City & Guilds Level 2 Diploma in Aerospace and Aviation Engineering (Foundation Competence) (OQ) (4605-02)

April 2024 Version 7.0

Qualification Handbook

Qualification at a glance

Subject area	Engineering
City & Guilds number	4605
Age group approved	16+
Entry requirements	The apprenticeship standard requires a candidate would have typically achieved 4 GCSEs at Grade C or equivalent, including Mathematics, English and a Science.
Assessment	Portfolio of evidence
Approvals	Fast-track
Support materials	Centre handbook
Registration and certification	Consult the Walled Garden/Online Catalogue for last dates

Title and level	Size (GLH)	TQT	City & Guilds qualification number	Ofqual accreditation number
City & Guilds Level 2 Diploma in Aerospace and Aviation Engineering (Foundation Competence) (OQ)	439	527	4605-02	601/7310/5

Version and date	Change detail	Section
Version 2.0 March 2016	Optional units 232-238, 246	Structure, Units
Version 3.0 June 2017	Unit 211 – unit aim amended.	Units
Version 4.0 September 2018	Unit 232 – LO 5 removed and other Los renumbered.	Units
Version 5.0 September 2018	Changed from a seven to a nine	Unit 201 Assessment criteria 4
Version 6.0 February 2022	GLH and TQT clarified and highlighted	Qualification at a glance
Version 6.1 March 2023	GLH and TQT amended Title amended	Qualification at a glance

		Throughout
Version 7.0 March 2024	Updated to current format. Added OQ to title	

Contents

1 Introduction

This document tells you what you need to do to deliver the qualifications:

Area	Description
Who is the qualification for?	It is aimed at anyone over the age of 16 who has an interest in working and progressing in the Aerospace and Aviation sector.
What does the qualification cover?	This qualification allows candidates to learn, develop and practise the skills required for employment and/or career progression in the Aerospace and Aviation sector and the Advanced Manufacturing and Engineering sector in general.
What opportunities for progression are there?	Candidates can progress into the Development Phase of the Aerospace and Aviation Engineering Apprenticeship Standards, and to the following City & Guilds qualifications: • 4705-02 Level 2 Diploma in Aerospace and Aviation (Foundation Knowledge) – available November 2015 • 1145-30, 31, 32 Level 3 Advanced Technicals in Engineering
Who did we develop the qualification with?	This qualification was developed in collaboration with employers from the Aerospace and Aviation Sector, SEMTA and other Awarding Organisations.
Is it part of an apprenticeship framework or initiative?	This qualification is a mandatory component of the Foundation Phase of the following Apprenticeship Standards: • Aerospace Manufacturing Fitter • Aerospace Manufacturing Electrical, Mechanical and Systems Fitter • Aircraft Maintenance Fitter/Technician (Fixed and Rotary Wing)

Structure

To achieve the City & Guilds Level 2 Diploma in Aerospace and Aviation Engineering (Foundation Competence) (OQ):

Aerospace Manufacturing Fitter Apprenticeship Standard - learners must achieve **four** mandatory units 201-204 and **four** optional units from 205-238,246.

Aircraft Maintenance Fitter/Technician (Fixed and Rotary Wing) Apprenticeship Standard

Workshop Maintenance - learners must achieve **four** mandatory units 201- 203, 294 and **four** optional units from 206-213, 217-220, 222-230, 232, 246.

Units 205, 214-216, 221, 231, 233-238 can be taken as additional units but will not count towards achievement of the qualification.

Line and Base Maintenance - learners must achieve **four** mandatory units 201- 203, 294 and **four** optional units from 206-211, 217-219, 222-232, 246.

Units 205, 212-216, 220-221, 233-238 can be taken as additional units but will not count towards achievement of the qualification.

Barred unit combinations as shown on the next page should be taken into account for **all** learners.

Level 2 Aerospace and Aviation Engineering (Foundation Competence)

UAN	City & Guilds unit number	Unit title	Barred unit(s)	GLH
Mandatory	**Aerospace Manufacturing Fitter standard**			
J/507/3874	201	Complying with statutory regulations and organisational safety requirements		18
J/507/3955	202	Working efficiently and effectively in an engineering environment		18
L/507/3956	203	Using and communicating technical information		18
R/507/3957	204	Conducting business improvement activities		70
Mandatory	**Aircraft Maintenance Fitter/Technician standard**			
J/507/3874	201	Complying with statutory regulations and organisational safety requirements		18
J/507/3955	202	Working efficiently and effectively in an engineering environment		18
L/507/3956	203	Using and communicating technical information		18
Y/507/3958	294	Demonstrating personal accountability in an aircraft maintenance environment		70
Optional				
D/507/3959	205	Producing mechanical engineering drawings using a CAD system	233	140
R/507/3991	206	Producing components using hand fitting techniques		175
Y/507/3992	207	Producing mechanical assemblies	225	140
R/507/3960	208	Forming and assembling pipework systems		140
Y/507/3961	209	Carrying out aircraft detail fitting activities	219	175
D/507/3962	210	Installing aircraft mechanical fasteners		105
H/507/3963	211	Producing aircraft detail assemblies		140
K/507/3964	212	Preparing and using lathes for turning operations	228	140
M/507/3965	213	Preparing and using milling machines	228	140
T/507/3966	214	Preparing and proving CNC machine tool programs		140
A/507/3967	215	Preparing and using CNC turning machines	228	140
F/507/3968	216	Preparing and using CNC milling machines	228	140

J/507/3969	217	Maintaining mechanical devices and equipment	226	175
A/507/3970	218	Assembling and testing fluid power systems		105
F/507/3971	219	Producing sheet metal components and assemblies	209	140
J/507/3972	220	Preparing and using manual TIG or Plasma-arc welding equipment		140
L/507/3973	221	Preparing and using semi-automatic MIG, MAG and flux cored arc welding equipment	228	140
R/507/3974	222	Producing composite mouldings using Wet Lay-up techniques		140
Y/507/3975	223	Producing composite mouldings using Pre-Preg techniques		140
D/507/3976	224	General electrical and electronic engineering applications	232	140
H/507/3977	225	Dressing aircraft engines	207	105
K/507/3978	226	Maintaining aircraft mechanical devices and equipment		175
M/507/3979	227	Maintaining fluid power equipment		105
H/507/3980	228	General turning, milling and welding applications	212, 213, 215, 216, 221	140
K/507/3981	229	Checking for defects in composite mouldings		35
M/507/3982	230	Carrying out repairs on composite mouldings		105
T/507/3983	231	Lifting and trestling/shoring aircraft for maintenance and repair activities		70
A/507/3984	232	General electrical and avionic engineering applications	224	140
F/507/3985	233	Producing electrical or electronic engineering drawings using a CAD system	205	140
J/507/3987	234	Wiring and testing electrical equipment and circuits		140
L/507/3988	235	Assembling, wiring and testing electrical panels/components mounted in enclosures		140
R/507/3988	236	Assembling and testing electronic circuits		140
Y/507/3989	237	Maintaining electrical equipment/systems		175
L/507/3990	238	Maintaining electronic equipment/systems		140
A/507/9431	246	Producing composite assemblies		105

Total Qualification Time (TQT)

Total Qualification Time (TQT) is the number of notional hours which represents an estimate of the total amount of time that could reasonably be expected for a learner to demonstrate the achievement of the level of attainment necessary for the award of a qualification.

TQT comprises of the following two elements:

1) the number of hours that an awarding organisation has assigned to a qualification for guided learning
2) an estimate of the number of hours a learner will reasonably be likely to spend in preparation, study or any other form of participation in education or training, including assessment, which takes place as directed by – but, unlike guided learning, not under the immediate guidance or supervision of – a lecturer, supervisor, tutor or other appropriate provider of education or training.

Title and level	GLH	TQT
City & Guilds Level 2 Diploma in Aerospace and Aviation Engineering (Foundation Competence)	439	527

2 Centre requirements

Approval

If your Centre is approved to offer the qualification 7682-20 you can apply for the new 4605-02 approval using the **fast track approval form**, available from the City & Guilds website.

Centres should use the fast track form if:

- there have been no changes to the way the qualification is delivered, and
- they meet all of the approval criteria in the fast track form guidance notes.

Fast track approval is available for 12 months from the launch of the qualification. After 12 months, the Centre will have to go through the standard Qualification Approval Process. The centre is responsible for checking that fast track approval is still current at the time of application.

To offer this qualification, new centres will need to gain both centre and qualification approval. Please refer to the *City & Guilds Centre Manual* for further information.

Centre staff should familiarise themselves with the structure, content and assessment requirements of the qualification before designing a course programme.

Resource requirements

Centre staffing
Staff delivering this qualification must be able to demonstrate that they meet the following occupational expertise requirements. They should:

- be occupationally competent or technically knowledgeable in the area[s] for which they are delivering training and/or have experience of providing training (this knowledge must be to the same level as the training being delivered)
- have recent relevant experience in the specific area they will be assessing
- have credible experience of providing training.

Continuing professional development (CPD)

Centres are expected to support their staff in ensuring that their knowledge remains current of the occupational area and of best practice in delivery, mentoring, training, assessment and quality assurance, and that it takes 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 Apprenticeship Foundation and Development phases, the plan must meet the relevant provider and employer requirements.

Assessors and Internal Quality Assurers (IQAs)

Assessor requirements to demonstrate effective assessment practice

Assessment must be carried out by competent Assessors that as a minimum must hold the 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 Level 3 Award as they are still appropriate for the assessment requirements. 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 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 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/learner in the units being assessed.

Assessors must also:

Be fully conversant with the City & Guilds assessment recording documentation used for the 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 QA process.

Internal Quality Assurer (IQA) requirements

Internal quality assurance (internal verification) must be carried out by competent IQAs that as a minimum must hold the Level 4 Award in the Internal Quality Assurance of Assessment Processes and Practices. Current and operational IQAs that hold internal verification units V1 or D34 will not be required to achieve the Level 4 Award as they are still appropriate for the verification requirements set out in this Unit Assessment Strategy. IQAs must be familiar with, and preferably hold, either the nationally recognised Assessor units D32 and/or D33 or A1 and/or A2 or the Level 3 Award in Assessing Competence in the Work Environment

IQAs 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 Units of Competence.

IQAs will also be expected to be fully conversant with the terminology used in the Units of Competence against which the assessments and verification are to be carried out, City & Guilds' systems and procedures and documentation, systems and procedures within which the assessment and verification is taking place.

Specific technical requirements for IQAs

IQAs must be able to demonstrate that they 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 tables below show the recommended levels of technical competence for Assessors and IQAs:

Technical requirements for Assessors and IQAs

Position	Prime activity requirements	Support activity requirements	Technical requirements (see notes)
Assessor	Assessment Skills	IV Systems	Technical *competence* in the areas covered by the Units of Competence being assessed
Internal Quality Assurer	Verification Skills	Assessment Knowledge	Technical *understanding* of the areas covered by the Units of Competence being verified

Notes

1. Technical *competence* is defined here as a combination of practical skills, knowledge, and 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 & 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 Quality Assurer and External Quality Assurer 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 Quality Assurer			
External Quality Assurer			

Centre staff may undertake more than one role, eg tutor and assessor or internal quality assurer, but cannot internally verify their own assessments.

Assessors/Teachers/Trainers/Lecturers (as applicable)

To enable learners to progress onto the Development Phase of the Apprenticeship Standard, delivery staff 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 Engineering Apprenticeship Standards – Engineering Technician Performance Indicators Recording Document.

They must also understand the requirements of the Aerospace and Aviation Engineering Apprenticeship Standards – End of Scheme Assessment Recording Document.

Learner entry requirements

City & Guilds does not set entry requirements for this qualification. However, centres must ensure that candidates have the potential and opportunity to gain the qualification successfully.

Age restrictions

City & Guilds cannot accept any registrations for candidates under 16 as this qualification is not approved for under 16s.

This qualification is a mandatory component of the Foundation Phase of the following Apprenticeship Standards:

- Aerospace Manufacturing Fitter
- Aerospace Manufacturing Electrical, Mechanical and Systems Fitter
- Aircraft Maintenance Fitter/Technician (Fixed and Rotary Wing)

The Standards have been designed by Employers. Centres should make themselves familiar with the Standards, Assessment Plan and Employer Occupational Brief requirements, details of which can be found at:

https://www.gov.uk/government/collections/apprenticeship-standards

Access arrangements and reasonable adjustments

City & Guilds has considered the design of this qualification and its assessments in order to best support accessibility and inclusion for all learners. We understand however that individuals have diverse learning needs and may require reasonable adjustments to fully participate. Reasonable adjustments, such as additional time or alternative formats, may be provided to accommodate learners with disabilities and support fair access to assessment.

Access arrangements are adjustments that allow candidates with disabilities, special educational needs, and temporary injuries to access the assessment and demonstrate their skills and knowledge without changing the demands of the assessment. These arrangements must be made before assessment takes place.

The Equality Act 2010 requires City & Guilds to make reasonable adjustments where a disabled person would be at a substantial disadvantage in undertaking an assessment.

It is the responsibility of the centre to ensure at the start of a programme of learning that candidates will be able to access the requirements of the qualification.

Please refer to the JCQ access arrangements and reasonable adjustments and Access arrangements - when and how applications need to be made to City & Guilds for more information. Both are available on the City & Guilds website:
http://www.cityandguilds.com/delivering-our-qualifications/centre-development/centre-document-library/policies-and-procedures/access-arrangements-reasonable-adjustments

3 Delivering the qualification

Initial assessment and induction

An initial assessment of each candidate should be made before the start of their programme to identify:

- if the candidate has any specific training needs
- support and guidance they may need when working towards their qualification
- any units they have already completed, or credit they have accumulated which is relevant to the qualifications
- the appropriate type and level of qualification.

We recommend that centres provide an induction programme so the candidate fully understands the requirements of the qualification, their responsibilities as a candidate, and the responsibilities of the centre. This information can be recorded on a learning contract.

Inclusion and diversity

City & Guilds is committed to improving inclusion and diversity within the way we work and how we deliver our purpose which is to help people and organisations develop the skills they need for growth.

More information and guidance to support centres in supporting inclusion and diversity through the delivery of City & Guilds qualifications can be found here:

Inclusion and diversity | City & Guilds (cityandguilds.com)

Sustainability

City & Guilds are committed to net zero. Our ambition is to reduce our carbon emissions by at least 50% before 2030 and develop environmentally responsible operations to achieve net zero by 2040 or sooner if we can. City & Guilds is committed to supporting qualifications that support our customers to consider sustainability and their environmental footprint.

More information and guidance to support centres in developing sustainable practices through the delivery of City & Guilds qualifications can be found here:

Our Pathway to Net Zero | City & Guilds (cityandguilds.com)

Centres should consider their own carbon footprint when delivering this qualification and consider reasonable and practical ways of delivering this qualification with sustainability in mind. This could include:

- reviewing purchasing and procurement processes (such as buying in bulk to reduce the amount of travel time and energy, considering and investing in the use of components that can be reused, instead of the use of disposable or single use consumables)
- reusing components wherever possible
- waste procedures (ensuring that waste is minimised, recycling of components is in place wherever possible)

- minimising water use and considering options for reuse/salvage as part of plumbing activities wherever possible.

Support materials

The following resources are available for these qualifications:

Description	How to access
Fast track approval form	www.cityandguilds.com

Recording documents

Candidates and centres may decide to use a paper-based or electronic method of recording evidence.

City & Guilds endorses several ePortfolio systems, including our own, **Learning Assistant**, an easy-to-use and secure online tool to support and evidence learners' progress towards achieving qualifications. Further details are available at: **www.cityandguilds.com/eportfolios**.

City & Guilds has developed a set of generic *Recording forms* including examples of completed forms, for new and existing centres to use as appropriate. *Recording forms* are available on the City & Guilds website.

Although new centres are expected to use these forms, centres may devise or customise alternative forms, which must be approved for use by the external verifier, before they are used by candidates and assessors at the centre. Amendable (MS Word) versions of the forms are available on the City & Guilds website.

4 Assessment

Summary of assessment methods

Candidates must have a completed portfolio of evidence covering chosen units.

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 apprentice 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.

Assessment strategy

Assessment environment of the units of competence in the Foundation Phase of the Apprenticeship

The Units of Competence are intended to have a wide application throughout the Aerospace and Aviation Sector. It is necessary therefore to have a flexible approach to the environment in which the 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 industry. This assessment method 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 Apprentice's competence in a sheltered but realistic environment **is acceptable** for the 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, techniques required by the Units of Competence so that achievement will properly reflect the Apprentice's capabilities.

Assessors must therefore ensure that the competency 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 and the consequence of making mistakes and the effect this has on customer, supplier and departmental relationships.

Access to assessment

There are no entry requirements required for the 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

The 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 employer and specified in the Apprentice's Training Plan. The Skills section of the Units of Competence makes reference to a number of optional items listed **(for example 'any three from five')**. This is the minimum standard set by employers.

Where the unit requirements gives a choice of optional areas, Assessors should note that Apprentices do not need to provide evidence of the other areas to complete the unit, unless specified by the employer (in this example above, two items) particularly where these additional items may relate to other activities or methods that are not part of the Apprentice's normal workplace activities or required by the employer.

Performance evidence requirements

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 Apprentice's 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 Quality Assurer should be consulted.

Example:

Unit 210: 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
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 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 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 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 qualification 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 Apprentice's 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 Apprentice's 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 Apprentice's 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 Units of Competence. For example if a knowledge statement is repeated in a number of separate 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

Recognition of prior learning (RPL)

Recognition of prior learning means using a person's previous experience or qualifications which have already been achieved to contribute to a new qualification.

Please refer to the City & Guilds RPL policy on our website

http://www.cityandguilds.com/delivering-our-qualifications/centre-development/centre-document-library/policies-and-procedures/quality-assurance-documents

5 Units

Availability of units

All current units relating to this qualification can be found in this document.

Structure of the units

These units each have the following:

- City & Guilds reference number
- title
- level
- guided learning hours (GLH)
- unit aim
- assessment type
- learning outcomes, which are comprised of a number of assessment criteria

Unit 201 Complying with statutory regulations and organisational safety requirements

UAN	J/507/3874
Unit level:	2
GLH	18
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF01
Unit aim:	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 apprentice 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.

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.

Learning Outcome

The learner must be able to:

LO1 Comply with their duties and obligations as defined in the Health and Safety at Work Act
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Present themselves in the workplace suitably prepared for the activities to be undertaken
LO4 Follow organisational accident and emergency procedures
LO5 Recognise and control hazards in the workplace
LO6 Use correct manual lifting and carrying techniques
LO7 Apply safe working practices and procedures

Practical 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

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 be able to:

1. Describe the roles and responsibilities of themselves and others under the Health and Safety at Work Act 1974 and other current legislation (eg, 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)

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

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

4. Identify the warning signs for the nine main groups of hazardous substances defined by Classification, Labelling and packaging of Dangerous Substances and mixtures Regulations

5. State the location of relevant health and safety information for their tasks; the sources of expert assistance when help is needed

6. Explain what constitutes a hazard in the workplace (eg 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)
7. Describe their responsibilities for dealing with hazards and reducing risks in the workplace (eg hazard spotting and safety inspections; the use of hazard check lists, carrying out risk assessments, COSHH assessments and safe systems of working)
8. Describe the risks associated with their working environment (eg 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)
9. Outline the processes and procedures that are used to identify and rate the level of risk (eg safety inspections, the use of hazard check lists, carrying out risk and COSHH assessments)
10. Explain the control measures that can be used to eliminate/reduce the hazard (eg 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)
11. 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
12. State what constitutes dangerous occurrences and hazardous malfunctions, and why these must be reported even when no one was injured
13. 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
14. Outline the organisational policy with regard to firefighting procedures; the common causes of fire and what they can do to help prevent them
15. State the protective clothing and equipment that is required for their areas of activity and the importance of wearing appropriate clothing and equipment
16. Explain the need to observe personal protection and hygiene procedures at all times (eg skin care (barrier creams, gloves), eye protection (safety glasses, goggles, full face helmets), hearing protection (ear plugs, 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)
17. 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
18. Outline the procedure for lifting and carrying loads safely and identify the manual and mechanical aids available
19. Describe how to prepare and maintain safe working areas; standards and procedures to ensure good housekeeping

20. Explain the importance of safe storage of tools, equipment, materials and products

21. Describe the extent of their own authority and who they should report to in the event of problems that they cannot resolve

Unit 202 Working efficiently and effectively in an engineering environment

UAN	J/507/3955
Unit level:	2
GLH	18
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF02
Unit aim:	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 apprentice 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, obtain 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 apprentice'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.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety and environmental legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives/values
LO3 Plan the engineering activities before they start them
LO4 Prepare the work area for carrying out the engineering activity
LO5 Obtain all necessary tools and equipment and check that they are in a safe and usable condition
LO6 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
LO7 Maintain effective working relationships with colleagues and supervisors
LO8 Review personal training and development, as appropriate to the job role
LO9 Clean, tidy up and restore the work area on completion of the engineering activity

Practical 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
   - 2.4 able to 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 include 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
   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 needs to:

1. Explain the importance of applying the appropriate behaviours in the workplace and the implications for both the apprentice and the business if these are not adhered to
2. 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
3. Explain the benefits of team working and understanding of team objectives
4. Outline the roles of individual team members and how they contribute to the team
5. Describe the importance of clear communication both oral and written, using appropriate language and format
6. Identify the need to change communication styles to meet the needs of the target audience
7. Describe the need to adhere to timescales set for work, whilst maintaining appropriate quality standards and the implications if these are not adhered to
8. Explain the importance of seeking additional support and guidance when required
9. Explain why it is important to be open and honest and admit to any errors and/or mistakes
10. Explain the importance of being flexible and taking an active and positive part in the implementation of any amendments or changes to work requirements
11. Describe their individual responsibility to work in an ethical manner and the organisation's policies relating to ethical working and behaviours
12. Explain the importance of respecting others, including an awareness of diversity and inclusion
13. Explain the importance of ensuring that all documentation relating to the work being carried out is available, prior to starting the activity
14. Explain the importance of ensuring that all tools and equipment are available prior to undertaking the activity
15. Outline the checks to be carried out to ensure that tools and equipment are in full working order, prior to undertaking the activity
16. Outline the checks to be carried out to ensure that all materials required are correct and complete, prior to undertaking the activity
17. 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
18. Outline their role in helping to develop their own skills and knowledge (eg 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)
19. Describe the benefits of continuous personal development, and the training opportunities that are available in the workplace

20. 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
21. Outline their responsibilities for providing evidence of their performance and progress (eg submitting work for assessment or the completion of assignments or tests)
22. Explain the importance of maintaining effective working relationships within the workplace (eg 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)
23. Explain the reason for informing others of their activities which may have impact on their work (eg 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)
24. 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
25. Outline the organisational procedures to deal with and report any problems that can affect working relationships
26. Identify the regulations that affect how individuals should be treated at work (eg Equal Opportunities and Equal Pay, Race Relations and Sex Discrimination, Working Time Directive, Disabled Persons Acts)
27. Explain the need to dispose of waste materials and consumables (eg oils and chemicals) in a safe and environmentally friendly way
28. 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
29. Explain when to act on their own initiative and when to seek help and advice from others
30. Explain the importance of leaving the work area in a safe condition on completion of their activities (eg equipment correctly isolated, cleaning the work area and removing and disposing of waste)

Unit 203 Using and communicating technical information

UAN	L/507/3956
Unit level:	2
GLH	18
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF03
Unit aim:	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 apprentice 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, which 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.

