vernier/digital/dial callipers
   - 9.4 surface finish equipment (such as comparison plates, machines)

   Plus **four** more of the following:
   - 9.5 rules
   - 9.6 bore/hole gauges
   - 9.7 internal micrometers
   - 9.8 thread gauges (such as ring, plug, profile)

Skills

The learner must be able to:

9.9 depth micrometers

9.10 plug gauges

9.11 depth Verniers

9.12 radius/profile gauges

9.13 slip gauges

9.14 protractors

9.15 coordinate measuring machine (CMM)

10. Produce components to **all** of the following quality and accuracy standards, as applicable to the operation:

10.1 components to be free from false tool cuts, burrs and sharp edges

10.2 general dimensional tolerance +/- 0.25mm or +/- 0.010”

10.3 there must be one or more specific dimensional tolerances within +/- 0.1mm or +/- 0.004”

10.4 surface finish 63 µin or 1.6µm

10.5 reamed holes within H8

10.6 screw threads BS medium fit

10.7 angles/tapers within +/- 0.5 degree

Knowledge and understanding

The learner must:

K1 Describe the hazards associated with the using CNC lathes, (e.g. automatic machine operations, power operated chucks, revolving/moving parts of machinery, airborne and hot metal particles, sharp cutting tools, and burrs and sharp edges on components), and how they can be minimised

K2 Define the safety mechanisms on the machine (e.g. emergency stop buttons, emergency brakes), and describe the procedure for checking that they function correctly

K3 Explain the correct operation of the various hand and automatic modes of machine control (e.g. program operating and control buttons)

K4 Describe how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency

K5 Describe the computer coding language used in CNC programs, with regard to machine axis, positional information, machine management and auxiliary/miscellaneous functions

K6 Describe the process for setting the machine controller in the program and editing mode, and how to enter or download the prepared program

Knowledge and understanding *The learner must:*	
K7	Explain how to deal with error messages and faults on the program or equipment
K8	Define the range of workholding methods and devices that are used on CNC lathes
K9	Explain the importance of setting the workholding device in relationship to the machine datums and reference points
K10	Define the methods of setting the workholding devices, and the tools and equipment that can be used
K11	Define the range of cutting tools that are used on CNC lathes, and typical applications
K12	Describe the process for checking that the cutting tools are in a safe and serviceable condition
K13	Define the use of tungsten carbide, ceramic and diamond indexible tips, and the factors that determine their selection and use (e.g. the condition of material supplied, hardness of the material, the cutting characteristics of the material, tolerances to be achieved, component surface finish and specifications)
K14	Define the various tool holding devices that are used, and the methods of correctly mounting and securing the cutting tools to the tool holders
K15	Explain the advantages of using pre-set tooling, and describe how to set the tooling by using setting jigs/fixtures
K16	Define the use of tool posts, magazines and carousels, and how to position and identify the tools in relationship to the operating program
K17	Describe the steps needed to place the machine into the correct operating mode, and how to access the program edit facility in order to enter tooling data (e.g. tool datums, positions, lengths, offsets and radius compensation)
K18	Explain the importance of conducting trial runs using single block run, dry run, and feed and speed override controls
K19	Define the checks that are needed before allowing the machine to operate in full program run mode
K20	Define the factors that affect the feeds and speeds that can be used, and why these may need to be adjusted from the program setting (e.g. type and condition of material, workholding method, tooling used, tolerance and finish to be achieved)
K21	Explain the importance of the application of cutting fluids with regard to a range of different materials, and why some materials do not require the use of cutting fluids
K22	Explain the importance of storing programs and storage devices safely and correctly, away from contaminants and possible corruption
K23	Describe the typical problems that can occur with the CNC turning activities, and what to do if they occur

Unit 17: Preparing and using CNC Milling Machines

Level: 2

Guided learning hours: 140

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to prepare and use CNC milling machines. This will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment.

In preparing the milling machine, they will be expected to select the appropriate workholding devices, and to mount and secure them to the machine table. They will be required to select the appropriate milling cutters/cutting tools, to mount and secure them to the appropriate tool holding devices and machine spindle, or to place the cutting tools in the relevant positions within the turrets, slides or tool change magazine/carousel, where this is applicable.

They will need to ensure that all the tools have been allocated a relevant tool number, and that the relevant data on their co-ordinates and datum positions is entered into the operating program and machine. This will involve loading and checking component programs, checking for errors/faults, and editing and saving program changes. They will also be required to adjust the machine tool equipment and program, following editing procedures, to achieve component specification. They will be expected to produce components that combine a number of different features, such as flat faces, parallel faces, faces square to each other, faces at an angle, steps/shoulders, open and enclosed slots, drilled, bored and reamed holes, internal threads, and special forms/profiles.

During, and on completion of, the milling operations, they will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and the tolerances to be achieved. On completion of the milling activities, they will be expected to remove all cutting tools and workholding devices, and to leave the machine and work area in a safe and tidy condition.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the CNC milling activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the milling activities, and to seek appropriate help and advice in determining and implementing a suitable solution.

They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they produce.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate CNC setting and milling techniques safely. They will understand the CNC milling process, and its application, and will know about the equipment, workholding devices, tooling, machine operating programs and setting-up procedures, to the required depth to provide a sound basis for carrying out the milling activities to the required specification.

They will understand the safety precautions required when working with the CNC milling machine, and with its associated tools and equipment. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

In order to prove their ability to combine different milling operations, at least one of the machined components produced must be of a significant nature, and must have a minimum of **five** of the features listed in paragraph 5 of the *Skills* section.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements

The learner must be able to:

P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines

P2 Demonstrate the required behaviours in line with the job role and company objectives

P3 Plan the CNC machining activities before they start them

P4 Load/input the program to the machine controller and check the program for errors using the approved procedures

P5 Mount and set the required workholding devices, workpiece and cutting tools

P6 Check that all safety mechanisms are in place, and that the equipment is set correctly for the required operations

P7 Run the operating program, and check and adjust the machine tool speeds, feeds and operating parameters to achieve the component specification

P8 Measure and check that all dimensional and geometrical aspects of the component are to the specification

P9 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

P10 Shut down the equipment to a safe condition on completion of the machining activities

Skills

The learner must be able to:

1. Ensure that they apply **all** of the following checks and practices at all times during the milling activities:
   - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
   - 1.2 machine guards are in place and correctly adjusted
   - 1.3 components are held securely (without damage or distortion)
   - 1.4 cutting tools are maintained in a suitable/safe condition
   - 1.5 the work area is maintained and left in a safe and tidy condition

2. Position and secure workpieces, using **two** of the following workholding methods and devices:
   - 2.1 machine vices
   - 2.2 direct clamping to machine table
   - 2.3 fixtures
   - 2.4 pneumatic or magnetic table
   - 2.5 chucks

Skills

The learner must be able to:

2.6 ancillary indexing devices

2.7 angle plate

2.8 other workholding devices

3. Select and mount **four** of the following types of milling cutters to the appropriate tool holding device:

3.1 face mills

3.2 reamers

3.3 end mills

3.4 slot drills

3.5 twist/core drills

3.6 special profile cutters

3.7 boring tools

4. Prepare the tooling for operation, by carrying out **all** of the following activities, as applicable to the machine type:

4.1 securing tools to the machine spindle or positioning tools in the correct position in the tool magazine/carousel

4.2 checking that tools have specific tool number in relation to the operating program

4.3 entering all relevant tool data to the operating program (such as tool lengths, tool offsets, radius compensation)

4.4 pre-setting tooling using setting jigs/fixtures (where appropriate)

4.5 setting tool datum

4.6 saving changes to the program

5. Produce machined components that combine different operations and have features that cover **all** of the following:

5.1 flat faces

5.2 open ended slots

5.3 drilled holes linearly pitched

5.4 steps/shoulders

5.5 enclosed slots/recesses

Plus **three** more from the following:

5.6 parallel faces

5.7 external profiles

Skills

The learner must be able to:

5.8 tapped holes

5.9 square faces

5.10 drilled holes on pitched circles

5.11 circular/curved profiles

5.12 angular faces

5.13 bored holes

5.14 special forms (such as concave, convex)

5.15 internal profiles

5.16 reamed holes

6. Confirm that the machine and program operates safely and correctly, by checking **all** of the following:

6.1 datums for each machine axis are set in relation to all equipment and tooling used

6.2 all operations are carried out to the program co-ordinates

6.3 tool change positions are safe and clear of the workpiece and machine equipment

6.4 the correct tools are selected at the appropriate points in the program

6.5 tool offsets are correctly entered into the machine controller

6.6 tool cutter paths are executed safely and correctly

6.7 auxiliary functions operate at the correct point in the program (such as cutter start/stop, coolant flow)

6.8 programs have been saved in the appropriate format

7. Machine components made from **two** of the following types of material:

7.1 low carbon/mild steel

7.2 cast iron

7.3 plastic/nylon/composite

7.4 high carbon steel

7.5 brass/brass alloys

7.6 aluminium/aluminium alloys

7.7 other specific material

Skills

The learner must be able to:

8. Carry out the necessary checks for accuracy, to include **all** of the following:
   - 8.1 linear dimensions (such as lengths, depths)
   - 8.2 flatness
   - 8.3 slots (such as position, width, depth)
   - 8.4 surface finish

   Plus **four** more from the following:
   - 8.5 squareness
   - 8.6 angles
   - 8.7 parallelism
   - 8.8 recesses
   - 8.9 hole size/fit
   - 8.10 thread fit

9. Use **all** of the following measuring equipment during the machining and checking activities:
   - 9.1 external micrometers
   - 9.2 dial test indicators (DTI)
   - 9.3 Vernier/digital/dial callipers
   - 9.4 surface finish equipment (such as comparison plates, machines)

   Plus **four** more of the following:
   - 9.5 rules
   - 9.6 bore/hole gauges
   - 9.7 internal micrometers
   - 9.8 thread gauges
   - 9.9 depth micrometers
   - 9.10 plug gauges
   - 9.11 depth Verniers
   - 9.12 radius/profile gauges
   - 9.13 slip gauges
   - 9.14 Vernier protractors
   - 9.15 coordinate measuring machine (CMM)

Skills

The learner must be able to:

10. Produce components to **all** of the following quality and accuracy standards, as applicable to the operation:
    - 10.1 components to be free from false tool cuts, burrs and sharp edges
    - 10.2 general dimensional tolerance +/- 0.25mm or +/- 0.010”
    - 10.3 there must be one or more specific dimensional tolerances within +/- 0.1mm or +/- 0.004”
    - 10.4 surface finish 63 µin or 1.6µm
    - 10.5 reamed holes within H8
    - 10.6 screw threads BS medium fit
    - 10.7 angles/tapers within +/- 0.5 degree
    - 10.8 flatness and squareness 0.001” per inch or 0.025mm per 25mm

Knowledge and understanding

The learner must:

K1 Describe the hazards associated with the using CNC milling machines (e.g. automatic machine operations, revolving/moving parts of machinery, airborne and hot metal particles, sharp cutting tools, lifting and handling workholding devices, and burrs and sharp edges on component), and how they can be minimised

K2 Define the safety mechanisms on the machine (e.g. emergency stop buttons, emergency brakes), and the procedure for checking that they function correctly

K3 Explain the correct operation of the various hand and automatic modes of machine control (e.g. program operating and control buttons)

K4 Describe how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency

K5 Describe the computer coding language used in CNC programs (with regard to machine axis, positional information, machine management and auxiliary functions)

K6 Describe the process for setting the machine controller in the program and editing mode, and how to enter or download the prepared program

K7 Explain how to deal with error messages and faults on the program or equipment

K8 Define the range of workholding methods and devices that are used on CNC milling machines

K9 Explain the importance of setting the workholding device in relationship to the machine axis and reference points

K10 Define the methods of setting the workholding devices, and the tools and equipment that can be used

Knowledge and understanding *The learner must:*
K11 Define the range of milling cutters/cutting tools that are used on CNC milling machines, and their typical applications
K12 Describe the process for checking that the cutting tools are in a safe and serviceable condition
K13 Define the use of tungsten carbide, ceramic and diamond indexible tips, and the factors which will determine their selection and use (e.g. the condition of material supplied, hardness of the material, the cutting characteristics of the material, tolerances to be achieved, component surface finish and specifications)
K14 Define the various tool holding devices that are used, and the methods of correctly mounting and securing the cutting tools to the tool holders and machine spindle
K15 Explain the advantages of using pre-set tooling, and how to set the tooling by using setting jigs/fixtures
K16 Define the use of tool magazines and carousels, and how to position and how identify the tools in relationship to the operating program
K17 Describe the steps needed to place the machine into the correct operating mode, and how to access the program edit facility in order to enter tooling data (e.g. tool datums, positions, lengths, offsets and radius compensation)
K18 Explain the importance of conducting trial runs (using single block run, dry run, and feed and speed override controls)
K19 Define the checks that are needed before allowing the machine to operate in full program run mode
K20 Define the factors that affect the feeds and speeds that can be used, and why these may need to be adjusted from the program setting (e.g. type and condition of material, workholding method, tooling used, tolerance and finish to be achieved)
K21 Explain the importance of the application of cutting fluids with regard to a range of different materials, and why some materials do not require the use of cutting fluids
K22 Explain the importance of storing programs and storage devices safely and correctly, away from contaminants and possible corruption
K23 Describe typical problems that can occur with the CNC milling activities, and what to do if they occur

Unit 18: Maintaining Mechanical Devices and Equipment

Level: 2

Guided learning hours: 175

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to maintain mechanical devices and equipment. This will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment.

They will be expected to prepare for the maintenance activities by obtaining all necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required maintenance activities and the sequence of operations they intend to use.

They will be required to select the appropriate equipment to use, based on the maintenance operations to be carried out and the type of mechanical equipment being maintained. This will include equipment such as gearboxes, pumps, machine tools, conveyor systems, workholding arrangements, engines, processing plant and equipment, and other organisation-specific equipment. They will be expected to use a variety of maintenance diagnostic techniques and procedures, such as gathering information from fault reports, using recognised fault-finding techniques and diagnostic aids, measuring, inspecting and operating the equipment.

They will then be expected to dismantle, remove and replace or repair any faulty units or components, on a variety of mechanical assemblies and sub-assemblies. This will include components such as shafts, bearings, couplings, gears, pulleys, clutches, brakes, levers and linkages, cams and followers, and other specific mechanical components. They will be expected to cover a range of maintenance activities, such as draining and removing fluids, releasing stored energy, labelling/proof marking to aid reassembly, dismantling components to the required level, dismantling components requiring pressure or expansion/contraction techniques, checking components for serviceability, replacing faulty components and 'lifed' items, setting, aligning and adjusting components, tightening fasteners to the required torque and making `off-load' checks of the maintained equipment.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the mechanical maintenance activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the maintenance activities, and to seek appropriate help and advice in determining and implementing a suitable solution.

They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate mechanical maintenance techniques and procedures safely. They will understand the maintenance process, and its application, and will know about the mechanical equipment being maintained, the equipment components, tools and consumables used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

They will understand the safety precautions required when carrying out the maintenance activities, and when using maintenance tools and equipment. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

In order to prove their ability to combine different maintenance operations, at least one of the maintenance activities must be of a significant nature, and must cover at least **seven** of the activities listed in the skills section, paragraph 4 plus the removal and replacement of a minimum of **five** of the components listed in paragraph 5 of the *Skills* section.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements *The learner must be able to:*	
P1	Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
P2	Demonstrate the required behaviours in line with the job role and company objectives
P3	Plan the maintenance activities before they start them
P4	Obtain all the information they need for the safe removal and replacement of the equipment components
P5	Obtain and prepare the appropriate tools and equipment
P6	Apply appropriate maintenance diagnostic techniques and procedures
P7	Use appropriate methods and techniques to remove and replace the required components
P8	Carry out tests on the maintained equipment, in accordance with the test schedule/defined test procedures
P9	Deal promptly and effectively with problems within their control and seek help and guidance from the relevant people if they have problems that they cannot resolve
P10	Leave the work area in a safe and tidy condition on completion of the maintenance activities

Skills *The learner must be able to:*		
1.	Carry out **all** of the following during the maintenance activity:	
	1.1	adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
	1.2	ensure the safe isolation of equipment (such as mechanical, electrical, gas, air or fluids), where appropriate
	1.3	follow job instructions, maintenance drawings and procedures
	1.4	check that the tools and test instruments are within calibration date, and are in a safe and usable condition
	1.5	ensure that the system is kept free from foreign objects, dirt or other contamination
	1.6	return all tools and equipment to the correct location on completion of the maintenance activities

Skills

The learner must be able to:

2. Carry out maintenance activities on **two** of the following types of mechanical equipment:
   - 2.1 gearboxes
   - 2.2 machine tools
   - 2.3 engines
   - 2.4 pumps
   - 2.5 compressors
   - 2.6 processing plant
   - 2.7 transfer equipment
   - 2.8 workholding devices
   - 2.9 process control valves
   - 2.10 mechanical structures
   - 2.11 lifting and handling equipment
   - 2.12 company-specific equipment

3. Use **four** of the following maintenance diagnostic techniques, tools and aids:
   - 3.1 fault-finding techniques (such as half-split, input/output, unit substitution)
   - 3.2 diagnostic aids (such as manuals, flow charts, troubleshooting guides, maintenance records)
   - 3.3 information gathered from fault reports
   - 3.4 visual checks (such as signs of leakage, damage, missing parts, wear/deterioration)
   - 3.5 alignment checks
   - 3.6 movement checks (such as excessive movement or clearance, loose fittings and connections)
   - 3.7 force/pressure checks (such as spring pressure, belt or chain tension)
   - 3.8 overheating checks (such as bearings, friction surfaces)
   - 3.9 sensory input (such as sight, sound, smell, touch)
   - 3.10 information from monitoring equipment or gauges
   - 3.11 operating (such as manual operation, timing and sequencing)
   - 3.12 test instrumentation measurement (such as pressure, flow, timing, sequence, movement)
   - 3.13 measuring instruments (such as dial test indicators, torque measuring devices, feeler gauges)

Skills

The learner must be able to:

4. Carry out **all** of the following maintenance activities, as applicable to the equipment being maintained:
   - 4.1 dismantling equipment to unit/sub-assembly level
   - 4.2 setting, aligning and adjusting replaced components
   - 4.3 dismantling units to component level
   - 4.4 proof marking/labelling of components
   - 4.5 tightening fastenings to the required torque
   - 4.6 checking components for serviceability
   - 4.7 making 'off-load' checks before starting up
   - 4.8 replacing all 'lifed' items (such as seals, bearings, gaskets)
   - 4.9 replenishing oils and greases
   - 4.10 replacing damaged/defective components

5. Remove and refit a range of mechanical components, to include **eight** of the following:
   - 5.1 shafts
   - 5.2 bearing and seals
   - 5.3 slides
   - 5.4 couplings
   - 5.5 fitting keys
   - 5.6 rollers
   - 5.7 gears
   - 5.8 springs
   - 5.9 housings
   - 5.10 clutches
   - 5.11 diaphragms
   - 5.12 actuating mechanisms
   - 5.13 valves and seats
   - 5.14 cams and followers
   - 5.15 structural components
   - 5.16 pistons
   - 5.17 chains and sprockets
   - 5.18 locking and retaining devices (such as circlips, pins)
   - 5.19 brakes
   - 5.20 pulleys and belts

Skills

The learner must be able to:

5.21 splines

5.22 levers and links

5.23 other specific components

6. Carry out checks on the maintained equipment, to include **three** of the following:

6.1 correct operation of moving parts

6.2 correct working clearance of parts

6.3 backlash in gears

6.4 belt/chain tension

6.5 bearing loading

6.6 torque loading of fasteners

6.7 operational performance

6.8 functionally test the system

7. Maintain mechanical equipment in compliance with **one** or more of the following:

7.1 organisational guidelines and codes of practice

7.2 equipment manufacturers' operation range

7.3 BS and/or ISO standards

Knowledge and understanding

The learner must:

K1 Describe hazards associated with carrying out mechanical maintenance activities (e.g. handling oils, greases, stored energy/force, misuse of tools, using damaged or badly maintained tools and equipment, not following laid-down maintenance procedures), and how to minimise them

K2 Describe the system isolation procedures or permit-to-work procedure that apply

K3 Describe the basic principles of how the equipment functions, its operating sequence, the working purpose of individual units/components and how they interact

K4 Describe the various maintenance diagnostic techniques and aids that can be used (such as fault reports, visual checks, measuring, movement and alignment checks, testing)

K5 Describe the various fault location techniques that can be used, and how they are applied (such as half-split, input-to-output, function testing, unit substitution, and equipment self-diagnostics)

Knowledge and understanding *The learner must:*	
K6	Explain methods for evaluating sensory information (sight, sound, smell, touch)
K7	Describe the sequence to be adopted for the dismantling/re-assembly of various types of assemblies
K8	Describe the methods and techniques used to dismantle/assemble mechanical equipment (e.g. release of pressures/force, proof marking, extraction, pressing, alignment)
K9	Explain methods of checking that components are fit for purpose, and how to identify defects and wear characteristics
K10	Describe the identification, application, fitting and removal of different types of bearings (e.g. roller, ring, thrust)
K11	Explain methods and techniques of fitting keys and splines
K12	Describe identification, application, fitting and removal of different types of gears
K13	Explain how to correctly tension belts and chains
K14	Describe the identification and application of different types of locking device
K15	Describe methods of checking that removed components are fit for purpose, and the need to replace 'lifed' items (e.g. seals and gaskets)
K16	Describe the uses of measuring equipment (e.g. micrometers, verniers, run-out devices and other measuring devices)
K17	Describe how to check that tools and equipment are free from damage or defect, are in a safe and usable condition, are within calibration, and are configured correctly for the intended purpose
K18	Describe how to make adjustments to components/assemblies to ensure that they function correctly (such as setting working clearance, setting travel, setting backlash in gears, preloading bearings)
K19	Describe the importance of making 'off-load' checks before running the equipment under power
K20	Describe the importance of completing maintenance documentation and/or reports following the maintenance activity
K21	Describe the problems associated with the mechanical maintenance activity, and how they can be overcome

Unit 19: Assembling and Testing Fluid Power Systems

Level: 2

Guided learning hours: 105

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to assemble and test fluid power systems. This will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment.

