City & Guilds Level 2 Diploma in Engineering Operations (Skills) (4505-12)

Version 4.2 November 2024

Qualification Handbook

Qualification at a glance

Subject area	Engineering
City & Guilds number	4505
Age group approved	16-18, 19+
Entry requirements	None
Assessment	Portfolio
Grading	Pass/Fail
Approvals	Fast track approval
Support materials	NA
Registration and certification	Consult the Walled Garden/Online Catalogue for last dates

Title and level	City & Guilds number	Accreditation number
Level 2 Diploma in Engineering Operations (Skills)	4505-12	603/6365/4

Version and date	Change detail	Section
1.1 Dec 2019	Generic info and units added	All
1.6 July 2020	Document proofread	All
2.0 September 2021	Updated Contents page Barring correction – replaced unit 10 with unit 19 in the second rule. Re-numbered units 43 and 44 to match Walled Garden Supporting Information pages re-titled to correct unit, and some recommended timings updated to match standard.	Page 6 Page 14 Page 10/11, p355-371 Section 5 (p465 onwards)
3.0 October 2021	Barring correction – 2nd rule: • Replaced Unit 43 with unit 44 • Added Units 67 and 68. • Removed Units 70 and 71	Page 14

4.0 March 2022	Qualification structure: • Amended unit range 89-93 • Barring rules updated	Page 8 Page 14
4.1 September 2024	handbook reviewed and updated to the new template	Throughout
4.2 November 2024	Evidence sources – minimum number of performance examples stipulated	Evidence sources - page 21

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1 Introduction

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

Area	Description
Who is the qualification for?	Those working as engineering operatives within the engineering and manufacturing sector.
What does the qualification cover?	This qualification allows learners to develop the skills and underpinning knowledge required for employment and/or career progression in the engineering and manufacturing industry sector in general.
What opportunities for progression are there?	Upon completion, apprentices will have achieved the on-programme competence qualification. This is a mandatory component of the level 2 engineering operative apprenticeship framework. Whilst progression into further study is an option, the intent for this standard is that progression is into one of the job roles defined within the standard as an operative.
Who did we develop the qualification with?	The units of competence were developed by SEMTA (now Enginuity) in collaboration with the Engineering and Manufacturing Employer Group which included the following organisations: Roquette UK, William Hare Ltd, JCB, MoveTech, Ministry of Defence, KMF, Severfield (UK) Limited, Royal Armoured Corps, Cooney Marine, Unipres (UK) limited, Quinton Major, Renishaw, Siemens, CSPS
Is it part of an apprenticeship framework or initiative?	Yes. This qualification forms part of the on-programme engineering operative apprenticeship standard. The qualification can also be used for full time students who would like to gain the skills that will enable them to progress into further training.

Structure

To achieve the City & Guilds Level 2 Diploma in Engineering Operations (Skills) learners must achieve all three mandatory units 001-003 and **four** optional units from units 004-024, 029-087 and 089-093.

Note: The following unit numbers have not been included in this structure due to duplication with the foundation competence qualification 025, 026, 027, 028 and 088.

City & Guilds unit number	Unit title	GLH
Mandatory units:		
Learners must achieve all **three** mandatory units		
001	Complying with statutory regulations and organisational safety requirements	50
002	Working efficiently and effectively in an engineering environment	50
003	Using and communicating technical information	40
Optional units:		
Learners must achieve **four** optional units		
004	Conducting business improvement activities	80
005	Producing components using hand fitting techniques	140
006	Maintaining mechanical devices and equipment	140
007	Assembling and testing fluid power systems	140
008	Maintaining fluid power equipment	140
009	Maintaining electrical equipment/systems	150
010	Wiring and testing electrical equipment and circuits	140
011	Wiring and testing programmable controller based systems	150
012	Producing mechanical assemblies	150
013	Preparing and using lathes for turning operations	150
014	Preparing and using milling machines	150

City & Guilds unit number	Unit title	GLH
015	Preparing and using semi-automatic MIG, MAG and flux cored arc welding equipment	150
016	Assembling and testing electronic circuits	140
017	Maintaining electronic equipment/systems	150
018	Preparing and using industrial robots	140
019	General turning, milling and welding applications	180
020	Forming and assembling pipework systems	140
021	Preparing and proving CNC machine tool programs	140
022	Producing sheet metal components and assemblies	140
023	Maintaining and testing process instrumentation and control devices	150
024	Producing components by rapid prototyping techniques	110
029	Using computer software packages to assist with engineering activities	80
030	Producing CAD models (drawings) using a CAD system	110
031	Producing electrical or electronic engineering drawings using a cad system	110
032	Producing engineering project plans	80
033	Preparing and using grinding machines	150
034	Preparing and using CNC turning machines	140
035	Preparing and using CNC milling machines	140
036	Preparing and using CNC machining centres	140
037	Carrying out heat treatment of engineering materials	90
038	Producing mechanical engineering drawings using a CAD system	110

City & Guilds unit number	Unit title	GLH
039	Assembling, wiring and testing electrical panels/components mounted in enclosures	140
040	Forming and assembling electrical cable enclosure and support systems	130
041	Preparing and using electro discharge machines	150
042	Preparing and using manual TIG or plasma-arc welding equipment	150
043	Preparing and using CNC fabrication equipment	140
044	General welding applications	150
045	Producing tool and die assemblies	150
046	Produce composite mouldings using Pre-Preg techniques	140
047	Carrying out repairs to composite mouldings	140
048	General machining, fitting and assembly applications	120
049	General fabrication and welding applications	120
050	General electrical and electronic engineering applications	120
051	General maintenance engineering applications	120
052	Carrying out aircraft detail fitting activities	140
053	Installing aircraft mechanical fasteners	110
054	Restoring mechanical components to usable condition by repair	230
055	Assembling fluid power components to mechanical equipment	490
056	Assembling electrical or electronic components to mechanical equipment	490
057	Assembling pipework components to mechanical equipment	490
058	Producing composite mouldings using wet lay-up techniques	420
059	Producing components by acrylic moulding	320

City & Guilds unit number	Unit title	GLH
060	Vacuum forming composite materials	320
061	Trimming composite mouldings using hand tools	320
062	Identifying defects in composite mouldings	230
063	Applying surface finishes to composite mouldings	320
064	Bonding composite mouldings	230
065	Producing composite assemblies	420
066	Carrying out inspection activities on optical components	420
067	Preparing and using manual metal arc welding equipment	150
068	Preparing and using manual oxy/fuel gas welding equipment	140
069	Preparing and using manual flame brazing and braze welding equipment	110
070	Producing aircraft detail assemblies	140
071	Producing platework components and assemblies	140
072	Cutting and shaping materials using thermal cutting equipment	140
073	Preparing and proving CNC fabrication machine tool programs	140
074	Using wood for pattern, model making and other engineering applications	150
075	Assembling pattern, model and engineering woodwork components	140
076	Producing composite mouldings using resin flow infusion techniques	140
077	Producing and preparing sand moulds and cores for casting	140
078	Producing and preparing molten materials for casting	140
079	Producing cast components by manual means	130
080	Fettling, finishing and checking cast components	110

City & Guilds unit number	Unit title	GLH
081	Finishing surfaces by applying coatings or coverings	90
082	Finishing surfaces by applying treatments	90
083	Preparing and manoeuvring armoured fighting vehicles AFVS for maintenance and transportation	140
084	Handing over and confirming completion of maintenance or installation activities	180
085	Carrying out fault location on mechanical equipment	260
086	Carrying out maintenance activities on mechanical equipment	350
087	Carrying out scheduled maintenance activities on mechanical equipment	190
089	Stripping and rebuilding motorsport vehicles (pre-competition)	140
090	Inspecting a motorsport vehicle during competition	140
091	Diagnosing and rectifying faults on motorsport vehicle systems (during a competition)	150
092	Carrying out maintenance activities on motor vehicle electrical equipment	150
093	Stripping and rebuilding motorsport engines (pre-competition)	140

Barred units

Units 030, 031 and 038 are barred with each other
Only one of the three CAD units 030, 031 and 038 may be undertaken as the apprentices' choice of optional units. However, they can be undertaken as additional units if required by the employer.