Learning Outcome

The learner must be able to:

LO1 Use the approved source to obtain the required data, documentation or specifications
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Extract and interpret information from engineering drawings and other related documentation
LO4 Report any inaccuracies or discrepancies in the drawings and specifications
LO5 Use the information obtained to establish work requirements
LO6 Record and communicate the technical information by appropriate means
LO7 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

Practical 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
   - 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

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 needs to:

1. Describe the information sources used for the data and documentation that they use in their work activities (eg verbal, written, electronic)
2. Explain why technical information is presented in different forms (eg drawings, data sheets, and national and international standards)
3. State where to obtain the various documents that they will be using (eg safety hand outs, drawings, planning documentation, work instructions, maintenance records, technical manuals and reference tables/charts),
4. Outline the types of engineering drawings used and describe how they interrelate (eg 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)

5. 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
6. Describe how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
7. State the meaning of the different symbols and abbreviations found on the documents that they use (eg 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)
8. Explain the importance of using other sources of information to support the data in documentation (eg 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)
9. Outline the procedures for reporting discrepancies in the data or documents and for reporting lost or damaged drawings and documents
10. Outline the care and control procedures for the documents
11. State how damage or graffiti on drawings can lead to scrapped work
12. State the importance of returning the documents/drawings to the designated location on completion of the work activities
13. State typical ways of communicating technical information (eg sketches, test and inspection reports, work planning documents) and the amount of detail that should be included
14. Explain the importance of ensuring that sketches are of a suitable size, use appropriate drawing conventions, are in proportion and are legible to others
15. Explain the importance of using a fixed common reference point for dimensioning of drawings and sketches
16. State when to act on their own initiative to find, clarify and evaluate information and when to seek help and advice from others
17. 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
18. Identify who they should report to in the event of problems that they cannot resolve

Unit 204 Conducting business improvement activities

UAN	R/507/3957
Unit level:	2
GLH	70
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF04a
Unit aim:	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 apprentice 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, which 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.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety and other relevant regulations and guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Apply and document a systematic plan, do, check, act (PDCA) approach to problems/improvement activities
LO4 Apply the principles of workplace organisation to an operation or process using a 5S/5C audit and a `red tag' exercise
LO5 Identify where information, and/or resources are missing and where improvement can be made to increase the 5S/5C score

LO6 Apply the principle and processes of visual management to an operation or process using a variety of visual management techniques
LO7 Identify appropriate parts of the operation or process that will have visual controls
LO8 Identify key performance indicators that will be displayed in the work area
LO9 Produce or update a Standard Operating Procedure (SOP) and visual controls for the operation or process
LO10 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

Practical 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
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
   - 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

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)
   4.6 stock turns
   4.7 cost breakdown in term of labour, material and overhead
   4.8 floor space utilization (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 be able to:

1. Describe the health and safety requirements of the area in which they are carrying out the business improvement activities
2. Explain the importance of following a systematic Plan, Do, Check, Act (PDCA) approach to problem-solving and business improvement
3. Outline the implications of not taking account of legislation, regulations, standards and guidelines when conducting business improvement activities
4. Explain the importance of applying the appropriate behaviours in the workplace and the implications for both the apprentice and the business if these are not adhered to
5. Describe what is meant by business improvement and how continuous improvement activities can benefit a company
6. 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)
7. Describe how to obtain and interpret information on the engineering/manufacturing operation or process requirements (eg customer specifications and instructions, quality control requirements, product drawings/specification, methods and techniques to be used)
8. 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
9. Explain the steps in a 5S/5C audit and a `red tag' exercise and Describe how to carry them out

10. Explain how to score and audit the 5S/5C exercise
11. Explain the importance of arranging and labelling the necessary equipment for rapid identification and access
12. Describe how to use “root cause” problem solving analysis using the 5 whys/how technique
13. Describe methods of evaluating improvement ideas in order to select those that are to be pursued
14. Describe how improvements to the process could be achieved by engaging the knowledge and experience of the people working on the process
15. Explain the importance of creating Standard Operating Procedures (SOPs) and of relating work activities to them
16. Describe the methods that can be used to communicate information using visual control systems (eg Kanban systems, card systems, colour coding, floor footprints, graphs, team boards, tool/equipment shadow boards)
17. Describe how information can be displayed differently depending on various work applications

Unit 294 Demonstrating personal accountability in an aircraft maintenance environment

UAN	Y/507/3958
Unit level:	2
GLH	70
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF04b
Unit aim:	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 apprentice 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, which 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.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety and other relevant regulations and guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Apply and document a systematic plan, do, check, act (PDCA) approach to problems/improvement activities
LO4 Apply basic principles of auditing techniques, process and recording
LO5 Apply the principle and processes of visual management to an operation or process using a variety of visual management techniques
LO6 Identify appropriate parts of the operation or process that will have visual controls
LO7 Identify key performance indicators that will be displayed in the work area
LO8 Produce or update a Standard Operating Procedure (SOP) and visual controls for the operation or process
LO9 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

Practical 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
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 be able to:

1. Describe the health and safety requirements of the area in which they are carrying out the business improvement activities
2. Explain the importance of following a systematic Plan, Do, Check Act (PDCA) approach to problem-solving and business improvement
3. Outline the implications of not taking account of legislation, regulations, standards and guidelines when conducting business improvement activities
4. Explain the importance of applying the appropriate behaviours in the workplace and the implications for both the apprentice and the business if these are not adhered to
5. Describe what is meant by business improvement and how continuous improvement activities can benefit a company
6. 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)
7. Describe how to obtain and interpret information on the engineering/manufacturing operation or process requirements (eg customer specifications and instructions, quality control requirements, product drawings/specification, methods and techniques to be used)
8. 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
9. Explain the importance of arranging and labelling the necessary equipment for rapid identification and access
10. Describe how to use “root cause” problem solving analysis using the 5 whys/how technique
11. Describe methods of evaluating improvement ideas in order to select those that are to be pursued
12. Describe how improvements to the process could be achieved by engaging the knowledge and experience of the people working on the process
13. Explain the importance of creating Standard Operating Procedures (SOPs) and of relating work activities to them.
14. Describe the methods that can be used to communicate information using visual control systems (eg Kanban systems, card systems, colour coding, floor footprints, graphs, team boards, tool/equipment shadow boards)
15. Describe how information can be displayed differently depending on various work applications

Unit 205 Producing mechanical engineering drawings using a CAD system

UAN	D/507/3959
Unit level:	2
GLH	140
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF05
Unit aim:	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 apprentice 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 detail 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 the skills section, paragraph 7.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines

LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the drawing activities before they start them
LO4 Use appropriate sources to obtain the required information for the drawing to be created
LO5 Access and use the correct drawing software
LO6 Use appropriate techniques to create drawings, in the required formats, that are sufficiently and clearly detailed
LO7 Use codes and other references that follow the required conventions
LO8 Make sure that drawings are checked and approved by the appropriate person
LO9 Save the drawings in the appropriate medium and location
LO10 Produce hard copies of the finished drawings
LO11 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
LO12 Shut down the CAD system to a safe condition on completion of the drawing activities

Practical 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)
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

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

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 be able to:

1. 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)
2. Describe the methods and procedures used to minimise the chances of infecting a computer with a virus
3. Explain the implications if the computer they are using does become infected with a virus and who to contact if it does occur
4. 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
5. Define the functionality of the component being drawn and describe its interrelationship with other components and assemblies
6. Describe the correct start-up and shutdown procedures to be used for the computer systems
7. Explain the importance of using software manuals and related documents to aid efficient operation of the relevant drawing system

8. 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)
9. 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)
10. 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)
11. Define the national, international and organisational standards and conventions that are used for the drawings
12. Explain the importance of being able to access, recognise and use a wide range of standard components and symbol libraries from the CAD equipment
13. Describe the need for document control (such as ensuring that completed drawings are approved, labelled and stored on a suitable storage medium)
14. Explain the need to create backup copies, and to file them in a separate and safe location
15. Explain the advantages and disadvantages of printers and plotters

Unit 206 Producing components using hand fitting techniques

UAN	R/507/3991
Unit level:	2
GLH	175
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF06
Unit aim:	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 apprentice can demonstrate that they are competent in being able to produce components using hand fitting techniques that 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 the skills section paragraph 7.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the fitting activities before they start them
LO4 Obtain the appropriate tools and equipment for the hand fitting operations, and check that they are in a safe and usable condition
LO5 Mark out the components for the required operations, using appropriate tools and techniques
LO6 Cut and shape the materials to the required specification, using appropriate tools and techniques
LO7 Measure and check that all dimensional and geometrical aspects of the component are to the specification
LO8 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
LO9 Leave the work area in a safe and tidy condition on completion of the fitting activities

Practical 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
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
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
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)
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 be able to:

1. Describe the hazards associated with the hand fitting activities (eg 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
2. Describe how to prepare the materials in readiness for the marking out activities, in order to enhance clarity, accuracy and safety (eg visually checking for defects, cleaning the materials, removing burrs and sharp edges, applying a marking out medium)
3. Describe the importance of ensuring that marking out is undertaken from the selected datum, and the possible effects of working from a different datum
4. Describe the methods of holding and supporting the workpiece during the marking out activities, and equipment that can be used (eg surface plates, angle plates, vee blocks and clamps, parallel bars, screw jacks)
5. 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)
6. Explain the importance of laying out the marking-out shapes or patterns to maximise use of materials
7. Explain the importance of clear and dimensional accuracy in marking out to specification and drawing requirements
8. Explain the importance of setting and adjusting tools (eg squares, protractors and verniers)
9. Describe the various types of file that are available, the cut of files for different applications and the importance of ensuring that file handles are secure and free from embedded foreign bodies or splits
10. Explain the importance of preparing the components for the filing operations (cleaning, de-burring, marking out)
11. Explain the importance of vice jaw plates to protect the workpiece from damage
12. Explain saw blade selection for different applications and materials, and methods of setting saw blades for cutting externally and internally (eg hand saws, mechanical saws, band saws)
13. Describe the method of fixing and adjusting the dies to give the correct thread fit
14. Explain how to determine the drill size for tapped holes and the importance of using the taps in the correct sequence
15. Explain how to prepare drilling machines for operations and the importance of preparing them correctly (eg 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)

16. Describe how to mount the workpiece (eg 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
17. Explain how to produce a sliding or mating fit using filing, scraping and lapping techniques
18. Describe the problems that can occur with the hand fitting activities, and how these can be overcome (eg defects caused by incorrectly ground drills, inappropriate speeds, damage by workholding devices)

Unit 207 Producing mechanical assemblies

UAN	Y/507/3992
Unit level:	2
GLH	140
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF07
Unit aim:	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 apprentice can demonstrate that they are competent in being able to produce mechanical assemblies that 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 the skills section paragraph 3.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the assembly activities before they start them
LO4 Obtain and prepare the appropriate components, tools and equipment
LO5 Use the appropriate methods and techniques to assemble the components in their correct positions

LO6 Secure the components using the specified connectors and securing devices
LO7 Check the completed assembly to ensure that all operations have been completed and that the finished assembly meets the required specification
LO8 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
LO9 Leave the work area in a safe and tidy condition on completion of the assembly activities

Practical 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
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
   - 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
   - 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 be able to:

1. Describe the hazards associated with the assembly activities (eg 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
2. Explain the importance of preparing the components in readiness for the assembly activities (eg visually checking for defects, cleaning the components, removing burrs and sharp edges)
3. 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)
4. Explain the importance of adhering to the assembly/joining procedures
5. Describe the methods for aligning, adjusting and positioning components prior to securing and the tools and equipment to be used for this
6. Detail the various mechanical fastening devices that are used (eg nuts, bolts, machine screws, cap screws, clips, pins, locking and retaining devices)
7. Explain the importance of using the specified components and joining devices for the assembly, and why they must not use substitutes
8. Describe where appropriate, the application of sealants and adhesives within the assembly activities, and the precautions that must be taken when working with them
9. Explain the importance of conducting the necessary checks to ensure the accuracy, position, security, function and completeness of the assembly (eg 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)
10. Explain how to detect assembly defects, and what to do to rectify them (eg ineffective joining techniques, foreign objects, component damage)
11. Describe problems that could occur with the assembly operations, and the importance of informing appropriate people of non-conformances

Unit 208 Forming and assembling pipework systems

UAN	R/507/3960
Unit level:	2
GLH	140
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF08
Unit aim:	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 apprentice can demonstrate that they are competent in being able to form and assemble pipework systems, that 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 the skills section, paragraph 9.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the pipe fitting activities before they start them
LO4 Cut the pipes to the appropriate lengths making allowances for bending and attachment of fittings
LO5 Bend and form the pipes using the appropriate tools and equipment for the types and sizes of pipe
LO6 Assemble and secure the pipework, using the correct fittings and joining techniques
LO7 Check the completed assembly to ensure that all operations have been completed and that the finished pipe assembly meets the required specification
LO8 Test the completed pipe assembly, using the appropriate techniques, tools and equipment
LO9 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
LO10 Leave the work area in a safe and tidy condition on completion of the assembly activities

Practical 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
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

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

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 needs to know and understand:

1. Describe the hazards associated with the pipe fitting activities (eg 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
2. Explain the importance of using the correct principles, methods and equipment for marking out pipework
3. Explain the importance of preparing the pipes in readiness for the marking out activities (eg visually checking for defects, cleaning the materials, removing burrs and sharp edges)
4. 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
5. 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

6. Explain the reasons for incorporating expansion loops in a system, and where they should be positioned
7. Explain the importance of preparing pipework and fittings for the assembly operation (eg checking for damage, removing foreign objects, dirt and swarf from bore of pipe, removing burrs)
8. 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)
9. Define the different types of fittings available (eg screwed fittings, soldered fittings, compression fittings, push fit fittings and glued/cemented fittings)
10. Describe the methods used to seal screwed joints (eg tapes and sealing compounds)
11. Describe the advantages and disadvantages of using flanges to connect pipes
12. Explain the importance of using gaskets; and torque loading of flange bolts
13. 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
14. Describe the various types of soldered connectors available (eg solder ring types and capillary fittings)
15. Describe the methods used to solder the joints, and how to recognise when the fitting is correctly soldered
16. Explain the precautions to be taken when using gas torches to form the joint, and the effect of overheating the joint
17. 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
18. Describe the methods used to cement the joints and how to recognise when the fitting is correctly secured
19. Describe the various adhesives and sealing compounds that are used on non-metallic pipework
20. Explain the precautions to be taken when using the adhesives, cements and sealing compounds (eg adequate ventilation, fume extraction, away from naked flames, avoiding skin contact)
21. Describe the advantages and disadvantages of using compression fittings
22. State how the pipes are sealed and the effects of over tightening the fittings
23. Describe the benefits of using push-fit connectors
24. Describe the process for identifying the correct orientation of fittings with regard to flow, and the consequences of incorrect orientation
25. Define the supporting methods that are used when assembling pipework, and the type of fittings that are used
26. Describe the different methods of testing pipework systems for leaks (using air, water or hydraulic testing methods)

Unit 209 Carrying out aircraft detail fitting activities

UAN	Y/507/3961
Unit level:	2
GLH	175
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF09
Unit aim:	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 apprentice can demonstrate that they are competent in being able to carry out aircraft detail fitting assemblies, that 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, to 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 the skills section paragraph 8.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the aircraft detail fitting activities before they start them
LO4 Obtain the appropriate tools and equipment for the aircraft detail fitting operations, and check that they are in a safe and usable condition
LO5 Mark out the components for the required operations, using appropriate tools and techniques
LO6 Cut and shape the materials to the required specification, using appropriate tools and techniques
LO7 Bend and form the materials, using the appropriate tools and equipment
LO8 Assemble and secure the components, using the correct fastening devices and joining techniques
LO9 Measure and check that all dimensional and geometrical aspects of the component are to the specification
LO10 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
LO11 Leave the work area in a safe and tidy condition on completion of the fitting activities

Practical 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)
   - 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
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

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)
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 be able to:

1. Describe the hazards associated with the aircraft detail fitting activities (eg 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
2. Explain material selection for different applications (including material identification systems, codes used and grain flow indicators)
3. Explain the principles of marking out, and the equipment used in the aerospace industry
4. Describe the importance of cleaning and preparing the surfaces to be marked out, ensuring that grain flow is taken into account where appropriate
5. Describe the process for calculating bending allowances when marking out
6. Describe the importance of ensuring that marking out is undertaken from the selected datums, and the possible effects of working from different datums
7. Describe the various methods of pattern development that can be used (eg parallel line; radial line; triangulation), and typical applications of each method
8. Describe the importance of laying out the marking-out shapes or patterns to maximise use of materials
9. Describe the need for clear and dimensional accuracy in marking out to specification and drawing requirements
10. Describe the shaping methods and techniques that can be used to produce a range of shapes/profiles on the various section materials (eg sawing, shearing, drilling, filing, abrading), and the sequence in which the operations will need to be carried out
11. Explain saw blade selection for different applications and materials; methods of setting saw blades for cutting externally and internally (eg hand saws, mechanical saws, band saws)
12. Describe the various shearing methods that can be used (eg tin snips, bench shears, guillotines, cropping machines and nibbling machines)
13. Describe the range of hand tools and associated equipment that is used to produce a variety of shapes, bends, curved surfaces, dished profiles
14. Describe the range of bending and forming machines to be used (eg fly presses, bending machines, rolling machines, flanging machines)
15. Describe the importance of setting up a bending machine to produce a range of forms (eg right-angled bends, angled bends, tray sections, channel sections)
16. Describe the importance of setting up pinch/pyramid forming rolls to produce a variety of forms (eg curved profiles, cylinders, cones) - *this knowledge criteria only applies if learner has chosen skill 9.5*
17. Describe the importance of producing flanges on curved/cylindrical components - *this knowledge criteria only applies if learner has chosen skill 10.9*

18. Describe the methods of drilling and finishing holes in sheet and stock materials (eg drills, reamers, countersinks, hole saws)
19. 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
20. Describe the preparations and/or treatments that may need to be carried out on the materials before and after the cutting and shaping operations
21. Describe the purpose and use of joint sealing agents and anti-electrolysis barriers, and the precautions to be taken when using them
22. Describe the problems that can occur with the cutting, shaping and forming operations, and how these can be overcome

Unit 210 Installing aircraft mechanical fasteners

UAN	D/507/3962
Unit level:	2
GLH	105
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF10
Unit aim:	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 apprentice can demonstrate that they are competent in being able to install aircraft mechanical fasteners, which 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 the skills section, paragraph 2.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the installation of the mechanical fasteners before they start the activity
LO4 Obtain the appropriate tools and equipment for the installation operations, and check that they are in a safe and usable condition
LO5 Assemble and secure the components, using the correct fastening devices and joining techniques
LO6 Measure and check that all dimensional and geometrical aspects of the component are to the specification
LO7 Check that the installation is complete, and that all components are free from damage
LO8 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
LO9 Leave the work area in a safe and tidy condition on completion of the fitting activities

Practical 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
   - 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
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 be able to:

1. Describe the hazards associated with installing aircraft mechanical fasteners, and with the tools and equipment used (eg use of power tools, trailing leads or hoses, damaged or badly maintained tools and equipment), and how they can be minimised
2. Explain the importance of working to the installation instructions and appropriate specifications
3. Explain the implications if the correct and specified fastener is not fitted to the component and the impact this could have on the business
4. Describe the process for the control of materials, and the need for component control and quarantine
5. Explain the methods of identifying the mechanical fasteners to be used (eg material identification systems, codes used and grain flow indicators)
6. Explain why they must obtain design approval before removing and replacing faulty fasteners
7. Describe the purpose and use of joint sealing agents and anti-electrolysis barriers, and the precautions to be taken when using them
8. Explain the regulations concerning electrical bonding and anti-electrolysis barriers
9. Explain the various types and range of screwed fasteners used on aircraft fittings, and the methods of installing them
10. Explain the types and applications of aircraft rivets, and the advantages of hollow rivets over solid rivets
11. Explain the reasons for using screw fastenings rather than rivets
12. Describe the purpose and use of a countersink cage
13. Describe the various locking devices used with fastenings
14. Describe the purpose and use of locating dowels, gripping pins and gauges, when carrying out fastening operations
15. Describe the procedures to be adopted when removing rivets and other fasteners
16. Explain the term `quilting', its occurrence and avoidance
17. Describe bolt break-offs, and where they occur
18. 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
19. Describe the types of gauges used to measure angles, depths, countersinks and torque
20. Describe how and why tools are calibrated, and how to check that the tools they are using are within calibration dates
21. Explain the importance of conducting the necessary checks to ensure the accuracy and quality of the installations produced

22. Describe the problems that can occur with the installation of the mechanical fasteners, and how these can be overcome

Unit 211 Producing aircraft detail assemblies

UAN	H/507/3963
Unit level:	2
GLH	140
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF11
Unit aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Aerospace 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 EUC identifies the training and development required in order that the apprentice can demonstrate that they are competent in being able to assemble components to produce aircraft detail assemblies, which 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 the skills section, paragraph 2.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the aircraft detail assembly activities before they start them
LO4 Obtain the appropriate tools and equipment for the aircraft detail assembly operations, and check that they are in a safe and usable condition
LO5 Obtain the specified components and check that they are in a usable condition
LO6 Use the appropriate methods and techniques to assemble the components in their correct positions
LO7 Secure the components using the specified connectors and securing devices
LO8 Measure and check that all dimensional and geometrical aspects of the component are to the specification
LO9 Check the completed assembly to ensure that all operations have been completed and that the finished assembly meets the required specification
LO10 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
LO11 Leave the work area in a safe and tidy condition on completion of the fitting activities

Practical 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
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
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 be able to:

1. 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)
2. 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
3. Explain the importance of working to the assembly instructions and appropriate specifications
4. Explain the importance of identifying the components to be used (eg component identification systems, codes used and component orientation indicators)
5. Describe the preparations to be undertaken on the components prior to fitting them into the assembly
6. Describe the assembly methods and procedures to be used, and the importance of adhering to these procedures
7. Describe the methods used to hold the components in their correct position prior to securing them with the appropriate fasteners

8. Describe the various mechanical fasteners that will be used, and their method of installation (including open and blind rivets, threaded fasteners, special securing devices)
9. Describe the importance of using the specified fasteners for the particular assembly, and why they must not use substitutes
10. Explain what to do if the components or fastening devices are not assembled correctly, are damaged, or have other faults
11. Explain why they must obtain design approval before removing and replacing faulty fasteners
12. 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
13. Describe the purpose and use of joint sealing agents and anti-electrolysis barriers, and the precautions to be taken when using them
14. Describe the quality control procedures to be followed during the assembly operations
15. Explain the importance of conducting the necessary checks to ensure the accuracy and quality of the assemblies produced
16. Explain how and why tools are calibrated, and how to check that the tools they are using are within calibration dates
17. Explain the importance of using all tools in the correct manner and within their permitted operating range
18. Explain the importance of ensuring that the completed assembly is free from dirt, swarf and foreign objects
19. Describe the problems that can occur with the detail assembly operations, and how these can be overcome

Unit 212 Preparing and using lathes for turning operations

UAN	K/507/3964
Unit level:	2
GLH	140
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF12
Unit aim:	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 apprentice can demonstrate that they are competent in being able to prepare and use lathes for turning operations, that 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 the skills section, paragraph 5.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the machining activities before they start them
LO4 Obtain and prepare the appropriate materials, tools and equipment
LO5 Mount and set the required workholding devices, workpiece and cutting tools
LO6 Set and adjust the machine tool speeds and feeds to achieve the component specification
LO7 Use the machine tool controls safely and correctly, in line with operational procedures
LO8 Measure and check that all dimensional and geometrical aspects of the component are to the specification
LO9 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
LO10 Shut down the equipment to a safe condition on completion of the machining activities

Practical 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
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 reamers
   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
   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)

   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 be able to:

1. Describe the hazards associated with the turning operations (eg 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
2. Define the safety mechanisms on the machine (eg emergency stop buttons, emergency treadle brakes), and the procedure for checking that they function correctly
3. Explain the correct operation of the machine controls in both hand and power modes
4. Describe how to stop the machine in both normal and emergency situations and the procedure for restarting after an emergency
5. Describe the process for planning and preparing to carry out the machining operations (eg 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)

6. Define the main features of the lathe and the accessories that can be used (eg saddle, capstan/turret head, compound slide, tailstock, taper turning attachments, profile attachments, fixed and travelling steadies)
7. Explain the importance of positioning and securing workholding devices to the machine spindle, and the checks to be made (eg 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)
8. Describe the effects of clamping the workpiece in a chuck/workholding device, and how this can cause damage or distortion in the finished components
9. 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)
10. Describe different methods of mounting and securing the cutting tools in the tool holding devices (eg front or rear tools posts; mounting drills in chucks or by the use of morse taper sockets
11. Explain the importance of ensuring that the tool is at the correct centre height and that tool overhang is kept to a minimum
12. Describe the process for checking that cutting tools are in a safe and usable condition and how to handle and store tools safely/correctly
13. Define the effects of backlash in machine slides and screws, and how this can be overcome
14. 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
15. Define the factors that affect the selection of cutting feeds and speeds, and the depth of cut that can be taken (eg 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)
16. 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
17. 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)
18. 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 (eg lengths, diameters, depths, slots, hole positions, angles, profiles); measuring geometric features (eg flatness, squareness, parallelism, concentricity, ovality); how to check surface finish (eg by using comparison blocks or instruments)

19. Describe the problems that can occur with the turning activities (eg defects caused by incorrectly ground tools, inappropriate feeds/speeds, damage by workholding devices), and how these can be overcome

Unit 213 Preparing and using milling machines

UAN	M/507/3965
Unit level:	2
GLH	140
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF13
Unit aim:	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 apprentice can demonstrate that they are competent in being able to prepare and use milling machines, that 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 the skills section paragraph 5.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the machining activities before they start them
LO4 Obtain and prepare the appropriate materials, tools and equipment
LO5 Mount and set the required workholding devices, workpiece and cutting tools
LO6 Set and adjust the machine tool speeds and feeds to achieve the component specification
LO7 Use the machine tool controls safely and correctly, in line with operational procedures
LO8 Measure and check that all dimensional and geometrical aspects of the component are to the specification
LO9 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
LO10 Shut down the equipment to a safe condition on completion of the machining activities

Practical 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
   - 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
   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
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 be able to:

1. Describe the hazards associated with the milling operations (eg 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
2. Define the safety mechanisms on the machine (eg emergency stop buttons, emergency brakes), and the procedure for checking that they function correctly
3. Explain the correct operation of the machine controls in both hand and power modes
4. Describe how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
5. Describe the process for planning and preparing to carry out the machining operations (eg 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)
6. Define the main features of the milling machine, and the accessories that can be used (such as vertical heads, indexing devices)

7. Explain the importance of positioning and securing workholding devices to the machine table, and the checks to be made (eg 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)
8. 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
9. Define the various milling operations that can be performed, and the types of cutters that are used (eg face mills, slab/cylindrical cutters, side and face cutters, end mills, slot drills, form cutters, twist drills)
10. Describe different methods of mounting and securing the cutting tools in the tool holding devices and to the machine spindle (eg 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)
11. Explain how to position the workpiece in relation to the milling cutters to give conventional or climb milling conditions
12. Describe the process for checking that the milling cutters are in a safe and usable condition, and how to handle and store cutters safely
13. Define the effects of backlash in machine slides and screws, and how this can be overcome
14. 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
15. Define the factors that affect the selection of cutting feeds and speeds, and the depth of cut that can be taken (eg type of material, type of tool used, operations being performed, workholding method/security of workpiece, condition of machine, finish and tolerance required)
16. 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
17. 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)
18. Describe the process for checking that the measuring equipment is within current calibration dates and that the instruments are correctly zeroed; measuring linear dimensions (eg lengths, depths, slots, positions, angles, profiles); measuring geometric features (eg flatness, squareness, parallelism); how to check surface finish (eg by using comparison blocks or instruments)
19. 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 214 Preparing and proving CNC machine tool programs

UAN	T/507/3966
Unit level:	2
GLH	140
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF14
Unit aim:	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 apprentice can demonstrate that they are competent in being able to prepare and prove CNC machine tool programmes, that 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 the skills section in paragraph 5.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the programming activities before they start them
LO4 Determine an operational sequence that avoids wasted tool/cutter movements and tool changes
LO5 Develop component programs using appropriate programming codes and techniques
LO6 Specify positional information and machine axes that are consistent with the requirements of each stage/operation
LO7 Load/input the program to the machine controller, and check/prove the program for errors using approved procedures
LO8 Save and store the program in line with organisational procedures
LO9 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
LO10 Shut down the equipment to a safe condition on completion of the programming activities

Practical 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
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
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

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 be able to:

1. Describe the hazards associated with using CNC machine tools (eg 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
2. Define the safety mechanisms on the machine (eg emergency stop buttons, emergency brakes), and describe the procedure for checking that they function correctly
3. Explain the correct operation of the various hand and automatic modes of machine control (eg program operating and control buttons)
4. Describe how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
5. Describe the computer coding language used in CNC programs (with regard to machine axes, positional information, machine management and auxiliary functions)
6. Define the use of features that enable reductions in program size and input time (eg canned cycles, subroutines and labels)
7. Define the function keys and operating system of the machine computer control system being operated
8. Describe the process for setting the machine control system in the programming and editing mode, download (input) and upload (output) modes
9. Explain how to deal with error messages and faults on the program or equipment
10. Describe the steps needed to access the program edit facility, in order to enter tooling data (eg tool datums, positions, lengths, offsets and radius compensation)
11. Define the use of tool posts, magazines, carousels and turrets, and how to identify the tools in relationship to the operating program
12. Explain the importance of conducting trial runs (using single block run, dry run and feed and spindle speed override controls)

13. 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 (eg condition of material, workholding method, tooling used, tolerance and finish to be achieved)
14. Define the checks to be made before allowing the CNC machine to operate in full program run mode
15. Describe the typical problems that can occur with the programming, loading and editing activities, and what to do if they occur
16. Define the methods and procedures used to minimise the chances of infecting a computer with a virus
17. Describe the implications if the computer they are using does become infected with a virus and who to contact if it does occur

Unit 215 Preparing and using CNC turning machines

UAN	A/507/3967
Unit level:	2
GLH	140
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF15
Unit aim:	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 apprentice can demonstrate that they are competent in being able to prepare and use CNC turning machines, that 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 the skills section, paragraph 5.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the CNC machining activities before they start them
LO4 Load/input the program to the machine controller and check the program for errors using the approved procedures
LO5 Mount and set the required workholding devices, workpiece and cutting tools
LO6 Check that all safety mechanisms are in place, and that the equipment is set correctly for the required operations
LO7 Run the operating program, and check and adjust the machine tool speeds, feeds and operating parameters to achieve the component specification
LO8 Measure and check that all dimensional and geometrical aspects of the component are to the specification
LO9 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
LO10 Shut down the equipment to a safe condition on completion of the machining activities

Practical 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
   - 2.5 collet chucks
   - 2.6 faceplates
   - 2.7 magnetic/pneumatic devices
   - 2.8 other workholding devices

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
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

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)
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 be able to:

1. Describe the hazards associated with the using CNC lathes, (eg 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
2. Define the safety mechanisms on the machine (eg emergency stop buttons, emergency brakes), and describe the procedure for checking that they function correctly
3. Explain the correct operation of the various hand and automatic modes of machine control (eg program operating and control buttons)
4. Describe how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
5. Describe the computer coding language used in CNC programs, with regard to machine axis, positional information, machine management and auxiliary/miscellaneous functions
6. Describe the process for setting the machine controller in the program and editing mode, and how to enter or download the prepared program
7. Explain how to deal with error messages and faults on the program or equipment
8. Define the range of workholding methods and devices that are used on CNC lathes
9. Explain the importance of setting the workholding device in relationship to the machine datums and reference points
10. Define the methods of setting the workholding devices, and the tools and equipment that can be used
11. Define the range of cutting tools that are used on CNC lathes, and typical applications
12. Describe the process for checking that the cutting tools are in a safe and serviceable condition
13. Define the use of tungsten carbide, ceramic and diamond indexible tips, and the factors that determine their selection and use (eg the condition of material supplied, hardness of the material, the cutting characteristics of the material, tolerances to be achieved, component surface finish and specifications)
14. Define the various tool holding devices that are used, and the methods of correctly mounting and securing the cutting tools to the tool holders
15. Explain the advantages of using pre-set tooling, and how to set the tooling by using setting jigs/fixtures

16. Define the use of tool posts, magazines and carousels, and how to position and identify the tools in relationship to the operating program
17. 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 (eg tool datums, positions, lengths, offsets and radius compensation)
18. Explain the importance of conducting trial runs using single block run, dry run, and feed and speed override controls
19. Define the checks that are needed before allowing the machine to operate in full program run mode
20. 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 (eg type and condition of material, workholding method, tooling used, tolerance and finish to be achieved)
21. 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
22. Explain the importance of storing programs and storage devices safely and correctly, away from contaminants and possible corruption
23. Describe the typical problems that can occur with the CNC turning activities, and what to do if they occur

Unit 216 Preparing and using CNC milling machines

UAN	F/507/3968
Unit level:	2
GLH	140
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF16
Unit aim:	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 apprentice can demonstrate that they are competent in being able to prepare and use CNC milling machines, that 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 the skills section, paragraph 5.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the CNC machining activities before they start them
LO4 Load/input the program to the machine controller and check the program for errors using the approved procedures
LO5 Mount and set the required workholding devices, workpiece and cutting tools
LO6 Check that all safety mechanisms are in place, and that the equipment is set correctly for the required operations
LO7 Run the operating program, and check and adjust the machine tool speeds, feeds and operating parameters to achieve the component specification
LO8 Measure and check that all dimensional and geometrical aspects of the component are to the specification
LO9 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
LO10 Shut down the equipment to a safe condition on completion of the machining activities

Practical 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
   - 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
   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
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)
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 be able to:

1. Describe the hazards associated with the using CNC milling machines (eg 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
2. Define the safety mechanisms on the machine (eg emergency stop buttons, emergency brakes), and the procedure for checking that they function correctly
3. Explain the correct operation of the various hand and automatic modes of machine control (eg program operating and control buttons)
4. Describe how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
5. Describe the computer coding language used in CNC programs (with regard to machine axis, positional information, machine management and auxiliary functions)
6. Describe the process for setting the machine controller in the program and editing mode, and how to enter or download the prepared program
7. Explain how to deal with error messages and faults on the program or equipment
8. Define the range of workholding methods and devices that are used on CNC milling machines
9. Explain the importance of setting the workholding device in relationship to the machine axis and reference points
10. Define the methods of setting the workholding devices, and the tools and equipment that can be used
11. Define the range of milling cutters/cutting tools that are used on CNC milling machines, and their typical applications
12. Describe the process for checking that the cutting tools are in a safe and serviceable condition
13. Define the use of tungsten carbide, ceramic and diamond indexible tips, and the factors which will determine their selection and use (eg the condition of material supplied, hardness of the material, the cutting characteristics of the material, tolerances to be achieved, component surface finish and specifications)
14. 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
15. Explain the advantages of using pre-set tooling, and how to set the tooling by using setting jigs/fixtures
16. Define the use of tool magazines and carousels, and how to position, and how to identify the tools in relationship to the operating program

17. 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 (eg tool datums, positions, lengths, offsets and radius compensation)
18. Explain the importance of conducting trial runs (using single block run, dry run, and feed and speed override controls)
19. Define the checks that are needed before allowing the machine to operate in full program run mode
20. 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 (eg type and condition of material, workholding method, tooling used, tolerance and finish to be achieved)
21. 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
22. Explain the importance of storing programs and storage devices safely and correctly, away from contaminants and possible corruption
23. Describe typical problems that can occur with the CNC milling activities, and what to do if they occur

Unit 217 Maintaining mechanical devices and equipment

UAN	J/507/3969
Unit level:	2
GLH	175
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF17
Unit aim:	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 apprentice can demonstrate that they are competent in being able to maintain mechanical devices and equipment, which 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 the skills section, paragraph 5.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the maintenance activities before they start them
LO4 Obtain all the information they need for the safe removal and replacement of the equipment components
LO5 Obtain and prepare the appropriate tools and equipment
LO6 Apply appropriate maintenance diagnostic techniques and procedures
LO7 Use appropriate methods and techniques to remove and replace the required components
LO8 Carry out tests on the maintained equipment, in accordance with the test schedule/defined test procedures
LO9 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
LO10 Leave the work area in a safe and tidy condition on completion of the maintenance activities

Practical 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
   - 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, flowcharts, 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)
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
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 be able to:

1. Describe hazards associated with carrying out mechanical maintenance activities (eg 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
2. Describe the system isolation procedures or permit-to-work procedure that apply
3. Describe the basic principles of how the equipment functions, its operating sequence, the working purpose of individual units/components and how they interact
4. Describe the various maintenance diagnostic techniques and aids that can be used (such as fault reports, visual checks, measuring, movement and alignment checks, testing)
5. 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)
6. Explain methods for evaluating sensory information (sight, sound, smell, touch)
7. Describe the sequence to be adopted for the dismantling/re-assembly of various types of assemblies
8. Describe the methods and techniques used to dismantle/assemble mechanical equipment (eg release of pressures/force, proof marking, extraction, pressing, alignment)

9. Explain methods of checking that components are fit for purpose, and how to identify defects and wear characteristics
10. Describe the identification, application, fitting and removal of different types of bearings (eg roller, ring, thrust)
11. Explain methods and techniques of fitting keys and splines
12. Describe identification, application, fitting and removal of different types of gears
13. Explain how to correctly tension belts and chains
14. Describe the identification and application of different types of locking device
15. Describe methods of checking that removed components are fit for purpose, and the need to replace `lifed' items (eg seals and gaskets)
16. Describe the uses of measuring equipment (eg micrometers, verniers, run-out devices and other measuring devices)
17. 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
18. 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)
19. Describe the importance of making `off-load' checks before running the equipment under power
20. Describe the importance of completing maintenance documentation and/or reports following the maintenance activity
21. Describe the problems associated with the mechanical maintenance activity, and how they can be overcome

Unit 218 Assembling and testing fluid power systems

UAN	A/507/3970
Unit level:	2
GLH	105
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF18
Unit aim:	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 apprentice can demonstrate that they are competent in being able to assemble and test fluid power systems, that 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 the skills section, paragraph 3.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the assembly activities before they start them
LO4 Obtain all the information they need for the safe assembly of the fluid power system
LO5 Obtain and prepare the appropriate components, assembly tools and test equipment
LO6 Use the appropriate methods and techniques to assemble the components in their correct positions
LO7 Secure the components, using the specified connectors and securing devices
LO8 Check the completed assembly to ensure that all operations have been completed and that the finished system meets the required specification
LO9 Carry out tests on the assembled system, in accordance with the test schedule/defined test procedures
LO10 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
LO11 Leave the work area in a safe and tidy condition on completion of the assembly activities

Practical 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
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

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
   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

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Knowledge and understanding

The learner must be able to:

1. Describe the hazards associated with carrying out assembly activities on fluid power equipment (eg handling fluids, stored energy/force, misuse of tools), and how these can be minimised
2. 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
3. Outline the procedure for obtaining components, materials and other consumables necessary for the assembly activities
4. 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
5. Describe the different types of pipework, fittings and manifolds, and their application
6. Outline the identification and application of different types of valve (such as poppet, spool, piston, disc)
7. Outline the identification and application of different types of sensors and actuators (such as rotary, linear, mechanical, electrical)
8. Outline the identification and application of different types of cylinder (such as single acting, double acting)
9. Outline the identification and application of different types of pump (such as positive and non-positive displacement)
10. Outline the identification and application of different types compressors (such as screw, piston, rotary vane)
11. Outline the application and fitting of static and dynamic seals
12. Describe the techniques used to assemble/install fluid power equipment (eg 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)

13. Explain the need to ensure that pipework is supported at appropriate intervals, and the need to eliminate stress on the pipework connections
14. Explain the need to ensure cleanliness of the fluid power system, and the ways of purging pipework before connection to components and pressure sources
15. Outline the recognition of contaminants and the problems they can create, and the effects and likely symptoms of contamination in the system
16. Describe the methods of testing the fluid power system; the types of test equipment to be used, and their selection for particular tests
17. 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
18. 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
19. Explain how to carry out the tests (eg applying test pressures in incremental stages; checking for leaks; taking appropriate test readings; adjusting appropriate components to give required operating conditions)
20. Explain how to determine pressure settings, and their effect on the system
21. Explain how to display/record test results, and the documentation used
22. Explain how to interpret the test readings obtained, and the significance of the readings gained
23. Describe the problems associated with the fluid power assembly and testing activity, and how they can be overcome