They will be expected to prepare for the assembly activities by obtaining all necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required assembly activities and the sequence of operations they intend to use. They will be required to select the appropriate equipment to use, based on the assembly operations to be carried out and the type of fluid power equipment being assembled, which will include hydraulic, pneumatic or vacuum systems.

In carrying out the fluid power assembly operations, they will be required to follow specific assembly techniques in order to assemble the various components, which will include rigid and flexible pipework, hoses, valves, actuators and cylinders, regulators, switches and sensors. The assembly activities will also include making all necessary checks and adjustments to ensure that fluid power components are correctly positioned and aligned, are dimensionally accurate and secure; pipework is dimensionally accurate and free from ripples, creases and damage; and joints are checked for security, with threaded devices tightened correctly. They will also be expected to carry out appropriate test procedures (such as leak or pressure) to confirm that the fluid power assembly meets the operational performance required.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the fluid power assembly activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the assembly activities, and to seek appropriate help and advice in determining and implementing a suitable solution. They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate fluid power assembly techniques and procedures safely. They will understand the assembly process, and its application, and will know about the fluid power equipment being assembled, the system components, tools and consumables used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

They will understand the safety precautions required when carrying out the assembly activities, and when using assembly tools and equipment. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

In order to prove their ability to combine different fluid power assembly operations, at least one of the fluid power assemblies produced must be of a significant nature, and must contain a minimum of **six** of the components listed in paragraph 3 of the *Skills* section.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements *The learner must be able to:*	
P1	Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
P2	Demonstrate the required behaviours in line with the job role and company objectives
P3	Plan the assembly activities before they start them
P4	Obtain all the information they need for the safe assembly of the fluid power system
P5	Obtain and prepare the appropriate components, assembly tools and test equipment
P6	Use the appropriate methods and techniques to assemble the components in their correct positions
P7	Secure the components, using the specified connectors and securing devices
P8	Check the completed assembly to ensure that all operations have been completed and that the finished system meets the required specification
P9	Carry out tests on the assembled system, in accordance with the test schedule/defined test procedures
P10	Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
P11	Leave the work area in a safe and tidy condition on completion of the assembly activities

Skills The learner must be able to:	
1.	Carry out **all** of the following during the assembly of the fluid power system:
	1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
	1.2 ensure the safe isolation of equipment (such as mechanical, electrical, gas, air or fluids)
	1.3 follow job instructions, assembly drawings and procedures
	1.4 check that assembly tools and test instruments to be used are within calibration date and are in a safe and usable condition
	1.5 ensure that the fluid power system is kept free from foreign objects, dirt or other contamination
	1.6 return all tools and equipment to the correct location on completion of the assembly activities

Skills

The learner must be able to:

2. Assemble **one** of the following types of fluid power system:
   - 2.1 pneumatic
   - 2.2 hydraulic
   - 2.3 vacuum

3. Produce fluid power assemblies that contain a range of components, including **all** of the following:
   - 3.1 pipes
   - 3.2 hoses
   - 3.3 valves
   - 3.4 cylinders/actuators

   Plus **six** more from the following:
   - 3.5 pumps
   - 3.6 lubricators
   - 3.7 switches
   - 3.8 bearings
   - 3.9 compressors
   - 3.10 pressure intensifiers
   - 3.11 sensors
   - 3.12 cables and wires
   - 3.13 accumulators
   - 3.14 regulators
   - 3.15 receivers
   - 3.16 gaskets and seals
   - 3.17 reservoirs/storage devices
   - 3.18 gauges/indicators
   - 3.19 filters
   - 3.20 motors
   - 3.21 coolers
   - 3.22 timers
   - 3.23 other specific components

Skills

The learner must be able to:

4. Apply fluid power assembly methods and techniques to include **all** of the following:
   - 4.1 checking components for serviceability
   - 4.2 applying screw fastener locking devices
   - 4.3 positioning equipment/components
   - 4.4 tightening fastenings to the required torque
   - 4.5 aligning pipework and connections
   - 4.6 applying hose/cable clips and fasteners
   - 4.7 dressing and securing pipes and hoses
   - 4.8 making de-energised checks before filling and/or pressurising the system
   - 4.9 setting, aligning and adjusting system components
   - 4.10 securing by using mechanical fixings

5. Carry out quality checks, to include **all** of the following, using appropriate equipment:
   - 5.1 the system is complete, as per specification
   - 5.2 connections to components are tightened to the required torque
   - 5.3 dimensions are within specification requirements
   - 5.4 components are correctly positioned
   - 5.5 pipework is free from ripple and creases
   - 5.6 components are correctly aligned
   - 5.7 electrical connections are correctly made (where applicable)
   - 5.8 direction and flow indicators on components are correct
   - 5.9 components are securely held in place

6. Carry out tests and adjustments on the assembled system, to include:
   - 6.1 leak test

   Plus **one** more from the following:
   - 6.2 pressure line pressure tests
   - 6.3 speed
   - 6.4 return line pressure test
   - 6.5 sequence
   - 6.6 flow
   - 6.7 operational performance

Skills

The learner must be able to:

6.8 contamination

6.9 correct sense/direction

7. Carry out **all** of the following checks to ensure the accuracy and quality of the tests carried out:

7.1 the test equipment is correctly calibrated

7.2 the test equipment used is appropriate for the tests being carried out

7.3 test procedures used are as recommended in the appropriate specifications

7.4 test readings are taken at the appropriate points, and where appropriate components are adjusted to give the required readings

7.5 test equipment is operated within its specification range

8. Produce fluid power assemblies which meet **all** of the following:

8.1 all components are correctly assembled and aligned, in accordance with the specification

8.2 moving parts are correctly adjusted and have appropriate clearances

8.3 the system functions in line with the specification requirements

8.4 the system is leak free or within acceptable/agreed tolerances

Knowledge and understanding

The learner must:

K1 Describe the hazards associated with carrying out assembly activities on fluid power equipment (e.g. handling fluids, stored energy/force, misuse of tools), and how these can be minimised

K2 Describe how to obtain and interpret drawings, charts, circuit and physical layouts, specifications, manufacturers' manuals, symbols used in fluid power, and other documents needed in the assembly activities

K3 Outline the procedure for obtaining components, materials and other consumables necessary for the assembly activities

K4 State the basic principles of how pneumatic, hydraulic and vacuum fluid power equipment functions, its operating sequence, the purpose of individual units/components and how they interact

K5 Describe the different types of pipework, fittings and manifolds, and their application

K6 Outline the identification and application of different types of valve (such as poppet, spool, piston, disc)

K7 Outline the identification and application of different types of sensors and actuators (such as rotary, linear, mechanical, electrical)

Knowledge and understanding *The learner must:*	
K8	Outline the identification and application of different types of cylinder (such as single acting, double acting)
K9	Outline the identification and application of different types of pump (such as positive and non-positive displacement)
K10	Outline the identification and application of different types compressors (such as screw, piston, rotary vane)
K11	Outline the application and fitting of static and dynamic seals
K12	Describe the techniques used to assemble/install fluid power equipment (e.g. marking out the positions of components; making pipe bends using fittings and by hand bending methods; connecting components using rigid and flexible pipework; using gaskets/seals and jointing/sealing compounds)
K13	Explain the need to ensure that pipework is supported at appropriate intervals, and the need to eliminate stress on the pipework connections
K14	Explain the need to ensure cleanliness of the fluid power system, and the ways of purging pipework before connection to components and pressure sources
K15	Outline the recognition of contaminants and the problems they can create, and the effects and likely symptoms of contamination in the system
K16	Describe the methods of testing the fluid power system; the types of test equipment to be used, and their selection for particular tests
K17	Explain how to make safety checks of the system before carrying out tests, to ensure that all pipes and components are secure and that moving parts are chocked or parked
K18	Explain how to connect suitably calibrated test equipment into the circuit, and how to connect the circuit to a suitable pressure source containing appropriate ancillary equipment
K19	Explain how to carry out the tests (e.g. applying test pressures in incremental stages; checking for leaks; taking appropriate test readings; adjusting appropriate components to give required operating conditions)
K20	Explain how to determine pressure settings, and their effect on the system
K21	Explain how to display/record test results, and the documentation used
K22	Explain how to interpret the test readings obtained, and the significance of the readings gained
K23	Describe the problems associated with the fluid power assembly and testing activity, and how they can be overcome

Unit 20: Producing Sheet Metal Components and Assemblies

Level: 2

Guided learning hours: 140

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to produce sheet metal components and assemblies. This will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment.

They will be expected to prepare for the sheet metalworking activities by obtaining all necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required cutting, forming and assembly activities, and the sequence of operations they intend to use.

They will be required to select the appropriate equipment to use, based on the type and thickness of material, the operations to be carried out and the accuracy to be achieved. In carrying out the cutting and shaping activities, they will need to use a range of hand tools, portable power tools and simple machines to produce a variety of shapes, profiles and forms. They will also be expected to produce simple sheet metal assemblies, using self-secured joints, thermal methods or mechanical fastening devices.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the sheet metalworking activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the activities, and to seek appropriate help and advice in determining and implementing a suitable solution. They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate sheet metalworking techniques and procedures safely. They will understand the cutting, forming and assembly process, and its application, and will know about the tools and equipment used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

They will understand the safety precautions required when carrying out sheet metalworking activities, and when using the various tools and equipment, especially with the use of guillotines and bending/forming equipment. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

In order to prove their ability to combine different sheet metal cutting and forming operations, at least one of the jobs produced must be of a significant nature, and must contain a minimum of three of the features listed in the skills section, paragraph 7 plus **three** of the features listed in paragraph 9 of the *Skills* section.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements

The learner must be able to:

P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines

P2 Demonstrate the required behaviours in line with the job role and company objectives

P3 Plan the sheet metalworking activities before they start them

P4 Obtain the appropriate tools and equipment for the sheet metalworking operations, and check that they are in a safe and usable condition

P5 Mark out the components for the required operations, using appropriate tools and techniques

P6 Cut and shape the materials to the required specification, using appropriate tools and techniques

P7 Use the appropriate methods and techniques to assemble and secure the components in their correct positions

P8 Measure and check that all dimensional and geometrical aspects of the component are to the specification

P9 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

P10 Leave the work area in a safe and tidy condition on completion of the fitting activities

Skills

The learner must be able to:

1. Carry out **all** of the following during the sheet metalworking activities:

    1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations

    1.2 ensure that all power tool cables, extension leads or air supply hoses are in a tested and serviceable condition

    1.3 return all tools and equipment to the correct location on completion of the sheet metalworking activities

    1.4 check that all measuring equipment is within calibration date

2. Use marking out methods and techniques, including:

    2.1 direct marking using instruments

    Plus **one** more from the following:

    2.2 use of templates

    2.3 tracing/transfer methods

Skills

The learner must be able to:

3. Use a range of marking out equipment, to include **all** of the following:
   - 3.1 scriber
   - 3.2 rule or tape
   - 3.3 square
   - 3.4 dividers or trammels
   - 3.5 punch
   - 3.6 straight edge
   - 3.7 protractor
   - 3.8 chalk, blueing or paint

4. Mark out material, to include **all** of the following features:
   - 4.1 datum and centre lines
   - 4.2 curved profiles
   - 4.3 square/rectangular profiles
   - 4.4 cutting and bending detail (including allowances)
   - 4.5 angles
   - 4.6 hole centring and outlining (such as circular or linear)
   - 4.7 circles

5. Cut and finish material to the marked out shape, using **both** of the following hand tools:
   - 5.1 tin snips
   - 5.2 bench shears

   Plus **two** more from the following:
   - 5.3 hacksaw
   - 5.4 files
   - 5.5 hand power tools (such as drill, nibbling, saw)
   - 5.6 pneumatic tools
   - 5.7 trepanning
   - 5.8 thermal device
   - 5.9 other specific tool

Skills

The learner must be able to:

6. Cut and finish material to the marked out shape, using the following machine tool:

   6.1 guillotine

   Plus **two** more of the following:

   6.2 pillar drill

   6.3 punch/cropping machine

   6.4 trepanning machine

   6.5 bench saw

   6.6 nibbling machine

   6.7 band saw

7. Perform cutting operations to produce components with **all three** of the following shapes:

   7.1 square or rectangular profiles

   7.2 angled profiles

   7.3 external curved profiles

   Plus **two** more from the following:

   7.4 notches

   7.5 internal curved contours

   7.6 round holes

   7.7 square holes

8. Use **both** of the following types of forming equipment/techniques:

   8.1 bending machine (hand or powered)

   8.2 rolling machine (hand or powered)

   Plus **two** more from the following:

   8.3 hammers/panel beating equipment

   8.4 wheeling machine

   8.5 stakes and formers

   8.6 swaging machine

   8.7 presses

   8.8 shrinking techniques

   8.9 jenny/wiring machine

   8.10 stretching techniques

Skills

The learner must be able to:

9. Carry out forming operations which produce components having **all** of the following shapes:
   - 9.1 bends/upstands
   - 9.2 tray/box sections
   - 9.3 folds/safe edges
   - 9.4 cylindrical sections

   Plus **one** more from the following:
   - 9.5 wired edges
   - 9.6 cowlings and rounded covers
   - 9.7 swages
   - 9.8 square to round trunking
   - 9.9 curved panels
   - 9.10 lobster-back trunking
   - 9.11 ribbed components
   - 9.12 concertina ducting or trunking

10. Assemble sheet metal components, using **two** of the following methods:
   - 10.1 temporary tack welding
   - 10.2 adhesive bonding
   - 10.3 soldering or brazing
   - 10.4 flanged and mechanically fastened (such as bolts, screws)
   - 10.5 resistance spot welding
   - 10.6 self-securing joints (such as knocked up, paned down, swaged, joggled)
   - 10.7 riveting (such as hollow or solid)

11. Use sheet metal (up to and including 3mm) in **two** different materials from the following:
   - 11.1 hot rolled mild steel
   - 11.2 cold rolled mild steel
   - 11.3 coated mild steel (such as primed, tinned, galvanised)
   - 11.4 copper
   - 11.5 brass
   - 11.6 lead
   - 11.7 stainless steel
   - 11.8 titanium
   - 11.9 aluminium

Skills

The learner must be able to:

12. Produce sheet metal components which meet **all** of the following:

    12.1 all dimensions are within +/- 2.0 mm or +/- 0.079”

    12.2 finished components meet the required shape/geometry (square, straight, angles free from twists)

    12.3 completed components are free from excessive tooling marks, deformation, cracking, sharp edges, slivers or burrs

    12.4 all components are correctly assembled and have secure and firm joints

Knowledge and understanding

The learner must:

K1 Describe the hazards associated with carrying out sheet metalworking activities (such as handling sheet materials, using dangerous or badly maintained tools and equipment, operating guillotines and bending machines, and when using hand and bench shears), and how they can be minimised

K2 Explain how to prepare the materials in readiness for the marking out activities, in order to enhance clarity, accuracy and safety (such as visually checking for defects, cleaning the materials, removing burrs and sharp edges, applying a marking out medium)

K3 Explain the importance of ensuring that marking out is undertaken from the selected datum, and the possible effects of working from a different datum

K4 Describe the use of marking out conventions when marking out the workpiece (including datum lines, cutting guidelines, square and rectangular profiles, circular and radial profiles, angles, holes linearly positioned, boxed and on pitch circles)

K5 Explain the importance of laying out the marking-out shapes or patterns to maximise use of materials

K6 Outline the tools and techniques available for cutting and shaping sheet metal (such as tin snips, bench shears, guillotines, portable power tools, bench drills, saws)

K7 Describe hand tools used in sheet metal forming activities (such as range of hammers, stakes, formers, sand bags), and typical operations that they are used for

K8 Describe the various machine tool forming equipment that can be used to produce a range of shapes (such as bends, box sections, cylinders and curved sections, wired edges and swages)

K9 Describe methods of stretching and shrinking materials, and the tools, equipment and techniques used for this *this knowledge criteria only applies if learner has chosen skill 8.8 or 8.10*

K10 Explain how to set up the various machines to produce the required forms (setting up of rolls; setting fingers on bending machines; setting forming tools for swaging)

Knowledge and understanding *The learner must:*
K11 Outline ways of limiting distortion, marking, creases, flats (in curved sections)
K12 Describe the characteristics of the various materials used (with regard to the bending and forming process)
K13 Explain how the materials are to be prepared for the forming operations, and why some materials may require a heating process prior to forming
K14 Describe the various methods of securing the assembled components, and the range of mechanical fastening devices that are used (such as nuts and bolts, rivets, screws, special fasteners), resistance and tack welding methods and techniques, adhesive bonding of components and self-secured joints (such as knocked up, paned down, swaged and joggled)
K15 Describe the preparations to be carried out on the components prior to assembling them
K16 Explain how to set up and align the various components, and the tools and equipment that are used for this
K17 Outline methods of temporarily holding the joints together to aid the assembly activities (such as clamps, rivet clamps)
K18 Describe the inspection techniques that can be applied to check that shape (including straightness) and dimensional accuracy are to specification and within acceptable limits
K19 Explain the problems that can occur with the sheet metalworking activities (such as defects caused by incorrectly set or blunt shearing blades), and how these can be overcome

Unit 21: Preparing and using Manual TIG or Plasma-arc Welding Equipment

Level: 2

Guided learning hours: 140

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to prepare and use manual tungsten inert gas (TIG) or plasma-arc welding equipment. This will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment.

They will be expected to prepare the welding equipment and to ensure that all the leads/cables, hoses and torches are securely connected and free from damage. They will also need to obtain and check that all the workholding equipment is in a safe and usable condition.

In preparing to weld, they will need to set and adjust the welding conditions in line with instructions and/or the welding procedure specification. They must operate the equipment safely and correctly, and make any necessary adjustments to settings in line with their permitted authority, in order to produce the welded joints to the required specification.

On completion of the welding operations, they will be expected to check the quality of the welds using measuring equipment, visual examination and destructive testing techniques, as appropriate to the aspects being checked. They will need to be able to recognise welding defects, to take appropriate action to limit any faults that occur and to ensure that the finished workpiece is within the specification requirements. On completion of the welding activities, they will be expected to return all tools, equipment and workholding devices to their designated location and to leave the welding equipment and work area in a safe and tidy condition.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the welding activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the welding activities, and to seek appropriate help and advice in determining and implementing a suitable solution.