Units 019, 044, 049 are barred with each other
Only one of the General welding units 019, 044, 049 may be undertaken as the apprentices' choice of optional units. However, they can be undertaken as additional units if required by the employer.

Two units from 015, 042, 067, 068, 069
Only two of the specialist Welding units 015, 042, 067, 068 or 069 may be undertaken as the apprentices' choice of optional units. However, they can be undertaken as additional units if required by the employer.

Unit 044 is barred with 015, 042, 067, 068, 069
If the General welding unit 044 is undertaken the specialist Welding units 015, 042, 067, 068 or 069 cannot be undertaken as the apprentices' choice of optional units. However, they can be undertaken as additional units if required by the employer.

Unit 019 is barred with units 013, 014, 048, 075
Unit 019 cannot be undertaken if any of the following machining units have been undertaken as the apprentices' choice of optional units i.e. units 013, 014, 048 or 075.

Unit 012 is barred with unit 045
Only one of the following units 012 or 045 may be undertaken as the apprentices' choice of optional units. However, they can be undertaken as additional units if required by the employer.

Unit 005 is barred with unit 052
Only one of the following units 005 or 052 may be undertaken as the apprentices' choice of optional units. However, they can be undertaken as additional units if required by the employer.

Unit 048 is barred with units 005, 012, 013, 014, 045, 052
If unit 48 is undertaken then units 005, 012, 013, 014, 045, 052 cannot be undertaken as the apprentices' choice of optional units. However, it can be undertaken as an additional unit if required by the employer.

Unit 049 is barred with units 015, 019, 022, 040, 042, 043, 044
If unit 049 is undertaken then units 015, 019, 022, 040, 042, 043, 044 cannot be undertaken as the apprentices' choice of optional units. However, it can be undertaken as an additional unit if required by the employer.

Unit 050 is barred with units 010, 011, 016, 039
If unit 050 is undertaken then units 010, 011, 016, 039 cannot be undertaken as the apprentices' choice of optional units. However, it can be undertaken as an additional unit if required by the employer.

Unit 051 is barred with units 006, 008, 009, 011, 017, 023
If unit 051 is undertaken then units 006, 008, 009, 011, 017, 023 cannot be undertaken as the apprentices' choice of optional units. However, it can be undertaken as an additional unit if required by the employer.

Total Qualification Time

Total Qualification Time (TQT) is the total amount of time, in notional hours, which represents an estimate of the total amount of time expected for a learner to achieve and demonstrate the achievement of the level of attainment a necessary to award a qualification.

TQT is comprised of the following two elements:

1) The number of hours which an awarding organisation has assigned to a qualification for Guided Learning, and
2) An estimate of the number of hours a learner will 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, not under the immediate guidance or supervision of a lecturer, supervisor, tutor or other education or training provider.

Title and level	GLH	TQT
City & Guilds Level 2 Diploma in Engineering Operations (Skills)	470	470

2 Centre requirements

Approval

Fast track

If your centre is approved to offer the 7682-20 Level 2 NVQ Diploma in Performing Engineering Operations then you can apply for fast track approval for the new City & Guilds Level 2 Diploma in Engineering Operations (Skills) 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 qualifications are delivered
- 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, centres 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.

Please refer to the document **Centre Approval Process: Quality Assurance Standards** for further information.

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

Resource requirements

Centre staffing

Staff delivering these qualifications 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.

Quality assurance

Approved centres must have effective quality assurance systems to ensure optimum delivery and assessment of qualifications. Quality assurance includes initial centre approval, qualification approval and the centre's own internal procedures for monitoring quality. Centres are responsible for internal quality assurance and City & Guilds is responsible for external quality assurance. All external quality assurance processes reflect the minimum requirements for verified and moderated assessments, as detailed in the Centre Assessment Standards Scrutiny (CASS), section H2 of Ofqual's General Conditions. For more information on both CASS and City and Guilds Quality Assurance processes visit: the What is CASS? and Quality Assurance Standards documents on the City & Guilds website.

Standards and rigorous quality assurance are maintained by the use of:

- Internal quality assurance
- City & Guilds external quality assurance.

In order to carry out the quality assurance role, Internal Quality Assurers must

- have appropriate teaching and vocational knowledge and expertise
- have experience in quality management/internal quality assurance
- hold or be working towards an appropriate teaching/training/assessing qualification
- be familiar with the occupation and technical content covered within the qualification.

External quality assurance for the qualification will be provided by City & Guilds EQA process. EQAs are appointed by City & Guilds to approve centres, and to monitor the assessment and internal quality assurance carried out by centres. External quality assurance is carried out to ensure that assessment is valid and reliable, and that there is good assessment practice in centres.

The role of the EQA is to:

- provide advice and support to centre staff
- ensure the quality and consistency of assessments and marking/grading within and between centres by the use of systematic sampling
- provide feedback to centres and to City & Guilds.

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.

Individual employers will set the criteria, but employers who recruit learners without English and Maths at level 1 (or equivalent), must ensure that the learner achieves this requirement and take the test for Level 2, prior to completion of the Apprenticeship.

This qualification is a mandatory component of the on-programme phase of the Engineering Operative Apprenticeship Standard for the following occupational engineering job roles; maintenance operative, mechanical manufacturing operative, electrical and electronic operative, fabrication operative, materials, processing, finishing operative, and technical support operative.

The Standard and Assessment plan was designed by Employers. Centres should make themselves familiar with the Standard, Assessment Plan and Employer Occupational Brief requirements, details of which can be found at:
https://www.gov.uk/government/collections/apprenticeship-standards

Age restrictions

City & Guilds cannot accept any registrations for learners under 16 as these qualifications are not approved for learners under 16.

Access arrangements and reasonable adjustments

City & Guilds has considered the design of these qualifications and their 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 learner should be made before the start of their programme to identify:

- if the learner 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 qualification
- the appropriate type and level of qualification.

We recommend that centres provide an induction programme so the learner fully understands the requirements of the qualification, their responsibilities as a learner 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.

4 Assessment

Summary of assessment methods

Candidates must:
- have a completed portfolio of evidence for the mandatory and optional units selected.

One portfolio record can be used (see **Portfolio of evidence** section below) with performance evidence collected over the course of completing the required activities indicated in the mandatory and optional units selected.

Assessment strategy

Units are assessed through a portfolio of evidence. All evidence in the portfolio for the skills learning outcomes must be generated in the workplace or a realistic working environment.

Portfolio of evidence

Candidate 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 candidates' progress towards achieving qualifications. Further details are available at **www.cityandguilds.com/eportfolios**.

City & Guilds has developed a set of **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 quality assurers, 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.

Evidence sources

Within the portfolio of evidence, 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.

Evidence sources may include:
- training logbooks
- centre-produced worksheets and activities
- annotated photographs
- video clips (maximum duration in total = 10 minutes)
- workplace documentation/records, for example job cards/job sheets, equipment check/maintenance/service records, parts order records.

This is not a definitive list; other evidence sources are permitted.

The evidence provided must be valid and attributable to the candidate; the portfolio of evidence must contain a statement from the centre confirming this.

Evidence **must not** include:

- any methods of self-assessment
- any employer contributions should focus on direct observation of evidence (for example witness statements) of competence rather than opinions.

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.

RPL is not allowed for this qualification.

Grading, submission of results and certification

Assessors should grade each mandatory and selected optional unit ensuring that all performance evidence is authenticated as the candidate's own work and meets the assessment criteria in the units and the requirements of the Assessment Strategy outlined above.

All assessments are graded pass or fail.