Unit 219 Producing sheet metal components and assemblies

UAN	F/507/3971
Unit level:	2
GLH	140
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF19
Unit aim:	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 apprentice can demonstrate that they are competent in being able to produce sheet metal components and assemblies, that 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 the skills section, paragraph 9.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the sheet metalworking activities before they start them
LO4 Obtain the appropriate tools and equipment for the sheet metalworking operations, and check that they are in a safe and usable condition
LO5 Mark out the components for the required operations, using appropriate tools and techniques
LO6 Cut and shape the materials to the required specification, using appropriate tools and techniques
LO7 Use the appropriate methods and techniques to assemble and secure the components in their correct positions
LO8 Measure and check that all dimensional and geometrical aspects of the component are to the specification
LO9 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
LO10 Leave the work area in a safe and tidy condition on completion of the fitting activities

Practical 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
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
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
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 3 mm) 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
12. Produce sheet metal components which meet **all** of the following:
    12.1 all dimensions are within +/- 2.0mm 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 be able to:

1. 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

2. 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)
3. Explain the importance of ensuring that marking out is undertaken from the selected datum, and the possible effects of working from a different datum
4. 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)
5. Explain the importance of laying out the marking-out shapes or patterns to maximise use of materials
6. 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)
7. 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
8. 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)
9. 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*
10. 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)
11. Outline ways of limiting distortion, marking, creases, flats (in curved sections)
12. Describe the characteristics of the various materials used (with regard to the bending and forming process)
13. Explain how the materials are to be prepared for the forming operations, and why some materials may require a heating process prior to forming
14. 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)
15. Describe the preparations to be carried out on the components prior to assembling them
16. Explain how to set up and align the various components, and the tools and equipment that are used for this
17. Outline methods of temporarily holding the joints together to aid the assembly activities (such as clamps, rivet clamps)
18. Describe the inspection techniques that can be applied to check that shape (including straightness) and dimensional accuracy are to specification and within acceptable limits
19. 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 220 Preparing and using manual TIG or plasma-arc welding equipment

UAN	J/507/3972
Unit level:	2
GLH	140
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF20
Unit aim:	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 apprentice can demonstrate that they are competent in being able to prepare and use manual tungsten inert gas (TIG) or plasma-arc welding equipment, that 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 150mm long, using single or multi-run welds (as appropriate), with at least one stop and start included.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the welding activities before they start them
LO4 Obtain and prepare the appropriate welding equipment and welding consumables
LO5 Prepare and support the joint, using the appropriate methods
LO6 Tack weld the joint at appropriate intervals, and check the joint for accuracy before final welding
LO7 Weld the joint to the specified quality, dimensions and profile
LO8 Use appropriate methods and equipment to check the quality, and that all dimensional and geometrical aspects of the weld are to the specification

LO9 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

LO10 Shut down and make safe the welding equipment on completion of the welding activities

Practical 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
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 150mm 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 3mm)
   - 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)
   - 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
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 3mm 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

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Knowledge and understanding

The learner must be able to:

1. State the hazards associated with TIG and plasma-arc welding, and how they can be minimised
2. Describe the correct handling and storage of gas cylinders (eg manual handling and use of cylinder trolley, leak detection procedures, relevant BCGA codes of practice, cylinder identification, gas pressures, cylinder and equipment safety features)
3. Describe the types, selection and application of filler wires and welding electrodes
4. Explain the reasons for using shielding gases, and the types and application of the various gases
5. Outline gas pressures and flow rates (in relationship to the type of material being welded)
6. Describe the benefits and application of the welded joints to be produced (eg lap joints, corner joints, tee joints and butt welds)
7. State the terminology used for the appropriate welding positions
8. Describe how to prepare the materials in readiness for the welding activity (eg 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)
9. Explain how to set up and restrain the joint, and the tools and techniques to be used (eg the use of jigs and fixtures, restraining devices such as clamps and weights/blocks; setting up the joint in the correct position and alignment)
10. Outline tack welding size and spacing (in relationship to material thickness)
11. 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)
12. Describe the techniques of operating the welding equipment to produce a range of joints in the various joint positions (eg fine adjustment of parameters; correct manipulation of the torch; blending in stops/starts and tack welds)
13. Explain how to control distortion (eg welding sequence; deposition technique)
14. Describe the problems that can occur with the welding activities (eg causes of distortion and methods of control; effects of welding on materials and sources of weld defects), and how these can be overcome

15. Explain how to close down the welding equipment safely and correctly
16. Outline the safe working practices and procedures to be adopted when preparing the welds for examination (eg handling hot materials, using chemicals for cleaning and etching, using equipment to fracture welds)
17. 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
18. Describe how to check the welded joints for uniformity, alignment, position, weld size and profile
19. Outline the various procedures for visual examination of the welds for cracks, porosity and slag inclusions (eg dye penetrant, fluorescent penetrant; magnetic particle testing)
20. Outline the various procedures for carrying out destructive tests on the welds (eg macroscopic examination, bend tests, nick break tests)
21. Describe methods of removing a specimen of weld from a suitable position in the joint (eg a stop/start position) using a non-thermal process (eg hand saws, power saws, abrasive discs)
22. 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 221 Preparing and using semi-automatic MIG, MAG and flux cored arc welding equipment

UAN	L/507/3973
Unit level:	2
GLH	140
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF21
Unit aim:	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 apprentice can demonstrate that they are competent in being able to prepare and use semi-automatic MIG, MAG and flux cored arc welding equipment, that 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 150mm long, using single or multi-run welds (as appropriate), with at least one stop and start included.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the welding activities before they start them
LO4 Obtain and prepare the appropriate welding equipment and welding consumables
LO5 Prepare and support the joint, using the appropriate methods
LO6 Tack weld the joint at appropriate intervals, and check the joint for accuracy before final welding
LO7 Weld the joint to the specified quality, dimensions and profile
LO8 Use appropriate methods and equipment to check the quality, and that all dimensional and geometrical aspects of the weld are to the specification
LO9 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
LO10 Shut down and make safe the welding equipment on completion of the welding activities

Practical 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
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 150mm 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 3mm)
   - 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)
   - 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

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 3mm 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 be able to:

1. State the hazards associated with MIG, MAG or flux cored-wire arc welding, and how they can be minimised
2. Describe the correct handling and storage of gas cylinders (eg manual handling and use of cylinder trolley, leak detection procedures, relevant BCGA codes of practice, cylinder identification, gas pressures, cylinder and equipment safety features)
3. Describe the types, selection and application of electrode wires (eg solid and cored)
4. Explain the reasons for using shielding gases, and the types and application of the various gases
5. Outline gas pressures and flow rates (in relation to the type of material being welded)
6. Describe the benefits and application of the welded joints to be produced (eg lap joints, corner joints, tee joints and butt welds)
7. State the terminology used for the appropriate welding positions
8. Describe how to prepare the materials in readiness for the welding activity (eg 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)
9. 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)

10. Outline tack welding size and spacing (in relation to material thickness)
11. Describe the checks to be made prior to welding (eg 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)
12. Describe the techniques of operating the welding equipment to produce a range of joints in the various joint positions (eg fine adjustment of parameters; correct manipulation of the welding gun; blending in stops/starts and tack welds)
13. Outline methods/modes of metal transfer and their uses (eg dip, globular, free flight, spray and pulsed)
14. Explain how to close down the welding equipment safely and correctly
15. Explain how to control distortion (eg welding sequence; deposition technique)
16. Describe the problems that can occur with the welding activities (eg causes of distortion and methods of control; effects of welding on materials and sources of weld defects), and how these can be overcome
17. Outline the safe working practices and procedures to be adopted when preparing the welds for examination (eg handling hot materials, using chemicals for cleaning and etching, using equipment to fracture welds)
18. Explain how to prepare the welds for examination (eg removing surface irregularities; cleaning the weld, polishing and making saw cuts on welds to be break tested)
19. Describe how to check the welded joints for uniformity, alignment, position, weld size and profile
20. Outline the various procedures for visual examination of the welds for cracks, porosity and slag inclusions (eg dye penetrant, fluorescent penetrant; magnetic particle testing)
21. Outline the various procedures for carrying out destructive tests on the welds (eg macroscopic examination, bend tests, nick break tests)
22. 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)
23. 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 222 Producing composite mouldings using wet lay-up techniques

UAN	R/507/3974
Unit level:	2
GLH	140
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF22
Unit aim:	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 apprentice can demonstrate that they are competent in being able to produce composite mouldings using wet lay-up techniques, which 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 the skills section, paragraph 7.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the moulding/laying-up activities before they start them
LO4 Prepare the moulds, jigs or formers ready for the manufacturing operations
LO5 Mix and prepare the required materials
LO6 Carry out the moulding or laying-up activities, using the correct methods and techniques
LO7 Remove the mouldings from the formers and trim/finish them to specification
LO8 Check that all the required operations have been completed to specification
LO9 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
LO10 Leave the work area in a safe and tidy condition on completion of the moulding activities

Practical 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

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

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
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** types 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
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 be able to:

1. 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
2. Describe the specific environmental conditions that must be observed when producing composite mouldings (eg temperature, humidity, styrene levels to threshold limits, fume/dust extraction systems and equipment)
3. 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
4. Outline the conventions and terminology used for wet lay-up techniques (eg resin and fibre weights/volumes, material orientation, material identification, material tailoring, mixing ratios, gel times, exotherm, bleed plies)
5. Outline the different types of resins, reinforcement, catalysts, accelerators and additives used, and their applications
6. Outline the different types of fibre materials, fabrics, orientations, their combinations and applications
7. Outline different core, insert and filler materials, and their applications

8. Outline the different types of production tooling used for producing composite mouldings, and their applications
9. Outline methods for handling and preparing the reinforcing fibres
10. Describe how to estimate/calculate resin volume/weight required to wet-out the reinforcing fibres
11. Explain mixing ratios for gel coats, resins, accelerators and catalysts, and the associated working times
12. 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*
13. State the tools and equipment used in the lay-up activities and outline their care, preparation and control procedures
14. Describe the problems that can occur during the lay-up process (including defects such as contamination, resin/fibre rich areas, and distortion)
15. Explain how defects can be overcome during the lay-up activity
16. Outline the different methods and techniques used to cure composite mouldings including cure cycles and the need for monitoring
17. Outline the methods and techniques used to trim mouldings prior to release (green trimming)
18. Outline the care and safe handling of production tooling and composite mouldings throughout the production cycle
19. Explain the production controls used in the work area, and actions to be taken for unaccounted items
20. Explain how the composite moulding relates to its own quality documents and the production tooling used

Unit 223 Producing composite mouldings using pre-preg techniques

UAN	Y/507/3975
Unit level:	2
GLH	140
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF23
Unit aim:	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 apprentice can demonstrate that they are competent in being able to produce composite mouldings using pre-preg techniques, which 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 the skills section, paragraph 6.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the moulding/laminating activities before they start them
LO4 Prepare the moulds, jigs or formers ready for the manufacturing operations
LO5 Mix and prepare the required materials
LO6 Carry out the moulding/laminating activities, using the correct methods and techniques
LO7 Remove the mouldings from the formers, and trim/finish them to specification
LO8 Check that all the required operations have been completed to specification
LO9 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
LO10 Leave the work area in a safe and tidy condition on completion of the moulding activities

Practical 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

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

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
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
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 carry out **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)

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 be able to:

1. 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
2. Describe the specific environmental conditions the must be observed when producing composite mouldings (eg temperature, humidity, fume/dust extraction systems and equipment)
3. 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
4. Outline the conventions and terminology used for pre-preg laminating techniques (eg material orientation, material identification, material templates, ply lay-up, pressure plates, vacuum bagging, cure cycles, exotherm)
5. Outline the different types of resins, reinforcement, catalysts, accelerators and additives used, and their applications
6. Outline the different types of fibre materials, fabrics, orientations, their combinations and applications
7. Explain the building up laminates (including orientation and balance of plies) to minimise spring and distortion in composite mouldings
8. Outline the different core, insert and filler materials, and their applications
9. Outline the identification of materials by product codes
10. Outline the different types of production tooling used for producing composite mouldings, and their applications
11. Describe the correct methods of storage, thawing and handling of pre-preg materials (including monitoring temperature, storage life and out-life)
12. Describe the methods used in the application of pre-preg materials to tooling surfaces (including methods of tailoring and cutting)
13. Outline the correct methods of storage and handling of ancillary and consumable materials
14. Outline the selection and use of ancillary and consumable materials (eg release films, breather fabrics, bagging films, tapes) to meet performance requirements (eg temperature and compatibility)
15. State the tools and equipment used in the pre-preg laminating activities, and their care, preparation and control procedures
16. 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)
17. Outline the cure cycles (including temperature and pressure ramps, dwell times, post curing)
18. Explain the need for monitoring the cure cycle (using thermocouples, probes, chart recorders and data logs)
19. Outline the care and safe handling of production tooling and composite mouldings throughout the production cycle
20. Explain the production controls used in the work area, and actions to be taken for unaccounted items

21. Explain how the composite moulding relates to its own quality documents, and the production tooling used

Unit 224 General electrical and electronic engineering applications

UAN	D/507/3976
Unit level:	2
GLH	140
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF24
Unit aim:	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 apprentice can demonstrate that they are competent in being able to apply basic electrical and electronic engineering principles, which 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.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the electrical and electronic wiring and testing activities before they start them
LO4 Use appropriate sources to obtain the required specifications, circuit diagrams and test information
LO5 Obtain the correct tools and equipment for the wiring and testing operations, and check that they are in a safe and usable condition
LO6 Mount and secure the electrical and electronic components safely and correctly, to meet specification requirements
LO7 Install and terminate the cables to the appropriate connections on the components
LO8 Use appropriate test methods and equipment to check that the completed circuit is safe and meets all aspects of the specification
LO9 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
LO10 Leave the work area in a safe and tidy condition on completion of the wiring and testing activities

Practical 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
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 multi core

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
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)
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)
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 be able to:

1. 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)
2. Describe the hazards associated with wiring and testing electrical and electronic circuits and equipment, and with the tools and equipment used (eg 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
3. Explain what constitutes a hazardous voltage and how to recognise victims of electric shock
4. Describe how to reduce the risks of a phase to earth shock
5. Explain the basic principles of operation of the equipment/circuits being produced, and the purpose of the individual modules/components used
6. Outline the different types of cabling and their application (eg multicore cables, single core cables, solid and multi-stranded cables, steel wire armoured (SWA), mineral insulated (MI), screened cables, data/communications cables, fibre-optics)
7. 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)

8. Describe the application and use of circuit protection equipment (such as fuses and other overload protection devices, trips, residual current device (RCD))
9. Outline the various types of circuit boards used (such as printed circuit boards, thin film, thick film and flexible film circuitry)
10. 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)
11. 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
12. 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)
13. 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)
14. Explain the importance of conducting inspections and checks before connecting to the supply (eg 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)
15. Outline the care, handling and application of electrical and electronic test and measuring instruments (eg multimeter, insulation resistance tester, loop impedance test instruments, oscilloscopes, signal generators and logic probes)
16. 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
17. Explain how to set the instrument zero readings; obtaining instrument readings and comparing them with circuit parameters
18. Describe the problems that can occur with the wiring and testing operations, and how these can be overcome

Unit 225 Dressing aircraft engines

UAN	H/507/3977
Unit level:	2
GLH	105
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF25
Unit aim:	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 apprentice can demonstrate that they are competent in being able to dress aircraft engines that 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 the skills section paragraph 3.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the assembly activities before they start them
LO4 Obtain and prepare the appropriate components, tools and equipment
LO5 Use the appropriate methods and techniques to assemble the components in their correct positions
LO6 Secure the components using the specified connectors and securing devices
LO7 Check the completed assembly to ensure that all operations have been completed and that the finished assembly meets the required specification
LO8 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
LO9 Leave the work area in a safe and tidy condition on completion of the assembly activities

Practical 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)
   - 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
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 be able to:

1. Outline the hazards associated with the engine dressing activities, and how they can be minimised
2. Outline the different types of drawing and specifications that are used during the engine dressing and assembly activities
3. Explain the assembly/joining methods, techniques and procedures to be used, and the importance of adhering to these procedures
4. Describe how the components are to be aligned, adjusted and positioned prior to securing, and the tools and equipment to be used for this
5. Outline the various mechanical fastening devices that are used (such as nuts, bolts, machine screws, cap screws, clips, pins, locking and retaining devices)
6. Explain the importance of using the specified components and joining devices for the assembly, and why they must not use substitutes
7. Outline where appropriate, the application of sealants and adhesives within the assembly activities, and the precautions that must be taken when working with them
8. Explain what to do to rectify and assembly defects (eg ineffective joining techniques, foreign objects, component damage)
9. Explain the importance of ensuring that all tools are used correctly and within their permitted operating range
10. Outline the problems that could occur with the assembly operations, and the importance of informing appropriate people of non-conformances
11. Explain when to act on their own initiative and when to seek help and advice from others
12. 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 226 Maintaining aircraft mechanical devices and equipment

UAN	K/507/3978
Unit level:	2
GLH	175
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF26
Unit aim:	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 apprentice can demonstrate that they are competent in being able to maintain mechanical devices and equipment, which 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 the skills section, paragraph 5.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the maintenance activities before they start them
LO4 Obtain all the information they need for the safe removal and replacement of the equipment components
LO5 Obtain and prepare the appropriate tools and equipment
LO6 Apply appropriate maintenance diagnostic techniques and procedures
LO7 Use appropriate methods and techniques to remove and replace the required components
LO8 Carry out tests on the maintained equipment, in accordance with the test schedule/defined test procedures
LO9 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
LO10 Leave the work area in a safe and tidy condition on completion of the maintenance activities

Practical 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
   - 2.4 mechanical flight control system.
   - 2.5 undercarriage and associated equipment
   - 2.6 ancillary equipment ie 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, flowcharts, 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
   - 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 springs
   - 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
   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 manufacturers' approved technical data
   7.2 information provided by regulatory authorities
   7.3 service Bulletins and Airworthiness Directives

Knowledge and understanding

The learner must be able to:

1. Describe the hazards associated with carrying out mechanical maintenance activities, and how to minimise them
2. Describe the system isolation procedures that applies to the activity being undertaken
3. Explain how to obtain and interpret drawings, specifications, manufacturers' approved data and other documents needed in the maintenance process
4. Describe the procedure for obtaining replacement parts, materials and other consumables necessary for the maintenance activities
5. Describe the basic principles of how the equipment functions, its operating sequence, the working purpose of individual units/components and how they interact
6. Describe the various maintenance diagnostic techniques and aids that can be used (eg fault reports, visual checks, measuring, movement and alignment checks, testing)
7. Describe the various fault location techniques that can be used, and how they are applied (eg function testing, unit substitution, and equipment self-diagnostics)
8. Explain how to evaluate sensory information (eg sight, sound, smell, touch)
9. Describe the sequence to be adopted for the dismantling/re-assembly of various types of assemblies
10. Describe the methods and techniques used to dismantle/assemble mechanical equipment (eg release of pressures/force, proof marking, extraction, pressing, alignment)
11. Describe the methods of checking that components are fit for purpose, and how to inspect for defects and wear characteristics
12. Explain the identification, application, fitting and removal of different types of bearings (eg roller, ring, thrust)
13. Describe the methods and techniques of fitting keys and splines
14. Explain the identification, application, fitting and removal of different types of gears
15. Explain how to correctly tension belts, cables and chains
16. Describe the identification and application of different types of locking device
17. Describe methods of checking that removed components are fit for purpose, and the need to replace consumable items (such as seals and gaskets)
18. Describe the uses of measuring equipment (such as micrometers, verniers, run-out devices and other measuring devices)
19. 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)
20. Describe the importance of making freedom of movement checks before running the equipment under power
21. Describe the importance of new and replacement part documentation/history
22. Describe the importance of completing maintenance documentation and/or reports following the maintenance activity
23. Describe the problems associated with the mechanical maintenance activity, and how they can be overcome

Unit 227 Maintaining fluid power equipment

UAN	M/507/3979
Unit level:	2
GLH	105
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF27
Unit aim:	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 apprentice can demonstrate that they are competent in being able to maintain fluid power equipment using a range of methods and techniques that 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 the skills section, paragraph 6.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the maintenance activities before they start them
LO4 Obtain all the information they need for the safe isolation, removal and replacement of the system components
LO5 Obtain and prepare the appropriate tools and test equipment
LO6 Apply appropriate maintenance diagnostic techniques and procedures
LO7 Use the appropriate methods and techniques to remove and replace the required components
LO8 Carry out tests on the maintained system in accordance with the test schedule/defined test procedures
LO9 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
LO10 Leave the work area in a safe and tidy condition on completion of the maintenance activities

Practical 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
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
   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

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 be able to:

1. Describe hazards associated with carrying out maintenance activities on fluid power equipment, and how these can be minimised
2. Explain the system isolation procedures or permit-to-work procedure that applies
3. 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
4. Outline the procedure for obtaining replacement parts, materials and other consumables necessary for the maintenance activities
5. 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
6. Describe the different types of pipework, fittings and manifolds, and their application
7. Outline the identification and application of different types of valve (eg poppet, spool, piston, disc)
8. Outline the identification and application of different types of sensors and actuators (eg rotary, linear, mechanical, electrical)
9. Outline the identification and application of different types of cylinder (eg single acting, double acting)
10. Outline the identification and application of different types of pump (eg positive and non-positive displacement)
11. Outline the identification and application of different types compressors (eg screw, piston, rotary vane)
12. Outline the application and fitting of static and dynamic seals
13. Describe the techniques used to dismantle/assemble fluid power equipment (eg release of energy/force, proof marking, extraction)
14. Describe the methods of checking that components are fit for purpose
15. Describe how to make adjustments to components/assemblies to ensure that they function correctly
16. Describe how to determine pressure settings, and their effect on the system
17. State how to select fluids for the system
18. Describe how to recognise contaminants and the problems they can create, and the effects and likely symptoms of contamination in the system
19. Outline the various maintenance diagnostic techniques and aids that can be used (eg fault reports, visual checks, measuring, movement and alignment checks, testing)
20. Outline the various fault location techniques that can be used, and how they are applied (eg half-split, input-to-output, function testing, unit substitution, and equipment self-diagnostics)

21. Explain how to evaluate sensory information (sight, sound, smell, touch)
22. Explain the care, handling and application of mechanical measuring/test equipment (eg measuring instruments, pressure and flow indicators and self-diagnostic equipment)
23. Describe types of test equipment to be used, and their selection for particular tests
24. Explain how the test equipment is connected into the circuit, and the methods of doing this
25. Describe the techniques, methods and procedures to be used during the tests
26. Explain how to display/record test results, and the documentation used
27. Explain how to interpret the test readings obtained, and the significance of the readings gained
28. Describe the problems associated with maintaining fluid power equipment, and how they can be overcome

Unit 228 General turning, milling and welding applications

UAN	H/507/3980
Unit level:	2
GLH	140
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF28
Unit aim:	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 apprentice can demonstrate that they are competent in being able to undertake a broad range of basic turning, milling and welding activities that 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 in 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 in the skills section. **Welding** Welded joints must be at least 150mm long, using single or multi-run welds (as appropriate).