They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate manual TIG or plasma-arc welding techniques safely. They will understand the welding process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification. They will understand the safety precautions required when working with the TIG or plasma-arc welding equipment, and with the associated tools and equipment. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

Welded joints must be at least 150 mm long, using single- or multi-run welds (as appropriate), with at least one stop and start included.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements *The learner must be able to:*	
P1	Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
P2	Demonstrate the required behaviours in line with the job role and company objectives
P3	Plan the welding activities before they start them
P4	Obtain and prepare the appropriate welding equipment and welding consumables
P5	Prepare and support the joint, using the appropriate methods
P6	Tack weld the joint at appropriate intervals, and check the joint for accuracy before final welding
P7	Weld the joint to the specified quality, dimensions and profile
P8	Use appropriate methods and equipment to check the quality, and that all dimensional and geometrical aspects of the weld are to the specification
P9	Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
P10	Shut down and make safe the welding equipment on completion of the welding activities

Skills *The learner must be able to:*		
1.	Prepare for the TIG or plasma-arc welding process by carrying out **all** of the following:	
	1.1	adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
	1.2	check the condition of and correctly connect welding leads, earthing arrangements, hoses and welding torch
	1.3	set and adjust the welding conditions/parameters, in accordance with the welding procedure specification
	1.4	prepare the work area for the welding activities (such as positioning welding screens and fume extraction)
	1.5	prepare the materials and joint in readiness for welding (such as cleaning of joint faces, grinding weld preparations, setting up the joint, supporting the joint)
	1.6	make sure that the work area is maintained and left in a safe and tidy condition

Skills

The learner must be able to:

2. Use manual welding and related equipment, to include **one** of the following welding processes:
   - 2.1 TIG
   - 2.2 Plasma-arc

3. Use welding consumables appropriate to the material and application, to include **one** of the following:
   - 3.1 AC current types
   - 3.2 DC current types

4. Produce **three** of the following welded joints of at least 150 mm long, by single or multi-run (as appropriate), with at least one stop and start included:
   - 4.1 fillet lap joints
   - 4.2 corner joints
   - 4.3 tee fillet joints
   - 4.4 butt joints

   And using **one** of the following methods:
   - 4.5 with filler wire
   - 4.6 without filler wire (autogenously)

5. Produce joints in the following: **one** type of material from the following:
   - 5.1 carbon steel
   - 5.2 stainless steel
   - 5.3 aluminium

   And **two** forms of material from the following:
   - 5.4 sheet (less than 3 mm)
   - 5.5 pipe/tube
   - 5.6 plate
   - 5.7 section
   - 5.8 other forms

6. Weld joints in good access situations, in **two** of the following BS EN ISO 6947 positions:
   - 6.1 Flat (PA)
   - 6.2 Vertical upwards (PF)
   - 6.3 Horizontal vertical (PB)

Skills

The learner must be able to:

6.4 Vertical downwards (PG)

6.5 Horizontal (PC)

7. Check that the welded joint conforms to the specification, by checking **all** of the following:

7.1 dimensional accuracy

7.2 size and profile of weld

7.3 number of runs

7.4 alignment/squareness

8. Carry out non-destructive testing of the welds, using **one** of the following:

8.1 dye penetrant

8.2 fluorescent penetrant

8.3 magnetic particle

9. Carry out destructive tests on weld specimens, using **one** of the following:

9.1 macroscopic examination

9.2 nick break test

9.3 bend tests (such as face, root or side, as appropriate)

10. Identify **all** of the following weld defects:

10.1 lack of continuity of the weld

10.2 uneven and irregular ripple formation

10.3 incorrect weld size or profile

Plus **four** more of the following:

10.4 undercutting

10.5 internal cracks

10.6 overlap

10.7 surface cracks

10.8 inclusions

10.9 lack of fusion

10.10 porosity

10.11 lack of penetration

Skills

The learner must be able to:

11. Produce welded joints which meet **all** of the following (with reference to BS 4872 Part 1 Weld test requirements):

    11.1 welds meet the required dimensional accuracy

    11.2 fillet welds are equal in leg length and slightly convex in profile (where applicable), with the size of the fillet equivalent to the thickness of the material welded

    11.3 the weld contour is linear, of uniform profile, free from excessive undulations, with regular and even ripple

    11.4 the welds are adequately fused, and there is minimal undercut, overlap and surface inclusions

    11.5 weld finishes are built up to the full section of the weld

    11.6 joins at stop/start positions merge smoothly, with no pronounced hump or crater in the weld surface

    11.7 tack welds are blended in to form part of the finished weld, without excessive hump

    11.8 corner joints have minimal burn through to the underside of the joint or, where appropriate, penetration is present to a maximum depth of 3 mm for at least 75% of the joint

    11.9 the weld surface is free from cracks, and substantially free from porosity, shrinkage cavities and trapped slag

    11.10 the weld surface and adjacent parent metal is substantially free from arcing or chipping marks

Knowledge and understanding

The learner must:

K1 State the hazards associated with TIG and plasma-arc welding, and how they can be minimised

K2 Describe the correct handling and storage of gas cylinders (e.g. manual handling and use of cylinder trolley, leak detection procedures, relevant BCGA codes of practice, cylinder identification, gas pressures, cylinder and equipment safety features)

K3 Describe the types, selection and application of filler wires and welding electrodes

K4 Explain the reasons for using shielding gases, and the types and application of the various gases

K5 Outline gas pressures and flow rates (in relationship to the type of material being welded)

K6 Describe the benefits and application of the welded joints to be produced (e.g. lap joints, corner joints, and butt welds)

Knowledge and understanding *The learner must:*	
K7	State the terminology used for the appropriate welding positions
K8	Describe how to prepare the materials in readiness for the welding activity (e.g. ensuring that the material is free from excessive surface contamination – such as rust, scale, paint, oil/grease and moisture; ensuring edges to be welded are correctly prepared - such as made flat, square or bevelled)
K9	Explain how to set up and restrain the joint, and the tools and techniques to be used (e.g. the use of jigs and fixtures, restraining devices such as clamps and weights/blocks; setting up the joint in the correct position and alignment)
K10	Outline tack welding size and spacing (in relationship to material thickness)
K11	Describe the checks to be made prior to welding (such as confirming the correct set-up of the joint; the condition of electrical connections, welding return and earthing arrangements; operating parameters)
K12	Describe the techniques of operating the welding equipment to produce a range of joints in the various joint positions (e.g. fine adjustment of parameters; correct manipulation of the torch; blending in stops/starts and tack welds)
K13	Explain how to control distortion (e.g. welding sequence; deposition technique)
K14	Describe the problems that can occur with the welding activities (e.g. causes of distortion and methods of control; effects of welding on materials and sources of weld defects), and how these can be overcome
K15	Explain how to close down the welding equipment safely and correctly
K16	Outline the safe working practices and procedures to be adopted when preparing the welds for examination (e.g. handling hot materials, using chemicals for cleaning and etching, using equipment to fracture welds)
K17	Explain how to prepare the welds for examination (such as removing surface irregularities; cleaning the weld, polishing and making saw cuts on welds to be fracture tested
K18	Describe how to check the welded joints for uniformity, alignment, position, weld size and profile
K19	Outline the various procedures for visual examination of the welds for cracks, porosity and slag inclusions (e.g. dye penetrant, fluorescent penetrant; magnetic particle testing)
K20	Outline the various procedures for carrying out destructive tests on the welds (e.g. macroscopic examination, bend tests, nick break tests)
K21	Describe methods of removing a specimen of weld from a suitable position in the joint (e.g. a stop/start position) using a non-thermal process (e.g. hand saws, power saws, abrasive discs)
K22	Explain how to examine the welds after the tests and how to check for such defects as the degree of penetration and fusion, inclusions, porosity, cracks, undercut and overlap, uneven and irregular ripple formation

Unit 22: Preparing and using Semi-automatic MIG, MAG and Flux Cored Arc Welding Equipment

Level: 2

Guided learning hours: 140

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to prepare and use semi-automatic MIG, MAG and flux cored arc welding equipment. This will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment.

They will be expected to prepare the welding equipment and to ensure that all leads/cables, shielding gas system, hoses and wire feed mechanisms are securely connected and free from damage. They will also need to obtain and check that all the workholding equipment is in a safe and usable condition.

In preparing to weld, they will need to set and adjust the welding conditions, in line with instructions and/or the welding procedure specification. They must operate the equipment safely and correctly, and make any necessary adjustments to settings in line with their permitted authority, in order to produce the welded joints to the required specification.

On completion of the welding operations, they will be expected to check the quality of the welds using measuring equipment, visual examination and destructive testing techniques, as appropriate to the aspects being checked. They will need to be able to recognise welding defects, to take appropriate action to limit any faults that occur and to ensure that the finished workpiece is within the specification requirements. On completion of the welding activities, they will be expected to return all tools, equipment and workholding devices to their designated location, and to leave the welding equipment and work area in a safe and tidy condition.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the welding activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the welding activities, and to seek appropriate help and advice in determining and implementing a suitable solution.

They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate semi-automatic MIG, MAG or flux cored wire welding techniques safely. They will understand the welding process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification. They will understand the safety precautions required when working with the MIG, MAG or flux cored wire welding equipment, and with the associated tools and equipment. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

Welded joints must be at least 150 mm long, using single- or multi-run welds (as appropriate), with at least one stop and start included.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements *The learner must be able to:*	
P1	Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
P2	Demonstrate the required behaviours in line with the job role and company objectives
P3	Plan the welding activities before they start them
P4	Obtain and prepare the appropriate welding equipment and welding consumables
P5	Prepare and support the joint, using the appropriate methods
P6	Tack weld the joint at appropriate intervals, and check the joint for accuracy before final welding
P7	Weld the joint to the specified quality, dimensions and profile
P8	Use appropriate methods and equipment to check the quality, and that all dimensional and geometrical aspects of the weld are to the specification
P9	Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
P10	Shut down and make safe the welding equipment on completion of the welding activities

Skills *The learner must be able to:*		
1.	Prepare for the MIG, MAG or flux cored wire arc welding process by carrying out **all** of the following:	
	1.1	adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
	1.2	check the condition of, and correctly connect, welding leads/cables, hoses, shielding gas supply and wire feed mechanisms
	1.3	set and adjust the welding conditions/parameters, in accordance with the welding procedure specification
	1.4	prepare the work area for the welding activities (such as positioning welding screens and fume extraction)
	1.5	prepare the materials and joint in readiness for welding (such as cleaning of joint faces, grinding weld preparations, setting up the joint, supporting the joint)
	1.6	make sure the work area is maintained and left in a safe and tidy condition

Skills

The learner must be able to:

2. Use manual/semi-automatic welding and related equipment to include **one** of the following:
   - 2.1 MIG
   - 2.2 MAG
   - 2.3 Flux cored wire welding equipment

3. Use consumables appropriate to the material and application, to include: **one** of the following wire types:
   - 3.1 solid wire
   - 3.2 cored wire

   Plus **one** of the following types of shielding gas:
   - 3.3 inert
   - 3.4 active

4. Produce **three** of the following welded joints of at least 150 mm long, by single or multi-run (as appropriate), with at least one stop and start included:
   - 4.1 fillet lap joints
   - 4.2 corner joints
   - 4.3 Tee fillet joints
   - 4.4 butt joints

5. Produce joints as follows: **one** type of material from the following:
   - 5.1 carbon steel
   - 5.2 stainless steel
   - 5.3 aluminium

   And **two** forms of material from the following:
   - 5.4 plate
   - 5.5 sheet (less than 3 mm)
   - 5.6 pipe/tube
   - 5.7 section
   - 5.8 other forms

6. Weld joints in good access situations in **two** of the following BS EN ISO 6947 positions:
   - 6.1 Flat (PA)
   - 6.2 Vertical upwards (PF)

Skills

The learner must be able to:

6.3 Horizontal vertical (PB)

6.4 Vertical downwards (PG)

6.5 Horizontal (PC)

7. Check that the welded joint conforms to the specification, by checking **all** of the following:

7.1 dimensional accuracy

7.2 size and profile of weld

7.3 number of runs

7.4 alignment/squareness

8. Carry out non-destructive testing of the welds, using **one** of the following:

8.1 dye penetrant

8.2 fluorescent penetrant

8.3 magnetic particle

9. Carry out destructive tests on weld specimens using **one** of the following:

9.1 macroscopic examination

9.2 nick break test

9.3 bend tests (such as face, root or side, as appropriate)

10. Identify **all** of the following weld defects:

10.1 lack of continuity of the weld

10.2 uneven and irregular ripple formation

10.3 incorrect weld size or profile

Plus **four** more of the following:

10.4 undercutting

10.5 internal cracks

10.6 overlap

10.7 surface cracks

10.8 inclusions

10.9 lack of fusion

10.10 porosity

10.11 lack of penetration

Skills

The learner must be able to:

11. Produce welded joints which meet **all** of the following (with reference to BS 4872 Part 1 Weld test requirements):
    - 11.1 welds meet the required dimensional accuracy
    - 11.2 fillet welds are equal in leg length and slightly convex in profile, with the size of the fillet equivalent to the thickness of the material welded
    - 11.3 the weld contour is linear, of uniform profile, free from excessive undulations, with regular and even ripple
    - 11.4 the welds are adequately fused, and there is minimal undercut, overlap and surface inclusions
    - 11.5 weld finishes are built up to the full section of the weld
    - 11.6 joins at stop/start positions merge smoothly, with no pronounced hump or crater in the weld surface
    - 11.7 tack welds are blended in to form part of the finished weld, without excessive hump
    - 11.8 corner joints have minimal burn through to the underside of the joint or, where appropriate, penetration is present to a maximum depth of 3 mm for at least 75% of the joint
    - 11.9 the weld surface is free from cracks, and substantially free from porosity, shrinkage cavities and trapped slag
    - 11.10 the weld surface and adjacent parent metal is substantially free from arcing or chipping marks

Knowledge and understanding

The learner must:

K1 State the hazards associated with MIG, MAG or flux cored wire arc welding, and how they can be minimised

K2 Describe the correct handling and storage of gas cylinders (e.g. manual handling and use of cylinder trolley, leak detection procedures, relevant BCGA codes of practice, cylinder identification, gas pressures, cylinder and equipment safety features)

K3 Describe the types, selection and application of electrode wires (e.g. solid and cored)

K4 Explain the reasons for using shielding gases, and the types and application of the various gases

K5 Outline gas pressures and flow rates (in relation to the type of material being welded)

K6 Describe the benefits and application of the welded joints to be produced (e.g. lap joints, corner joints, tee joints and butt welds)

K7 State the terminology used for the appropriate welding positions

Knowledge and understanding *The learner must:*	
K8	Describe how to prepare the materials in readiness for the welding activity (e.g. ensuring that the material is free from excessive surface contamination - such as rust, scale, paint, oil/grease and moisture; ensuring edges to be welded are correctly prepared - such as made flat, square or bevelled)
K9	Explain how to set up and restrain the joint, and the tools and techniques to be used (such as the use of jigs and fixtures, restraining devices - such as clamps and weights/blocks; setting up the joint in the correct position and alignment)
K10	Outline tack welding size and spacing (in relation to material thickness)
K11	Describe the checks to be made prior to welding (e.g. confirming the correct set-up of the joint; the condition of electrical connections, welding return and earthing arrangements; wire feed mechanisms; gas supply; operating parameters)
K12	Describe the techniques of operating the welding equipment to produce a range of joints in the various joint positions (e.g. fine adjustment of parameters; correct manipulation of the welding gun; blending in stops/starts and tack welds)
K13	Outline methods/modes of metal transfer and their uses (e.g. dip, globular, free flight, spray and pulsed)
K14	Explain how to close down the welding equipment safely and correctly
K15	Explain how to control distortion (e.g. welding sequence; deposition technique)
K16	Describe the problems that can occur with the welding activities (e.g. causes of distortion and methods of control; effects of welding on materials and sources of weld defects), and how these can be overcome
K17	Outline the safe working practices and procedures to be adopted when preparing the welds for examination (e.g. handling hot materials, using chemicals for cleaning and etching, using equipment to fracture welds)
K18	Explain how to prepare the welds for examination (e.g. removing surface irregularities; cleaning the weld, polishing and making saw cuts on welds to be break tested)
K19	Describe how to check the welded joints for uniformity, alignment, position, weld size and profile
K20	Outline the various procedures for visual examination of the welds for cracks, porosity and slag inclusions (e.g. dye penetrant, fluorescent penetrant; magnetic particle testing)
K21	Outline the various procedures for carrying out destructive tests on the welds (e.g. macroscopic examination, bend tests, nick break tests)
K22	Describe methods of removing a specimen of weld from a suitable position in the joint (such as a stop/start position), using a non-thermal process (such as hand saws, power saws, abrasive discs)
K23	Explain how to examine the welds after the tests, and how to check for such defects as the degree of penetration and fusion, inclusions, porosity, cracks, undercut and overlap, uneven and irregular ripple formation

Unit 23: Producing Composite Mouldings using Wet Lay-up Techniques

Level: 2

Guided learning hours: 140

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to produce composite mouldings using wet lay-up techniques. This will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment.

They will be expected to prepare for the wet lay-up moulding activities by obtaining all necessary information, documentation, materials, tools and equipment required, and to plan how they intend to carry out the moulding/laying up activities and the sequence of operations they intend to use.

They will be expected to prepare the tooling, apply release agents and prepare the composite materials. They will produce composite mouldings, which will incorporate a range of features, using a range of application methods. Mouldings produced will include laminates and sandwich structures, using suitable resin, fibre and core materials. The activities will also include making all necessary visual and dimensional checks, to ensure that the mouldings meet the required specification and have an appropriate cosmetic appearance.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the wet lay-up production activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the activities, and to seek appropriate help and advice in determining and implementing a suitable solution. They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate composite moulding wet lay-up techniques and procedures safely. They will understand the moulding/laying-up procedure, and its application, and will know about the equipment, materials and consumables, to the required depth to provide the basis for carrying out the activities to the required specification.

They will understand the safety precautions required when carrying out the wet lay-up moulding activities, and when using the associated tools and equipment. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

In order to prove their ability to combine different wet lay-up operations, at least one of the components produced must be of a significant nature, and must have a minimum of **three** of the features listed in paragraph 7 of the *Skills* section.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements The learner must be able to:
P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
P2 Demonstrate the required behaviours in line with the job role and company objectives
P3 Plan the moulding/laying-up activities before they start them
P4 Prepare the moulds, jigs or formers ready for the manufacturing operations
P5 Mix and prepare the required materials
P6 Carry out the moulding or laying-up activities, using the correct methods and techniques
P7 Remove the mouldings from the formers and trim/finish them to specification
P8 Check that all the required operations have been completed to specification
P9 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
P10 Leave the work area in a safe and tidy condition on completion of the moulding activities

Skills *The learner must be able to:*
1. Carry out **all** of the following during the moulding activities: 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations 1.2 follow job instructions, drawings, process specifications and moulding/lay-up procedures 1.3 ensure that all equipment and tools used are in a safe and serviceable condition 1.4 return all tools and equipment to the correct location on completion of the moulding/lay-up activities
2. Carry out **all** of the following activities when preparing production tooling: 2.1 check that tooling is correct and complete 2.2 clean tooling and remove resin build-ups 2.3 check for surface defects 2.4 correctly apply sealers/release agents 2.5 clean and store tooling suitably after use

Skills

The learner must be able to:

3. Carry out **all** of the following activities to prepare materials for production:
   - 3.1 obtain correct materials for the activity
   - 3.2 check that materials are fit for purpose and in life
   - 3.3 cut materials to correct size and shape
   - 3.4 calculate the correct resin to fibre ratios
   - 3.5 check correct quantity of resin is available
   - 3.6 identify and protect materials in the work area
   - 3.7 check correct measure and mix of resin/catalyst

4. Produce a range of mouldings using **one** of the following types of production tool:
   - 4.1 pattern
   - 4.2 mandrel
   - 4.3 metallic
   - 4.4 tooling block
   - 4.5 wet lay-up
   - 4.6 infused mould
   - 4.7 glass pre-preg
   - 4.8 carbon pre-preg
   - 4.9 female tooling
   - 4.10 male tooling
   - 4.11 multi-part tools
   - 4.12 matched tooling
   - 4.13 closed tooling

5. Produce a range of mouldings using **two** of the following application techniques:
   - 5.1 spray application of a gel coat
   - 5.2 brush application of a gel coat
   - 5.3 spray application of fibre/resin
   - 5.4 brush application of fibre/resin
   - 5.5 roller application of fibre/resin
   - 5.6 removal of voids and air pockets
   - 5.7 brush/roller consolidation
   - 5.8 use of vacuum bagging
   - 5.9 use of bleed plies

Skills

The learner must be able to:

6. Produce a range of mouldings incorporating **two** of the following in the lay-up:
   - 6.1 butt joins
   - 6.2 overlap joins
   - 6.3 staggered joins
   - 6.4 feathered joins
   - 6.5 orientated plies
   - 6.6 inserts
   - 6.7 fixtures