A binary grade will be awarded on successful completion of this qualification. All unit assessments must be achieved at a minimum of **Pass** for the qualification to be achieved.

When a candidate has been successful, the result should be submitted to City & Guilds via the Walled Garden.

Retention of evidence

In order to fully support candidates, centres are required to retain copies of candidates' assessment records for three years after certification. This may be in electronic format.

5 Units

Structure of the units

These units each have the following:

- City & Guilds reference number
- Title
- Level
- Guided learning hours (GLH)
- Learning outcomes, which are comprised of a number of assessment criteria

Unit 001 Complying with statutory regulations and organisational safety requirements

Level:	2
GLH:	50
Relationship to NOS:	EUCL2F-001
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 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. Although working under close supervision they must take 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

Performance Requirements

The apprentice must be able to:

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

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

P3 **present themselves in the workplace suitably prepared for the activities to be undertaken**

P4 **follow organisational accident and emergency procedures**

P5 **recognise and control hazards in the workplace**

P6 **use correct manual lifting and carrying techniques**

P7 apply safe working practices and procedures

Skills Requirements

The apprentice must be able to:

S1 **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

S2 **Comply with all emergency requirements, to include:**

2. identifying the appropriate qualified first aiders or appointed person and the location of first aid facilities

2. identifying the procedures to be followed in the event of injury to themselves or others

2. following organisational procedures in the event of fire/fire drills and the evacuation of premises/work area

2. identifying the procedures to be followed in the event of dangerous occurrences or hazardous malfunctions of equipment, processes or machinery

S3 **Identify the hazards and risks that are associated with all of the following:**

3. their working environment (such as working at heights, confined spaces, environmental conditions)
3. the tools and equipment that they use (such as machine tools, power tools, cutting tools)
3. the materials and substances that they use (such as fluids, oils, fluxes)
3. using working practices that do not follow laid-down procedures

S4 **Demonstrate the following method of manual lifting and carrying techniques:**

4. **lifting alone**

Plus one from:

4. with assistance of others
4. with mechanical assistance

S5 **Apply safe working practices in an industrial environment, to include all of the following:**

5. maintaining a tidy workplace with exits and gangways free from obstructions
5. using tools and equipment safely and only for the purpose intended
5. observing organisational safety rules, signs and hazard warnings
5. taking measures to protect others from harm resulting from any work they are carrying out
5. observe personal protection and hygiene procedures at all times

Knowledge and understanding
The apprentice must know and understand:

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

K2 the specific regulations, environmental requirements, safe working practices and procedures that apply to their work activities

K3 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

K4 the warning signs for the nine main groups of hazardous substances defined by Classification, Labelling and packaging of Dangerous Substances and mixtures Regulations

K5 how to locate relevant health and safety information for their tasks, and the sources of expert assistance when help is needed

K6 what constitutes a hazard in the workplace (such as moving parts of machinery, electricity, slippery and uneven surfaces, dust and fumes, handling and transporting, contaminants and irritants, material ejection, fire, working at height, environment, pressure/stored energy systems, volatile or toxic materials, unshielded processes)

K7 their responsibilities for dealing with hazards and reducing risks in the workplace (such as hazard spotting and safety inspections; the use of hazard check lists, carrying out risk assessments, COSHH assessments and safe systems of working)

K8 the risks associated with their working environment (the tools, materials and equipment that they use, spillages of oil and chemicals, not reporting accidental breakages of tools or equipment and not following laid-down working practices and procedures)

K9 the processes and procedures that are used to identify and rate the level of risk (such as safety inspections, the use of hazard check lists, carrying out risk and COSHH assessments)

K10 control measures that can be used to eliminate/reduce the hazard (such as lock-off and permit top work procedures, provision of safe access and egress, use of guards and fume extraction equipment, use of personal protective equipment)

K11 the first aid facilities that exist within their work area and within the organisation in general, and the procedures to be followed in the case of accidents involving injury

K12 what constitutes dangerous occurrences and hazardous malfunctions, and why these must be reported even when no one was injured

K13 the procedures for sounding the emergency alarms, evacuation procedures and escape routes to be used, and the need to report their presence at the appropriate assembly point

K14 the organisational policy with regard to firefighting procedures; the common causes of fire and what they can do to help prevent them

K15 the protective clothing and equipment that is available for their areas of activity

K16 the need to observe personal protection and hygiene procedures at all times (such as 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)

K17 how to act responsibly within the working environment (such as observing restricted area notices, complying with warning signs, walking not running, using equipment only for its intended purpose, not interfering with equipment or processes that are not within their job role, following approved safety procedures at all times)

K18 how to lift and carry loads safely, and the manual and mechanical aids available

K19 how to prepare and maintain safe working areas; standards and procedures to ensure good housekeeping

K20 the importance of safe storage of tools, equipment, materials and products

K21 the extent of their own authority and whom they should report to in the event of problems that they cannot resolve

Unit 001 Complying with statutory regulations and organisational safety requirements

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	4th July 2014
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **customer.services@enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail

Unit 002 Working efficiently and effectively in engineering

Level:	Level 2
GLH:	25
Relationship to NOS:	EUCL2F_002
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 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 you owe to themselves and others in the workplace.

Performance Requirements

The apprentice must be able to:

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

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

P3 **plan the engineering activities before they start them**

P4 **prepare the work area for carrying out the engineering activity**

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

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

P7 **maintain effective working relationships with colleagues and supervisors**

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

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

Skills Requirements
The apprentice must be able to:

S1 **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

S2 **Create and maintain effective working relationships and behaviours, to include carrying out and demonstrating all of the following:**

2. maintains a consistently good record of punctuality and attendance in accordance with company policy

2. always suitably dressed for the activities to be undertaken.

2. follows both verbal and written instructions provided, seeking additional information, clarification or assistance where necessary in a courteous and polite manner.

2. able take advice from others in a positive way

2. makes a positive contribution to any discussions

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

2. communicates with others using clear, accurate and appropriate language.

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

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

2. able to work to targets and deadlines

S3 **Prepare for the specific engineering activity, by producing work plans which includes all of the following as applicable to the processes being undertaken:**

3. documentation required (such as drawings and diagrams, technical/reference/maintenance documents, imperial to metric conversion books, component specifications, maintenance standard operating procedures)

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

3. equipment required (such as machine tools to be used, lifting and handling equipment, anti-static equipment, test equipment)

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

3. tools required (such as hand tools, portable power tools, cutting tools,)

3. measuring/test equipment required (such as mechanical, electrical, pressure, flow, level, speed, sound)

3. the operating sequence to be followed

3. timescale required to complete the engineering operations

S4 **Prepare to carry out the engineering activity, ensuring all of the following, as applicable to the work to be undertaken:**

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

4. any required safety procedures are implemented

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

4. all necessary drawings, specifications and associated documents are obtained

4. job instructions are obtained and understood

4. the correct materials or components are obtained

4. appropriate authorisation to carry out the work is obtained

S5 **Complete the work activities, to include all of the following:**

5. returning tools and equipment to the designated location

5. returning drawings and work instructions

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

5. completing all necessary documentation accurately and legibly

5. identifying, where appropriate, any damaged or unusable tools or equipment

S6 **Recognise and deal with problems affecting the engineering activity, to include four of the following:**

6. materials

6. job specification

6. timescales

6. tools and equipment

6. quality

6. safety

6. drawings

6. people

6. work activities or procedures

S7 **Contribute to developing their own engineering competence, to include all of the following:**

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

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

7. providing information on their expectations and progress towards their identified objectives

7. using feedback and advice to improve their personal performance

Knowledge and understanding
The apprentice must know and understand:

K1 the safe working practices and procedures to be followed whilst preparing and tidying up your work area

K2 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

K3 how to present themselves in the workplace suitably dressed for the activities to be undertaken (such as being neat, clean and dressed in clothes appropriate to the area of activity)

K4 the importance of reporting to work on time and returning from breaks on time and the potential consequences if this is not adhered to

K5 the types of attitudes and behaviours that are likely to create conflict or negative responses

K6 the benefits of team working and understanding of team objectives.