Learning Outcome

The learner must be able to:

Turning and milling

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the machining activities before they start them
LO4 Obtain and prepare the appropriate materials, tools and equipment
LO5 Grind lathe tools and drills to meet the required component specification
LO6 Mount and set the required workholding devices, workpiece and cutting tools
LO7 Set and adjust the machine tool speeds and feeds to achieve the component specification
LO8 Use the machine tool controls safely and correctly, in line with operational procedures
LO9 Measure and check that all dimensional and geometrical aspects of the component are to the specification
LO10 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
LO11 Shut down the equipment to a safe condition on completion of the machining activities

Welding

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the welding activities before they start them
LO4 Obtain and prepare the appropriate welding equipment and welding consumables
LO5 Prepare and support the joint, using the appropriate methods
LO6 Tack weld the joint at appropriate intervals, and check the joint for accuracy before final welding
LO7 Weld the joint to the specified quality, dimensions and profile
LO8 Use appropriate methods and equipment to check the quality, and that all dimensional and geometrical aspects of the weld are to the specification
LO9 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
LO10 Shut down and make safe the welding equipment on completion of the welding activities

Practical skills

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 work holding/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
   - 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
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 +/- 0.25mm 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 0.05mm per 25mm 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
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 3mm)
    - 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 150mm 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
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 be able to:

General

1. Describe the health and safety requirements, and safe working practices and procedures required for the turning, milling and welding activities undertaken (eg 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
2. Describe the hazards associated with the activities, and how they can be minimised

Turning and milling

3. Explain how to mount and secure the cutting tools in the tool holding devices (eg 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)
4. 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
5. Describe factors that affect the selection of cutting feeds and speeds, and the depth of cut that can be taken (eg type of material, size of material, operations being performed, workholding method/security of workpiece, condition of machine, finish and tolerance required)
6. 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
7. 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 (eg lengths, diameters, depths, slots, hole positions, angles, profiles); measuring geometric features (eg flatness, squareness, parallelism, concentricity, ovality); how to check surface finish (such as by using comparison blocks or instruments)
8. Describe the problems that can occur with the turning and milling activities (eg defects caused by poor setting up of equipment and tooling, incorrect speeds and feeds) and how these can be overcome

Welding

9. Describe where applicable, the correct handling and storage of gas cylinders (eg manual handling and use of cylinder trolley, leak detection procedures, relevant BCGA codes of practice, cylinder identification, gas pressures, cylinder and equipment safety features)
10. 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)
11. Describe the types, selection and application of electrode/wires and other consumables
12. Explain how to prepare the materials in readiness for the welding activity (eg ensuring that the material is free from excessive surface contamination – eg rust, scale, paint, oil/grease and moisture; ensuring edges to be welded are correctly prepared - such as made flat, square or bevelled)
13. Explain how to set up and restrain the joint, and the tools and techniques to be used (eg the use of jigs and fixtures, restraining devices – eg clamps and weights/blocks; setting up the joint in the correct position and alignment)
14. Outline the appropriate tack welding size and spacing (in relation to material thickness)
15. 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)
16. Describe the techniques of operating the welding equipment to produce a range of joints in the various joint positions (eg. adjustment of parameters; correct manipulation of the welding gun; blending in stops/starts and tack welds)
17. Describe problems that can occur with the welding activities (eg causes of distortion and methods of control; effects of welding on materials and sources of weld defects), and how these can be overcome
18. Explain how to safely prepare the welds for examination (eg removing surface irregularities; cleaning the weld, polishing and making saw cuts on welds to be break tested)
19. 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 229 Checking for defects in composite mouldings

UAN	K/507/3981
Unit level:	2
GLH	35
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF29
Unit aim:	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 apprentice can demonstrate that they are competent in being able to check for defects in composite mouldings, that 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.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety, environmental and other relevant regulations, directives and guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Check for defects to the composite moulding
LO4 Report defects to the appropriate people promptly and in accordance with organisational procedures
LO5 Record details of defects in accordance with quality assurance and control systems and procedures

Practical 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
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
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 be able to:

1. 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
2. Describe the protective equipment (PPE) that is needed for personal protection and, where required, the protection of others
3. Explain the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables
4. Describe the specific environmental conditions that must be observed when handling composite mouldings (such as temperature, humidity, fume/dust extraction systems and equipment)
5. Describe the basic conventions and terminology used when identifying defects (such as dis-bonds, de-lamination, resin injection, resin voids, core potting, repair patches)
6. Explain how to recognise the different types of defect that can occur in composite mouldings
7. Describe the different methods used to identify defects in composite mouldings including sensory checks, hand measuring tools and machine tools
8. Describe the factors to be taken into consideration when selecting the method to check composite moulding for defects
9. Describe the importance of identifying defects in composite mouldings and the implications if defects are not identified during production
10. Explain the correct methods of storage and handling of composite materials

11. Explain the documentation to be completed during and/or on completion of the surface treatment activity

Unit 230 Carrying out repairs on composite mouldings

UAN	M/507/3982
Unit level:	2
GLH	105
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF30
Unit aim:	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 apprentice can demonstrate that they are competent in being able to carry out repairs on composite mouldings, which 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.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety, environmental and other relevant regulations, directives and guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Follow the relevant drawings and documentation for the moulding to be repaired
LO4 Complete any preparation required prior to undertaking the repair
LO5 Carry out the repairs within agreed timescale using approved materials and components and methods and procedures
LO6 Carry out any checks required confirming the repaired moulding meets the specified operating conditions
LO7 Deal promptly and effectively with problems within their control and report those that cannot be solved
LO8 Dispose of waste and excess materials in line with agreed organisational procedures
LO9 Produce accurate and complete records of all repair work carried out using organisational procedures and documentation

Practical 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
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

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
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 be able to:

1. 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
2. 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
3. Describe the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables
4. Describe the specific environmental conditions that must be observed when repairing composite mouldings (such as temperature, humidity, fume/dust extraction systems and equipment)
5. 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
6. 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
7. 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)
8. Describe the methods used to repair composite mouldings
9. Describe the methods used to cure bonded repairs and their applications
10. Explain the importance of carrying out dimensional/tolerance checks on completion of the repair activity
11. Describe why repairs may affect the structural integrity of the composite moulding
12. Describe the procedure used to determine if additional testing (such as joint integrity, strength testing) is required following a repair
13. Explain the correct methods of storing and handling composite materials
14. Describe the tools and equipment used for various activities associated with repairing composite mouldings
15. Describe the documentation to be completed during and/or on completion of the repair activity

Unit 231 Lifting and trestling/shoring aircraft for maintenance and repair activities

UAN	T/507/3983
Unit level:	2
GLH	70
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF31
Unit aim:	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 apprentice 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 manufactures 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.

Learning Outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines including aircraft manufactures approved data
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Position the lifting equipment so that the weight of the load is evenly distributed
LO4 Attach the appropriate lifting equipment securely to the load, using approved methods to eliminate slippage
LO5 Confirm that the load is secure before moving
LO6 Lift the load using approved techniques and procedures
LO7 Position and release the load safely in its intended location

Practical 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
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 trestling/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 be able to:

1. 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)
2. Describe the hazards associated with lifting and trestling/shoring aircraft, and how to minimise them and reduce any risk
3. Describe the Approved Code of Practice (ACOP) for safe use of lifting equipment, and Lifting Operation and Lifting Equipment Regulations (LOLER)
4. 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
5. Describe the specific requirements for the marking/calibration of lifting equipment and the specific method used in the organisation in which they are working
6. Describe the range of equipment that is to be used for the lifting operations (such as hydraulic jacks, power operated cranes, winches, pulling equipment)
7. Describe the lifting equipment accessories that are to be used (such as slings, eye bolts)
8. 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)
9. Explain the factors which affect the selection of the lifting equipment and lifting accessories (such as weight, type of load, operating environment)
10. Describe how to check that the lifting equipment is capable of lifting the load to be moved
11. Describe the signalling techniques used to communicate with the lifting team (to include both hand signals and verbal commands)
12. 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

13. Describe why balance/ballast weights are sometimes required during the lifting operations
14. Describe the various trestling/shoring methods and equipment that may be used
15. Describe the need to carry out the lifting and trestling/shoring operations without causing damage or undue stress to the airframe and its components
16. Explain how lifting and trestling/shoring equipment should be stored and handled
17. Describe the problems that can occur during the lifting, trestling or shoring of the aircraft and how these problems can be rectified
18. Describe the extent of own authority, and to whom they should report if they have problems that they cannot resolve

Unit 232 General electrical and avionic engineering applications

UAN	A/507/3984
Unit level:	2
GLH	140
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF32
Unit aim:	This unit 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 identifies the training and development required in order that the apprentice can demonstrate that they are competent in being able to apply basic aircraft electrical and electronic engineering principles, which 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 aircraft 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 aircraft 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 aircraft 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.

Learning outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the electrical and electronic wiring and testing activities before they start them
LO4 Use appropriate sources to obtain the required specifications, circuit diagrams and test information
LO5 Obtain the correct tools and equipment for the wiring and testing operations, and check that they are in a safe and usable condition
LO6 Mount and secure the electrical and electronic components safely and correctly, to meet specification requirements
LO7 Install and terminate the cables to the appropriate connections on the components
LO8 Use appropriate test methods and equipment to check that the completed circuit is safe and meets all aspects of the specification
LO9 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

LO10 Leave the work area in a safe and tidy condition on completion of the wiring and testing activities

Practical 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
2. Use **three** of the following types of cable when producing the electrical and electronic circuits:
   - 2.1 single core
   - 2.2 multi core
   - 2.3 fabric material (such as Nyvin)
   - 2.4 plasticised material (such as PTFE, Thin-wall)
   - 2.5 fibre optics
   - 2.6 coaxial
   - 2.7 screened
   - 2.8 data/communication
3. Wire up **three** of the following electrical circuits/systems:
   - 3.1 instrumentation and indication circuits
   - 3.2 emergency lighting systems
   - 3.3 aircraft lighting circuits
   - 3.4 avionic circuits and systems
   - 3.5 electro-pneumatic or electro-hydraulic control circuits
   - 3.6 communication systems
   - 3.7 general circuits (such as pumps, fans, blowers)
   - 3.8 other control AC/DC power generation and control 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 pins and sockets, end terminations (ring tongue))
   - 4.3 determining current rating and lengths of cables required
   - 4.4 stripping outer coating of multi coated cables/wires without damage to inner insulation
   - 4.5 soldering and de-soldering (such as switches and solder bucket connectors)

4.6 identifying and attaching suitable cable identification
4.7 stripping cable conductor insulation/protection without damaging conductors
4.8 leaving sufficient slack for termination and movement
4.9 secure wires and cables (such as glands, clips, plastic strapping, lacing, harnessing)
4.10 making mechanical/screwed/clamped connections

5. Carry out **eight** of the following activities during the mounting of the electrical components:
5.1 setting working clearance
5.2 aligning components
5.3 applying sealants/adhesives
5.4 drilling
5.5 torque setting fasteners
5.6 clamping
5.7 filing
5.8 earth bonding
5.9 crimping
5.10 riveting
5.11 securing using mechanical fasteners/threaded devices
5.12 component marking
5.13 sawing/cutting
5.14 making screw connections
5.15 forming
5.16 punching
5.17 measuring

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)

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 diagnosis techniques (such as half-split, input/output, unit substitution)

Plus **six** more from the following:

7.5 AC voltage/current levels
7.6 DC 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 polarity
7.14 oscillations
7.15 modulation/demodulation
7.16 power rating
7.17 attenuation
7.18 amplification
7.19 resistance
7.20 pulse width/rise time
7.21 signal noise/interference levels
7.22 capacitance
7.23 open/short circuit
7.24 waveform analysis

8. Assemble circuits to the required specification, to include using **fifteen** of the following types of component:

8.1 fixed resistors
8.2 variable resistors
8.3 potentiometers
8.4 encoders or resolvers
8.5 transistors
8.6 fixed resistors
8.7 variable resistors
8.8 potentiometers
8.9 encoders or resolvers
8.10 transistors
8.11 inverters or servo controllers
8.12 thyristors
8.13 edge connectors
8.14 thermistors
8.15 light dependant resistors (LDR)
8.16 analogue or digital integrated circuits
8.17 wiring pins/tags/wire links
8.18 fixing spacers
8.19 fixed capacitors
8.20 variable capacitors
8.21 insulators
8.22 surface mount packages

8.23 rectifiers
8.24 small heat sinks
8.25 electrolytic capacitors
8.26 switches
8.27 cables
8.28 diodes
8.29 Zener diodes
8.30 light emitting diodes (LEDs)
8.31 mini transformers
8.32 decoders
8.33 protection devices
8.34 cable connectors
8.35 regulators
8.36 relays
8.37 inductors
8.38 other specific electronic components

9. Assemble electronic components to produce **five** of the following types of circuit:
   9.1 audio amplifiers
   9.2 filters
   9.3 regulated power supplies
   9.4 signal converters
   9.5 microprocessor based applications (such as PIC chips)
   9.6 logic function controls
   9.7 signal generators
   9.8 comparators
   9.9 display circuits
   9.10 counter/timers
   9.11 power amplifiers
   9.12 ADC and DAC hybrid circuits
   9.13 oscillators
   9.14 motor control
   9.15 sensor/actuator circuit (such as linear, rotational, temperature, photo-optic, flow, level, pressure)
   9.16 digital circuit (such as process control, microprocessor, logic devices, display devices)
   9.17 signal processing circuit (such as frequency modulating/demodulating, amplifiers, filters)
   9.18 alarms and protection circuits
   9.19 other specific circuit

10. Carry out **all** of the following maintenance techniques and procedures during the repair activities:
   10.1 removing excessive dirt and grime
   10.2 dismantling/disconnecting equipment to the required level
   10.3 disconnecting and reconnecting wires and cables
   10.4 checking the condition/deterioration of components
   10.5 soldering and de-soldering
   10.6 repairing circuit board tracks
   10.7 removing and replacing electronic units/circuit boards
   10.8 removing and replacing electronic components
   10.9 making adjustments to components and/or connections

10.10 re-assembling of units or sub-assemblies

11. Replace/refit a range of electronic components, to include **twelve** of the following:
    - 11.1 cables and connectors
    - 11.2 rectifiers
    - 11.3 surface mount packages
    - 11.4 printed circuit boards
    - 11.5 encoders or resolvers
    - 11.6 integrated circuits
    - 11.7 fixed resistors
    - 11.8 variable resistors
    - 11.9 potentiometers
    - 11.10 thyristors
    - 11.11 transistors
    - 11.12 regulators
    - 11.13 decoders
    - 11.14 light dependant resistor (LDR)
    - 11.15 thermistors
    - 11.16 diodes
    - 11.17 Zener diodes
    - 11.18 opto-electronics/optical fibre components
    - 11.19 light emitting diodes (LEDs)
    - 11.20 analogue or digital integrated circuits
    - 11.21 fixed capacitors
    - 11.22 electrolytic capacitors
    - 11.23 variable capacitors
    - 11.24 sensors
    - 11.25 switches
    - 11.26 edge connectors
    - 11.27 heat sinks
    - 11.28 wiring pins/tags/wire links
    - 11.29 mini transformers
    - 11.30 protection devices
    - 11.31 inverters or servo controllers
    - 11.32 relays
    - 11.33 inductors
12. Set up and test sensing elements and/or stand-alone instruments, to include **three** of the following:
    - 12.1 pressure (such as bourdon tube gauge, capsule/diaphragm gauge, pressure transducers)
    - 12.2 temperature (such as thermocouple, resistance thermometers, liquid in steel thermometer)
    - 12.3 flow (such as differential pressure systems, balanced flow meters, positive, displacement)
    - 12.4 level (such as displacer systems, purged dip leg, capacitance probes, differential pressure systems, ultrasonic probes)
    - 12.5 other instruments/sensing elements (such as fire or gas detection, noise or vibration, speed or weight)
13. Use **four** of the following types of instrumentation test and calibration equipment:
    - 13.1 signal sources
    - 13.2 pressure sources

13.3 logic probes
13.4 standard test gauges
13.5 comparators
13.6 temperature baths
13.7 analogue or digital meters
13.8 manometers
13.9 workshop potentiometers
13.10 digital pressure indicators
13.11 current injection devices
13.12 dead weight testers
13.13 calibrated flow meters
13.14 calibrated weights
13.15 insulation testers
13.16 special-purpose test equipment

14. Apply wiring and connection methods and techniques, to include **five** of the following:
    14.1 locating and securing equipment in the correct positions
    14.2 attaching suitable cable identification
    14.3 making mechanical/screwed/clamped connections
    14.4 routeing and securing wires and cables
    14.5 soldering and de-soldering connections
    14.6 using heat shrinking devices or boots
    14.7 sealing and protecting cable connections
    14.8 stripping cable insulation/protection
    14.9 crimping (such as tags and pins)
    14.10 adding cable end fittings
    14.11 connecting all input and output devices
15. Produce electrical and electronic circuits which comply with **two** of the following:
    15.1 European Aviation Safety Agency (EASA) Civil Aviation Authority (CAA)/ regulations, guidelines or directives
    15.2 organisational guidelines and codes of practice
    15.3 customer standards and requirements
    15.4 aircraft/component manufacturer's operating specification/range
    15.5 other

Knowledge and understanding

The learner needs to be able to:

1. 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)
2. Describe the hazards associated with wiring and testing electrical and electronic circuits and equipment, and with the tools and equipment used (such as 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
3. Describe the procedures and precautions to be adopted to eliminate electrostatic discharge (ESD)
4. Explain what constitutes a hazardous voltage and how to recognise victims of electric shock
5. Describe how to reduce the risks of an electric shock (such as insulated tools, rubber mating and isolating transformers)
6. Explain how to interpret job instructions, circuit diagrams, wiring diagrams, and other relevant specifications (including manufacturer's data, specifications and manuals, schematics, wiring regulations, symbology and terminology)
7. Explain the application of Ohm's Law and relevant calculations (including units of electronic measurement and their multiples and sub-multiples)
8. Explain the basic principles of operation of the equipment/circuits being produced, and the purpose of the individual modules/components used
9. Describe the different types of cabling and their application (such as multicore , single core , solid and multi-stranded cables, thin wall insulation, high temp resistant, screened cables, data/communications cables, fibre-optics)
10. Describe the application and use of a range of electrical components (such as connectors (fixed and floating), switches, pins and sockets, relays, solenoids, transformers, sensors and actuators)
11. Describe the application and use of circuit protection equipment (such as fuses and circuit breakers)
12. Describe the various types of circuit boards used (such as printed circuit boards, thin film, thick film and flexible film circuitry)
13. 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)
14. Explain the basic principles of operation of programmable controllers, equipment and circuits, and the purpose of individual/modules/components used (such as input/output devices)
15. Describe the main programmable programmer types available and the different programmable controller codes

16. Explain the programming languages and numbering systems commonly used with programmable controller based systems
17. Describe the different programming codes used to identify factors such as sensor, actuator inputs/outputs, process management
18. Explain the basic principles of operation of instrumentation (to include pressure, temperature, level and flow sensors)
19. Explain how to identify various instrument sensors (including markings, calibration information, component values, operating parameters, working ranges)
20. Describe the various maintenance diagnostic techniques and aids that can be used (such as flow charts, fault reports, visual checks, measuring, movement and alignment checks, testing)
21. Explain the types and application of standard test equipment (such as pressure sources, deadweight testers, temperature baths, signal sources and comparators)
22. Explain how to check that components meet the required specification/operating conditions (such as values, tolerance, current carrying capacity, voltage rating, power rating, working temperature range)
23. Explain how preparations are to be undertaken on components and any enclosure(s), prior to mounting activities
24. Explain how the components are to be aligned, positioned prior to securing and any tooling required
25. Explain how to identify any orientation requirements, values, polarities of components
26. Describe the methods of mounting and securing electrical equipment/components to various surfaces (such as the use mechanical fixings (nuts, bolts and screws, solder)
27. Describe the methods of laying in or looming of cables and the need to ensure the cables are not twisted, plaited or over stressed (corners, bends or length)
28. Describe the techniques used to terminate electrical and electronic components and equipment (such as crimped/soldered pins sockets and end terminations)
29. Describe the use of manufacturer approved wiring regulations when selecting wires and cables, and when carrying out tests on circuits
30. Describe the methods of attaching markers/labels on components or cables to assist with identification (such as colour coded insulation, marker sleeves, pre-printed cable)
31. Outline the tools and equipment used in the wiring activities (including the use of cable stripping tools, crimping tools, soldering irons and torches, insert/extract tooling)
32. Explain how to check that tools and equipment are free from damage or defects, and are in a safe, calibrated, PAT tested and usable condition
33. Explain the importance of conducting inspections and checks (de-energised) before connecting to the supply (such as 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)
34. Describe the care, handling and application of electrical and electronic test and measuring instruments (such as multimeter, insulation resistance tester, loop impedance test instruments, oscilloscopes, signal generators and logic probes)

35. Explain the application of approved test procedures; the safe working practices and procedures required when carrying out the various tests, and the need to use suitable test probes and clips
36. Explain how to identify suitable test points within the circuit/components, and how to position the test instruments into the circuit/components so as to not damage the circuit/components
37. Explain how to set the instrument zero readings; obtaining instrument readings and comparing them with circuit parameters
38. Describe the problems that can occur with the wiring and testing operations, and how these can be overcome
39. Describe the fault diagnosing techniques to be used if the equipment fails to operate correctly

Unit 233 Producing electrical or electronic engineering drawings using a CAD system

UAN	F/507/3985
Unit level:	2
GLH	140
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF33
Unit aim:	This unit 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 identifies the training and development required in order that the apprentice 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 electrical or electronic engineering activities. It 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 types of drawing produced will include circuit and wiring diagrams, block diagrams, schematics, electrical cabling/routing, installation, assembly of panels and sub-assemblies and system design/modification. They will be given a specific drawing brief or a request for change/modification to an existing design, and they will be required to access these requirements and to 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, and must include the drawing title, scale used, date of drawing, and other relevant information. They will then be expected to produce fully detailed drawings to enable the electrical or electronic circuits to be assembled, installed, maintained, commissioned or modified. 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 safely the appropriate computer aided drawing procedures and techniques for electrical or electronic 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 electrical/ electronic 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 the skills section, paragraph 6.