7. Produce a range of mouldings incorporating **four** of the following shape features:
   - 7.1 internal corner
   - 7.2 external corner
   - 7.3 horizontal surface
   - 7.4 vertical surface
   - 7.5 double curvature
   - 7.6 concave surface
   - 7.7 convex surface
   - 7.8 return surfaces
   - 7.9 joggle details
   - 7.10 nett edges

8. Produce a range of mouldings using **one** type of resin from:
   - 8.1 bio resin
   - 8.2 acrylic
   - 8.3 polyester
   - 8.4 vinyl ester
   - 8.5 epoxy
   - 8.6 phenolic
   - 8.7 other (to be specified)

9. Produce a range of mouldings using techniques for **one** type of fibre from:
   - 9.1 natural fibre
   - 9.2 thermoplastic
   - 9.3 glass

Skills

The learner must be able to:

9.4 aramid

9.5 carbon

9.6 hybrid

9.7 other (to be specified)

10. Produce a range of mouldings using techniques for **two** type of reinforcement from:

10.1 uni-directional

10.2 roving

10.3 chopped strand

10.4 continuous filament

10.5 tissues/veils

10.6 bonded fabrics

10.7 woven

10.8 braids

10.9 tapes

10.10 multi-axis/stitched

10.11 other (to be specified)

11. Produce a range of mouldings using techniques for **one** type of core material from:

11.1 solid timber

11.2 end grain balsa

11.3 coremat

11.4 rigid foam

11.5 expanding foam

11.6 skinned honeycomb

11.7 other (to be specified)

12. Remove the moulding and carry out **all** of the following:

12.1 visually check that the moulding is complete and free from defects

12.2 use appropriate equipment/gauges to check for dimensional accuracy (such as overall dimensions, thickness of material/moulding, geometric features)

12.3 mark out the mouldings for trimming of excess material

Skills

The learner must be able to:

12.4 cut/trim the mouldings, using appropriate tools and equipment (such as cutting wheels/discs, routers, saws)

12.5 carry out repairs (where appropriate)

12.6 finish the mouldings, using appropriate tools and equipment (such as rubbing blocks, diamond files, disc or belt sanders, pencil grinders)

12.7 polish the mouldings, using appropriate tools and equipment (such as wet sanding, cutting compounds)

13. Produce composite mouldings which comply with **one** of the following standards:

13.1 components are dimensionally accurate within specification requirements

13.2 finished components meet the required shape/geometry (such as squareness, straightness, angularity and being free from twists)

13.3 completed components are free from defects, sharp edges or slivers

13.4 components meet company standards and procedures

Knowledge and understanding

The learner must:

K1 Describe the hazards associated with carrying out wet lay-up moulding techniques, and with the composite materials, consumables, tools and equipment used, and how to minimise these and reduce any risks

K2 Describe the specific environmental conditions that must be observed when producing composite mouldings (e.g. temperature, humidity, styrene levels to threshold limits, fume/dust extraction systems and equipment)

K3 Describe the quality procedures used in the workplace to ensure production control (in relation to currency, issue, meeting specification) and the completion of such documents

K4 Outline the conventions and terminology used for wet lay-up techniques (e.g. resin and fibre weights/volumes, material orientation, material identification, material tailoring, mixing ratios, gel times, exotherm, bleed plies)

K5 Outline the different types of resins, reinforcement, catalysts, accelerators and additives used, and their applications

K6 Outline the different types of fibre materials, fabrics, orientations, their combinations and applications

K7 Outline different core, insert and filler materials, and their applications

K8 Outline the different types of production tooling used for producing composite mouldings, and their applications

Knowledge and understanding *The learner must:*	
K9	Outline methods for handling and preparing the reinforcing fibres
K10	Describe how to estimate/calculate resin volume/weight required to wet-out the reinforcing fibres
K11	Explain mixing ratios for gel coats, resins, accelerators and catalysts, and the associated working times
K12	Describe the methods used in the application of the resin/fibre during the lay-up activity – *this knowledge criteria only applies if learner has chosen skill 5.3, 5.4 or 5.5*
K13	State the tools and equipment used in the lay-up activities and outline their care, preparation and control procedures
K14	Describe the problems that can occur during the lay-up process (including defects such as contamination, resin/fibre rich areas, and distortion)
K15	Explain how defects can be overcome during the lay-up activity
K16	Outline the different methods and techniques used to cure composite mouldings including cure cycles and the need for monitoring
K17	Outline the methods and techniques used to trim mouldings prior to release (green trimming)
K18	Outline the care and safe handling of production tooling and composite mouldings throughout the production cycle
K19	Explain the production controls used in the work area, and actions to be taken for unaccounted items
K20	Explain how the composite moulding relates to its own quality documents and the production tooling used

Unit 24: Producing Composite Mouldings using Pre-Preg Techniques

Level: 2

Guided learning hours: 140

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to produce composite mouldings using pre-preg techniques. This will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment.

They will be expected to prepare for the pre-preg laminating activities by obtaining all necessary information, documentation, materials, tools and equipment, and to plan how they intend to carry out the required activities and the sequence of operations they intend to use.

They will be expected to prepare the tooling, apply release agents and prepare the composite materials. They will produce composite mouldings, which will incorporate a range of features, using a range of application methods. Mouldings produced will include laminates and sandwich structures, using suitable resin, fibre and core materials. The activities will also include making all necessary visual and dimensional checks, to ensure that the mouldings meet the required specification and have an appropriate cosmetic appearance.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the pre-preg laminating activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the activities, and to seek appropriate help and advice in determining and implementing a suitable solution. They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate composite moulding pre-preg laminating techniques and procedures safely. They will understand the moulding/laminating procedure, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

They will understand the safety precautions required when carrying out the pre-preg laminating activities, and when using the associated tools and equipment. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

In order to prove their ability to combine different pre-preg laminating operations, at least one of the components produced must be of a significant nature, and must have a minimum of **three** of the features listed in paragraph 6 of the *Skills* section.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements *The learner must be able to:*	
P1	Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
P2	Demonstrate the required behaviours in line with the job role and company objectives
P3	Plan the moulding/laminating activities before they start them
P4	Prepare the moulds, jigs or formers ready for the manufacturing operations
P5	Mix and prepare the required materials
P6	Carry out the moulding/laminating activities, using the correct methods and techniques
P7	Remove the mouldings from the formers, and trim/finish them to specification
P8	Check that all the required operations have been completed to specification
P9	Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
P10	Leave the work area in a safe and tidy condition on completion of the moulding activities

Skills *The learner must be able to:*		
1.	Carry out **all** of the following during the moulding activities:	
	1.1	adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
	1.2	follow job instructions, drawings, process specifications and moulding/laminating procedures
	1.3	ensure that all equipment and tools used are in a safe and serviceable condition
	1.4	return all tools and equipment to the correct location on completion of the moulding/laminating activities
2.	Carry out **all** of the following activities when preparing production tooling:	
	2.1	check that tooling is correct and complete
	2.2	clean tooling and remove resin build-ups
	2.3	check for surface defects
	2.4	correctly apply sealers/release agents
	2.5	clean and store tooling suitably after use

Skills

The learner must be able to:

3. Carry out **all** of the following activities to prepare materials for production:
   - 3.1 obtain correct materials for the activity
   - 3.2 thaw material removed from freezer storage
   - 3.3 identifying defects in pre-preg materials
   - 3.4 check that materials are fit for purpose and in life
   - 3.5 check availability of ancillary materials required
   - 3.6 cut materials to correct shape and orientation
   - 3.7 check materials when provided in kit form
   - 3.8 identify and protect materials in the work area

4. Produce a range of mouldings, using **one** of the following types of production tool:
   - 4.1 pattern
   - 4.2 mandrels
   - 4.3 metal
   - 4.4 tooling block
   - 4.5 glass pre-preg
   - 4.6 carbon pre-preg
   - 4.7 female tooling
   - 4.8 male tooling
   - 4.9 multi-part tools
   - 4.10 matched tooling
   - 4.11 closed tooling

5. Produce a range of mouldings incorporating **two** of the following in the lay-up:
   - 5.1 butt joins
   - 5.2 overlap joins
   - 5.3 staggered joins
   - 5.4 orientated plies
   - 5.5 inverted plies
   - 5.6 balancing plies
   - 5.7 inserts
   - 5.8 fixtures

Skills

The learner must be able to:

6. Produce a range of mouldings incorporating **four** of the following shape features:
   - 6.1 internal corners
   - 6.2 external corners
   - 6.3 horizontal surface
   - 6.4 vertical surface
   - 6.5 double curvature
   - 6.6 concave surface
   - 6.7 convex surfaces
   - 6.8 return surfaces
   - 6.9 joggle details
   - 6.10 nett edges

7. Produce a range of mouldings using **one** type of resin from:
   - 7.1 bio resin
   - 7.2 thermoplastic
   - 7.3 epoxy
   - 7.4 phenolic
   - 7.5 bismaleimide
   - 7.6 cyanate ester
   - 7.7 other (to be specified)

8. Produce a range of mouldings using techniques for **one** type of fibre from:
   - 8.1 natural fibre
   - 8.2 thermoplastic
   - 8.3 glass
   - 8.4 aramid
   - 8.5 carbon
   - 8.6 hybrid
   - 8.7 other (to be specified)

9. Produce a range of mouldings using **one** type of reinforcement from:
   - 9.1 continuous
   - 9.2 uni-directional
   - 9.3 tapes

Skills

The learner must be able to:

9.4 tissues/veils

9.5 woven

9.6 braids

9.7 multi-axis

10. Produce a range of mouldings using **one** type of core material **(where applicable to the Sector or process):**

10.1 solid timber

10.2 end grain balsa

10.3 thermoplastic core

10.4 rigid foam

10.5 syntactic core

10.6 expanding core

10.7 fibrous honeycomb

10.8 aluminium honeycomb

10.9 other (to be specified)

11. Use **one** of the following methods when using core materials **(where applicable to the Sector or process)**:

11.1 core templates

11.2 pre-shaping core

11.3 core chamfers

11.4 core splicing

11.5 peel plies

11.6 bonding paste

11.7 edge filling

11.8 adhesive/resin films

11.9 potting/filler compound

11.10 single stage curing

11.11 multi-stage curing

12. Prepare the moulding for temperature curing using **one** of the following methods:

12.1 oven

12.2 autoclave

12.3 heated tools/moulds

Skills

The learner must be able to:

12.4 heat mats

12.5 heated press

12.6 curing lamps

12.7 infrared heating

12.8 UV curing

12.9 electro-magnetic inductance

12.10 micro-wave

12.11 other (to be specified)

13. Preparing the moulding for pressure consolidation using **one** of the following methods:

13.1 vacuum bags

13.2 hot de-bulk

13.3 pressure de-bulk

13.4 pressure bags

13.5 thermal mould expansion

13.6 fibre tensioning

13.7 press

13.8 autoclave

14. Remove composite moulding and carryout **all** of the following:

14.1 visually check that the moulding is complete and free from defects

14.2 use appropriate equipment/gauges to check for dimensional accuracy (such as overall dimensions, thickness of material/moulding, geometric features)

14.3 mark out the mouldings for trimming of excess material

14.4 cut/trim the mouldings using appropriate tools and equipment (such as cutting wheels/discs, routers, saws)

14.5 carry out repairs (where appropriate)

14.6 finish the mouldings, using appropriate tools and equipment (such as rubbing blocks, diamond files, disc or belt sanders, pencil grinders)

14.7 polish the mouldings using appropriate tools and equipment (such as wet sanding, cutting compounds)

Skills

The learner must be able to:

15. Produce mouldings which comply with **one** of the following standards:
    - 15.1 components are dimensionally accurate, within specification requirements
    - 15.2 finished components meet the required shape/geometry (such as square, straight, angle, free from twists)
    - 15.3 completed components are free from defects, sharp edges or slivers
    - 15.4 components meet company standards and procedures

Knowledge and understanding

The learner must:

K1 Describe the hazards associated with carrying out pre-preg laminating techniques, and with the composite materials, consumables, tools and equipment used, and how to minimise these and reduce any risks

K2 Describe the specific environmental conditions that must be observed when producing composite mouldings (e.g. temperature, humidity, fume/dust extraction systems and equipment)

K3 Describe the quality procedures used in the workplace to ensure production control (in relation to currency, issue, meeting specification) and the completion of such documents

K4 Outline the conventions and terminology used for pre-preg laminating techniques (e.g. material orientation, material identification, material templates, ply lay-up, pressure plates, vacuum bagging, cure cycles, exotherm)

K5 Outline the different types of resins, reinforcement, catalysts, accelerators and additives used, and their applications

K6 Outline the different types of fibre materials, fabrics, orientations, their combinations and applications

K7 Explain the building up laminates (including orientation and balance of plies) to minimise spring and distortion in composite mouldings

K8 Outline the different core, insert and filler materials, and their applications

K9 Outline the identification of materials by product codes

K10 Outline the different types of production tooling used for producing composite mouldings, and their applications

K11 Describe the correct methods of storage, thawing and handling of pre-preg materials (including monitoring temperature, storage life and out-life)

K12 Describe the methods used in the application of pre-preg materials to tooling surfaces (including methods of tailoring and cutting)

K13 Outline the correct methods of storage and handling of ancillary and consumable materials

Knowledge and understanding *The learner must:*
K14 Outline the selection and use of ancillary and consumable materials (e.g. release films, breather fabrics, bagging films, tapes) to meet performance requirements (e.g. temperature and compatibility)
K15 State the tools and equipment used in the pre-preg laminating activities, and their care, preparation and control procedures
K16 Describe the problems that can occur during the lay-up process (including modifications to the ply lay-up, and defects such as contamination and distortion)
K17 Outline the cure cycles (including temperature and pressure ramps, dwell times, post curing)
K18 Explain the need for monitoring the cure cycle (using thermocouples, probes, chart recorders and data logs)
K19 the care and safe handling of production tooling and composite mouldings throughout the production cycle
K20 Explain the production controls used in the work area, and actions to be taken for unaccounted items
K21 Explain how the composite moulding relates to its own quality documents, and the production tooling used

Unit 25: General Electrical and Electronic Engineering Applications

Level: 2

Guided learning hours: 140

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to apply basic electrical and electronic engineering principles. This will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment.

The electrical and electronic engineering activities will include the wiring and termination of a range of wire/cables, electrical components, circuit boards and electronic components. This will involve using a range of tools and equipment, along with soldering techniques and anti-static protection techniques.

They will be required to select the appropriate tools, materials and equipment to use, based on the operations to be performed and the components/circuits to be connected. They will be expected to use appropriate tools and techniques for the assembly and wiring of the various electrical and electronic components and connectors that make up the circuit. The wiring and testing activities will include making all necessary checks and adjustments to the circuit (such as continuity, polarity, insulation resistance, current, voltage and waveform values), and ensuring that the circuit functions to the specification.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the electrical and electronic wiring and testing activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the wiring and testing activities, or with the tools and equipment used, and to seek appropriate help and advice in determining and implementing a suitable solution. They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate electrical and electronic wiring and testing procedures and techniques safely. They will understand the wiring and testing methods and procedures used, and their application, and will know about the various cables and components used to produce the circuits, to the required depth to provide a sound basis for carrying out the activities to the required specification.

They will understand the safety precautions required when carrying out the wiring and testing activities, especially those for ensuring the safe isolation of the equipment and circuits produced. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements *The learner must be able to:*	
P1	Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
P2	Demonstrate the required behaviours in line with the job role and company objectives
P3	Plan the electrical and electronic wiring and testing activities before they start them
P4	Use appropriate sources to obtain the required specifications, circuit diagrams and test information
P5	Obtain the correct tools and equipment for the wiring and testing operations, and check that they are in a safe and usable condition
P6	Mount and secure the electrical and electronic components safely and correctly, to meet specification requirements
P7	Install and terminate the cables to the appropriate connections on the components
P8	Use appropriate test methods and equipment to check that the completed circuit is safe and meets all aspects of the specification
P9	Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
P10	Leave the work area in a safe and tidy condition on completion of the wiring and testing activities

Skills *The learner must be able to:*		
1.	Carry out **all** of the following during the wiring and testing activities:	
	1.1	adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
	1.2	ensure the safe isolation of services during the wiring and testing activities
	1.3	follow job instructions, circuit and assembly drawings and test procedures at all times
	1.4	check that tools and test instruments to be used are within calibration date and are in a safe, tested and usable condition
	1.5	ensure that the components used are free from damage, dirt or other contamination
	1.6	prepare the electrical and electronic components for the assembly and wiring operations (such as pre-forming and cleaning pins)
	1.7	where appropriate, apply procedures and precautions to eliminate electrostatic discharge (ESD) hazards (such as the use of grounded wrist straps and mats)
	1.8	return all tools and equipment to the correct location on completion of the wiring and testing activities

Skills

The learner must be able to:

2. Use **three** of the following types of cable when producing the electrical and electronic circuits:
   - 2.1 single core
   - 2.2 armoured
   - 2.3 fibre optics
   - 2.4 wiring loom/harness
   - 2.5 multicore
   - 2.6 coaxial
   - 2.7 screened
   - 2.8 data/communication
   - 2.9 PVC twin and earth
   - 2.10 ribbon cables
   - 2.11 flexible (such as cotton or rubber covered)
   - 2.12 mineral insulated (such as FP 200)

3. Wire up **three** of the following electrical circuits/systems:
   - 3.1 domestic lighting circuits
   - 3.2 vehicle heating or ventilating
   - 3.3 air conditioning control circuits
   - 3.4 domestic power circuits
   - 3.5 vehicle lighting
   - 3.6 refrigeration control circuits
   - 3.7 motor control circuits
   - 3.8 vehicle starting and ignition
   - 3.9 heating/boiler control circuits
   - 3.10 instrumentation and control circuits
   - 3.11 emergency lighting systems
   - 3.12 aircraft lighting circuits
   - 3.13 alarm systems (such as fire, intruder, process control)
   - 3.14 avionic circuits and systems
   - 3.15 electro-pneumatic or electro-hydraulic control circuits
   - 3.16 communication systems
   - 3.17 other control circuits (such as pumps, fans, blowers, extractors)
   - 3.18 computer systems

Skills

The learner must be able to:

3.19 power generation and control circuits

3.20 other specific electrical circuits

4. Apply wiring methods and techniques, to include **all** of the following:

4.1 positioning and securing of equipment and components

4.2 crimping (such as spade end, loops, tags and pins)

4.3 determining current rating and lengths of cables required

4.4 stripping outer coating without damage to conductor insulation

4.5 soldering and de-soldering

4.6 attaching suitable cable identification

4.7 stripping cable conductor insulation/protection

4.8 leaving sufficient slack for termination and movement

4.9 adding cable end fittings (such plugs, sockets multi-way connectors

4.10 secure wires and cables (such as glands, clips, plastic strapping, lacing, harnessing)

4.11 making mechanical/screwed/clamped connections

5. Assemble electronic components to produce **four** of the following types of circuit:

5.1 audio amplifiers

5.2 filters

5.3 regulated power supplies

5.4 signal converters

5.5 microprocessor-based applications (such as PIC chips)

5.6 logic function controls

5.7 signal generators

5.8 comparators

5.9 display circuits

5.10 counter-timers

5.11 power amplifiers

5.12 ADC and DAC hybrid circuits

5.13 oscillators

5.14 motor control

5.15 sensor/actuator circuit (such as linear, rotational, temperature, photo-optic, flow, level, pressure)

Skills

The learner must be able to:

5.16 digital circuit (such as process control, microprocessor, logic devices, display devices)

5.17 signal processing circuit (such as frequency modulating/demodulating, amplifiers, filters)

5.18 alarms and protection circuits

5.19 other specific circuit

6. Use **two** of the following test instruments during the wiring and testing activities:

6.1 low reading ohmmeter

6.2 clamp meter

6.3 insulation resistance tester

6.4 voltage indicator

Plus **three** more of the following:

6.5 multimeter

6.6 signal generator

6.7 oscilloscope

6.8 signal tracer

6.9 logic probe/clip

6.10 stabilised power supplies

6.11 logic analyser

6.12 measuring bridges

6.13 pulse sequencing analyser

6.14 software diagnostic programs

6.15 counter-timers

6.16 data communications test set

6.17 signature analysers

6.18 bus exerciser/analyser

6.19 protocol analyser

7. Carry out checks and adjustments, appropriate to the equipment and circuits being wired, to include **three** of the following:

7.1 making visual checks (such as signs of damage, incorrect termination/orientation, solder bridges, dry joints, incorrect value components)

Skills

The learner must be able to:

7.2 movement checks (such as loose wires, fittings and connections, incorrectly seated devices/packages)

7.3 testing that the equipment operates to the circuit specification

7.4 carrying out fault-finding techniques (such as half-split, input/output, unit substitution)