K7 the roles of individual team members and the strengths they bring to the team.

K8 the importance of clear communication both oral and written, using appropriate language and format.

K9 the need to change communication styles to meet the needs of the target audience

K10 the need to adhere to timescales set for work, whilst maintaining appropriate quality standards and the implications if these are not adhered to.

K11 the importance of seeking additional support and guidance when required.

K12 why it is important to be open and honest and admit to any errors and/or mistakes

K13 the need to be flexible in their approach to work, responding positively to changes or amendments required by the business.

K14 The importance of taking an active and positive part in the implementation of any amendments or changes to work requirements

K15 their individual responsibility to work in an ethical manner and the organisations policies relating to ethical working and behaviours.

K16 the importance of respecting others, including an awareness of diversity and inclusion.

K17 the personal protective equipment (PPE) to be worn for the engineering activities undertaken (such as correctly fitting overalls, safety shoes, eye protection, ear protection)

K18 the correct use of any equipment used to protect the health and safety of yourself and your colleagues

K19 planning and preparing to carry out the engineering activity (such as obtaining the appropriate drawings/documentation to be used, determining the materials required, determining the tools and equipment required, determining a suitable sequence of operations, determining the quality checks to be made and equipment to be used)

K20 the procedure for ensuring that all documentation relating to the work being carried out is available, prior to starting the activity

K21 the procedure for ensuring that all tools and equipment are available prior to undertaking the activity

K22 the checks to be carried out to ensure that tools and equipment are in full working order, prior to undertaking the activity

K23 the checks to be carried out to ensure that all materials required are correct and complete, prior to undertaking the activity

K24 how to deal effectively with problems that could arise with areas such as quality, safety, people, drawings and other documentation, tools and equipment or if material are incomplete or do not meet the requirements of the activity and the action that should be taken

K25 their role in helping to develop their own skills and knowledge (such as checking with your supervisor about the work they are expected to carry out and the standard you need to achieve; the safety points to be aware of and the skills and knowledge you will need to develop)

K26 the benefits of continuous personal development, and the training opportunities that are available in the workplace

K27 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

K28 their responsibilities for providing evidence of your performance and progress (such as submitting work for assessment or the completion of assignments or tests)

K29 the importance of maintaining effective working relationships within the workplace (such as 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)

K30 the reason for informing others of their activities which may have impact on their work (such as 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)

K31 dealing with disagreements with others in ways which will help to resolve difficulties and maintain long term relationships

K32 the organisational procedures to deal with and report any problems that can affect working relationships

K33 the difficulties that can occur in working relationships, and how to resolve them

K34 the regulations that affect how individuals should be treated at work (such as Equal Opportunities and Equal Pay, Race Relations and Sex Discrimination, Working Time Directive, Disabled Persons Acts)

K35 the need to dispose of waste materials and consumables (such as oils and chemicals) in a safe and environmentally friendly way

K36 where tools and equipment should be stored and located, and the importance of returning all tools and documentation to their designated area on completion of your work activities

K37 when to act on their own initiative and when to seek help and advice from others

K38 the importance of leaving the work area in a safe condition on completion of your activities (such as equipment correctly isolated, cleaning the work area and removing and disposing of waste)

Unit 002 Working efficiently and effectively in engineering

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	4th July 2014
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **customer.services@enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 003 Using and communicating technical information

Level:	Level 2
GLH:	40
Relationship to NOS:	EUCL2F-003
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 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

Performance Requirements

The apprentice must be able to:

P1 **use the approved source to obtain the required data, documentation or specifications**

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

P3 **extract and interpret information from engineering drawings and other related documentation**

P4 **if applicable report any inaccuracies or discrepancies in the drawings and specifications**

P5 **use the information obtained to establish work requirements**

P6 **record and communicate the technical information by appropriate means**

P7 **deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve**

Skills Requirements

The apprentice must be able to:

S1 **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 documentation

S2 **Use information extracted from engineering documentation, to include four or more of the following:**

2. detailed component drawings

2. illustrations

2. welding drawings

2. general assembly drawings

2. visual display screens

2. repair drawings

2. modification drawings

2. operational diagrams

2. fluid power drawings

2. sub-assembly drawings

2. physical layouts

2. wiring/circuit diagrams

2. schematic diagrams

2. manufacturers' manuals/drawings

2. installation drawings

2. fabrication drawings

2. photographic representations

2. approved sketches

S3 **Use information extracted from related documentation, to include four from the following:**

3. standard operating procedures

3. job instructions

3. material specifications

3. planning documentation

3. drawing instructions

3. finishing specifications

3. quality control documents

3. test schedules

3. reference tables/charts

3. operation sheets

3. manufacturers' instructions

3. national, international and organisational standards

3. process specifications

3. welding procedure specifications

3. performance parameters

S4 **Extract information that includes eight of the following:**

4. materials or components required

4. surface finish required

4. dimensions

4. location/orientation of parts

4. weld type and size

4. tolerances

4. process or treatments required

4. operations required

4. build quality

4. assembly sequence

4. shape or profiles

4. installation requirements

4. inspection requirements

4. test points to be used

4. connections to be made

4. part numbers for replacement parts

4. circuit characteristics (such as pressure, flow, current, voltage, speed)

4. maintenance requirements

S5 **Produce, record and communicate technical information, using the following method:**

5. reducing fully detailed drawings or sketches of work/circuits completed or required to the relevant standard (such as BS888)

Plus two more from the following

5. preparing work planning documentation

5. recording data from testing activities

5. producing technical reports on activities they have completed

5. completing material and tool requisition documentation

5. producing a list of replacement parts required for a maintenance activity

5. completing training records or portfolio references

Knowledge and understanding
The apprentice must know and understand:

K1 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

K2 the information sources used for the data and documentation that they use in their work activities (such as verbal, written, electronic)

K3 why technical information is presented in different forms (such as drawings, data sheets, and national and international standards)

K4 how and where to obtain the various documents that they will be using (such as safety handouts, drawings, planning documentation, work instructions, maintenance records, technical manuals and reference tables/charts), and how to check that they are current and valid

K5 the types of engineering drawings used (BS888), and how they interrelate (such as 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)

K6 the meaning of the different symbols and abbreviations found on the drawings/documents that they use (such as BS888, 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)

K7 how to use other sources of information to support the data (such as 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)

K8 the procedures for reporting discrepancies in the data or documents, and for reporting lost or damaged drawings and documents

K9 care and control procedures for the documents, how damage or graffiti on drawings can lead to scrapped work and the importance of returning them to the designated location on completion of the work activities

K10 typical ways of communicating technical information (such as sketches, test and inspection reports, work planning documents), and the amount of detail that should be included

K11 the need to ensure that sketches are of a suitable size, use appropriate drawing conventions, are in proportion and are legible to others

K12 why it is important to use a fixed common reference point for dimensioning of drawings and sketches

K13 when to act on their own initiative to find, clarify and evaluate information, and when to seek help and advice from others

K14 why they should always seek clarification if they are in any doubt as to the validity or suitability of the information they have gathered

K15 to whom they should report in the event of problems that they cannot resolve

Unit 003 Using and communicating technical informationUsing and communicating technical information

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	4th July 2014
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **customer.services@enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
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Grading System	Pass/Fail
Review Date	2017

Unit 004 Conducting business improvement activities

Level:	Level 2
GLH:	80
Relationship to NOS:	EUCL2F-004
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 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

Performance Requirements

The apprentice must be able to:

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

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

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

P4 **apply the principles of workplace organisation to an operation or process using a 5S/5C audit and a `red tag' exercise**

P5 **identify where information, and/or resources are missing and where improvement can be made to increase the 5S/5C score**

P6 **apply the principle and processes of visual management to an operation or process using a variety of visual management techniques**