Learning outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the drawing activities before they start them
LO4 Use appropriate sources to obtain the required information for the drawing to be created
LO5 Access and use the correct drawing software
LO6 Use appropriate techniques to create drawings, in the required formats, that are sufficiently and clearly detailed
LO7 Use codes and other references that follow the required conventions
LO8 Make sure that the drawings are checked and approved by the appropriate person
LO9 Save the drawings in the appropriate medium and location
LO10 Produce hard copies of the finished drawings

LO11 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

LO12 Shut down the CAD system to a safe condition on completion of the drawing activities.

Practical 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, lines type, 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)
2. Use **three** of the following to obtain the necessary data to produce the required drawings:
   - 2.1 drawing brief/request
   - 2.2 specifications
   - 2.3 drawing change or modification request
   - 2.4 electrical regulations
   - 2.5 manuals
   - 2.6 previous drawings/designs
   - 2.7 calculations (such as Ohm's law)
   - 2.8 standards
   - 2.9 sketches
   - 2.10 standard reference documents (such as current carrying capacity of cables, electrical or electronic component catalogues)
   - 2.11 notes from meetings/discussions
   - 2.12 other available data.
3. Take into account **four** of the following design features, as appropriate to the drawing being produced:
   - 3.1 function
   - 3.2 operating voltages
   - 3.3 ergonomics
   - 3.4 operating environment
   - 3.5 cost
   - 3.6 lifetime of the product
   - 3.7 tolerances
   - 3.8 interfaces
   - 3.9 aesthetics

3.10 physical space/dimensions of circuit
3.11 power supplies
3.12 safety
3.13 component orientation
3.14 connectors/test point access
3.15 types of components available/to be used
3.16 method of installation (such as conduit, trunking, traywork)
3.17 position of circuit elements/components
3.18 type of cables (such as PVC, mineral insulated)
3.19 connections between components
3.20 uses an appropriate type of circuit (such as digital, analogue, hybrid)
3.21 uses appropriate technology of circuit design (such as single sided, double sided, multi-layer, flexi-rigid)
3.22 meets signal integrity parameters (such as capacitance, inductance, resistance, insulation voltages)
3.23 meets specified operating conditions (such as temperature, humidity, shock and vibration)
3.24 any assembly/manufacturing schedule constraints (such as high profile components mounted after low profile SMT ones)

4. Carry out **all** of the following before producing the engineering drawing:
4.1 ensure that data and information are 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, technical)

5. Produce **three** of the following types of electrical or electronic engineering drawings:
5.1 circuit diagrams
5.2 general assembly drawings
5.3 installation/commissioning
5.4 wiring diagrams
5.5 panel assembly
5.6 manufacture of cable looms
5.7 block diagrams
5.8 cable and routing
5.9 fault diagnostics (such as flow diagrams)
5.10 schematics
5.11 circuit board assembly
5.12 system drawings
5.13 circuit board layout
5.14 modifications to equipment/systems (such as cable looms, cable routing and clipping, panels/sub-assemblies, installation of electrical systems)

6. Produce electrical or electronic drawings which include **ten** of the following:
6.1 straight lines
6.2 curved/contour lines
6.3 dimensions
6.4 circles or ellipses
6.5 angled lines
6.6 hidden detail
6.7 text
6.8 parts lists

6.9 insertion of standard electrical or electronic components
6.10 test points
6.11 type and size of cables
6.12 colour/component coding
6.13 connection/termination details
6.14 parts lists
6.15 electrical/electronic symbols and abbreviations
6.16 fault diagnosis (such as flow diagrams)
6.17 other specific electrical or electronic detail

7. Save and store drawings in appropriate locations, to include carrying out **all** of the following:
   7.1 ensure that their drawing has been checked and approved by the appropriate person(s)
   7.2 check that the drawing is correctly titled and referenced
   7.3 save the drawing to an appropriate storage medium (such as hard drive, DVD, external storage device)
   7.4 create a separate backup copy, and place it in safe storage
   7.5 produce a hard copy printout of the drawing for file purposes
   7.6 register and store the drawings in the appropriate company information system (where appropriate)
   7.7 where appropriate, record and store any changes to the drawings in the appropriate company information system
8. Produce drawings which comply with the following :
   8.1 BS and ISO standards and procedures

   Plus **one** more from the following:
   8.2 organisational guidelines
   8.3 statutory regulations and codes of practice
   8.4 CAD software standards
   8.5 other international standards

Knowledge and understanding

The learner needs to be able to:

1. 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)
2. Describe the methods and procedures used to minimise the chances of infecting a computer with a virus
3. Explain the implications if the computer they are using does become infected with a virus and who to contact if it does occur
4. Describe the relevant sources and methods for obtaining any required technical information relevant to the drawing being produced (such as drawing briefs, specification sheets, request for changes or modifications to drawings; technical information such as cable current carrying capacity, component values or coding systems, component pin configurations)
5. Define the functionality of the circuit being drawn, and its interrelationship with other circuits and assemblies
6. Describe the correct startup and shutdown procedures to be used for the computer systems
7. Identify the correct drawing software package from the menu or windows environment; the various techniques that are available to access and use the CAD software (such as mouse, menu or tool bar, light pens, digitisers and tablets, printers or plotters, and scanners)
8. Explain the use of software manuals and related documents to aid efficient operation of the relevant drawing system
9. Explain how to deal with system problems (such as error messages received, peripherals which do not respond as expected, obvious faults with the equipment or connecting leads)
10. Describe different types of electrical or electronic drawings that may be produced by the software (such as circuit and wiring diagrams, block and schematic diagrams, assembly and installation drawings)
11. Describe the national, international and organisational standards and conventions that are used for the drawings
12. Explain how to set up the drawing template parameters (such as layers of drawings, scale, paper size, colour set-up, line types, dimension system and text styles)
13. Explain the application and use of drawing tools (such as for straight lines, curves and circles; how to add dimensions and text to drawings, producing layers of drawings)
14. Explain how to access, recognise and use a wide range of standard components and symbol libraries from the CAD equipment

15. Describe the factors to be taken into account when producing electrical drawings (such as safety requirements, operating parameters of components, position of components in relation to other sources or circuits, possibility of external interference)
16. Explain the electrical or electronic equipment and circuits being worked on, and the function of the individual components within the circuits
17. Describe the selection of the various components and cables being used (with regard to their operating ranges and current carrying capacity)
18. Describe the use of specific regulations and standard reference tables when selecting components and cables
19. Explain how power cables might affect/corrupt signal transmission, and the need to consider this in siting and routing cables
20. Describe the basic calculations that may be required to verify the acceptability of components and circuits (such as Ohm's Law)
21. Explain how to save and store drawings (such as determining document size; how to check that there is sufficient space to save the file in their chosen destination; saving and naming the file/drawing)
22. Explain the need to create backup copies, and to file them in a separate and safe location
23. Explain how to produce hard copies of the drawings, and the advantages and disadvantages of printers and plotters

Unit 234 Wiring and testing electrical equipment and circuits

UAN	J/507/3986
Unit level:	2
GLH	140
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF34
Unit aim:	This unit 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 identifies the training and development required in order that the apprentice can demonstrate that they are competent in being able to: wire up and test electrical equipment and circuits. It 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 activities will include the wiring and termination of a range of cables, such as single and multicore cables, screened cables, fire resistant and armoured cables. They will be required to make a variety of terminations and to connect a range of electrical components, such as switches/switchgear, distribution panels, motors and starters, control systems, sensors and actuators, safety devices, and luminaires. They will be required to select the appropriate tools, materials and equipment to use, based on the operations to be performed and the components to be connected. They will be expected to use appropriate tools and techniques for the wiring of the various electrical components and connectors that make up the electrical system/circuit. In addition, they will be expected to make all necessary electrical connections to the switches, relays, sensors/actuators and other devices, as appropriate to the equipment and circuit being produced. The wiring and testing activities will include making all necessary checks and adjustments to the circuit, including continuity, polarity, insulation resistance values, and ensuring that the equipment functions to the specification.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the 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 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.

Specific unit requirements

In order to prove their ability to combine different electrical assembly and wiring activities, at least one of the electrical assemblies produced must be of a significant nature, and must contain a minimum of **five** of the components listed in the skills section, paragraph 3, plus **five** of the activities listed in paragraph 5.

Learning outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the wiring and testing activities before they start them
LO4 Use appropriate sources to obtain the required specifications, circuit diagrams and test information

LO5 Obtain the correct tools and equipment for the wiring and testing operations, and check that they are in a safe and usable condition
LO6 Mount and secure the electrical components safely and correctly, to meet specification requirements
LO7 Install and terminate the cables to the appropriate connections on the components
LO8 Use appropriate test methods and equipment to check that the completed circuit is safe and meets all aspects of the specification
LO9 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
LO10 Leave the work area in a safe and tidy condition on completion of the wiring and testing activities

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Practical skills:

The learner must be able to:

1. Carry out **all** of the following activities 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 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 and usable condition, including PAT tested
   - 1.5 ensure that the electrical system is kept free from foreign objects, dirt or other contamination
   - 1.6 where appropriate, apply procedures and precautions to eliminate electrostatic discharge (ESD) hazards
   - 1.7 return all tools and equipment to the correct location on completion of the wiring and testing activities
2. Wire circuits using **three** of the following types of cables:
   - 2.1 single core
   - 2.2 data/communication
   - 2.3 ribbon cables
   - 2.4 multicore
   - 2.5 fibre-optics
   - 2.6 mineral insulated
   - 2.7 PVC twin and earth
   - 2.8 screened
   - 2.9 armoured
   - 2.10 flexible (such as cotton or rubber covered)
   - 2.11 coaxial
   - 2.12 wiring loom/harness
3. Connect up **ten** of the following electrical modules/components to produce circuits:
   - 3.1 isolators
   - 3.2 blowers
   - 3.3 cable connectors
   - 3.4 switches
   - 3.5 lamp holders

3.6 fuses
3.7 sockets
3.8 panel lamps
3.9 circuit breakers
3.10 contactors
3.11 luminaires
3.12 sensors
3.13 motor starters
3.14 ballast chokes
3.15 actuators
3.16 solenoids
3.17 consumer units
3.18 junction boxes
3.19 relays
3.20 residual current device (RCD)
3.21 terminal blocks
3.22 alarm devices
3.23 instruments
3.24 electronic modules/units
3.25 motors
3.26 transformers
3.27 control devices
3.28 pumps
3.29 panels or sub-assemblies
3.30 heaters
3.31 other electrical components

4. Apply wiring methods and techniques to include **six** of the following:
   4.1 positioning and securing of equipment and components
   4.2 levelling and alignment of components
   4.3 determining current rating and lengths of cables required
   4.4 securing by using mechanical fixings (such as screws, nuts and bolts)
   4.5 laying in cables without twisting or plaiting
   4.6 feeding cables into conduit without twisting or plaiting
   4.7 leaving sufficient slack for termination and movement
5. Carry out **eight** of the following cable termination activities:
   5.1 stripping cable sheaths without damage to conductor insulation
   5.2 terminating mineral insulated cables
   5.3 removing cable insulation
   5.4 sealing/protecting cable connections
   5.5 connecting accessories (such as plugs, sockets multi-way connectors)
   5.6 attaching suitable cable identification
   5.7 making mechanical/screwed/clamped connections
   5.8 crimping (such as spade end, loops, tags and pins)
   5.9 soldering and de-soldering
   5.10 securing wires and cables (such as clips, plastic strapping, lacing, harnessing)
   5.11 terminating armoured cables
   5.12 heat shrinking (devices and boots)
   5.13 earth bonding
   5.14 cable glands and grips

6. Wire up **three** of the following electrical systems:
   - 6.1 domestic lighting circuits
   - 6.2 air conditioning control circuits
   - 6.3 domestic power circuits
   - 6.4 refrigeration control circuits
   - 6.5 motor start and control
   - 6.6 heating/boiler control circuits
   - 6.7 vehicle heating or ventilating
   - 6.8 aircraft lighting circuits
   - 6.9 vehicle lighting
   - 6.10 power generation and control circuits
   - 6.11 vehicle starting and ignition
   - 6.12 avionic circuits and systems
   - 6.13 instrumentation and control circuits
   - 6.14 emergency lighting systems
   - 6.15 alarm systems (such as fire, intruder, process control)
   - 6.16 communication systems
   - 6.17 electro-pneumatic or electro-hydraulic control circuits
   - 6.18 computer systems
   - 6.19 other control circuits (such as pumps, fans, blowers, extractors)
   - 6.20 other specific electrical circuits
7. Use **two** of the following test instruments during the wiring and testing activities:
   - 7.1 multimeter
   - 7.2 earth-loop impedance tester
   - 7.3 insulation resistance tester
   - 7.4 polarity tester/indicator
   - 7.5 RCD tester
   - 7.6 other specific test equipment
8. Carry out checks and adjustments, appropriate to the equipment and circuits being wired, to include **three** of the following:
   - 8.1 making visual checks (such as completeness, signs of damage, incorrect termination)
   - 8.2 movement checks (such as loose fittings and connections)
   - 8.3 testing that the equipment operates to the circuit specification
   - 8.4 carrying out fault finding techniques (such as half-split, input/output, unit substitution)

   Plus **three** more from the following:
   - 8.5 protective conductor resistance values
   - 8.6 load current
   - 8.7 power rating
   - 8.8 insulation resistance values
   - 8.9 polarity
   - 8.10 frequency values
   - 8.11 continuity
   - 8.12 resistance
   - 8.13 inductance
   - 8.14 voltage levels
   - 8.15 capacitance
   - 8.16 RCD disconnection time
   - 8.17 specialised tests (such as speed, sound, light, temperature)

9. Produce electrical circuits in accordance with one or more of the following standards:
   - 9.1 BS 7671/IET wiring regulations
   - 9.2 other BS and/or ISO standards
   - 9.3 company standards and procedures.

Knowledge and understanding

The learner needs to be able to:

1. Explain the specific safety practices and procedures that they need to observe when wiring and testing electrical equipment (including any specific legislation, regulations or codes of practice for the activities, equipment or materials)
2. Describe the hazards associated with wiring and testing electrical equipment, and with the tools and equipment used, (such as using sharp instruments for stripping cable insulation), and how they can be minimised
3. Explain what constitutes a hazardous voltage and how to recognise victims of electric shock
4. Describe how to reduce the risks of a phase to earth shock (such as insulated tools, rubber mating and isolating transformers)
5. Explain how to interpret circuit diagrams, wiring diagrams, and other relevant specifications (including BS and ISO schematics, wiring regulations, symbols and terminology)
6. Explain the basic principles of operation of the equipment/circuits being produced, and the purpose of the individual modules/components used
7. Describe the different types of cabling and their application (such as multicore cables, single core cables, solid and multi-stranded cables, steel wire armoured (SWA), Mineral Insulated (MI), screened cables, data/communications cables, fibre-optics)
8. 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)
9. Describe the application and use of circuit protection equipment (such as fuses and other overload protection devices, trips, Residual Current Device (RCD))
10. Explain how to check that components meet the required specification/operating conditions (such as values, tolerance, current carrying capacity, voltage rating, power rating, working temperature range)
11. Describe methods of mounting and securing electrical equipment/components to various surfaces (such as the use of nuts and bolts, screws and masonry fixing devices)
12. Explain how checking that the positions selected for mounting the components does not interfere with or damage existing services (such as cable harnesses, pipework or electricity supplies)
13. Describe the 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

14. Describe the techniques used to terminate electrical equipment (such as plugs and sockets; soldering; screwed, clamped and crimped connections, glands and sealed connectors)
15. Explain the use of BS7671/IET wiring regulations when selecting wires and cables and when carrying out tests on systems
16. Describe the methods of attaching markers/labels to components or cables to assist with identification (such as colour coding conductors, using coded tabs)
17. Outline the tools and equipment used in the wiring and testing activities (including the use of cable stripping tools, crimping tools, soldering irons and torches, gland connecting tools)
18. Explain how to check that tools and equipment are free from damage or defects, and are in a safe, PAT tested, calibrated and usable condition
19. Explain the importance of conducting inspections and checks before connecting to the supply (such as 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)
20. Describe the care, handling and application of electrical test and measuring instruments (such as multimeter, insulation resistance tester, loop impedance test instruments)
21. Explain the application of approved test procedures; the safe working practices and procedures required when carrying out the various tests, and the need to use suitably fused test probes and clips
22. Explain how to identify suitable test points within the circuit, and how to position the test instruments into the circuit whilst ensuring the correct polarity and without damaging the circuit components and the test equipment
23. Explain how to set the instrument's zero readings; obtaining instrument readings and comparing them with circuit parameters
24. Explain why electrical bonding/earthing is critical, and why it must be both mechanically and electrically secure
25. Describe the problems that can occur with the wiring and testing operations, and how these can be overcome
26. Describe the fault-finding techniques to be used if the equipment fails to operate correctly (such as half split, unit substitution and input/output)

Unit 235 Assembling, wiring and testing electrical panels/components mounted in enclosures

UAN	L/507/3987
Unit level:	2
GLH	140
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF35
Unit aim:	This unit 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 identifies the training and development required in order that the apprentice can demonstrate that they are competent in being able to assemble, wire and test electrical panels and components mounted in enclosures. It 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 activities will include the assembly of a range of electrical components such as component panels, isolator switches, fuses and circuit breakers, contactors and relays, bases for plug-in devices, rail-mounted terminal blocks, trunking, earthing bonding, and sub-assemblies such as power supplies, card racks, and process controller units. This will involve using a range of tools and equipment along with soldering techniques and anti-static protection techniques. The assembly activities will also include making all necessary checks and adjustments to ensure that components are free from damage, correctly positioned and secured, are terminated correctly and pass the required insulation and resistance checks. Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the electrical component assembly and wiring activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the assembly and wiring 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 assembly, wiring and testing procedures and techniques safely. They will understand the assembly methods and procedures used, and their application, and will know about the various components 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 mounting electrical components in enclosures, and with 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 electrical panel assembly and wiring operations, at least one of the assemblies produced must be of a significant nature, and must contain a minimum of **eight** of the components listed in the skills section, paragraph 2, **plus six** of the activities listed in paragraph 5.