Plus **six** more from the following:

7.5 protective conductor resistance values

7.6 AC voltage/current levels

7.7 frequency values

7.8 insulation resistance

7.9 logic states

7.10 inductance

7.11 continuity

7.12 clock/timer switching

7.13 RCD disconnection time

7.14 polarity

7.15 oscillations

7.16 modulation/demodulation

7.17 power rating

7.18 attenuation

7.19 amplification

7.20 resistance

7.21 pulse width/rise time

7.22 signal noise/interference levels

7.23 capacitance

7.24 open/short circuit

7.25 DC voltage/current levels

7.26 waveform analysis

8. Produce electrical and electronic circuits which comply with **one** or more of the following standards:

8.1 BS 7671/IET wiring regulations

8.2 other BS and/or ISO standards

8.3 company standards and procedures

Knowledge and understanding *The learner must:*	
K1	Explain the specific safety practices and procedures that they need to observe when wiring and testing electrical and electronic circuits (including any specific legislation, regulations or codes of practice for the activities, equipment or materials)
K2	Describe the hazards associated with wiring and testing electrical and electronic circuits and equipment, and with the tools and equipment used (e.g. heat, toxic fumes, spilled/splashed chemicals/solder, static electricity, using sharp instruments for stripping cable insulation, connecting clips/probes into circuits), and how they can be minimised
K3	Explain what constitutes a hazardous voltage and how to recognise victims of electric shock
K4	Describe how to reduce the risks of a phase to earth shock
K5	Explain the basic principles of operation of the equipment/circuits being produced, and the purpose of the individual modules/components used
K6	Outline the different types of cabling and their application (e.g. multicore cables, single core cables, solid and multi-stranded cables, steel wire armoured (SWA), mineral insulated (MI), screened cables, data/communications cables, fibre-optics)
K7	Describe the application and use of a range of electrical components (such as plugs, switches, sockets, lighting and fittings, junction boxes, consumer units, relays, solenoids, transformers, sensors and actuators)
K8	Describe the application and use of circuit protection equipment (such as fuses and other overload protection devices, trips, residual current device (RCD))
K9	Outline the various types of circuit boards used (such as printed circuit boards, thin film, thick film and flexible film circuitry)
K10	Explain how to recognise, read the values and identify polarity and any other orientation requirements for all electronic components being used in the assemblies (such as capacitors, diodes, transistors, integrated circuit chips, and other discrete through-hole or surface-mounted components)
K11	Describe methods of laying in or drawing cables into conduit, trunking and traywork systems, and the need to ensure the cables are not twisted or plaited
K12	Describe the techniques used to terminate electrical and electronic components and equipment (such as plugs and sockets; soldering; screwed, clamped and crimped connections, glands and sealed connectors)
K13	Outline the tools and equipment used in the wiring activities (including the use of cable stripping tools, crimping tools, soldering irons and torches, gland connecting tools)
K14	Explain the importance of conducting inspections and checks before connecting to the supply (e.g. visual examination for loose or exposed conductors, excessive solder or solder spikes which may allow short circuits to occur, strain on terminations, insufficient slack cable at terminations, continuity and polarity checks, insulation checks)

Knowledge and understanding *The learner must:*
K15 Outline the care, handling and application of electrical and electronic test and measuring instruments (e.g. multimeter, insulation resistance tester, loop impedance test instruments, oscilloscopes, signal generators and logic probes)
K16 Explain how to identify suitable test points within the circuit, and how to position the test instruments into the circuit so as to ensure the correct polarity and without damaging the circuit components
K17 Explain how to set the instrument zero readings; obtaining instrument readings and comparing them with circuit parameters
K18 Describe the problems that can occur with the wiring and testing operations, and how these can be overcome

Unit 26: Dressing Aircraft Engines

Level: 2

Guided learning hours: 175

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to dress aircraft engines. This will prepare them for entry into the engineering or manufacturing sector, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competencies in the working environment.

They will be expected to prepare for the engine dressing activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required activities and the sequence of operations they intend to use. They will be required to select the appropriate tools, equipment to use, based on the operations to be carried out and the type of components to be assembled.

In carrying out the engine dressing operations, they will be required to follow specified methods and techniques, in order to produce the required engine assembly. The engine dressing activities will also include making all necessary checks and adjustments, to ensure that components are correctly orientated, positioned and aligned, that moving parts have the correct working clearances, that all fasteners are tightened to the correct torque, and that the assembled parts are checked for completeness and they function as per the specification.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the engine dressing activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the activities, and to seek appropriate help and advice in determining and implementing a suitable solution. They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate engine dressing techniques safely. They will understand the engine dressing process, and its application, and will know about the equipment being assembled, the components, tools and consumables used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

They will understand the safety precautions required when carrying out the engine dressing activities, and when using assembly tools and equipment. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

In order to prove their ability to combine different engine dressing operations, at least one of the assessments must be of a significant nature, and must contain a minimum of **eight** of the components listed in paragraph 3 of the *Skills* section.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements *The learner must be able to:*	
P1	Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
P2	Demonstrate the required behaviours in line with the job role and company objectives
P3	Plan the assembly activities before they start them
P4	Obtain and prepare the appropriate components, tools and equipment
P5	Use the appropriate methods and techniques to assemble the components in their correct positions
P6	Secure the components using the specified connectors and securing devices
P7	Check the completed assembly to ensure that all operations have been completed and that the finished assembly meets the required specification
P8	Deal promptly and effectively with problems within their control and seek help and guidance from the relevant people if they have problems that they cannot resolve
P9	Leave the work area in a safe and tidy condition on completion of the assembly activities

Skills *The learner must be able to:*		
1.	Carry out **all** of the following during the dressing activities:	
	1.1	adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
	1.2	follow job instructions, assembly drawings and procedures
	1.3	ensure that all power tool cables, extension leads or air supply hoses are in a safe and serviceable condition (where applicable)
	1.4	check that tools and measuring instruments to be used are within calibration date
	1.5	use lifting and slinging equipment in accordance with health and safety guidelines and procedures (where applicable)
	1.6	ensure that the components used are free from foreign objects, dirt or other contamination
	1.7	return all tools and equipment to the correct locations on completion of the assembly activities
2.	Dress engine assemblies using **six** of the following methods and techniques:	
	2.1	assembling of components by expansion/contraction
	2.2	applying sealants/adhesives
	2.3	fitting (such as filing, scraping, lapping or polishing)

Skills

The learner must be able to:

2.4 electrical bonding of components

2.5 securing by using mechanical fasteners/threaded devices

2.6 assembling of products by pressure

2.7 setting and adjusting

2.8 applying bolt locking methods

2.9 aligning components

2.10 shimming and packing

2.11 pinning

2.12 torque setting

3. Dress aircraft engines to meet the required specification, using **twelve** of the following types of component:

3.1 pre-machined components

3.2 brackets

3.3 pumps (fuel and oil)

3.4 valves

3.5 oil tank

3.6 coolers (air, oil and fuel)

3.7 heat exchangers

3.8 rigid tubes

3.9 engine suspension mounts

3.10 couplings

3.11 levers/linkages

3.12 bearings

3.13 gaskets

3.14 seals

3.15 pipework/hoses

3.16 bushes

3.17 sensors (vibration and fire detection)

3.18 electrical units (igniter box and thermocouples)

3.19 electrical harnesses

3.20 other specific component

Skills

The learner must be able to:

4. Secure components using the specified connectors and securing devices to include **both** of the following

    4.1 threaded fasteners (such as nuts, bolts, machine screws, cap screws)

    4.2 locking and retaining devices (such as tab washers, locking nuts, wire locks, special purpose types)

    Plus **one** more from the following:

    4.3 pins (such as parallel/dowels, hollow/roll, tapered, split)

    4.4 spring clips (such as external circlips, internal circlips, special clips)

    4.5 rivets (such as countersunk, roundhead, blind, special purpose types)

5. Check the aircraft engine assembly to ensure that all operations have been completed correctly and that the final assembly meets the required specification by making **all** of the following checks using the correct tools/equipment:

    5.1 positional accuracy

    5.2 alignment

    5.3 freedom of movement

    5.4 completeness

    5.5 operating/working clearances

    5.6 freedom from damage or foreign objects

    5.7 orientation

    5.8 torque settings

Knowledge and understanding

The learner must:

K1 Outline the hazards associated with the engine dressing activities, and how they can be minimised

K2 Outline the different types of drawing and specifications that are used during the engine dressing and assembly activities

K3 Explain the assembly/joining methods, techniques and procedures to be used, and the importance of adhering to these procedures

K4 Describe how the components are to be aligned, adjusted and positioned prior to securing, and the tools and equipment to be used for this

K5 Outline the various mechanical fastening devices that are used (such as nuts, bolts, machine screws, cap screws, clips, pins, locking and retaining devices)

K6 Explain the importance of using the specified components and joining devices for the assembly, and why they must not use substitutes

Knowledge and understanding *The learner must:*	
K7	Outline where appropriate, the application of sealants and adhesives within the assembly activities, and the precautions that must be taken when working with them
K8	Explain what to do to rectify and assembly defects (e.g. ineffective joining techniques, foreign objects, component damage)
K9	Explain the importance of ensuring that all tools are used correctly and within their permitted operating range
K10	Outline the problems that could occur with the assembly operations, and the importance of informing appropriate people of non-conformances
K11	Explain when to act on their own initiative and when to seek help and advice from others
K12	Explain the importance of leaving the work area in a safe and clean condition on completion of the assembly activities (such as returning hand tools and equipment to the designated location, cleaning the work area and removing and disposing of waste)

Unit 27: Maintaining Aircraft Mechanical Devices and Equipment

Level: 2

Guided learning hours: 175

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to maintain mechanical devices and equipment. This will prepare them for entry into the engineering aviation sector, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment.

They will be expected to prepare for the maintenance activities by obtaining all necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required maintenance activities and the sequence of operations they intend to use.

They will be required to select the appropriate equipment to use, based on the maintenance operations to be carried out and the type of mechanical equipment being maintained. This will include equipment such as gearboxes, pumps, engines, auxiliary power units, ancillary equipment, mechanical flight control systems and undercarriage and associated equipment. They will be expected to use a variety of maintenance diagnostic techniques and procedures, such as gathering information from defect reports, using recognised fault-finding techniques and diagnostic aids, measuring, inspecting and operating the equipment.

They will then be expected to dismantle, remove and replace or repair any faulty units or components, on a variety of mechanical assemblies and sub-assemblies. This will include components such as shafts, bearings, couplings, gears, pulleys, clutches, brakes, levers and linkages, cams and followers, and other specific mechanical components. They will be expected to cover a range of maintenance activities, such as draining and removing fluids, releasing stored energy, labelling to aid reassembly, dismantling components to the required level, dismantling components requiring pressure or expansion/contraction techniques, inspecting components for serviceability, replacing faulty components and consumable items, setting, aligning and adjusting components, tightening fasteners to the required torque and making freedom of motion checks for the maintained equipment.

Their responsibilities will require them to comply with health and safety requirements and the approved technical data for the maintenance activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the maintenance activities, and to seek appropriate help and advice in determining and implementing a suitable solution. They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate mechanical maintenance techniques and procedures safely. They will understand the maintenance process, and its application, and will know about the mechanical equipment being maintained, the equipment components, tools and consumables used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

They will understand the safety precautions required when carrying out the maintenance activities, and when using maintenance tools and equipment. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

In order to prove their ability to combine different maintenance operations, at least one of the maintenance activities must be of a significant nature, and must cover at least **seven** of the activities listed in the skills section, paragraph 4 plus the removal and replacement of a minimum of **five** of the components listed in paragraph 5 of the *Skills* section.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements

The learner must be able to:

P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines

P2 Demonstrate the required behaviours in line with the job role and company objectives

P3 Plan the maintenance activities before they start them

P4 Obtain all the information they need for the safe removal and replacement of the equipment components

P5 Obtain and prepare the appropriate tools and equipment

P6 Apply appropriate maintenance diagnostic techniques and procedures

P7 Use appropriate methods and techniques to remove and replace the required components

P8 Carry out tests on the maintained equipment, in accordance with the test schedule/defined test procedures

P9 Deal promptly and effectively with problems within their control and seek help and guidance from the relevant people if they have problems that they cannot resolve

P10 Leave the work area in a safe and tidy condition on completion of the maintenance activities

Skills

The learner must be able to:

1. Carry out **all** of the following during the maintenance activity:
   - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
   - 1.2 ensure the safe isolation of equipment (such as mechanical, electrical, gas, air or fluids), where appropriate
   - 1.3 follow job instructions, maintenance drawings and procedures
   - 1.4 check that the tools and test instruments are within calibration date, and are in a safe and usable condition
   - 1.5 ensure that the system is kept free from foreign objects, dirt or other contamination
   - 1.6 return all tools and equipment to the correct location on completion of the maintenance activities

2. Carry out maintenance activities on **two** of the following types of mechanical equipment:
   - 2.1 gearboxes/power transfer devices
   - 2.2 engines/auxiliary power units
   - 2.3 compressors

Skills

The learner must be able to:

2.4 mechanical flight control system.

2.5 undercarriage and associated equipment

2.6 ancillary equipment i.e. air cycle machine, air conditioning pack, mechanical screw jacks etc.

2.7 company-specific equipment

3. Use **four** of the following maintenance diagnostic techniques, tools and aids:

3.1 fault-finding techniques (such as visual inspection, borescope inspection, use of test equipment, filter and magnetic plug inspection)

3.2 diagnostic aids (such as manuals, flow charts, troubleshooting guides, maintenance records)

3.3 information gathered from defect reports

3.4 visual checks (such as signs of leakage, damage, missing parts, wear/deterioration)

3.5 alignment checks

3.6 movement checks (such as excessive movement or clearance, loose fittings and connections)

3.7 force/pressure checks (such as spring pressure, belt or chain tension)

3.8 overheating checks (such as bearings, friction surfaces)

3.9 sensory input (such as sight, sound, smell, touch)

3.10 use of aircraft indicating and recording systems

3.11 functional checks

3.12 test instrumentation measurement (such as pressure, flow, timing, sequence, movement)

3.13 measuring instruments (such as dial test indicators, torque measuring devices, feeler gauges)

4. Carry out **all** of the following maintenance activities, as applicable to the equipment being maintained:

4.1 dismantling equipment to unit/sub-assembly level

4.2 shimming, adjusting and setting up of replaced components

4.3 dismantling units to component level

4.4 labelling of components

4.5 tightening fastenings to the required torque and locking techniques

4.6 inspecting components for serviceability

4.7 freedom of movement checks before starting functional checks

Skills *The learner must be able to:*
4.8 replacing all consumable items (such as seals, bearings, gaskets) 4.9 replenishing fluids and greases 4.10 replacing damaged/defective components 5. Remove and refit a range of mechanical components, to include **eight** of the following: 5.1 shafts 5.2 bearing and seals 5.3 slides 5.4 couplings 5.5 fitting keys 5.6 rollers 5.7 gears 5.8 spring 5.9 housings 5.10 clutches 5.11 diaphragms 5.12 actuating mechanisms 5.13 cams and followers 5.14 structural components 5.15 pistons 5.16 chains and sprockets 5.17 flight control cables and rods 5.18 locking and retaining devices (such as circlips, pins, tab washers, wire locking) 5.19 brakes 5.20 pulleys, cables and belts 5.21 splines 5.22 levers and links 5.23 other specific components 6. Carry out checks on the maintained equipment, to include **three** of the following: 6.1 correct operation and sense of moving parts 6.2 correct working clearance of parts

Skills

The learner must be able to:

6.3 backlash/wear checks in gears

6.4 belt /chain/cable tension

6.5 system adjustments and setting up

6.6 torque loading and locking of fasteners

6.7 operational performance

6.8 functionally test the system

7. Maintain mechanical equipment in compliance with all of the following:

7.1 manufactures' approved technical data

7.2 information provided by regulatory authorities

7.3 service Bulletins and Airworthiness Directives

Knowledge and understanding

The learner must:

K1 Describe the hazards associated with carrying out mechanical maintenance activities, and how to minimise them

K2 Describe the system isolation procedures that applies to the activity being undertaken

K3 Explain how to obtain and interpret drawings, specifications, manufacturers' approved data and other documents needed in the maintenance process

K4 Describe the procedure for obtaining replacement parts, materials and other consumables necessary for the maintenance activities

K5 Describe the basic principles of how the equipment functions, its operating sequence, the working purpose of individual units/components and how they interact

K6 Describe the various maintenance diagnostic techniques and aids that can be used (e.g. fault reports, visual checks, measuring, movement and alignment checks, testing)

K7 Describe the various fault location techniques that can be used, and how they are applied (e.g. function testing, unit substitution, and equipment self-diagnostics)

K8 Explain how to evaluate sensory information (e.g. sight, sound, smell, touch)

K9 Describe the sequence to be adopted for the dismantling/re-assembly of various types of assemblies

K10 Describe the methods and techniques used to dismantle/assemble mechanical equipment (e.g. release of pressures/force, proof marking, extraction, pressing, alignment)

K11 Describe the methods of checking that components are fit for purpose, and how to inspect for defects and wear characteristics

Knowledge and understanding *The learner must:*
K12 Explain the identification, application, fitting and removal of different types of bearings (e.g. roller, ring, thrust)
K13 Describe the methods and techniques of fitting keys and splines
K14 Explain the identification, application, fitting and removal of different types of gears
K15 Explain how to correctly tension belts, cables and chains
K16 Describe the identification and application of different types of locking device
K17 Describe methods of checking that removed components are fit for purpose, and the need to replace consumable items (such as seals and gaskets)
K18 Describe the uses of measuring equipment (such as micrometers, verniers, run-out devices and other measuring devices)
K19 Explain how to make adjustments to components/assemblies to ensure that they function correctly (such as setting working clearance, setting travel, setting backlash in gears, preloading bearings)
K20 Describe the importance of making freedom of movement checks before running the equipment under power
K21 Describe the importance of new and replacement part documentation/history
K22 Describe the importance of completing maintenance documentation and/or reports following the maintenance activity
K23 Describe the problems associated with the mechanical maintenance activity, and how they can be overcome

Unit 28: Maintaining Fluid Power Equipment

Level: 2

Guided learning hours: 105

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to maintain fluid power equipment using a range of methods and techniques. This will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or will provide a basis for the development of additional skills and occupational competences in the working environment.

They will be expected to prepare for the maintenance activities by obtaining all necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required maintenance activities and the sequence of operations they intend to use. They will be required to select the appropriate equipment to use, based on the maintenance operations to be carried out and the type of fluid power equipment being maintained, which will include hydraulic, pneumatic or vacuum equipment and circuits.

They will be expected to use a variety of maintenance diagnostic techniques and procedures, such as gathering information from fault reports, using recognised fault-finding techniques and diagnostic aids, measuring, inspecting and operating the equipment. They will then be expected to dismantle, remove and replace, or repair any faulty units or components, including pumps, valves, actuators, sensors, intensifiers, regulators, compressors, pipes and hoses, and other specific fluid power equipment. They will be expected to cover a range of maintenance activities, such as draining and removing fluids, removing stored pressure, labelling/proof marking to aid reassembly, dismantling components to the required level, checking components for serviceability, replacing faulty components and 'lifed' items, setting and adjusting components, tightening fasteners to the required torque and making 'off-load' checks, before starting up and testing the maintained equipment, using appropriate techniques and procedures.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the fluid power maintenance activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the maintenance activities, and to seek appropriate help and advice in determining and implementing a suitable solution.