P7 **identify appropriate parts of the operation or process that will have visual controls**

P8 **identify key performance indicators that will be displayed in the work area**

P9 **produce or update a Standard Operating Procedure (SOP) and visual controls for the operation or process**

P10 **deal promptly and effectively with problems within their control and seek help and guidance from the relevant people when they have problems they cannot resolve**

Skills Requirements

The apprentice must be able to:

S1 **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

1.1(improvement to training and development programmes

S2 **Produce/contribute to improvements in existing standard operating procedures for three of the following:**

- **2.** customer service
- **2.** health and safety practices
- **2.** product quality
- **2.** cleaning of equipment/work area
- **2.** process procedures
- **2.** maintenance of equipment
- **2.** manufacturing operations
- **2.** employee development (such as apprenticeship programme)

S3 **Create and/or update visual controls that promote six of the following:**

- **3.** producing shadow boards to standardise the storage and location of area equipment
- **3.** colour coding of equipment
- **3.** safety
- **3.** performance measures
- **3.** parts control system
- **3.** zero defects
- **3.** process control boards
- **3.** skills matrices
- **3.** process concerns or corrective actions
- **3.** workplace organisation
- **3.** work in progress locations and quantities (WIP)
- **3.** problem resolution (such as Kaizen boards)
- **3.** standard operating procedures
- **3.** autonomous maintenance worksheets

S4 **Determine and calculate both of the following:**

4. not right first time

4. delivery schedule achievement

Plus one more of the following:

4. parts per operator hour (PPOH)

4. overall equipment effectiveness (OEE)

4. value added per person (VAPP)

4. stock turns

4. cost breakdown in term of labour, material and overhead

4. floor space utilization (FSU)

S5 **Record and present the records from business improvement activities to the appropriate people using:**

5. verbal report using visual aids such as. flipcharts and white boards

Plus one more method from the following:

5. written or typed report

5. computer based presentation

5. specific company documentation

Knowledge and understanding
The apprentice must know and understand:

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

K2 how to conduct a systematic plan, do, check, act (PDCA) approach to problem-solving and business improvement

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

K4 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

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

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

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

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

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

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

K11 How to arrange and label the necessary equipment for rapid identification and access

K12 how to use “root cause” problem solving analysis using the 5 whys/how technique

K13 how to evaluate improvement ideas in order to select those that are to be pursued

K14 how improvements to the process are achieved by engaging the knowledge and experience of the people working on the process

K15 how to create Standard Operating Procedures (SOPs) and correlate work activities into them.

K16 the techniques required to communicate information using visual control systems (such as Kanban systems, card systems, colour coding, floor footprints, graphs, team boards, tool/equipment shadow boards)

K17 how information and equipment can be displayed for various work applications (IT systems)

K18 the extent of their own authority and whom they should report to, in the event of problems that they cannot resolve

Unit 004 Conducting business improvement activitiesConducting business improvement activities

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	4th July 2014
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **customer.services@enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 005 Producing components using hand fitting techniques

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-005
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 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 will include hand sawing, band sawing, filing, drilling, threading, and off- hand grinding. The components produced will 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 Standard 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 scope 6 in the skills requirement section.

Performance Requirements

The apprentice must be able to:

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

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

P3 plan the fitting activities before they start them

P4 obtain the appropriate tools and equipment for the hand fitting operations, and check that they are in a safe and usable condition

P5 mark out the components for the required operations, using appropriate tools and techniques

P6 cut and shape the materials to the required specification, using appropriate tools and techniques

P7 measure and check that all dimensional and geometrical aspects of the component are to the specification

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

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

Skills Requirements

The apprentice must be able to:

S1 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

S2 Mark out a range of material forms, to include **two** of the following:

2. square/rectangular (such as bar stock, sheet material, machined components)

2. circular/cylindrical (such as bar stock, tubes, turned components, flat discs)

2. sections (such as angles, channel, tee section, joists, extrusions)

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

S3 Use a range of marking out equipment/methods, to include **all** of the following:

3. rules

3. scribers

3. dividers/trammels

3. centre punches

3. squares

3. Vernier instruments (such as height gauges)

Plus **one** from the following:

3. templates

3. protractor

S4 Mark out workpieces which include **all** of the following features:

4. datum/centre lines

4. circles

4. linear hole positions

4. square/rectangular profiles

4. radial profiles

4. angles/angular profiles

4. radial hole positions

S5 Use **all** of the following hand fitting activities:

5. filing

5. hand sawing

5. power sawing

5. off hand grinding (must include grinding drills)

S6 Produce components which combine different operations and have features that cover **all** of the following:

6. **flat datum faces**

6. drilled through holes

6. internal threads

6. faces which are square to each other

6. reamed holes

6. external threads

6. curved profiles

6. faces that are parallel to each other

6. chamfers and radii

6. faces angled to each other

6. counterbore, countersink, or spot face

6. holes drilled to a depth

6. sliding or mating parts (if appropriate)

S7 Cut and shape **all** of the following materials:

7. ferrous

7. non ferrous

7. non metallic

S8 Carry out the necessary checks for accuracy, to include **all** of the following:

8. linear dimensions

8. hole position

8. flatness

8. hole size/fit

8. squareness

8. Depths

8. angles

8. thread size and fit

8. profiles

8. surface finish

S9 Use **all** of the following measuring equipment during the hand fitting and checking activities:

9.1 external micrometers

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

9.3 vernier calliper

Plus **six** more of the following:

9.4 rules

9.5 feeler gauges

9.6 squares

9.7 bore/hole gauges

9.8 callipers

9.9 slip gauges

9.10 protractors

9.11 radius/profile gauges

9.12 depth micrometers

9.13 thread gauges

9.14 depth verniers

9.15 dial test indicators (DTI)

9.16 coordinate measuring machine (CMM)

S10 Produce components to **all** of the following standards, as applicable to the process:

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

1(general dimensional tolerance +/- 0.25mm or +/- 0.010”

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

1(flatness and squareness 0.05mm per 25mm or 0.002″ per inch

1(angles within +/- 1 degree

1(screw threads to BS Medium fit

1(reamed within H8

1(surface finish 63 µin or 1.6 µm

Knowledge and understanding

The apprentice must know and understand:

K1	the health and safety requirements and safe working practices and procedures required for the hand fitting activities undertaken
K2	the importance of wearing appropriate protective clothing and equipment (PPE), and of keeping the work area safe and tidy
K3	the hazards associated with the hand fitting activities (such as 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
K4	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
K5	the procedure for obtaining the required drawings, job instructions and other related specifications
K6	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
K7	how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
K8	how to convert metric systems of measurement to imperial and vice versa
K9	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)
K10	how to select and establish a suitable datum; the importance of ensuring that marking out is undertaken from the selected datum, and the possible effects of working from a different datum
K11	methods of holding and supporting the workpiece during the marking out activities, and equipment that can be used (such as surface plates, angle plates, vee blocks and clamps, parallel bars, screw jacks)
K12	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 which are linearly positioned, boxed and on pitch circles)
K13	ways of laying out the marking out shapes or patterns to maximise use of materials
K14	the need for clear and dimensional accuracy in marking out to specification and drawing requirements
K15	setting and adjusting tools (such as squares, protractors and verniers)
K16	the importance of using tools only for the purpose intended; the care that is required when using the equipment and tools; the proper way of storing tools and equipment between operations
K17	the cutting and shaping methods to be used, and the sequence in which the operations are to be carried out
K18	the methods and techniques to hand grind drills for different applications
K19	the various types of file that are available, and the cut of files for different applications
K20	the importance of ensuring that file handles are secure and free from embedded foreign bodies or splits

K21 how to prepare the components for the filing operations (cleaning, de-burring, marking out)

K22 the use of vice jaw plates to protect the workpiece from damage

K23 how to file flat, square and curved surfaces, and how to achieve a smooth surface finish (such as by draw filing, the use of abrasive cloth, lapping using abrasive pastes)