Learning outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the electrical assembly, wiring and testing activities before they start them
LO4 Use appropriate sources to obtain the required specifications, circuit diagrams, components, assembly and test
LO5 Obtain the correct tools and equipment for the assembly and test operations, and check that they are in a safe and usable condition
LO6 Use the appropriate methods and techniques to assemble the components in their correct positions
LO7 Secure the components, using the specified connectors and securing devices
LO8 Wire and terminate cables to the appropriate connections on the components
LO9 Use appropriate test methods and equipment to check that the completed assembly is safe and meets all aspects of the specification

LO10 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

LO11 Leave the work area in a safe and tidy condition on completion of the electrical assembly and testing activities

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Practical skills:

The learner must be able to:

1. Carry out **all** of the following during the mounting of the electrical components:
   - 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 test procedures at all times
   - 1.3 ensure that the components are free from damage, foreign objects, dirt or other contamination
   - 1.4 check that the tools and test instruments are within calibration date and are in a safe, tested and usable condition
   - 1.5 prepare the electrical components and enclosures for the assembly operations
   - 1.6 use safe and approved techniques to mount the electrical components in the enclosures
   - 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 assembly activities
2. Mount electrical components on panels or into enclosures, to include **twelve** of the following items:
   - 2.1 enclosure partitions
   - 2.2 bases for plug-in devices
   - 2.3 soft starters
   - 2.4 component mounting plates
   - 2.5 switches (push button, toggle)
   - 2.6 variable speed drives
   - 2.7 component marking
   - 2.8 capacitors
   - 2.9 limit switches
   - 2.10 trunking
   - 2.11 resistors
   - 2.12 sensors
   - 2.13 conduit
   - 2.14 rectifiers
   - 2.15 programmable controllers
   - 2.16 contactors
   - 2.17 timers
   - 2.18 plugs/sockets
   - 2.19 overload and other relays
   - 2.20 power supplies
   - 2.21 grommets/grommet strip
   - 2.22 transformers/chokes
   - 2.23 circuit boards
   - 2.24 lighting fixtures

2.25 circuit breakers/fuses
2.26 thermistors/thermocouples
2.27 batteries
2.28 panel meters (voltage, current)
2.29 indicators (lamps, LEDs)
2.30 connector rails
2.31 terminal blocks/junction boxes
2.32 thermostats
2.33 solenoids
2.34 safety interlocks
2.35 busbars
2.36 isolators
2.37 other specific components

3. Carry out **eight** of the following activities during the mounting of the electrical components:
   3.1 setting working clearance
   3.2 aligning components
   3.3 applying sealants/adhesives
   3.4 drilling
   3.5 torque setting fasteners
   3.6 clamping
   3.7 filing
   3.8 earth bonding
   3.9 crimping
   3.10 riveting
   3.11 securing using mechanical fasteners/threaded devices
   3.12 component marking
   3.13 sawing/cutting
   3.14 making screw connections
   3.15 forming
   3.16 punching
   3.17 measuring
4. Wire up electrical components on panels or in enclosures, using **two** of the following cable/wire types:
   4.1 single core cable
   4.2 mineral insulated cable
   4.3 twisted pair/ribbon cable
   4.4 multicore cable
   4.5 screened cable
   4.6 braided copper
   4.7 laminated copper
   4.8 fibre-optic
   4.9 data/communication cable
   4.10 other specialist cable
5. Use **ten** of the following methods and techniques (and the appropriate tools) during the wiring activities:
   5.1 cable forming/bending
   5.2 making screwed connections
   5.3 cable supporting/tying
   5.4 soldering (where appropriate)

5.5 cable/wire clamping
5.6 cable routeing
5.7 cable protection (such as sleeving, grommets)
5.8 connecting pre-formed looms
5.9 cable/wire crimping
5.10 wire marking/colour coding
5.11 insulation stripping

6. Carry out quality checks, to include **all** of the following:
   6.1 positional accuracy of all components
   6.2 correct termination of all wires to components
   6.3 correct orientation
   6.4 completeness
   6.5 correct alignment
   6.6 ensuring enclosure is free of debris (such as cable offcuts/ insulation, enclosure/trunking breakouts)
   6.7 component security
   6.8 security of all terminations
   6.9 ensuring freedom from damage

   Plus **all** of the following electrical checks:

   6.10 continuity of cable/wiring connections (such as battery and lamp checks)
   6.11 polarity
   6.12 protective conductor resistance values
   6.13 earth continuity
   6.14 insulation resistance

7. Assemble electrical components on panels or in enclosures, in accordance with one or more of the following:
   7.1 BS7671/IET wiring regulations
   7.2 other BS or ISO standards and procedures
   7.3 company standards and procedures

Knowledge and understanding

The learner needs to be able to:

1. Explain the specific safety practices and procedures that they need to observe when assembling, wiring and testing electrical components mounted in enclosures (including any specific legislation, regulations or codes of practice for the activities, equipment or materials)
2. Describe the hazards associated with assembling, wiring and testing electrical panels (such as using sharp instruments for stripping cable insulation, use of soldering irons, carrying out insulation tests), and how they can be minimised
3. Explain the precautions to be taken to prevent electrostatic discharge (ESD) damage to circuits and sensitive components (such as use of earthed wrist straps, anti-static mats, special packaging and handling areas)
4. Explain what constitutes a hazardous voltage and how to recognise victims of electric shock
5. Describe how to reduce the risks of a phase to earth shock (such as insulated tools, rubber matting and isolating transformers)
6. Explain how to obtain and interpret drawings, circuit and physical layouts, charts, specifications, graphical electrical symbols, BS and ISO wiring regulations, and other documents needed for the electrical component mounting, wiring and testing activities
7. Explain the basic principles of operation of the equipment/circuits being assembled and wired, and the purpose of individual components within the circuit
8. Describe the assembly methods and techniques to be used when wiring electrical panels or components mounted in enclosures (such as cable stripping, soldering, crimping, securing cables using cable ties, lacing/strapping of wires)
9. Describe the type of components and sub-assemblies that are used in the assembly activities (such as contactors, relays, circuit breakers/fuses, solenoids, switches, transformers, ballast chokes, terminal blocks, sub-assemblies)
10. Explain preparations to be undertaken on the components and enclosure, prior to the mounting activities
11. Explain how the components are to be aligned and positioned prior to securing, and the tools and equipment that are used
12. Explain how to identify any orientation requirements, values or polarity for the components used in the electrical wiring activities
13. Describe methods of attaching identification markers/labels during electrical assembly activities
14. Describe the different types of cabling, and their application (such as multicore cables, single core cables, single insulated, double insulated, steel wire armoured (SWA), mineral insulated (MI), screened cables)
15. Explain why electrical bonding/earthing is critical, and why it must be both mechanically and electrically secure

16. Explain the use of BS7671/IET wiring, and other regulations, when selecting wires and cables and when carrying out tests on electrical circuits
17. Explain how to conduct any necessary checks to ensure the accuracy and quality of the assembly produced (such as visual checks for completeness and freedom from damage to conductors or components, mechanical checks for security of components and connections, ingress protection, electrical checks for electrical continuity and earth continuity, insulation resistance and polarity checks)
18. Explain how to check that tools and equipment are free from damage or defects, are in a safe, tested, calibrated and usable condition, and are configured correctly for the intended purpose
19. Describe the problems that can occur with the wiring and testing operations, and how these can be overcome

Unit 236 Assembling and testing electronic circuits

UAN	R/507/3988
Unit level:	2
GLH	140
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF36
Unit aim:	This unit 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 identifies the training and development required in order that the apprentice can demonstrate that they are competent in being able to assemble and test electronic circuits. It 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 activities will include the assembly of a range of electronic components such as resistors (fixed and variable), capacitors (fixed and variable), diodes, transistors and other semiconductor devices, integrated circuits (analogue and digital), miniature transformers, switches, indicators, wire links and a range of connectors, spacers and brackets to form various types of circuits. This will involve using a range of tools and equipment along with soldering techniques and anti-static protection techniques. The assembly activities will include making all necessary checks and adjustments to the circuits, including continuity checks, voltage, current and resistance values, waveform 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 electronic assembly activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the assembly and wiring 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 electronic assembly, wiring and testing procedures and techniques safely. They will understand the assembly methods and procedures used, and their application, and will know about the various 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 electronic component assembly activities, and with 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 electronic assembly and testing activities, at least one of the electronic assemblies produced must be of a significant nature, and must contain a minimum of **ten** of the components listed in the skills section, paragraph 5.

Learning outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the electronic assembly, wiring and testing activities before they start them
LO4 Use appropriate sources to obtain the required specifications, circuit diagrams, component assembly and test information
LO5 Obtain the correct tools and equipment for the assembly and test operations, and check that they are in a safe and usable condition
LO6 Use the appropriate methods and techniques to assemble the components in their correct positions
LO7 Secure the components, using the specified connectors, securing devices and soldering techniques
LO8 Wire and terminate cables to the appropriate connections on the circuit boards

LO9 Use appropriate test methods and equipment to check that the completed assembly is safe and meets all aspects of the specification

LO10 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

LO11 Leave the work area in a safe and tidy condition on completion of the electronic assembly and testing activities

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Practical skills:

The learner must be able to:

1. Carry out **all** of the following during the electronic assembly 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 follow job instructions, assembly drawings and test procedures at all times
   - 1.3 ensure that the components are free from damage, dirt or other contamination
   - 1.4 prepare the electronic components for the assembly operations (such as pre-forming and cleaning pins)
   - 1.5 use safe and approved techniques to mount the electronic components on the circuit boards
   - 1.6 check that the tools and test instruments are within calibration date and are in a safe, tested and usable condition
   - 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 follow clean work area protocols, where appropriate
   - 1.9 return all tools and equipment to the correct location on completion of the assembly activities
2. Assemble **one** of the following circuit types:
   - 2.1 single-sided circuit
   - 2.2 thick film circuit
   - 2.3 thin film circuit
   - 2.4 flexible circuit
   - 2.5 double-sided circuit
   - 2.6 hybrid circuit
3. Assemble electronic components using **two** of the following:
   - 3.1 manual soldering techniques
   - 3.2 surface mount techniques
   - 3.3 mechanical fixing methods
4. Assemble circuits using **four** of the following tools:
   - 4.1 heat shunts/tweezers
   - 4.2 component forming devices
   - 4.3 mechanical fasteners (screwdriver, spanners)
   - 4.4 snipe or long nosed pliers
   - 4.5 wire strippers
   - 4.6 anti-static packaging, mats and straps
   - 4.7 sleeving pliers

4.8 side or end cutters
4.9 specialised assembly tools/equipment

5. Assemble circuits to the required specification, to include using **fifteen** of the following types of component:
   5.1 fixed resistors
   5.2 variable resistors
   5.3 potentiometers
   5.4 encoders or resolvers
   5.5 transistors
   5.6 inverters or servo controllers
   5.7 thyristors
   5.8 edge connectors
   5.9 thermistors
   5.10 light dependant resistors (LDR)
   5.11 analogue or digital integrated circuits
   5.12 wiring pins/tags/wire links
   5.13 fixing spacers
   5.14 fixed capacitors
   5.15 variable capacitors
   5.16 insulators
   5.17 surface mount packages
   5.18 rectifiers
   5.19 small heat sinks
   5.20 electrolytic capacitors
   5.21 switches
   5.22 cables
   5.23 diodes
   5.24 Zener diodes
   5.25 light emitting diodes (LEDs)
   5.26 mini transformers
   5.27 decoders
   5.28 protection devices
   5.29 cable connectors
   5.30 regulators
   5.31 relays
   5.32 inductors
   5.33 other specific electronic components
6. Assemble electronic components to produce **five** of the following types of circuit:
   6.1 audio amplifiers
   6.2 filters
   6.3 regulated power supplies
   6.4 signal converters
   6.5 microprocessor based applications (such as PIC chips)
   6.6 logic function controls

6.7 signal generators
6.8 comparators
6.9 display circuits
6.10 counter/timers
6.11 power amplifiers
6.12 ADC and DAC hybrid circuits
6.13 oscillators
6.14 motor control
6.15 sensor/actuator circuit (such as linear, rotational, temperature, photo-optic, flow, level, pressure)
6.16 digital circuit (such as process control, microprocessor, logic devices, display devices)
6.17 signal processing circuit (such as frequency modulating/ demodulating, amplifiers, filters)
6.18 alarms and protection circuits
6.19 other specific circuit

7. Carry out visual checks on the completed circuits, to include **all** of the following:
7.1 soldered joints are clean, shiny, free from solder spikes, bridges, holes, excess solder and flux
7.2 components are correctly mounted for best physical support, and are correctly orientated
7.3 excess component leads have been trimmed off to the standard required
7.4 circuit tracks are free from faults (such as lifting, breaks, bridges, hot spots)
7.5 there are no obvious signs of damage, to components or to the substrate
7.6 all required connectors, wire links, spacers and other ancillary items are in place

8. Use **five** of the following types of test equipment:
8.1 multimeter
8.2 signal generator
8.3 oscilloscope
8.4 signal tracer
8.5 logic probe/clip
8.6 stabilised power supplies
8.7 logic analyser
8.8 measuring bridges
8.9 pulse sequencing analyser
8.10 software diagnostic programs
8.11 counter/timers
8.12 data communications test set
8.13 signature analysers
8.14 bus exerciser/analyser
8.15 protocol analyser

9. Carry out checks, adjustments and fault rectification where appropriate to the circuits being assembled, to include **six** of the following:
9.1 logic states
9.2 pulse width/rise time

9.3 inductance
9.4 dc voltage/current levels
9.5 open/short circuit
9.6 frequency modulation/demodulation
9.7 ac voltage/current levels
9.8 resistance
9.9 amplification
9.10 clock/timer switching
9.11 capacitance
9.12 signal noise/interference levels
9.13 oscillations
9.14 waveform analysis
9.15 attenuation

10. Produce electronic circuits in accordance with **one** of the following:
    10.1 BS or ISO standards and procedures
    10.2 customer standards and requirements
    10.3 company standards and procedures
    10.4 other international standards

Knowledge and understanding

The learner needs to be able to:

1. Explain the specific safety practices and procedures that they need to observe when assembling and testing electronic circuits (including any specific legislation, regulations or codes of practice for the activities, equipment or materials)
2. Describe the hazards associated with assembling and testing electronic circuits (such as 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
3. Explain the precautions to be taken to prevent electrostatic discharge (ESD) damage to electronic circuits and components (such as use of earthed wrist straps, anti-static mats, special packaging and handling areas)
4. Explain what constitutes a hazardous voltage and how to recognise victims of electric shock
5. Describe how to reduce the risks of a phase to earth shock (such as insulated tools, rubber matting and isolating transformers)
6. Explain how to use and extract information from circuit diagrams, block and schematic diagrams, equipment manuals, data sheets, test procedures and instructions (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken
7. Describe the various types of circuit boards used (such as printed circuit boards, thin film, thick film and flexible film circuitry)
8. 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)

9. Explain how to check that components meet the required specification/operating conditions (such as values, tolerance, current carrying capacity, voltage rating, power rating, working temperature range)
10. Explain the basic principles of operation of the electronic circuits being assembled, and the purpose of the individual modules/components within the circuits
11. Describe the application and use of circuit protection equipment (such as fuses and other overload protection devices)
12. Describe the preparation requirements for components to be used in the assembly (such as pre-forming component pins/legs)
13. Describe methods of mounting and securing electronic components to various surfaces (such as the use of manual soldering techniques, surface mount technologies and mechanical fixing devices, use of heat sinks/shunts)
14. Describe methods of attaching markers/labels to components or cables to assist with identification (such as colour coding conductors, using coded tabs)
15. Explain the use of calculations, and regulations, when selecting wires and cables and when carrying out tests on electronic circuits
16. Explain the importance of making visual checks of the completed assembly (such as examination for excessive solder or solder spikes which may allow short circuits to occur, correct orientation of components for pin configuration or polarity, obvious signs of damage (such as heat damage) or strain on terminations)
17. Describe the tools and equipment used in the electronic assembly activities (including the use of cable stripping tools, crimping tools, soldering irons, specialist assembly tools)
18. Explain the importance of ensuring that all tools are in a safe and serviceable condition, are used correctly and are returned to their correct location on completion of the assembly activities
19. Describe the care, handling and application of electronic test and measuring instruments (such as multimeter, oscilloscope, signal generators, stabilised power supplies, logic probes/analyzers, measuring bridges)
20. Describe the methods of checking that test equipment is safe to use (such as condition of power cables, using suitably fused test probes, clips and leads); that equipment is within current calibration approval dates and PAT tested; that the test equipment is suitable for the tests they are to carry out and can cover the range and values they are to measure
21. Explain how to connect to an approved power supply and, where appropriate, signal source; identifying correct test points in the circuit; how to position test instruments into circuits without damaging circuit components (such as using test probes, ensuring correct polarity, taking antistatic precautions); setting instrument zero readings; obtaining instrument readings and comparing them with expected results
22. Describe how to make adjustments to circuit components; make decisions on circuit performance and faulty components; removal and replacement of faulty components

23. Describe the fault-finding techniques to be used when the equipment fails to operate correctly (such as half split, unit substitution and input/output)

24. Describe the problems that can occur with the assembling and testing operations, and how these can be overcome

Unit 237 Maintaining electrical equipment/systems

UAN	Y/507/3989
Unit level:	2
GLH	175
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF37
Unit aim:	This unit 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 identifies the training and development required in order that the apprentice can demonstrate that they are competent in being able to prepare for the electrical 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 electrical equipment/systems being maintained. This will include electrical equipment that uses single, three-phase or direct current power supplies, and includes equipment such as control systems, motors and starters, switchgear and distribution panels, electrical plant, pumps, fans, alternators, generators, transformers, wiring enclosures and luminaires, portable appliances and other specific electrical 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 be expected to cover a range of maintenance activities, such as isolating and locking off, disconnecting, removing and reconnecting electrical components, wires and cables, attaching cable identification markers, replacing damaged or defective components, cables and wires, setting and adjusting components, and making `off-load' checks before testing the 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 electrical 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 electrical maintenance techniques and procedures safely. They will understand the electrical maintenance process, and its application, and will know about the electrical equipment and systems being maintained, 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 maintenance activities (especially those for ensuring that the equipment is correctly isolated), and when using maintenance tools and equipment. 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.

Specific unit requirements

In order to prove their ability to combine different electrical maintenance operations, at least one of the electrical maintenance activities carried out must be of a significant nature, and must cover a minimum of **eight** of the activities listed in the skills section, paragraph 5.

Learning outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the maintenance activities before they start them
LO4 Obtain all the information they need for the safe removal and replacement of the equipment/system components
LO5 Obtain and prepare the appropriate tools and equipment

LO6 Apply appropriate maintenance diagnostic techniques and procedures
LO7 Use the appropriate methods and techniques to remove and replace the required components
LO8 Carry out tests on the maintained equipment, in accordance with the test schedule/defined test procedures
LO9 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
LO10 Leave the work area in a safe and tidy condition on completion of the maintenance activities

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Practical skills:

The learner must be able to:

1. Carry out **all** of the following during the electrical maintenance 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 equipment (such as electrical, mechanical, 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, PAT tested 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/repair activities on **two** of the following types of electrical equipment:
   - 2.1 electrical plant
   - 2.2 motors and starters
   - 2.3 transformers
   - 2.4 wiring enclosures
   - 2.5 heaters
   - 2.6 pumps
   - 2.7 portable appliances
   - 2.8 luminaires
   - 2.9 fans/blowers
   - 2.10 generators
   - 2.11 switchgear
   - 2.12 distribution panels
   - 2.13 alternators
   - 2.14 other specific electrical equipment
3. Carry out maintenance/repair activities on **three** of the following electrical systems:
   - 3.1 Single-phase lighting circuits
   - 3.2 air conditioning control circuits
   - 3.3 single-phase power circuits

3.4 refrigeration control circuits
3.5 three-phase power supplies
3.6 heating/boiler control circuits
3.7 direct current power supplies
3.8 aircraft lighting circuits
3.9 motor start and control
3.10 power generation and control circuits
3.11 vehicle heating or ventilating
3.12 avionic circuits and systems
3.13 vehicle lighting
3.14 emergency lighting systems
3.15 vehicle starting and ignition
3.16 communication systems
3.17 instrumentation and control circuits
3.18 computer systems
3.19 alarm systems (such as fire, intruder, process control)
3.20 electro-pneumatic or electro-hydraulic control circuits
3.21 other control systems
3.22 other specific electrical systems

4. Use **four** of the following maintenance diagnostic techniques, tools and aids:
   4.1 fault finding techniques (such as six point, half-split, input/output, unit substitution)
   4.2 diagnostic aids (such as manuals, flow charts, troubleshooting guides, maintenance records)
   4.3 information gathered from fault reports
   4.4 visual checks (such as signs of damage, overheating, missing parts, wear/deterioration)
   4.5 movement checks (such as loose fittings and connections)
   4.6 monitoring equipment or gauges
   4.7 test instrumentation measurement (such as voltage, resistance, current)
5. Carry out **all** of the following maintenance activities:
   5.1 removing excessive dirt and grime
   5.2 making mechanical/screwed/clamped connections
   5.3 dismantling/disconnecting equipment to the required level
   5.4 soldering and de-soldering
   5.5 crimping (such as tags and pins)
   5.6 disconnecting and reconnecting wires and cables
   5.7 replacing damaged/defective components
   5.8 stripping cable insulation/protection
   5.9 removing and replacing damaged wires and cables
   5.10 attaching suitable cable identification markers
   5.11 setting and adjusting replaced components
   5.12 removing electrical units/components
   5.13 making de-energised checks before reconnecting power supply
   5.14 removing/replacing cable end fittings
   5.15 checking components for serviceability

6. Replace/refit a range of electrical components, to include **six** of the following:
   - 6.1 cables and connectors
   - 6.2 capacitors
   - 6.3 batteries
   - 6.4 locking and retaining devices
   - 6.5 circuit boards
   - 6.6 transformers
   - 6.7 overload protection devices
   - 6.8 luminaires
   - 6.9 solenoids
   - 6.10 inverter and servo controllers
   - 6.11 switches or sensors
   - 6.12 thermistors or thermocouples
   - 6.13 relay components
   - 6.14 contactors
   - 6.15 encoders or resolvers
   - 6.16 rectifiers
   - 6.17 other specific components
7. Carry out checks and tests on the maintained equipment, to include:
   - 7.1 making visual checks for completeness and freedom from damage