They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate fluid power maintenance techniques and procedures safely. They will understand the maintenance process, and its application, and will know about the fluid power equipment being maintained, the system components, tools and consumables used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

They will understand the safety precautions required when carrying out the maintenance activities, and when using maintenance tools and equipment. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

In order to prove their ability to combine different maintenance operations, at least one of the fluid power maintenance activities must be of a significant nature, and must involve the removal and replacement of a minimum of **five** of the components listed in paragraph 6 of the *Skills* section.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements

The learner must be able to:

P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines

P2 Demonstrate the required behaviours in line with the job role and company objectives

P3 Plan the maintenance activities before they start them

P4 Obtain all the information they need for the safe isolation, removal and replacement of the system components

P5 Obtain and prepare the appropriate tools and test equipment

P6 Apply appropriate maintenance diagnostic techniques and procedures

P7 Use the appropriate methods and techniques to remove and replace the required components

P8 Carry out tests on the maintained system in accordance with the test schedule/defined test procedures

P9 Deal promptly and effectively with problems within their control and seek help and guidance from the relevant people when they have problems they cannot resolve

P10 Leave the work area in a safe and tidy condition on completion of the maintenance activities

Skills

The learner must be able to:

1. Carry out **all** of the following during the maintenance activity:
   - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
   - 1.2 ensure the safe isolation of equipment (such as mechanical, electrical, gas, air or fluids)
   - 1.3 follow job instructions, maintenance drawings and procedures
   - 1.4 check that tools and test instruments to be used are within calibration and are in a safe and usable condition
   - 1.5 ensure that the system is kept free from foreign objects, dirt or other contamination
   - 1.6 return all tools and equipment to the correct location on completion of the maintenance activities

2. Carry out maintenance activities on **one** of the following types of fluid power equipment:
   - 2.1 pneumatic
   - 2.2 hydraulic
   - 2.3 vacuum

Skills

The learner must be able to:

3. Use **four** of the following maintenance diagnostic techniques, tools and aids:
   - 3.1 fault-finding techniques (such as six point, half-split, input/output, unit substitution, emergent sequence)
   - 3.2 diagnostic aids (such as manuals, flow charts, troubleshooting guides, maintenance records)
   - 3.3 information gathered from fault reports
   - 3.4 inspecting (such as checking for damage, wear/deterioration, leaks, loose fittings and connections)
   - 3.5 sensory input (such as sight, sound, smell, touch)
   - 3.6 monitoring equipment or gauges
   - 3.7 operating the equipment (such as manual operation, timing and sequencing)
   - 3.8 test instrumentation measurement (such as pressure, flow, timing, sequence, movement)

4. Use **two** of the following types of fluid power test instruments:
   - 4.1 measuring devices
   - 4.2 flow indicators
   - 4.3 self-diagnostic equipment
   - 4.4 pressure indicators
   - 4.5 test rigs

5. Carry out **all** of the following maintenance activities, as applicable to the equipment being maintained:
   - 5.1 chocking/supporting/locking cylinders/rams/components
   - 5.2 draining and removing fluids (as applicable)
   - 5.3 releasing stored energy
   - 5.4 disconnecting/removing hoses and pipes
   - 5.5 removing and replacing units/components (such as pumps, cylinders, valves, actuators)
   - 5.6 proof marking/labelling of removed components
   - 5.7 checking components for serviceability
   - 5.8 replacing damaged/defective components
   - 5.9 replacing all 'lifed' items (such as seals, filters, gaskets)
   - 5.10 tightening fastenings to the required torque
   - 5.11 setting, aligning and adjusting replaced components

Skills *The learner must be able to:*
5.12 prime, bleed and recharge the system (as applicable) 5.13 making de-energised checks before re-pressurising the system 6. Remove and replace a range of fluid power components, to include **all** of the following: 6.1 pipework/hoses 6.2 valves 6.3 cylinders/actuators Plus **five** more of the following: 6.4 reservoirs/storage devices 6.5 pumps 6.6 switches 6.7 accumulators 6.8 motors 6.9 sensors 6.10 pressure intensifiers 6.11 gaskets and seals 6.12 lubricators 6.13 compressors 6.14 pistons 6.15 filters 6.16 receivers 6.17 spools 6.18 cables, wires and connectors 6.19 regulators 6.20 bearings 6.21 gauges/indicators 6.22 timers 6.23 coolers 6.24 other specific components

Skills

The learner must be able to:

7. Carry out tests on the maintained equipment, to include both of the following:

   7.1 leak test

   7.2 operational performance

   Plus **one** more from the following:

   7.3 pressure line pressure tests

   7.4 speed

   7.5 return line pressure test

   7.6 sequence

   7.7 flow

   7.8 fluid contamination test

   7.9 correct sense/direction

8. Carry out **all** of the following checks to ensure the accuracy and quality of the tests carried out:

   8.1 the test equipment is correctly calibrated

   8.2 the test equipment used is appropriate for the tests being carried out

   8.3 test procedures used are as recommended in the appropriate specifications

   8.4 test readings are taken at the appropriate points, and where appropriate components are adjusted to give the required readings

   8.5 test equipment is operated within its specification range

9. Maintain fluid power equipment in compliance with **one** or more of the following:

   9.1 organisational guidelines and codes of practice

   9.2 specific system requirements

   9.3 equipment manufacturers' operation range

   9.4 BS and/or ISO standards

Knowledge and understanding *The learner must:*	
K1	Describe hazards associated with carrying out maintenance activities on fluid power equipment, and how these can be minimised
K2	Explain the system isolation procedures or permit-to-work procedure that applies
K3	Describe how to obtain and interpret drawings, charts, circuit and physical layouts, specifications, manufacturers' manuals, history/maintenance reports, symbols used in fluid power, and other documents needed in the maintenance activities
K4	Outline the procedure for obtaining replacement parts, materials and other consumables necessary for the maintenance activities
K5	State the basic principles of how pneumatic, hydraulic and vacuum fluid power equipment functions, its operating sequence, the purpose of individual units/components and how they interact
K6	Describe the different types of pipework, fittings and manifolds, and their application
K7	Outline the identification and application of different types of valve (e.g. poppet, spool, piston, disc)
K8	Outline the identification and application of different types of sensors and actuators (e.g. rotary, linear, mechanical, electrical)
K9	Outline the identification and application of different types of cylinder (e.g. single acting, double acting)
K10	Outline the identification and application of different types of pump (e.g. positive and non-positive displacement)
K11	Outline the identification and application of different types compressors (e.g. screw, piston, rotary vane)
K12	Outline the application and fitting of static and dynamic seals
K13	Describe the techniques used to dismantle/assemble fluid power equipment (e.g. release of energy/force, proof marking, extraction)
K14	Describe the methods of checking that components are fit for purpose
K15	Describe how to make adjustments to components/assemblies to ensure that they function correctly
K16	Describe how to determine pressure settings, and their effect on the system
K17	State how to select fluids for the system
K18	Describe how to recognise contaminants and the problems they can create, and the effects and likely symptoms of contamination in the system
K19	Outline the various maintenance diagnostic techniques and aids that can be used (e.g. fault reports, visual checks, measuring, movement and alignment checks, testing)
K20	Outline the various fault location techniques that can be used, and how they are applied (e.g. half-split, input-to-output, function testing, unit substitution, and equipment self-diagnostics)

Knowledge and understanding *The learner must:*
K21 Explain how to evaluate sensory information (sight, sound, smell, touch)
K22 Explain the care, handling and application of mechanical measuring/test equipment (e.g. measuring instruments, pressure and flow indicators and self-diagnostic equipment)
K23 Describe types of test equipment to be used, and their selection for particular tests
K24 Explain how the test equipment is connected into the circuit, and the methods of doing this
K25 Describe the techniques, methods and procedures to be used during the tests
K26 Explain how to display/record test results, and the documentation used
K27 Explain how to interpret the test readings obtained, and the significance of the readings gained
K28 Describe the problems associated with maintaining fluid power equipment, and how they can be overcome

Unit 29: General Turning, Milling and Welding Applications

Level: 2

Guided learning hours: 140

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to undertake a broad range of basic turning, milling and welding activities. This will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment.

They will be expected to carry out a range of practical skills tasks in order to gain an understanding of how these machining and welding activities are undertaken, the types of equipment used, the manufacturing techniques, and the operating and safety procedures that are required.

In carrying out the activities, they will use appropriate tools, equipment, methods and techniques appropriate to the operations being performed. These activities will include turning, milling and welding operations.

During, and on completion of, the operations, they will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and the tolerances to be achieved. They will need to be able to recognise when the activities/outputs are not meeting the required specification, and to discuss/determine what action needs to be taken to remedy any faults that occur, in order to ensure that the finished workpiece is within the specification requirements. On completion of the activities, they will be expected to return all tools and equipment that they have used to the correct location, and to leave the work area in a safe and tidy condition.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the activities, and to seek appropriate help and advice in determining and implementing a suitable solution. They will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate machining, fitting and assembly techniques and procedures safely. They will understand the turning, milling and welding processes, and their application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

They will understand the safety precautions required when carrying out the various turning, milling and welding techniques, and when using any hand tools and machinery. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Specific unit requirements

Turning

In order to prove their ability to combine different turning operations, at least one of the machined components produced must be of a significant nature, and must have a minimum of **nine** of the features listed in paragraph 4 of the *Skills* section.

Milling

In order to prove their ability to combine different milling features, at least one of the components produced must be of a significant nature, and must have a minimum of **eight** of the features listed in paragraph 5 of the *Skills* section.

Welding

Welded joints must be at least 150 mm long, using single- or multi-run welds (as appropriate).

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements

The learner must be able to:

Turning and Milling

P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines

P2 Demonstrate the required behaviours in line with the job role and company objectives

P3 Plan the machining activities before they start them

P4 Obtain and prepare the appropriate materials, tools and equipment

P5 Grind lathe tools and drills to meet the required component specification

P6 Mount and set the required workholding devices, workpiece and cutting tools

P7 Set and adjust the machine tool speeds and feeds to achieve the component specification

P8 Use the machine tool controls safely and correctly, in line with operational procedures

P9 Measure and check that all dimensional and geometrical aspects of the component are to the specification

P10 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

P11 Shut down the equipment to a safe condition on completion of the machining activities

Welding

P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines

P2 Demonstrate the required behaviours in line with the job role and company objectives

P3 Plan the welding activities before they start them

P4 Obtain and prepare the appropriate welding equipment and welding consumables

P5 Prepare and support the joint, using the appropriate methods

P6 Tack weld the joint at appropriate intervals, and check the joint for accuracy before final welding

P7 Weld the joint to the specified quality, dimensions and profile

P8 Use appropriate methods and equipment to check the quality, and that all dimensional and geometrical aspects of the weld are to the specification

P9 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

P10 Shut down and make safe the welding equipment on completion of the welding activities

Skills

The learner must be able to:

Machining: ***The learner must be able to:***

1. Carry out **all** of the following during the machining, fitting and assembly activities:
   - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
   - 1.2 ensure that all hand tools and equipment used are in a safe and serviceable condition (such as cables to hand tools and extension leads, file handles, hammer striking faces)
   - 1.3 ensure that all machine tools are correctly guarded at all times
   - 1.4 check that all measuring equipment is within calibration date
   - 1.5 return all tools and equipment to the correct location on completion of the fitting activities

2. Machine **two** different types of material from the following:
   - 2.1 ferrous
   - 2.2 non-ferrous
   - 2.3 non-metallic

3. Use **four** of the following workholding methods and techniques:
   - 3.1 three-jaw chuck
   - 3.2 collet chuck
   - 3.3 four-jaw chuck
   - 3.4 machine vice
   - 3.5 clamping direct to milling machine table
   - 3.6 dividing/indexing head
   - 3.7 other workholding/supporting methods (such as vee blocks, parallels, drive plate and centres)

4. Carry out turning operations to include **all** of the following:
   - 4.1 mounting the workpiece in an appropriate workholding device
   - 4.2 mounting cutting tools in tool holders to give the correct centre height
   - 4.3 selecting and setting appropriate feeds and speeds
   - 4.4 facing off
   - 4.5 producing chamfers

Skills

The learner must be able to:

4.6 producing tapered diameters

4.7 producing parallel diameters

4.8 centre drilling and drilling a hole

4.9 producing stepped diameters

4.10 reaming or boring a hole

4.11 producing and/or maintaining internal and external threads

4.12 producing grooves/undercuts

4.13 producing radii

4.14 parting off

4.15 knurling

5. Carry out milling operations, to include **all** of the following:

5.1 mounting the workpiece in an appropriate workholding device

5.2 mounting cutting tools on appropriate arbors or direct to the machine spindle

5.3 selecting and setting appropriate feeds and speeds

5.4 producing flat and square faces

5.5 producing an enclosed slot (such as a key way)

5.6 producing parallel faces

5.7 producing an open ended slot

5.8 producing angular faces

5.9 centre drilling and drilling a hole

5.10 reaming a hole

5.11 producing a tapped hole

6. Carry out the necessary checks for accuracy, to include **all** of the following:

6.1 linear dimensions (such as length, depth and width)

6.2 external and internal diameters

6.3 hole size and position

6.4 thread size and fit

6.5 squareness

6.6 angles

6.7 position

6.8 parallelism

6.9 surface finish

Skills

The learner must be able to:

7. Use **all** the following during the machining activities:

   7.1 external micrometers

   7.2 vernier/digital/dial calliper

   7.3 protractors

   7.4 dial test indicators (DTI)

   7.5 squares

   Plus **four** more of the following:

   7.6 rules

   7.7 bore/hole gauges

   7.8 squares

   7.9 slip gauges

   7.10 radius/profile gauges

   7.11 depth micrometers

   7.12 thread gauges

   7.13 depth verniers

   7.14 feeler gauges

   7.15 surface finish equipment (such as comparison plates, machines)

   7.16 coordinate measuring machine (CMM)

8. Produce components within **all** of the following standards, as applicable to the process:

   8.1 components to be free from false tool cuts, burrs and sharp edges

   8.2 general dimensional tolerance +/- 0.25 mm or +/- 0.010”

   8.3 there must be one or more specific dimensional tolerances within +/- 0.1 mm or +/- 0.004”

   8.4 flatness and squareness 0.05 mm per 25 mm or 0.002” per inch

   8.5 angles within +/- 0.5 degree

   8.6 screw threads to BS Medium fit

   8.7 reamed holes within H8

   8.8 surface finish 63µin or 1.6 µm

Skills

The learner must be able to:

Welding: *The learner must be able to:*

9. Carry out **all** of the following during the fabrication and welding activities:
   - 9.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
   - 9.2 ensure that all hand tools and equipment used are in a safe and serviceable condition and electrically safe condition, such as PAT tested (such as extension leads, powered hand tools and welding equipment cables, welding plant hoses and hammers)
   - 9.3 return all tools and equipment to the correct location on completion of the fabrication activities

10. Use **two** appropriate materials from the following:
   - 10.1 carbon steel
   - 10.2 stainless steel
   - 10.3 aluminium
   - 10.4 plate
   - 10.5 sheet (less than 3 mm)
   - 10.6 pipe/tube
   - 10.7 section
   - 10.8 other forms

11. Use manual welding and related equipment, to include **two** of the following welding processes:
   - 11.1 MMA
   - 11.2 MIG
   - 11.3 MAG
   - 11.4 TIG
   - 11.5 Flux cored wire welding
   - 11.6 manual oxy/fuel gas welding

12. Produce **two** of the following welded joints of at least 150 mm long, with at least one stop and start included:
   - 12.1 fillet lap joints
   - 12.2 corner joints
   - 12.3 tee fillet joints
   - 12.4 butt joints

Skills

The learner must be able to:

13. Weld joints in good access situations in **two** of the following BS EN ISO 6947 positions:
    - 13.1 Flat (PA)
    - 13.2 Vertical upwards (PF)
    - 13.3 Horizontal vertical (PB)
    - 13.4 Vertical downwards (PG)
    - 13.5 Horizontal (PC)

14. Check that the welded joint conforms to the specification, by checking **all** of the following:
    - 14.1 dimensional accuracy
    - 14.2 size and profile of weld
    - 14.3 alignment/squareness

15. Carry out testing of the welds, using **one** of the following:
    - 15.1 dye or fluorescent penetrant
    - 15.2 nick break test
    - 15.3 bend tests (such as face, root or side, as appropriate)

16. Produce welded joints which meet all of the following (with reference to BS 4872 Part 1 Weld test requirements) as applicable to the weld being produced:
    - 16.1 welds meet the required dimensional accuracy
    - 16.2 fillet welds are equal in leg length and slightly convex in profile, with the size of the fillet equivalent to the thickness of the material welded
    - 16.3 the weld contour is linear, of uniform profile, free from excessive undulations, with regular and even ripple
    - 16.4 the welds are adequately fused, and there is minimal undercut, overlap and surface inclusions
    - 16.5 joins at stop/start positions merge smoothly, with no pronounced hump or crater in the weld surface
    - 16.6 tack welds are blended in to form part of the finished weld, without excessive hump
    - 16.7 the weld surface is free from cracks, and substantially free from porosity, shrinkage cavities and trapped slag
    - 16.8 the weld surface and adjacent parent metal is substantially free from arcing or chipping marks

Knowledge and understanding

The learner must:

General

K1 Describe the health and safety requirements, and safe working practices and procedures required for the turning, milling and welding activities undertaken (e.g. wearing the required protective clothing and equipment (PPE), using the appropriate guarding, fire prevention, safety in combined spaces, fume extraction and control and keeping the work area safe and tidy

K2 Describe the hazards associated with the activities, and how they can be minimised

Turning and Milling

K3 Explain how to mount and secure the cutting tools in the tool holding devices (e.g. front or rear tools posts; mounting milling cutters on arbors; mounting drills in chucks or by the use of morse taper sockets; the need to ensure that the tool is sharp and secure)

K4 Describe the techniques of taking trial cuts and checking dimensional accuracy; the application of roughing and finishing cuts, and the effect on tool life, surface finish and dimensional accuracy

K5 Describe factors that affect the selection of cutting feeds and speeds, and the depth of cut that can be taken (e.g. type of material, size of material, operations being performed, workholding method/security of workpiece, condition of machine, finish and tolerance required)

K6 Describe the application of cutting fluids and compounds with regard to a range of different materials, and why some materials do not require cutting fluids to be used

K7 Explain the need to check that the measuring equipment is within current calibration dates, and that the instruments are correctly zeroed; measuring internal and external dimensions (e.g. lengths, diameters, depths, slots, hole positions, angles, profiles); measuring geometric features (e.g. flatness, squareness, parallelism, concentricity, ovality); how to check surface finish (such as by using comparison blocks or instruments)

K8 Describe the problems that can occur with the turning and milling activities (e.g. defects caused by poor setting up of equipment and tooling, incorrect speeds and feeds) and how these can be overcome

Knowledge and understanding *The learner must:*
Welding
K9 Describe where applicable, the correct handling and storage of gas cylinders (e.g. manual handling and use of cylinder trolley, leak detection procedures, relevant BCGA codes of practice, cylinder identification, gas pressures, cylinder and equipment safety features)
K10 Describe the general principles of the type of welding process being undertaken, power sources requirements, the major parts of the welding equipment, their function and equipment set up requirements)
K11 Describe the types, selection and application of electrode/wires and other consumables
K12 Explain how to prepare the materials in readiness for the welding activity (e.g. ensuring that the material is free from excessive surface contamination – e.g. rust, scale, paint, oil/grease and moisture; ensuring edges to be welded are correctly prepared - such as made flat, square or bevelled)
K13 Explain how to set up and restrain the joint, and the tools and techniques to be used (e.g. the use of jigs and fixtures, restraining devices – e.g. clamps and weights/blocks; setting up the joint in the correct position and alignment)
K14 Outline the appropriate tack welding size and spacing (in relation to material thickness)
K15 Describe the checks to be made prior to welding (such as confirming the correct set-up of the joint; the condition of electrical connections, welding return and earthing arrangements; wire feed mechanisms; gas supply; operating parameters)
K16 Describe the techniques of operating the welding equipment to produce a range of joints in the various joint positions (e.g. adjustment of parameters; correct manipulation of the welding gun; blending in stops/starts and tack welds)
K17 Describe problems that can occur with the welding activities (e.g. causes of distortion and methods of control; effects of welding on materials and sources of weld defects), and how these can be overcome
K18 Explain how to safely prepare the welds for examination (e.g. removing surface irregularities; cleaning the weld, polishing and making saw cuts on welds to be break tested)
K19 Explain how to identify and check for defects such as lack of continuity of weld, uneven or irregular ripple formation, incorrect weld size or profile, undercutting, internal cracks, overlap, surface cracks, inclusions, lack of fusion, porosity, lack of penetration

Unit 30: Checking for Defects in Composite Mouldings

Level: 2

Guided learning hours: 35

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to check for defects in composite mouldings. This will prepare them for entry into the engineering or manufacturing sector, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competencies in the working environment.

They will need to be able to check for defects in composite mouldings (such as moulds, panels, components, jigs), in accordance with approved procedures. They will be required to use appropriate drawings, specifications and documentation to identify with defects in composites mouldings.

They will be able to identify a range of defects in composite mouldings using various methods and techniques.

Their responsibilities will require them to comply with organisational policy and procedures for the activities undertaken and to report any problems with the activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. They will be expected to work to instructions under supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work they carry out.

Their underpinning knowledge will provide a good understanding of their work and will provide an informed approach to checking for defects in composite mouldings, and to report to others so they can decide what action needs to be taken. They will understand composite materials and their application and will know about defects in adequate depth to provide a sound basis for dealing with the defects in line with organisation practice and procedures.