K24 how to select saw blades for different materials, and how to set the saw blades for different operations (such as cutting externally and internally)

K25 how to cut external threads using hand dies, and the method of fixing and adjusting the dies to give the correct thread fit

K26 how to determine the drill size for tapped holes, and the importance of using the taps in the correct sequence

K27 how to prepare drilling machines for operations (such as 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)

K28 how to mount the workpiece (such as 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

K29 how to produce a sliding or mating fit using by filing

K30 the problems that can occur with the hand fitting activities, and how these can be overcome (such as defects caused by incorrectly ground drills, inappropriate speeds, damage by workholding devices)

K31 when to act on their own initiative and when to seek help and advice from others

K32 the importance of leaving the work area in a safe and clean condition on completion of the fitting activities (such as removing and storing power leads, isolating machines, removing and returning drills, cleaning the equipment and removing and disposing of waste)

Unit 005 Producing components using hand fitting techniquesProducing components using hand fitting techniques

Supporting Information

Developed by	Advanced Manufacturing and Engineering Employer Trailblazer Group
Version number	1.0
Date approved	4th July 2015
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing and Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **customer.services@enginuity.org** quoting Trailblazer Advanced Manufacturing and Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 006 Maintaining mechanical devices and equipment

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-006
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 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/refit 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 Standard 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 scope 4 in the skills requirement section plus the removal and replacement/refitting of a minimum of five of the components listed in scope 5 in the skills requirement section.

Performance Requirements
The apprentice must be able to:

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

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

P3 plan the maintenance activities before they start them

P4 obtain all the information they need for the safe removal and replacement of the equipment components

P5 obtain and prepare the appropriate tools and equipment

P6 apply appropriate maintenance diagnostic techniques and procedures

P7 use appropriate methods and techniques to remove and replace the required components

P8 carry out tests on the maintained equipment, in accordance with the test schedule/defined test procedures

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

P10 leave the work area in a safe and tidy condition on completion of the maintenance activities

Skills Requirements
The apprentice must be able to:

S1 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

S2 Carry out maintenance activities on **four** of the following types of mechanical equipment:

2. gearboxes

2. machine tools

2. engines

2. pumps

2. compressors

2. processing plant

2. transfer equipment

2. workholding devices

2. process control valves

2. mechanical structures

2. lifting and handling equipment

2. company-specific equipment

S3 Use **six** of the following maintenance diagnostic techniques, tools and aids:

3. fault finding techniques (such as half-split, input/output, unit substitution)

3. diagnostic aids (such as manuals, flowcharts, troubleshooting guides, maintenance records)

3. information gathered from fault reports

3. visual checks (such as signs of leakage, damage, missing parts, wear/deterioration)

3. alignment checks

3. movement checks (such as excessive movement or clearance, loose fittings and connections)

3. force/pressure checks (such as spring pressure, belt or chain tension)

3. overheating checks (such as bearings, friction surfaces)

3. sensory input (such as sight, sound, smell, touch)

3. information from monitoring equipment or gauges

3. operating (such as manual operation, timing and sequencing)

3. test instrumentation measurement (such as pressure, flow, timing, sequence, movement)

3. measuring instruments (such as dial test indicators, torque measuring devices, feeler gauges)

S4 Carry out **all** of the following maintenance activities:

4. dismantling equipment to unit/sub-assembly level
4. setting, aligning and adjusting replaced components
4. dismantling units to component level
4. proof marking/labelling of components
4. tightening fastenings to the required torque
4. checking components for serviceability
4. making `off-load' checks before starting up
4. replacing all `lifed' items (such as seals, bearings, gaskets)
4. replenishing oils and greases
4. replacing damaged/defective components

S5 Remove and refit/replace a range of mechanical components, to include **twelve** of the following:

5. shafts
5. bearing
5. seals
5. slides
5. couplings
5. fitting keys
5. rollers
5. gears
5. springs
5. housings
5. clutches
5. diaphragms
5. actuating mechanisms

5. valves and seats

5. cams and followers

5. structural components

5. pistons

5. chains and sprockets

5. locking and retaining devices (such as circlips, pins)

5. brakes

5. pulleys and belts

5. splines

5. levers and links

5. other specific components

S6 Carry out checks on the maintained equipment, to include **seven** of the following:

6. freedom from damage and foreign objects

6. correct operation of moving parts

6. alignment

6. correct working clearance of parts

6. backlash in gears

6. belt/chain tension

6. bearing loading

6. torque loading of fasteners

6. completeness

6. operational performance

6. functionally test the system

S7 Maintain mechanical equipment in compliance with **two** of the following:

7. organisational guidelines and codes of practice

7. equipment manufacturers' operation range

7. BS and/or ISO standards

Knowledge and understanding
The apprentice must know and understand:

K1	the health and safety requirements, and safe working practices and procedures required for the mechanical maintenance activities undertaken
K2	the importance of wearing appropriate protective clothing and equipment (PPE), and of keeping the work area safe and tidy
K3	hazards associated with carrying out mechanical maintenance activities (such as 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
K4	the system isolation procedures or permit-to-work procedure that applies
K5	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
K6	how to obtain and interpret drawings, specifications, manufacturers' manuals and other documents needed in the maintenance process
K7	the procedure for obtaining drawings, job instructions, related specifications, replacement parts, materials and other consumables necessary for the maintenance activities
K8	the general operating principles of mechanical assembly(s) they have maintained such as a pump, gearbox, cylinder or valve and the purpose and function of the components and materials used (including component identification systems such as codes, component orientation indicators) and how they interact
K9	the various maintenance diagnostic techniques and aids that can be used (such as fault reports, visual checks, measuring, movement and alignment checks, testing)
K10	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)
K11	how to evaluate sensory information (sight, sound, smell, touch)
K12	the sequence to be adopted for the dismantling/re-assembly of various types of assemblies
K13	the methods and techniques used to dismantle/assemble mechanical equipment (such as release of pressures/force, proof marking, extraction, pressing, alignment)
K14	methods of checking that components are fit for purpose, and how to identify defects and wear characteristics
K15	the identification, application, fitting and removal of different types of bearings (such as roller, ring, thrust)
K16	methods and techniques of fitting keys and splines
K17	identification, application, fitting and removal of different types of gears
K18	how to correctly tension belts and chains
K19	the identification and application of different types of locking device
K20	methods of checking that removed components are fit for purpose, and the need to replace `lifed' items (such as seals and gaskets)

K21 the uses of measuring equipment (such as micrometers, verniers, run-out devices and other measuring devices)

K22 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

K23 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)

K24 the importance of making `off-load' checks before running the equipment under power

K25 the importance of completing maintenance documentation and/or reports following the maintenance activity

K26 how to use lifting and handling equipment in the maintenance activity

K27 the problems associated with the mechanical maintenance activity, and how they can be overcome

K28 when to act on their own initiative and when to seek help and advice from others

K29 the importance of leaving the work area and equipment in a safe and clean condition on completion of the maintenance activities (such as returning hand tools and test equipment to the designated locations, cleaning the work area, and removing and disposing of waste)

Unit 006 Maintaining mechanical devices and equipmentMaintaining mechanical devices and equipment

Supporting Information

Developed by	Advanced Manufacturing and Engineering Employer Trailblazer Group
Version number	1.0
Date approved	4th July 2015
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing and Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **customer.services@enginuity.org** quoting Trailblazer Advanced Manufacturing and Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review date	2017

Unit 007 Assembling and testing fluid power systems

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-007
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 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 Standard Requirements In order to prove their ability to combine different fluid power assembly operations, at least one of the fluid power assemblies produced must be of a significant nature, and must contain a minimum of six of the components listed in paragraph 3 in the Skills Section.