   Plus **three** more of the following:
   - 7.2 protective conductor resistance values
   - 7.3 load current
   - 7.4 power rating
   - 7.5 insulation resistance values
   - 7.6 polarity
   - 7.7 frequency values
   - 7.8 continuity
   - 7.9 resistance
   - 7.10 inductance
   - 7.11 voltage levels
   - 7.12 capacitance
   - 7.13 RCD disconnection time
   - 7.14 specialised tests (such as speed, sound, light, temperature)
8. Maintain electrical equipment, in accordance with one or more of the following quality and accuracy standards:
   - 8.1 BS 7671/IET wiring regulations
   - 8.2 other BS and/or ISO standards
   - 8.3 company standards and procedures
   - 8.4 equipment manufacturer's requirement

Knowledge and understanding

The learner needs to be able to:

1. Describe the isolation and lock-off procedure or permit-to-work procedure that applies to electrical maintenance activities (to include electrical isolation, locking off switchgear, removal of fuses, placing of maintenance warning notices, proving that isolation has been achieved and secured)
2. Describe hazards associated with carrying out electrical maintenance activities (such as dangers of electric shock, capacitor discharge, misuse of tools, using damaged or badly maintained tools and equipment, not following laid-down maintenance procedures), and how to minimise them
3. Explain what constitutes a hazardous voltage and how to recognise and deal with victims of electric shock (to include methods of safely removing the victim from the power source, isolating the power source, and how to obtain first aid assistance)
4. Describe the procedure for obtaining drawings, job instructions, related specifications, replacement parts, materials and other consumables necessary for the maintenance activities
5. Explain how to obtain and interpret information from job instructions and other documentation used in the maintenance activities (such as drawings, specifications, manufacturers' manuals, BS and ISO wiring regulations, symbols and terminology)
6. Explain the basic principles of how the equipment functions, and the working purpose of individual units/components
7. Describe the various maintenance diagnostic techniques and aids that can be used (such as fault reports, visual checks, measuring, movement and alignment checks, testing)
8. 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)
9. Explain how to use a range of fault diagnostic equipment to investigate the problem
10. Describe the care, handling and application of electrical measuring instruments
11. Describe the different types of cabling used in the maintenance activities, and their methods of termination
12. Describe the techniques used to dismantle/assemble electrical equipment (such as unplugging, de-soldering, removal of screwed, clamped and crimped connections)
13. Describe methods of removing and replacing cables and wires in wiring enclosures without causing damage to existing cables
14. Explain the use of BS 7671/IET wiring, and other regulations, when selecting wires and cables and when carrying out tests on systems
15. Describe the methods of attaching identification markers/labels to removed components or cables, to assist with re-assembly
16. Describe the tools and equipment used in the maintenance activities (such as the use of cable stripping tools, crimping tools, soldering irons and torches, gland connecting tools)

17. Describe methods of checking that components are fit for purpose, and the need to replace `lifed' items (such as seals and gaskets overload protection devices)
18. Explain how to check that tools and equipment are free from damage or defects, and are in a safe and usable condition
19. Describe the importance of completing documentation and/or reports following the maintenance activity
20. Explain the importance of making `off-load' checks before proving the equipment with the electrical supply on
21. Outline how to use appropriate lifting and handling equipment in the maintenance activity
22. Describe the problems that can occur during the electrical maintenance activity, and how they can be overcome

Unit 238 Maintaining electronic equipment/systems

UAN	L/507/3990
Unit level:	2
GLH	140
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF38
Unit aim:	This unit 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 identifies the training and development required in order that the apprentice can demonstrate that they are competent in being able to prepare for the electronic maintenance activities by obtaining all the 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 electronic equipment or systems being maintained. This will include power supplies, motor control systems, alarm and protection circuits, sensors and actuator circuits, digital circuits and systems, analogue circuits and systems, and hybrid circuits and systems. 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 be expected to apply a range of dismantling and reassembly methods and techniques at circuit board and component level, such as soldering, de-soldering, crimping, harnessing, securing cables and components, replacing damaged or defective components, cables and wires, setting and adjusting components, and making de-energised checks before testing the equipment, using appropriate techniques and procedures. They will be expected to take care that they do not cause further damage to the equipment/circuit during the repair

activities and, therefore, the application of Electrostatic discharge (ESD) procedures will be a critical part of their role.

Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the electronic 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 electronic maintenance techniques and procedures safely. They will understand the electronic maintenance process, and its application, and will know about the electronic equipment and systems 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 repair activities, especially those for isolating the equipment, and for taking the necessary safeguards to protect themselves, and others, against direct and indirect electric shock.

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 electronic maintenance operations, at least one of the electronic maintenance activities carried out must be of a significant nature, and must cover a minimum of **seven** of the activities listed in the skills section, paragraph 4 plus the removal and replacement of **three** of the components identified in paragraph 5.

Learning outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the maintenance activities before they start them
LO4 Obtain all the information they need for the safe removal and replacement of the equipment/system components
LO5 Obtain and prepare the appropriate tools and equipment
LO6 Apply appropriate maintenance diagnostic techniques and procedures
LO7 Use the appropriate methods and techniques to remove and replace the required components
LO8 Carry out tests on the maintained equipment, in accordance with the test schedule/defined test procedures
LO9 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
LO10 Leave the work area in a safe and tidy condition on completion of the maintenance activities

Practical skills:

The learner must be able to:

1. Carry out **all** of the following during the maintenance 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 equipment (where appropriate)
   - 1.3 follow job instructions, maintenance drawings and procedures
   - 1.4 take electrostatic discharge (ESD) precautions when handling sensitive components and circuit boards
   - 1.5 check that the tools and test instruments are within calibration date and are in a safe, PAT tested and usable condition
   - 1.6 ensure that the system is kept free from foreign objects, dirt or other contamination
   - 1.7 return all tools and equipment to the correct location on completion of the maintenance activities
   - 1.8 leave the work area in a safe and tidy condition
2. Carry out maintenance/repair activities on **three** of the following types of electronic equipment:
   - 2.1 power supplies (such as switched mode, series regulation, shunt regulation)
   - 2.2 motor control systems (such as closed loop servo/proportional control, inverter control)
   - 2.3 sensor/actuator circuit (such as linear, rotational, temperature, photo-optic, flow, level, pressure)
   - 2.4 digital circuit (such as process control, microprocessor, logic devices, display devices)

2.5 signal processing circuit (such as frequency modulating/demodulating, amplifiers, filters)
2.6 alarms and protection circuits
2.7 ADC and DAC hybrid circuits

3. Use **four** of the following maintenance diagnostic techniques, tools and aids:
3.1 fault finding techniques (such as six point, input/output, half-split, unit substitution)
3.2 diagnostic aids (such as manuals, flow charts, troubleshooting guides, maintenance records)
3.3 information gathered from the person who reported the fault
3.4 visual checks (such as signs of damage, overheating, missing parts, wear/deterioration)
3.5 movement checks (such as loose fittings and connections)
3.6 monitoring equipment or gauges
3.7 test instrumentation measurement (such as voltage, resistance, current, waveform)

4. Carry out **all** of the following maintenance techniques and procedures during the repair activities:
4.1 removing excessive dirt and grime
4.2 dismantling/disconnecting equipment to the required level
4.3 disconnecting and reconnecting wires and cables
4.4 checking the condition/deterioration of components
4.5 soldering and de-soldering
4.6 repairing circuit board tracks
4.7 removing and replacing electronic units/circuit boards
4.8 removing and replacing electronic components
4.9 making adjustments to components and/or connections
4.10 re-assembling of units or sub-assemblies

5. Replace/refit a range of electronic components, to include **twelve** of the following:
5.1 cables and connectors
5.2 rectifiers
5.3 surface mount packages
5.4 printed circuit boards
5.5 encoders or resolvers
5.6 integrated circuits
5.7 fixed resistors
5.8 variable resistors
5.9 potentiometers
5.10 thyristors
5.11 transistors
5.12 regulators
5.13 decoders
5.14 light dependant resistor (LDR)
5.15 thermistors
5.16 diodes
5.17 Zener diodes

5.18 opto-electronics/optical fibre components
5.19 light emitting diodes (LEDs)
5.20 analogue or digital integrated circuits
5.21 fixed capacitors
5.22 electrolytic capacitors
5.23 variable capacitors
5.24 sensors
5.25 switches
5.26 edge connectors
5.27 heat sinks
5.28 wiring pins/tags/wire links
5.29 mini transformers
5.30 protection devices
5.31 inverters or servo controllers
5.32 relays
5.33 inductors

6. Use the correct joining/connecting techniques to deal with **three** of the following types of connection:
   6.1 push-fit connectors
   6.2 crimped connections
   6.3 soldering or de-soldering
   6.4 zero insertion force (ZIF) connectors
   6.5 clip assemblies
   6.6 adhesive joints/assemblies
   6.7 threaded connections
   6.8 edge connectors
7. Use **five** of the following types of test equipment:
   7.1 multimeter
   7.2 signal generator
   7.3 oscilloscope
   7.4 signal tracer
   7.5 logic probe/clip
   7.6 stabilised power supplies
   7.7 logic analyser
   7.8 measuring bridges
   7.9 pulse sequencing analyser
   7.10 software diagnostic programs
   7.11 counter-timers
   7.12 data communications test set
   7.13 signature analysers
   7.14 bus exerciser/analyser
   7.15 protocol analyser
8. Carry out checks and tests on the maintained equipment, to include both of the following:

8.1 visual checks (such as for solder bridges, dry joints, incorrect value components, signs of damage, missing components)

8.2 movement checks (such as loose wires and connections, incorrectly seated devices/packages)

Plus **three** more from the following:

8.3 logic states

8.4 pulse width/rise time

8.5 inductance

8.6 dc voltage/current levels

8.7 open/short circuit

8.8 frequency modulation/demodulation

8.9 ac voltage/current levels

8.10 resistance

8.11 amplification

8.12 clock/timer switching

8.13 capacitance

8.14 signal noise/interference levels

8.15 oscillations

8.16 wave form analysis

8.17 attenuation

9. Carry out maintenance activities on electronic equipment, in accordance with one or more of the following:

9.1 organisational guidelines and codes of practice

9.2 equipment manufacturer's operation range

9.3 BS and ISO standards

Knowledge and understanding

The learner needs to be able to:

1. Describe the isolation and lock-off procedure or permit-to-work procedure that applies to the electronic repair activities and the electronic equipment or circuits being worked on (such as electrical isolation, locking off switchgear, removal of fuses, placing maintenance warning notices, proving that isolation has been achieved and secured)
2. Describe the hazards associated with maintaining electronic equipment, and with the tools and equipment that are used (such as live electrical components, capacitor discharge, misuse of tools, using damaged or badly maintained tools and equipment, not following laid-down maintenance procedures), and how these can be minimised
3. Explain what constitutes a hazardous voltage and how to recognise and deal with victims of electric shock (to include methods of safely removing the victim from the power source, isolating the power source, and how to obtain first aid assistance)
4. Describe the procedure for obtaining replacement parts, materials and other consumables necessary for the maintenance activities
5. Describe the procedures and precautions to be adopted to eliminate electrostatic discharge (ESD) hazards

6. Explain the basic principles of how the electronic circuit functions, and the working purpose of individual units/components
7. Describe the various maintenance diagnostic techniques and aids that can be used (such as fault reports, visual checks, measuring, movement and alignment checks, testing; fault location using techniques such as half-split, input-to-output, function testing, unit substitution, and equipment self-diagnostics)
8. Describe the care, handling and application of electronic measuring instruments/fault diagnostic equipment to investigate the problem (such as multimeter, oscilloscope, signal generators, logic probes/analyzers, measuring bridges)
9. Explain how to check that test equipment is safe to use (such as condition of power cables, using suitably fused test probes, clips and leads); is within current calibration approval dates and PAT tested and is suitable for the tests they are to carry out and can cover the range and values they are to measure
10. Explain how to connect to an approved power supply and, where appropriate, signal source; identifying correct test points in the circuit; how to position test instruments into circuits without damaging circuit components (such as using test probes, ensuring correct polarity, taking antistatic precautions); setting instrument zero readings; obtaining instrument readings and comparing them with expected results
11. Explain the application of Ohm's Law and relevant calculations (including units of electronic measurement and their multiples and sub-multiples)
12. Explain the use of calculations and regulations, when selecting wires and cables and when carrying out tests on electronic circuits
13. Describe how to make adjustments to circuit components; make decisions on circuit performance and faulty components and the removal and replacement of faulty components
14. Explain how to check that the replacement components meet the required specification/operating conditions (such as values, tolerance, current-carrying capacity, ambient temperatures, connection orientation)
15. Describe methods of removing and replacing the faulty components from the equipment (such as unplugging, de-soldering, removal of screwed, clamped, edge connected, zero insertion force, and crimped connections) without causing damage to other components, wiring, circuit boards or the surrounding structure
16. Describe the tools and equipment used in the repair activities (including the use of wire-stripping tools, crimping tools, soldering irons, insertion devices and connecting tools) and how to check that they are in a safe and usable condition
17. Describe the sequence for reconnecting the equipment, and the checks to be made prior to restoring power (such as checking components for correct polarity, ensuring that there are no exposed conductors, cable insulation is not damaged, all connections are mechanically and electrically secure, casings are free from loose screws, there are no wire ends or solder blobs/spikes that could cause short circuits, and all fuses/protection devices are installed)
18. Explain the importance of making de-energised checks before proving the equipment with the electrical supply on
19. Explain how to make adjustments to components/assemblies to ensure that they function correctly

20. Describe the importance of completing documentation and/or reports completed following the maintenance activity

21. Describe problems that can occur with the electronic equipment maintenance activity, and how they can be overcome

Unit 246 Producing composite assemblies

UAN	A/507/9431
Unit level:	2
GLH	105
Assessment type:	Portfolio of evidence
Relationship to NOS:	EUCAEF46
Unit aim:	This unit 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, relevant approved Apprenticeship Standards and Employer Occupational Brief. This unit identifies the training and development required in order that the apprentice can demonstrate that they are competent in being able to assemble composite mouldings to produce assemblies/sub-assemblies. It will prepare them for entry into the engineering or manufacturing sectors, creating progression between education and employment, or provide a basis for the development of additional skills and occupational competences in the working environment. They will be expected to prepare for the composite assembly 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. In carrying out the assembly operations, they will be required to use appropriate or specified assembly and joining techniques and methods for the composite components to be assembled. This will include a range of features such as loose and close fit tolerances, permanent and non-permanent fixing, shape location, staggered, return and overlap joins. Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the composite assembly 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 assembly techniques and procedures safely. They will understand the composite assembly techniques used, 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 composite assembly 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 assembly operations, at least one of the assemblies produced must be of a significant nature, and must contain a minimum of **two** of the components listed in the skills section, in paragraphs 7 and 8.

Learning outcome

The learner must be able to:

LO1 Work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines
LO2 Demonstrate the required behaviours in line with the job role and company objectives
LO3 Plan the composite assembly activities before they start them
LO4 Obtain and prepare the appropriate components, tools and equipment
LO5 Use the correct methods and techniques to assemble the components in the correct position
LO6 Secure the components, using the specified methods and securing devices
LO7 Where applicable, 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
LO8 Check the completed assembly to ensure that all operations have been completed, and that the finished assembly meets the required specification
LO9 Leave the work area in a safe and tidy condition on completion of the composite assembly activities

Practical 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/information and procedures
   - 1.3 ensure that all power tool cables, extension leads or air supply hoses are in a safe, tested 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 location on completion of the assembly activities
2. Carry out **all** of the following activities when preparing for the assembly activity:
   - 2.1 check that mouldings are correct and complete
   - 2.2 check for any defects in the mouldings
   - 2.3 check that components are correct and complete
   - 2.4 select correct equipment for the activity
   - 2.5 check availability of ancillary materials required
   - 2.6 check that equipment is suitable for use
   - 2.7 identify and protect the moulding and components in the work area
3. Produce **one** of the following types of composite assembly:
   - 3.1 trial assemblies
   - 3.2 one-off assemblies
   - 3.3 batch assemblies
   - 3.4 assembly line
4. Produce assemblies that incorporate **two** of the following features:
   - 4.1 loose fit tolerances
   - 4.2 close fit tolerances
   - 4.3 non-permanent fixing
   - 4.4 shape location
   - 4.5 joggle joins
   - 4.6 permanent fixing
   - 4.7 return joins
   - 4.8 overlap joins
   - 4.9 strap joins
5. Produce composite assemblies that require **four** of the following:
   - 5.1 fettling
   - 5.2 pinning
   - 5.3 clamping
   - 5.4 trial fitting

5.5 aligning
5.6 tongue and groove
5.7 assembly jigs
5.8 assembly sequences
5.9 datum points
5.10 orientation

6. Produce composite assemblies that use **two** of the following mechanical joining methods:
   6.1 thread inserts
   6.2 quick-release fasteners
   6.3 mechanical fasteners
   6.4 blind fasteners
   6.5 adhesive bonding
   6.6 anchor nuts
   6.7 pinning
   6.8 rivets
   6.9 thermo welding
   6.10 other (to be specified)
7. Produce composite assemblies that must include **two** of the following composite components:
   7.1 trim
   7.2 closing panels
   7.3 body panels
   7.4 tubes
   7.5 structural
   7.6 aerodynamic
   7.7 core materials
   7.8 sections
   7.9 casings/covers
   7.10 inserts
   7.11 housings
   7.12 other (to be specified)
8. Produce composite assemblies that must include **two** of the following non-composite components:
   8.1 brackets
   8.2 fixtures
   8.3 metal components
   8.4 fittings
   8.5 trim
   8.6 non metallic components
   8.7 finishing tapes
   8.8 memory foam
   8.9 labels/decals
   8.10 surface films
   8.11 edge bands

8.12 other (to be specified)

9. Produce a range of assemblies which comply with **all** of the following standards:
   - 9.1 assemblies are dimensionally accurate within specification requirements
   - 9.2 all components are correctly assembled and aligned, in accordance with the specification
   - 9.3 all fastenings are correctly fitted and are secure (where applicable)
   - 9.4 moving parts are correctly adjusted and have appropriate clearances (where applicable)
   - 9.5 finished assemblies meet the required shape/geometry, and are free from defects (such as square, straight, angle, free from twists)

Knowledge and understanding

The learner needs to be able to:

1. Describe the hazards associated with carrying out composite assembly activities, and with the composite materials, consumables, tools and equipment used, and how to minimise these and reduce any risks
2. Describe the specific environmental conditions the must be observed when producing composite mouldings (such as temperature, humidity, fume/dust extraction systems and equipment)
3. Describe the quality procedures and documentation used to ensure production and quality control
4. Outline the conventions and terminology used for assembly activities (such as metric and imperial threads, rivet specifications, clearances, types of fittings)
5. Outline the types of component trimming/cutting methods and preparation methods available
6. Describe how to visually identify cured composite materials
7. Outline the assembly operations and their sequence
8. Describe the methods for handling composite assemblies throughout the assembly activities
9. Explain how to identify and rectify defects in composite assemblies
10. State the tools and equipment used in assembly activities, and their care, preparation and control procedures
11. Describe the problems that can occur with the production of the composite assemblies
12. Outline the documentation to be completed before, during and on completion of the assembly operations

Appendix 1 Sources of general information

The following documents contain essential information for centres delivering City & Guilds qualifications. They should be referred to in conjunction with this handbook. To download the documents and to find other useful documents, go to the **Centre document library** on **www.cityandguilds.com** or click on the links below:

Centre Handbook: Quality Assurance Standards

This document is for all approved centres and provides guidance to support their delivery of our qualifications. It includes information on:

- centre quality assurance criteria and monitoring activities
- administration and assessment systems
- centre-facing support teams at City & Guilds/ILM
- centre quality assurance roles and responsibilities.

The Centre Handbook should be used to ensure compliance with the terms and conditions of the centre contract.

- Centre Handbook: Quality Assurance Standards

This document sets out the minimum common quality assurance requirements for our regulated and non-regulated qualifications that feature centre-assessed components. Specific guidance will also be included in relevant qualification handbooks and/or assessment documentation.

It incorporates our expectations for centre internal quality assurance and the external quality assurance methods we use to ensure that assessment standards are met and upheld. It also details the range of sanctions that may be put in place when centres do not comply with our requirements or actions that will be taken to align centre marking/assessment to required standards. Additionally, it provides detailed guidance on the secure and valid administration of centre assessments.

Access arrangements: When and how applications need to be made to City & Guilds provides full details of the arrangements that may be made to facilitate access to assessments and qualifications for candidates who are eligible for adjustments in assessment.

The Centre document library also contains useful information on such things as:

- conducting examinations
- registering learners
- appeals and malpractice.

Useful contacts

Please visit the **Contact us** section of the City & Guilds website.

Appendix 2 Relationships to other qualifications

Links to other qualifications

This qualification has connections to the:

- 7682-20 Level 2 NVQ in Performing Engineering Operations

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As the UK's leading vocational education organisation, City & Guilds is leading the talent revolution by inspiring people to unlock their potential and develop their skills. We offer over 500 qualifications across 28 industries through 8500 centres worldwide and award around two million certificates every year. City & Guilds is recognised and respected by employers across the world as a sign of quality and exceptional training.

City & Guilds Group

The City & Guilds Group operates from three major hubs: London (servicing Europe, the Caribbean and Americas), Johannesburg (servicing Africa), and Singapore (servicing Asia, Australia and New Zealand). The Group also includes the Institute of Leadership & Management (management and leadership qualifications), City & Guilds Licence to Practice (land-based qualifications), the Centre for Skills Development (CSD works to improve the policy and practice of vocational education and training worldwide) and Learning Assistant (an online e-portfolio).

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City & Guilds
5-6 Giltspur Street
London EC1A 9DE
E: centresupport@cityandguilds.com
F +44 (0)20 7294 2413
www.cityandguilds.com