They will understand the safety precautions required when working with the composite mouldings and when using associated tools and equipment. They will be required to demonstrate safe working practices throughout and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements *The learner must be able to:*	
P1	Work safely at all times, complying with health and safety, environmental and other relevant regulations, directives and guidelines
P2	Demonstrate the required behaviours in line with the job role and company objectives
P3	Check for defects to the composite moulding
P4	Report defects to the appropriate people promptly and in accordance with organisational procedures
P5	Record details of defects in accordance with quality assurance and control systems and procedures

Skills *The learner must be able to:*		
1	Carry out **all** of the following during the checking activities:	
	1.1	use the appropriate documentation (such as job instructions, drawings, material data sheets, specifications, planning and quality control documentation)
	1.2	adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment and other relevant safety regulations and procedures to realise a safe system of work
	1.3	maintain a safe working environment for the composite moulding inspection activities
	1.4	check that all tools and equipment to be used are in a safe and usable condition and, where appropriate, are within current calibration/certification dates
	1.5	follow safe practice/approved techniques and procedures at all times
	1.6	return all tools and equipment to the correct location on completion of the activities
	1.7	leave the work area in a safe and appropriate condition on completion of the activities
2	Identify defects in composite mouldings using **all** of the following methods:	
	2.1	touch
	2.2	sound
	2.3	visual

Skills

The learner must be able to:

3 Identify defects applicable to **one** of the following resin types:

- 3.1 polyester
- 3.2 vinyl ester
- 3.3 epoxy
- 3.4 phenolic
- 3.5 bismaleimide
- 3.6 cyanate ester
- 3.7 other (to be specified)

4 Identify defects applicable to **one** of the following fibre types:

- 4.1 thermo plastic
- 4.2 glass
- 4.3 carbon
- 4.4 other (to be specified)

5 Where core materials are required identify defects applicable to **two** of the following:

- 5.1 expanding foam
- 5.2 honeycomb
- 5.3 aluminium honeycomb
- 5.4 syntactic core

6 Identify **seven** of the following types of defect in composite mouldings:

- 6.1 dimensional
- 6.2 tolerances
- 6.3 surface finish
- 6.4 colour separation
- 6.5 distortion
- 6.6 blisters
- 6.7 dents or 'dings'
- 6.8 surface cracks
- 6.9 broken fibres
- 6.10 ply orientation
- 6.11 splintering
- 6.12 voids

Skills

The learner must be able to:

6.13 damaged cores

6.14 dis-bonds

6.15 insert positions

6.16 de-lamination

6.17 impact damage

6.18 puncture

6.19 gouges

6.20 holes

6.21 abrasion/erosion

6.22 other (to be specified)

7 Ensure actions recommended to rectify the defect comply with **all** of the following standards:

7.1 approved technical data

7.2 regulatory standards

Knowledge and understanding

The learner must:

K1 Describe the hazards associated with carrying out inspections on composite mouldings, and with the composite materials, consumables, tools and equipment used, and how to minimise these and reduce any risks

K2 Describe the protective equipment (PPE) that is needed for personal protection and, where required, the protection of others

K3 Explain the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables

K4 Describe the specific environmental conditions that must be observed when handling composite mouldings (such as temperature, humidity, fume/dust extraction systems and equipment)

K5 Describe the basic conventions and terminology used when identifying defects (such as dis-bonds, de-lamination, resin injection, resin voids, core potting, repair patches)

K6 Explain how to recognise the different types of defect that can occur in composite mouldings

K7 Describe the different methods used to identify defects in composite mouldings including sensory checks, hand measuring tools and machine tools

K8 Describe the factors to be taken into consideration when selecting the method to check composite moulding for defects

Knowledge and understanding *The learner must:*	
K9	Describe the importance of identifying defects in composite mouldings and the implications if defects are not identified during production
K10	Explain the correct methods of storage and handling of composite materials
K11	Explain the documentation to be completed during and/or on completion of the surface treatment activity

Unit 31: Carrying out Repairs on Composite Mouldings

Level: 2

Guided learning hours: 105

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to carry out repairs on composite mouldings. This will prepare them for entry into the engineering or manufacturing sector, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competencies in the working environment.

They will need to repair composite mouldings (such as cured panels, moulds, components and jigs), in accordance with approved procedures. They will be required to use appropriate drawings, specifications and documentation to repair composites materials, using the approved techniques.

They will repair a range of composite mouldings with various defects using a range of methods. Mouldings repaired will include a range of resin and fibre materials.

Their responsibilities will require them to comply with organisational policy and procedures for the repair activities undertaken and to report any problems with the repair activities, equipment or materials that they cannot personally resolve, or are outside their permitted authority, to the relevant people. They will be expected to work to instructions under supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they produce.

Their underpinning knowledge will provide a good understanding of their work and will provide an informed approach to applying composite moulding repair procedures. They will understand the repair techniques used and their application, in adequate depth to provide a sound basis for carrying out the activities to the required specification.

They will understand the safety precautions required when carrying out the repair activities and when using the associated tools and equipment. They will be required to demonstrate safe working practices throughout and will understand the responsibility they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements *The learner must be able to:*	
P1	Work safely at all times, complying with health and safety, environmental and other relevant regulations, directives and guidelines
P2	Demonstrate the required behaviours in line with the job role and company objectives
P3	Follow the relevant drawings and documentation for the moulding to be repaired
P4	Complete any preparation required prior to undertaking the repair
P5	Carry out the repairs within agreed timescale using approved materials and components and methods and procedures
P6	Carry out any checks required confirming the repaired moulding meets the specified operating conditions
P7	Deal promptly and effectively with problems within their control and report those that cannot be solved
P8	Dispose of waste and excess materials in line with agreed organisational procedures
P9	Produce accurate and complete records of all repair work carried out using organisational procedures and documentation

Skills *The learner must be able to:*		
1	Carry out **all** of the following during the repair activities:	
	1.1.	use the appropriate documentation (such as job instructions, drawings, material data sheets, specifications, planning and quality control documentation)
	1.2.	adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment and other relevant safety regulations and procedures to realise a safe system of work
	1.3.	maintain a safe working environment for the composite repair activities
	1.4.	check that all tools and equipment to be used are correct for the operation to be carried out and are in a safe and usable condition
	1.5.	follow safe practice/approved composite repair techniques and procedures at all times
	1.6.	return all tools and equipment to the correct location on completion of the composite repair activities
	1.7.	segregate and dispose of waste materials using the correct procedure
	1.8.	leave the work area in a safe and appropriate condition on completion of the activities
	1.9.	complete relevant production documentation

Skills

The learner must be able to:

2 Carry out **all** of the following activities when preparing for the repair activity:

- 2.1. confirm what has to be prepared
- 2.2. confirm the method of repair to be used
- 2.3. check availability of ancillary materials required
- 2.4. confirm the tools, materials and equipment selected is suitable for the repair activity
- 2.5. identify and protect the moulding and repair materials in the work area

3 Carry out **three** of the following types of repair:

- 3.1. non structural
- 3.2. graft/pre-cured patch
- 3.3. laminate only
- 3.4. partial thickness laminate
- 3.5. type A sandwich panel
- 3.6. single sided access
- 3.7. double sided access

4 Repair defects in **four** of the following types of composite moulding:

- 4.1. internal corners
- 4.2. external corners
- 4.3. horizontal surface
- 4.4. vertical surface
- 4.5. concave surface
- 4.6. flat surfaces
- 4.7. webs/ribs

5 Repair defects in composite mouldings using **three** of the following methods:

- 5.1. localised curing
- 5.2. laminating
- 5.3. resin injection
- 5.4. wet-lay patching
- 5.5. pre-preg patching
- 5.6. core patching
- 5.7. insert/core potting

Skills

The learner must be able to:

6 Repair defects using techniques/materials applicable to **one** of the following resin types:

6.1. polyester

6.2. epoxy

7 Repair defects using techniques/materials applicable to **one** of the following fibre types:

7.1. glass

7.2. carbon

8 Repair defects in **one** of the following core materials **(where applicable to the Sector or process):**

8.1. rigid foam

8.2. honeycomb

8.3. aluminium honeycomb

8.4. syntactic core

9 Repair **six** of the following types of defect in composite mouldings:

9.1. blisters

9.2. dents or 'dings'

9.3. surface cracks

9.4. broken fibres

9.5. stray fibres

9.6. splintering

9.7. voids

9.8. damaged cores

9.9. dis-bonds

9.10. de-lamination

9.11. impact damage

9.12. puncture

9.13. holes

9.14. abrasion/erosion

Skills *The learner must be able to:*	
10	Where applicable cure bonded repairs using two of the following methods: 10.1. room temperature 10.2. oven 10.3. heated tools/moulds 10.4. heat mats 10.5. hot bonder
11	Repair a range of mouldings in compliance with **all** of the following standards: 11.1. OEM approved data 11.2. Regulatory standards

Knowledge and understanding *The learner must:*	
K1	Describe the health and safety precautions to be taken and procedures used when working with composite materials, consumables, tools and equipment in the specific work area
K2	Describe the hazards associated with carrying out composite repair activities and with the composite materials, consumables, tools and equipment used and how to minimise these and reduce any risks
K3	Describe the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables
K4	Describe the specific environmental conditions that must be observed when repairing composite mouldings (such as temperature, humidity, fume/dust extraction systems and equipment)
K5	Explain how to identify and use information from engineering drawings and related documentation, to include symbols and conventions to appropriate BS, ISO or BSEN standards in relation to work undertaken
K6	Explain the quality procedures used in the workplace to ensure production control (in relation to currency, issue, meeting specification) and the completion of such documents
K7	Describe the basic conventions and terminology used when repairing composite mouldings (such as dis-bonds, de-lamination, resin injection, resin voids, core potting, repair patches)
K8	Describe the methods used to repair composite mouldings
K9	Describe the methods used to cure bonded repairs and their applications
K10	Explain the importance of carrying out dimensional/tolerance checks on completion of the repair activity

Knowledge and understanding *The learner must:*
K11 Describe why repairs may affect the structural integrity of the composite moulding
K12 Describe the procedure used to determine if additional testing (such as joint integrity, strength testing) is required following a repair
K13 Explain the correct methods of storing and handling composite materials
K14 Describe the tools and equipment used for various activities associated with repairing composite mouldings
K15 Describe the documentation to be completed during and/or on completion of the repair activity

Unit 32: Lifting and Trestling/Shoring Aircraft for Maintenance and Repair Activities

Level: 2

Guided learning hours: 70

Unit overview

This unit of competence has been developed by employers in the Aerospace and Aviation Sector and is part of an overall development programme designed to meet the requirements of the Sector, the published Apprenticeship Standard and Employer Occupational Brief.

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to lift and trestle/shore aircraft, in accordance with the aircraft maintenance manual or approved change documentation (service bulletin) requirements and aircraft manufacturers approved data.

They will be required to use correctly specified items of lifting and supporting equipment. They must check that the lifting equipment is within current authorisation dates, is undamaged and within the permitted safe working load (SWL) or working load limit (WLL). As part of a team they will be expected to establish the weight of the aircraft to be lifted, and to attach the appropriate lifting equipment/slings to the designated lifting points on the aircraft, in order to achieve a safe and balanced lift.

Their responsibilities will require them to comply with the specific practices and procedures identified in the aircraft manual or change/service bulletin documentation for the aircraft lifting and shoring activities undertaken, and to report any problems with the lifting and trestling/shoring activities or with the equipment used to the appropriate person. Although working under a high level of supervision and as part of a team they must demonstrate a significant personal contribution during activities, in order to satisfy the competency requirements of this unit. They will be expected to take personal responsibility for their own actions, for their contribution to the team, and for the safety and accuracy of the work that they carry out.

Their underpinning knowledge will provide a good understanding of their work, and will provide an informed approach to applying the correct aircraft lifting and trestling/shoring techniques and procedures. They will understand the lifting and trestling/shoring techniques used, their application, and will know about the lifting equipment and accessories for lifting, in adequate depth to provide a sound basis for carrying out the activities safely and correctly.

They will understand the safety precautions required when carrying out the lifting and trestling/shoring, and the safeguards that are necessary for undertaking these activities.

They will be required to demonstrate safe working practices throughout, and will understand the responsibilities they owe to themselves and others in the workplace.

They will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity, motivation and commitment.

Assessment requirements

Assessment requirements for this unit are set down in the Aerospace and Aviation Assessment Strategy which can be found in *Annexe A*. These requirements have been developed by employers for Aerospace and Aviation Engineering.

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems.

This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements *The learner must be able to:*	
P1	Work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines including aircraft manufacturers approved data
P2	Demonstrate the required behaviours in line with the job role and company objectives
P3	Position the lifting equipment so that the weight of the load is evenly distributed
P4	Attach the appropriate lifting equipment securely to the load, using approved methods to eliminate slippage
P5	Confirm that the load is secure before moving
P6	Lift the load using approved techniques and procedures
P7	Position and release the load safely in its intended location

Skills *The learner must be able to:*		
1.	Carry out **all** of the following during the aircraft lifting and trestling/shoring activities:	
	1.1	ensure that appropriate authorisation to work on the aircraft is obtained, and observe all relevant isolation and safety procedures
	1.2	obtain and use the appropriate documentation (such as job instructions, technical instructions, aircraft manuals and lifting/shoring maintenance documentation)
	1.3	check that the work area is free from hazards and suitably prepared for the activities to be undertaken
	1.4	adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment and other relevant safety regulations and procedures to realise a safe system of work
	1.5	ensure that the relevant safety devices and mechanical/physical locks are in place (where appropriate)
	1.6	use approved lifting and trestling/shoring techniques and procedures at all times
	1.7	leave the aircraft and equipment in a safe and appropriate condition, and ensure that components and surrounding structures are maintained free from damage and foreign object debris
	1.8	return tools and equipment to the correct storage location on completion of the activities
	1.9	ensure that the work carried out is correctly documented and recorded

Skills

The learner must be able to:

2. Ensure that the lifting and trestling/shoring equipment to be used is correct for the aircraft being lifted and is in a safe and usable condition, by establishing **all** of the following:
   - 2.1 the lifting equipment selected is as specified for the aircraft being lifted (such as type, lifting capacity)
   - 2.2 the lifting equipment is certified and is compliant, within current test dates (such as LOLER regulations and health and safety requirements)
   - 2.3 all lifting equipment documents/registers are up to date
   - 2.4 where appropriate, all slings and ancillary equipment are free from obvious defects
   - 2.5 all trestles and shoring equipment are in a safe and usable condition

3. Use **one** of the following lifting methods and techniques:
   - 3.1 single point wheel jacking
   - 3.2 other specific technique

4. Carry out jacking and treslling/shoring of an aircraft, to include carrying out **all** of the following:
   - 4.1 establishing the weight of the aircraft to be lifted, including fuel on board
   - 4.2 determining the correct lifting/jacking points on the aircraft
   - 4.3 removing access panels to expose the jacking/lifting points
   - 4.4 positioning the lifting/jacking equipment correctly on the aircraft
   - 4.5 attaching any required balance weights (ballast) to the aircraft (where appropriate)
   - 4.6 carrying out the lifting/jacking using the approved techniques and procedures for the aircraft type
   - 4.7 positioning the supporting equipment (such as contoured/cushioned supports, trestles, tail supports) and ensuring that it is installed at the appropriate/defined positions on the aircraft (where appropriate)
   - 4.8 lowering the aircraft onto the supporting equipment without causing damage to the aircraft structure (where appropriate)
   - 4.9 checking that the aircraft is correctly and safely balanced and held

5. Carry out aircraft lifting and trestling/shoring operations in compliance with **one** of the following:
   - 5.1 Civil Aviation Authority (CAA)/European Aviation Safety Agency (EASA)
   - 5.2 Ministry of Defence (MoD)
   - 5.3 aircraft manufacturer's approved data

Knowledge and understanding *The learner must:*	
K1	Describe the specific safety precautions to be taken when lifting and trestling/shoring aircraft, and the need for ensuring aircraft security (such as general workshop and site safety, appropriate personal protective equipment, protecting other workers during the lifting operations, accident procedures, statutory regulations, risk assessment procedures and COSHH regulations)
K2	Describe the hazards associated with lifting and trestling/shoring aircraft, and how to minimise them and reduce any risk
K3	Describe the Approved Code of Practice (ACOP) for safe use of lifting equipment, and Lifting Operation and Lifting Equipment Regulations (LOLER)
K4	Describe the requirements and importance of understanding and applying human factors as defined by the regulatory requirements and the potential impact if these are not adhered to
K5	Describe the specific requirements for the marking/calibration of lifting equipment and the specific method used in the organisation in which they are working
K6	Describe the range of equipment that is to be used for the lifting operations (such as hydraulic jacks, power operated cranes, winches, pulling equipment)
K7	Describe the lifting equipment accessories that are to be used (such as slings, eye bolts)
K8	Describe the pre-use checks that should be made on the lifting equipment prior to use and the problems that they should look for (such as making sure that the equipment has the lifting capacity required for the load and that the equipment is not damaged)
K9	Explain the factors which affect the selection of the lifting equipment and lifting accessories (such as weight, type of load, operating environment)
K10	Describe how to check that the lifting equipment is capable of lifting the load to be moved
K11	Describe the signalling techniques used to communicate with the lifting team (to include both hand signals and verbal commands)
K12	Explain how to identify the lifting and trestling/shoring points on the aircraft and why they must not use any other points to lift the aircraft
K13	Describe why balance/ballast weights are sometimes required during the lifting operations
K14	Describe the various trestling/shoring methods and equipment that may be used
K15	Describe the need to carry out the lifting and trestling/shoring operations without causing damage or undue stress to the airframe and its components
K16	Explain how lifting and trestling/shoring equipment should be stored and handled
K17	Describe the problems that can occur during the lifting, trestling or shoring of the aircraft and how these problems can be rectified
K18	Describe the extent of their own authority, and to whom they should report if they have problems that they cannot resolve

13 Further information and useful publications

To get in touch with us visit our 'Contact us' pages:

- Edexcel, BTEC and Pearson Work Based Learning contact details: qualifications.pearson.com/en/support/contact-us.html
- books, software and online resources for UK schools and colleges: www.pearsonschoolsandfecolleges.co.uk

Key publications

- *Adjustments for candidates with disabilities and learning difficulties – Access and Arrangements and Reasonable Adjustments, General and Vocational qualifications* (Joint Council for Qualifications (JCQ))
- *Supplementary guidance for reasonable adjustments and special consideration in vocational internally assessed units* (Pearson)
- *Suspected Malpractice in Examination and Assessments: Policies and Procedures* (JCQ)
- *Equality Policy* (Pearson)
- *Recognition of Prior Learning Policy and Process* (Pearson)
- *UK Information Manual* (Pearson)
- *UK Quality Vocational Assurance Handbook* (Pearson).

All of these publications are available on our website: qualifications.pearson.com

Further information and publications on the delivery and quality assurance of NVQ/Competence-based qualifications are available at our website on the Delivering BTEC pages. Our publications catalogue lists all the material available to support our qualifications. To access the catalogue and order publications, please go to the resources page of our website.

14 Professional development and training

Professional development and training

Pearson supports customers with training related to our qualifications. This support is available through a choice of training options offered on our website.

The support we offer focuses on a range of issues, such as:

- planning for the delivery of a new programme
- planning for assessment and grading
- developing effective assignments
- building your team and teamwork skills
- developing learner-centred learning and teaching approaches
- building in effective and efficient quality assurance systems.

The national programme of training we offer is on our website at: qualifications.pearson.com. You can request centre-based training through the website or you can contact one of our advisers in the Training from Pearson UK team via Customer Services to discuss your training needs.

Training and support for the lifetime of the qualifications

Training and networks: our training programme ranges from free introductory events through sector-specific opportunities to detailed training on all aspects of delivery, assignments and assessment. We also host some regional network events to allow you to share your experiences, ideas and best practice with colleagues in your region.

Regional support: our team of Regional Quality Managers, based around the country, are responsible for providing quality assurance support and guidance to anyone managing and delivering NVQs/Competence-based qualifications. The Regional Quality Managers can support you at all stages of the standard verification process as well as in finding resolutions of actions and recommendations as required.

To get in touch with our dedicated support teams please visit our website at: qualifications.pearson.com/en/support/contact-us.html

Online support: find the answers to your questions in *Knowledge Base*, a searchable database of FAQs and useful videos that we have put together with the help of our subject advisors to support you in your role. Whether you are a teacher, administrator, Assessment Associate or training provider, you will find answers to your questions. If you are unable to find the information you need please send us your query and our qualification or administrative experts will get back to you.

15 Contact us

We have a dedicated Account Support team, across the UK, to give you more personalised support and advice. To contact your Account Specialist:

Email: wblcustomerservices@pearson.com
Telephone: 0844 576 0045

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If you would like to register a complaint with us, please email wblcomplaints@pearson.com.

We will formally acknowledge your complaint within two working days of receipt and provide a full response within seven working days.

Apprenticeship Standards in the

Aerospace and Aviation Sector

Employer Occupational Brief

Occupational Competence and Technical Knowledge Qualifications

Assessment Strategy for

Employers, Training Providers and Awarding Organisations

Version 3

Table of Contents

Introduction

Employers in the Aerospace and Aviation Sectors have produced this Qualification Assessment Strategy to:

- support the implementation and delivery of the Apprenticeship Standard in a way that is appropriate, relevant, feasible, manageable and affordable in a wide range of employer contexts
- provide clarity for Awarding Organisations on what constitutes competent performance
- encourage and promote consistent assessment of Competence and Technical Knowledge requirements
- promote cost-effective delivery and assessment plans
- motivate apprentices to always maintain a high level of skills, knowledge and behaviours throughout the apprenticeship and not just to do enough to satisfy the minimum requirements, in the knowledge that they will be continually assessed leading to a final end point assessment with a technical interview (viva) and supported by the achievement of competence and technical knowledge qualifications coupled portfolio of evidence
- add value to both the apprentice and the employer, by complementing and building on normal company performance management and development tools including regular performance reviews
- enable and encourage progression and continuing professional development by being linked to professional recognition
- position the apprenticeship not just as a job, but as the starting point for a career in the sector – assessment at the end marks a clear recognition of achievements, on which the individual can build
- select assessment methods that will ensure relevance and consistency, irrespective of the specific job role of the apprentice
- ensure costs and practicalities will be appropriate and proportionate to large as well as SME employers
- including those with large or small numbers of apprentices.

This document also provides definitions for:

- the qualifications and experience required for Assessors/Trainers/Teachers and Verifiers
- the assessment environment for the Foundation and Development Phase Occupational Competence Qualifications
- access to assessment

and requirements relating to:

- carrying out occupational competence assessments
- performance evidence requirements for occupational competence
- assessing knowledge and understanding
- use of witness testimonies
- continuing professional development
- quality control of assessment.

Section 1

Occupational Competence Qualifications (Foundation and Development Phase)

Assessor Requirements to Demonstrate Effective Assessment Practice

Assessment must be carried out by competent Assessors that, as a minimum, must hold the QCF Level 3 Award in Assessing Competence in the Work Environment**.** Current and operational Assessors that hold units D32 and/or D33 or A1 and/or A2 as appropriate to the assessment being carried out will not be required to achieve the QCF Level 3 Award as they are still appropriate for the assessment requirements set out in this Assessment Strategy. However, they will be expected to regularly review their skills, knowledge and understanding and, where applicable, undertake continuing professional development to ensure that they are carrying out workplace assessment to the most up-to-date Employer Units of Competence.

Assessor Technical Requirements

Assessors must be able to demonstrate that they have verifiable, relevant and sufficient technical competence to evaluate and judge performance and knowledge evidence requirements as set out in the relevant outcomes in the Employer Units of Competence.

This will be demonstrated either by holding a relevant technical qualification or by proven industrial experience of the technical areas to be assessed. The assessor's competence must, at the very least, be at the same level as that required of the Apprentice in the units being assessed.

Assessors must also be fully conversant with the Awarding Organisation's assessment recording documentation used for the Employer Units of Competence against which the assessments and verification are to be carried out, plus any other relevant documentation and system and procedures to support the Quality Assurance (QA) process.

Verifier Requirements (internal and external)

Internal QA (Internal Verification) must be carried out by competent Verifiers that, as a minimum, must hold the QCF Level 4 Award in the Internal Quality Assurance of Assessment Processes and Practices.

Current and operational Internal Verifiers that hold internal verification units V1 or D34 will not be required to achieve the QCF Level 4 Award, as they are still appropriate for the verification requirements set out in this Assessment Strategy. Verifiers must be familiar with, and preferably hold, either the nationally recognised Assessor units D32 and/or D33 or A1 and/or A2 or the QCF Level 3 Award in Assessing Competence in the Work Environment.

External QA (External Verification) must be carried out by competent External Verifiers that as a minimum must hold the QCF Level 4 Award in the External Quality Assurance of Assessment Processes and Practices.

Current and operational External Verifiers that hold external verification units V2 or D35 will not be required to achieve the QCF Level 4 Award as they are still appropriate for the verification requirements set out in this Assessment Strategy. Verifiers must be familiar with, and preferably hold, either the nationally recognised Assessor units D32 and/or D33 or A1 and/or A2 or the QCF Level 3 Award in Assessing Competence in the Work Environment.

External and Internal Verifiers will be expected to regularly review their skills, knowledge and understanding and where applicable undertake continuing professional development to ensure that they are carrying out workplace Quality Assurance (verification) of Assessment Processes and Practices to the most up-to-date Employer Units of Competence.

Verifiers, both Internal and External, will also be expected to be fully conversant with the terminology used in the Employer Units of Competence against which the assessments and verification are to be carried out, the appropriate Regulatory Body's systems and procedures and the relevant Awarding Organisation's documentation, systems and procedures within which the assessment and verification is taking place.

Specific technical requirements for internal and external verifiers

Internal and external Verifiers for the Employer Units of Competence must be able to demonstrate that have verifiable, sufficient and relevant industrial experience, and must have a working knowledge of the processes, techniques and procedures that are used in the engineering industry.

The table below and on the following page show the recommended levels of technical competence for Assessors, Internal Verifiers and External Verifiers.

Technical Requirements for Assessors and Verifiers

Position	Prime activity requirements	Support activity requirements	Technical requirements (see Notes section below)
Assessor	Assessment Skills	IV Systems	Technical *competence* in the areas covered by the Employer Units of Competence being assessed
Internal Verifier	Verification Skills	Assessment Knowledge	Technical *understanding* of the areas covered by the Employer Units of Competence being verified
External Verifier	Verification skills	Assessment Understanding	Technical *awareness* of the areas covered by the Employer Units Competence being verified

Notes

1. Technical *competence* is defined here as a combination of practical skills and knowledge, as well as the ability to apply both of these in familiar and new situations, within a real working environment.
2. Technical *understanding* is defined here as having a good understanding of the technical activities being assessed, together with knowledge of relevant Health and Safety implications and requirements of the assessments.
3. Technical *awareness* is defined here as a general overview of the subject area, sufficient to ensure that assessment and evidence are reliable and that relevant Health and Safety requirements have been complied with.
4. The competence required by the Assessor, Internal Verifier and External verifier roles, in the occupational area being assessed, is likely to exist at three levels as indicated by the shaded zones in the following table.

Technical Competence / Required by:	An ability to *discuss* the general principles of the competences being assessed	An ability to *describe* the practical aspects of the competence being assessed	An ability to *demonstrate* the practical competences being assessed
Assessor			
Internal Verifier			
External Verifier			

Assessment Environment of the Employer Units of Competence in the Foundation Phase of the Apprenticeship

The Employer Units of Competence are intended to have a wide application throughout the Aerospace and Aviation Sector. It is therefore necessary to have a flexible approach to the environment in which the Employer Units of Competence are delivered and assessed during the Foundation Phase of the Apprenticeship.

Therefore, there is much to be gained by acquiring the basic engineering competencies required in the **Foundation Phase** of the Apprenticeship whilst working in a sheltered but realistic environment such as in a Training Centre or College. This is due to an ongoing emphasis on safety critical work activities and the need to ensure flexibility of assessment opportunities to both maintain and enhance the provision of competent personnel within the Aerospace and Aviation industry. These assessment conditions will allow a minimum safe level of skills, knowledge and understanding to be achieved and demonstrated by the Apprentice prior to being exposed to the hazards of the industrial environment, thus minimising the risk of injury to themselves and other employees.

For the above reasons, the assessment of the Apprentices competence in a sheltered but realistic environment **is acceptable** for the Employer Units of Competence included the **Foundation Phase** of the Apprenticeship, where the environment replicates that expected in industry.

Where applicable, the machinery, tools, materials, equipment and resources used must be representative of industry standards and there must be sufficient equipment/resources available for each Apprentice to demonstrate their competence on an individual basis. Workpieces or work outcomes assessed must be the Apprentice's own work and should be actual work examples that combine the skills and techniques required by the Employer Units of Competence so that achievement will properly reflect the Apprentice's capabilities.

Assessors must therefore ensure that the competency assessed in a simulated environment is fully transferable to the workplace. Other aspects that should be considered could include:

- environmental conditions, such as lighting conditions, noise levels and the presence of hazards
- pressure of work, such as time constraints and repetitive activities
- producing actual workpieces or work outcomes, the consequences of making mistakes and the effect these have on customer, supplier and departmental relationships.

Assessment Environment of the Employer Units of Competence in the Development Phase of the Apprenticeship

The evidence put forward for the Employer Units of Competence can **only** be regarded valid, reliable, sufficient and authentic if achieved and obtained in the working environment where the Apprentice is employed and be clearly attributable to the Apprentice. However, in certain circumstances, simulation/replication of work activities may be acceptable, but must be kept to an absolute minimum.

The use of high quality, realistic simulations/replication, which impose pressures consistent with workplace expectations, should only be used in relation to the assessment of the following:

- rare or dangerous occurrences, such as those associated with health, safety and the environment issues, emergency scenarios and rare operations at work
- the response to faults and problems for which no opportunity has presented for the use of naturally occurring workplace evidence of learners competence
- aspects of working relationships and communications for which no opportunity has presented for the use of naturally occurring workplace evidence of learners competence.

Simulations/replications will require prior approval from the specific Awarding Organisation and should be designed in accordance with the following parameters:

- the environment in which simulations take place must be designed to match the characteristics of the working environment
- competencies achieved via simulation/replication must be transferable to the working environment
- simulations which are designed to assess competence in dealing with emergencies, accidents and incidents must be verified as complying with relevant health, safety and environmental legislation by a competent health and safety/environmental control officer before being used
- simulated activities should place Apprentices under the same pressures of time, access to resources and access to information as would be expected if the activity was real
- simulated activities should require Apprentices to demonstrate their competence using plant and/or equipment used in the working environment
- simulated activities which require interaction with colleagues and contacts should require the Apprentice to use the communication media that would be expected at the workplace
- for health and safety reasons simulations need not involve the use of genuine substances/materials. Any simulations which require the Apprentice to handle or otherwise deal with materials substances/should ensure that the substitute takes the same form as in the workplace.

Access to Assessment

There are no entry requirements required for the Employer Units of Competence, unless this is a legal requirement of the process or the environment in which the Apprentice is working in. Assessment is open to any Apprentice who has the potential to reach the assessment requirements set out in the relevant units.

Aids or appliances, which are designed to alleviate disability, may be used during assessment, providing they do not compromise the standard required.

Carrying Out Assessments of the Occupational Competence Qualifications

The Employer Units of Competence have been specifically developed to cover a wide range of activities. The evidence produced for the units will, therefore, depend on the skills and knowledge required by employers and specified in the Apprentices Training Plan. The Skills section of the Employer Units of Competence makes reference to a number of optional items listed in the Skills section of the units **(for example 'any three from five'**). This is the minimum standard set by employers.

Where the unit requirements give a choice of optional areas, assessors should note that Apprentices do not need to provide evidence of the other areas to complete the unit (in the example above, two items), unless specified by the employer, particularly where these additional items may relate to other activities or methods that are not part of the Apprentices normal workplace activities or are not required by the employer.

Performance Evidence Requirements of the Occupational Competence Qualifications

Performance evidence must be the main form of evidence gathered. In order to demonstrate consistent competent performance for a unit, a minimum of **three** different examples of performance of the unit activity will be required. Items of performance evidence often contain features that apply to more than one unit, and **can be used as evidence in any unit** where they are suitable.

Performance evidence must be:

- products of the Apprentices work, such as items that have been produced or worked on, plans, charts, reports, standard operating procedures, documents produced as part of a work activity, records or photographs of the completed activity

together with:

- evidence of the way the Apprentice carried out the activities, such as witness testimonies, assessor observations or authenticated Apprentice reports of the activity undertaken.

Competent performance is more than just carrying out a series of individual set tasks. Many of the units in the Foundation Phase contain statements that require the Apprentice to provide evidence that proves they are capable of combining various features and techniques. Where this is the case, separate fragments of evidence would not provide this combination of features and techniques and, therefore, will not be acceptable as demonstrating competent performance.

If there is any doubt as to what constitutes suitable evidence the Internal/External Verifier should be consulted.

Example:

Foundation Unit 10: Preparing aircraft detail assemblies

Unit specific additional assessment requirements:

Specific Unit Requirements

In order to prove their ability to combine different aircraft detail assembly operations, at least one of the assemblies produced must be of a significant nature, and must contain a minimum of **four** of the components listed in the skills section, paragraph 2.

Assessing Knowledge and Understanding requirements in the Occupational Competence Qualifications

Knowledge and understanding are key components of competent performance, but it is unlikely that performance evidence alone will provide enough evidence in this area. Where the Apprentice's knowledge and understanding are not apparent from performance evidence, they must be assessed by other means and be supported by suitable evidence.

Knowledge and understanding can be demonstrated in a number of different ways. It is recommended that oral questioning and practical demonstrations are used perhaps whilst observing the apprentice undertake specific tasks, as these are considered the most appropriate for these units. Assessors should ask enough questions to make sure that the Apprentice has an appropriate level of knowledge and understanding, as required by the unit.

Evidence of knowledge and understanding will **not** be required for those items in the skills section of the Employer Units of Competence that have not been selected by the Employer.

The achievement of the specific knowledge and understanding requirements in the units may not simply be inferred by the results of tests, exams or assignments from other units such as in the technical knowledge qualifications or other training programmes. Where evidence is submitted from these sources, the assessor must, as with any assessment, make sure the evidence is valid, reliable, authentic, directly attributable to the Apprentice, and meets the full knowledge and understanding requirements of the unit.

Where oral questioning is used, the assessor must retain a record of the questions asked, together with the Apprentices answers.

Witness testimony

Where observation is used to obtain performance evidence, this must be carried out against the unit assessment criteria. Best practice would require that such observation is carried out by a qualified Assessor. If this is not practicable, then alternative sources of evidence may be used.

For example, the observation may be carried out against the assessment criteria by someone else that is in close contact with the Apprentice. This could be a team leader, supervisor, mentor or line manager who may be regarded as a suitable witness to the Apprentices competency. However, the witness must be technically competent in the process or skills that they are providing testimony for, to at least the same level of expertise as that required of the Apprentice. It will be the responsibility of the assessor to make sure that any witness testimonies accepted as evidence of the Apprentices competency are reliable, auditable and technically valid.

Maximising opportunities to use assessment evidence

One of the critical factors required in order to make this Assessment Strategy as efficient and effective as possible and to ease the burden of assessment, is the Assessor's ability and expertise to work in partnership with the apprentice and their employer to provide advice and guidance on how to maximise opportunities to cross-reference performance and knowledge evidence to all relevant Employer Units of Competence. For example, if a knowledge statement is repeated in a number of separate Employer Units of Competence and the expected evidence/response to that statement is the same including the context, then the same piece of evidence should be cross referenced to the appropriate units.

Section 2

Technical Knowledge Qualifications (Foundation and Development Phase)

Teacher/Trainer/Lecturer/Assessor requirements

Staff must:

- have relevant experience in teaching/training/assessing

or

- hold or are working towards an appropriate teaching/training/assessing qualification

and

- be technically knowledgeable in the area(s) for which they are delivering training/assessing, with appropriate qualifications
- be familiar with the Engineering Technician (UK spec) requirements where delivering/assessing Level 3, they will be required to provide a signed declaration confirming they have read and understood the Engineering Technician UK spec and the evidence requirements to meet the engineering technician (UK spec) criteria.

Internal Quality Assurance requirements

Staff must:

- have experience in quality management/internal verification

or

- hold or be working towards an appropriate internal quality assurance qualification

and

- be familiar with the occupation and technical content covered within the qualification
- be familiar with the Engineering Technician (UK spec) requirements where delivering/assessing Level 3, they will be required to provide a signed declaration confirming they have read and understood the Engineering Technician UK spec and the evidence requirements to meet the engineering technician (UK spec) criteria.

External Quality Assurance requirements

Staff must:

- have experience in quality management/external verification
- hold or be working towards an appropriate external quality assurance qualification
- be familiar with the occupation and technical content covered within the qualifications
- be familiar with the Engineering Technician (UK spec) requirements for Level 3 and understand the evidence requirements to meet the engineering technician (UK spec) criteria.

Assessments

The qualifications will include both internal and external assessments, which could include a range of different methods such as:

- Practical assessments
- Short-answer Questions
- Written or Multiple choice tests
- Paper-based or online assessments
- Other appropriate assessment methods

The assessments methods to be used will be agreed across all Awarding Organisations (AOs) involved in the development of the units.

Grading

The knowledge qualifications will be graded pass, merit or distinction in line with the grading criteria to be agreed across all AOs involved in the development of the units.

The agreed grading criteria will be made available to providers, teachers, assessors and learners to ensure they are fully aware of the achievement requirements for each grade. Please refer to the specifications from the individual AOs.

Section 3

General Requirements

Continuing Professional Development (CPD)

Centres must support their staff to ensure that they have current technical knowledge of the occupational area, that delivery, mentoring, training, assessment and verification are in line with best practice, technical advancements and that they will take account of any national or legislative developments.

There must be an auditable individual CPD plan in place for all staff assessing and verifying the qualifications within the Aerospace and Aviation Foundation and Development phases, the plan must meet the relevant provider and Aerospace and Aviation employer requirements.

Assessors/Teachers/Trainers/Lecturers (as applicable):

- must understand the Engineering Technician (UK spec) requirements when providing guidance to assessors. They will be required to provide a signed declaration confirming they have read and understood the Engineering Technician UK spec and the evidence requirements to meet the engineering technician (UK spec) criteria as it a mandatory requirement that all Apprentices complete the Aerospace and Aviation Apprenticeship Standard – Engineering Technician Performance Indicators Recording Document (currently in development). The engineering technician (UK spec) can be found at www.engc.org.uk
- must understand the requirements of the Aerospace and Aviation Apprenticeship Standard – End of Scheme Assessment Recording Document (currently in development).

Quality Control of Assessment

General

There are two major points where an Awarding Organisation interacts with the Centre in relation to the External Quality Control of Assessment and these are:

- approval – when a Centre takes on new qualifications/units, the Awarding Organisation, normally through an External Verifier (EV) ensures that the Centre is suitably equipped and prepared to deliver the new units/qualification
- monitoring – throughout the ongoing delivery of the qualification/units the Awarding Organisation, through EV monitoring and other mechanisms must maintain the quality and consistency of assessment of the units/qualification.

Approval

In granting Approval, the Awarding Organisation, normally through its External Verifiers (EV) must ensure that the prospective Centre:

- meets the requirements of the Qualification Regulator
- has sufficient and appropriate physical and staff resources
- meets relevant health and safety and/or equality and access requirements
- has a robust plan for the delivery of the qualification/units.

The Awarding Organisation may visit the Centre to view evidence or may undertake this via other means.

The Awarding Organisation must have a clear rationale for the method(s) deployed.

Monitoring

Each AO, through EV monitoring and other mechanisms, must ensure:

- that a strategy is developed and deployed for the ongoing AO monitoring of the Centre. This strategy must be based on an active risk assessment of the Centre. In particular, the strategy must identify the Apprentice, assessors and Internal Verifier sampling strategy to be deployed and the rationale behind this
- that the Centre's internal QA processes are effective in assessment
- that sanctions are applied to a Centre where necessary and that corrective actions are taken by the Centre and monitored by the AO/EV
- that reviews of the AO's external auditing arrangements are undertaken.

Notes

a) It is recognised that each AO will have its own guidance and procedure on the internal and external QA process applied to these qualifications. See individual AO websites for further information.

b) This Assessment Strategy is "work in progress" and will be amended and re-issued as the Competence and Technical Knowledge Qualifications and assessment methodologies are developed and modified. i.e. it is hoped that it will be adapted to meet the requirements of the Aerospace MRO Sector as their Standards and qualification requirements are developed.

c) The Aerospace and Aviation Sector is mindful that its Apprenticeships are and **must** be available across all four Nations in the UK. Therefore the Sector has ensured that the Employer Occupational Brief (EOB) and the associated Employer Units of Competence are directly aligned to the existing format and content of the Sectors National Occupational Standards (NOS).

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