Performance Requirements

The apprentice must be able to:

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

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

P3 **produce a drawing/sketch of a fluid power circuit using the correct symbols**

P4 **plan the assembly activities before they start them**

P5 **obtain all the information they need for the safe assembly of the fluid power system**

P6 **obtain and prepare the appropriate components, assembly tools and test equipment**

P7 **use the appropriate methods and techniques to assemble the components in their correct positions**

P8 **secure the components, using the specified connectors and securing devices**

P9 **check the completed assembly to ensure that all operations have been completed and that the finished system meets the required specification**

P10 **carry out tests on the assembled system, in accordance with the test schedule/defined test procedures**

P11 **deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve**

P12 **leave the work area in a safe and tidy condition on completion of the assembly activities**

Skills Requirements

The apprentice must be able to:

S1 **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

S2 **Assemble two of the following types of fluid power system:**

2. pneumatic

2. hydraulic

2. vacuum

S3 **Produce fluid power assemblies that contain a range of components, including all of the following:**

3. hoses

3. valves (such as mechanical, electrical or logic)

3. cylinders/actuators

Plus eight more from the following:

3. rigid pipework

3. pumps (such as gear and vane)

3. lubricators

3. switches

3. compressors

3. pressure intensifiers

3. sensors

3. cables and wires

3. accumulators

3. regulators

3. receivers

3. gaskets and seals

3. reservoirs/storage devices

3. gauges/indicators

3. filters

3. motors

3. coolers

3. timers (electrical, pneumatic and mechanical)

3. other specific components

S4 **Apply fluid power assembly methods and techniques to include all of the following:**

4. checking components for serviceability

4. applying screw fastener locking devices

4. positioning equipment/components

4. tightening fastenings to the required torque

4. aligning pipework and connections

4. applying hose/cable clips and fasteners

4. dressing and securing pipes and hoses

4. making de-energised checks before filling and/or pressurising the system

4. setting, aligning and adjusting system components

4. securing by using mechanical fixings

S5 **Carry out quality checks, to include all of the following, using appropriate equipment:**

5. the system is complete, as per specification

5. connections to components are tightened to the required torque

5. dimensions are within specification requirements

5. components are correctly positioned

5. pipework is free from ripple and creases

5. components are correctly aligned

5. electrical connections are correctly made (where applicable)

5. direction and flow indicators on components are correct

5. components are securely held in place

S6 **Carry out tests and adjustments on the assembled system, to include:**

6. **leak test**

6. operational performance

Plus two more from the following:

6. pressure line pressure tests

6. speed

6. return line pressure test

6. sequence

6. flow

6. contamination

S7 **Carry out all of the following checks to ensure the accuracy and quality of the tests carried out:**

7. the test equipment is correctly calibrated

7. the test equipment used is appropriate for the tests being carried out

7. test procedures used are as recommended in the appropriate specifications

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

7. test equipment is operated within its specification range

S8 **Produce fluid power assemblies which meet all of the following:**

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

8. moving parts are correctly adjusted and have appropriate clearances

8. the system functions in line with the specification requirements (including that the system is working within the specified and safe operating pressures)

8. the system is leak free

Knowledge and understanding
The apprentice must know and understand:

K1 the health and safety requirements, and safe working practices and procedures required for the fluid power assembly activities undertaken

K2 the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy

K3 hazards associated with carrying out assembly activities on fluid power equipment (such as handling fluids, stored energy/force, misuse of tools), and how these can be minimised

K4 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

K5 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

K6 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

K7 the procedure for obtaining drawings, job instructions, related specifications, components, materials and other consumables necessary for the assembly activities

K8 the general operating principles of the fluid power assembly(s) they have produced and how the fluid power equipment functions, its operating sequence, the purpose of individual units/components and how they interact

K9 the different types of pipework/hoses, fittings and manifolds, and their application

K10 the identification and application of different types of valve (such as poppet, spool, piston, disc)

K11 the identification and application of different types of sensors and actuators (such as rotary, linear, mechanical, electrical)

K12 the identification and application of different types of cylinder (such as single acting, double acting)

K13 the identification and application of different types of pump (such as positive and non-positive displacement)

K14 the identification and application of different types compressors (such as screw, piston, rotary vane)

K15 the applications of static and dynamic seals

K16 the techniques used to assemble/install fluid power equipment (such as 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)

K17 where applicable the need to ensure that pipework is supported at appropriate intervals, and the need to eliminate stress on the pipework connections

K18 the need to ensure cleanliness of the fluid power system, and the ways of purging pipework before connection to components and pressure sources

K19 recognition of contaminants and the problems they can create, and the effects and likely symptoms of contamination in the system

K20 methods of testing the fluid power system; the types of test equipment to be used, and their selection for particular tests

K21 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

K22 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

K23 how to carry out the tests (such as applying test pressures in incremental stages; checking for leaks; taking appropriate test readings; adjusting appropriate components to give required operating conditions)

K24 how to determine pressure settings, and their effect on the system

K25 how to display/record test results, and the documentation used

K26 how to interpret the test readings obtained, and the significance of the readings gained

K27 the importance of ensuring that test equipment is used only for its intended purpose and within its specified range and limits

K28 how to check that tools and test 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

K29 the problems associated with the fluid power assembly and testing activity, and how they can be overcome (such as leaks, pressure fluctuation and pressure loss)

K30 when to act on their own initiative and when to seek help and advice from others

K31 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 test equipment to is designated location, cleaning the work area, and removing and disposing of waste)

Unit 007 Assembling and testing fluid power systemsAssembling and testing fluid power systems

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	4th July 2014
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 008 Maintaining fluid power equipment

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-008
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 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/refit, 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 Standard 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/refitting of a minimum of five of the components listed in paragraph 6 in the Skills Section.

Performance Requirements

The apprentice must be able to:

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

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

P3 **plan the maintenance activities before they start them**

P4 **obtain all the information they need for the safe isolation, removal and replacement of the system components**

P5 **obtain and prepare the appropriate tools and test equipment**

P6 **apply appropriate maintenance diagnostic techniques and procedures**

P7 **use the appropriate methods and techniques to remove and replace the required components**

P8 **carry out tests on the maintained system in accordance with the test schedule/defined test procedures**

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

P10 **leave the work area in a safe and tidy condition on completion of the maintenance activities**

Skills Requirements

The apprentice must be able to:

S1 **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

S2 **Carry out maintenance activities on two of the following types of fluid power equipment:**

2. pneumatic

2. hydraulic

2. vacuum

S3 **Use five of the following maintenance diagnostic techniques, tools and aids:**

3. fault finding techniques (such as six point, half-split, input/output, unit substitution, emergent sequence)

3. diagnostic aids (such as manuals, flow charts, troubleshooting guides, maintenance records)

3. information gathered from fault reports

3. inspecting (such as checking for damage, wear/deterioration, leaks, loose fittings and connections)

3. sensory input (such as sight, sound, smell, touch)

3. monitoring equipment or gauges

3. operating the equipment (such as manual operation, timing and sequencing)

3. test instrumentation measurement (such as pressure, flow, timing, sequence, movement)

S4 **Use two of the following types of fluid power test instruments:**

4. measuring devices

4. flow indicators

4. self-diagnostic equipment

4. pressure indicators

4. test rigs

S5 **Carry out all of the following maintenance activities:**

5. chocking/supporting cylinders/rams/components

5. draining and removing fluids (as applicable)

5. releasing stored energy

5. disconnecting/removing hoses and pipes

5. removing and replacing units/components (such as pumps, cylinders, valves, actuators)

5. proof marking/labelling of removed components

5. checking components for serviceability

5. replacing damaged/defective components

5. replacing all `lifed' items (such as seals, filters, gaskets)

5. tightening fastenings to the required torque

5. setting, aligning and adjusting replaced components

5. prime, bleed and recharge the system (as applicable)

5. making de-energised checks before re-pressurising the system

S6 **Remove and replace/refit a range of fluid power components, to include all of the following:**

6. **pipework/hoses**

6. valves

6. cylinders/actuators

Plus eight of the following:

6. reservoirs/storage devices

6. pumps

6. switches

6. accumulators

6. motors

6. sensors

6. pressure intensifiers
6. gaskets and seals
6. lubricators
6. compressors
6. pistons
6. filters
6. receivers
6. spools
6. cables and wires
6. regulators
6. gauges/indicators
6. timers
6. coolers
6. other specific components
6. reservoirs/storage devices

S7 **Carry out tests on the maintained equipment, to include both of the following:**

7. leak test
7. operational performance

Plus two from the following:

7. pressure line pressure tests
7. speed
7. return line pressure test
7. sequence
7. flow
7. fluid contamination test

S8 **Carry out all of the following checks to ensure the accuracy and quality of the tests carried out:**

8. the test equipment is correctly calibrated

8. the test equipment used is appropriate for the tests being carried out

8. test procedures used are as recommended in the appropriate specifications

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

8. test equipment is operated within its specification range

S9 **Maintain fluid power equipment in compliance with two of the following:**

9. organisational guidelines and codes of practice

9. equipment manufacturers' operation range

9. BS and/or ISO standards

Knowledge and understanding
The apprentice must know and understand:

K1 the health and safety requirements, and safe working practices and procedures required for the fluid power maintenance activities undertaken

K2 the importance of wearing appropriate protective clothing and equipment (PPE) and keeping the work area safe and tidy

K3 hazards associated with carrying out maintenance activities on fluid power equipment (such as handling fluids, stored energy/force, misuse of tools), and how these can be minimised

K4 the system isolation procedures or permit-to-work procedure that applies

K5 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

K6 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

K7 the procedure for obtaining drawings, job instructions, related specifications, replacement parts, materials and other consumables necessary for the maintenance activities

K8 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

K9 the general principles of how the fluid power equipment that they have maintained functions, its operating sequence, the purpose of individual units/components and how they interact

K10 the different types of pipework/hoses, fittings and manifolds, and their application

K11 the identification and application of different types of valve (such as poppet, spool, piston, disc)

K12 the identification and application of different types of sensors and actuators (such as rotary, linear, mechanical, electrical)

K13 the identification and application of different types of cylinder (such as single acting, double acting)

K14 the identification and application of different types of pump (such as positive and non-positive displacement)

K15 the identification and application of different types compressors (such as screw, piston, rotary vane)

K16 the applications of static and dynamic seals

K17 the techniques used to dismantle/assemble fluid power equipment (such as release of energy/force, proof marking, extraction)

K18 methods of checking that components are fit for purpose

K19 how to make adjustments to components/assemblies to ensure that they function correctly

K20 how to determine pressure settings, and their effect on the system

K21 selection of fluids for the system

K22 recognition of contaminants and the problems they can create, and the effects and likely symptoms of contamination in the system

K23 the various maintenance diagnostic techniques and aids that can be used (such as fault reports, visual checks, measuring, movement and alignment checks, testing)

K24 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)

K25 how to evaluate sensory information (sight, sound, smell, touch)

K26 how to use a range of fault diagnostic equipment to investigate the problem

K27 the care, handling and application of mechanical measuring/test equipment (such as measuring instruments, pressure and flow indicators and self-diagnostic equipment)

K28 types of test equipment to be used, and their selection for particular tests

K29 how the test equipment is connected into the circuit, and the methods of doing this

K30 the techniques, methods and procedures to be used during the tests

K31 how to display/record test results, and the documentation used

K32 how to interpret the test readings obtained, and the significance of the readings gained

K33 the importance of ensuring that test equipment is used only for its intended purpose and within its specified range and limits

K34 how to check that tools and test 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

K35 the problems associated with maintaining fluid power equipment, and how they can be overcome (such as leaks, pressure fluctuation or pressure loss)

K36 when to act on their own initiative and when to seek help and advice from others

K37 the importance of leaving the work area in a safe and clean condition on completion of the maintenance activities (such as returning hand tools and test equipment to is designated location, cleaning the work area, and removing and disposing of waste)

Unit 008 Maintaining fluid power equipment

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	4th July 2014
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 009 Maintaining electrical equipment/systems

Level:	Level 2
GLH:	150
Relationship to NOS:	EUCL2F-009
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 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 Standard 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 scope 5 in the skills requirement section

Performance Requirements

The apprentice must be able to:

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

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

P3 plan the maintenance activities before they start them

P4 obtain all the information they need for the safe removal and replacement of the equipment/system components

P5 obtain and prepare the appropriate tools and equipment

P6 apply appropriate maintenance diagnostic techniques and procedures

P7 use the appropriate methods and techniques to remove and replace the required components

P8 carry out tests on the maintained equipment, in accordance with the test schedule/defined test procedures

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

P10 leave the work area in a safe and tidy condition on completion of the maintenance activities

Skills Requirements

The apprentice must be able to:

S1 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) including The Electricity at Work Regulations and other relevant guidelines

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 safe, (such as by PAT testing) and in a 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

S2 Carry out maintenance/repair activities on **four** of the following types of electrical equipment:

2. electrical plant

2. motors and starters

2. transformers

2. wiring enclosures

2. heaters

2. Pumps

2. portable appliances

2. luminaires

2. fans/blowers

2. generators

2. switchgear

2. distribution panels

2. other specific electrical equipment

S3 Carry out maintenance/repair activities on **three** of the following electrical systems:

3. lighting circuits

3. air conditioning control circuits

3. power circuits

3. refrigeration control circuits

3. motor start and control circuits

3. heating/boiler control circuits

3. power generation and control circuits

3. instrumentation and control circuits

3. emergency lighting systems

3. alarm systems (such as fire, intruder, process control)

3. communication systems

3. electro-pneumatic or electro-hydraulic control circuits

3. computer systems

3. other control circuits (such as pumps, fans, blowers, extractors)

3. other specific electrical circuits

S4 Use **both** of the following maintenance diagnostic techniques:

4. fault finding techniques (such as six point, half-split, input/output, unit substitution)

4. test instrumentation measurement (such as voltage, resistance, current)

Plus **three** from the following:

4. diagnostic aids (such as manuals, flow charts, troubleshooting guides, maintenance records)

4. information gathered from fault reports

4. visual checks (such as signs of damage, overheating, missing parts, wear/deterioration)

4. movement checks (such as loose fittings and connections)

4. monitoring equipment or gauges

S5 Carry out **all** of the following maintenance activities:

5. removing excessive dirt and grime

5. making mechanical/screwed/clamped connections

5. dismantling/disconnecting equipment to the required level

5. soldering and de-soldering

5. crimping (such as tags and pins)

5. disconnecting and reconnecting wires and cables

5. replacing damaged/defective components

5. stripping cable insulation/protection

5. removing and replacing damaged wires and cables

5. attaching suitable cable identification markers

5. setting and adjusting replaced components

5. removing electrical units/components

5. making de-energised checks before reconnecting power supply

5. removing/replacing cable end fittings

5. checking components for serviceability

S6 Replace/refit a range of electrical components, to include **six** of the following:

6. **cables and connectors**

6. capacitors

6. batteries

6. locking and retaining devices

6. circuit boards

6. transformers

6. overload protection devices

6. luminaires

6. solenoids

6. inverter and servo controllers

6. switches or sensors

6. thermistors or thermocouples

6. relay components

6. contactors

6. encoders or resolvers

6. rectifiers

6. other specific components

S7 Carry out **all** of the following checks and tests on the maintained equipment, to include**:**

7. making visual checks (such as completeness, signs of damage, incorrect termination)

7. movement checks (such as loose fittings and connections)

7. testing that the equipment operates to the circuit specification

7. check/test load current

Plus **five** from the following:

7. carrying out fault finding techniques (such as half-split, input/output, unit substitution)

7. protective conductor impedance

7. power rating

7. insulation resistance values

7. polarity

7. frequency values

7. continuity

7. resistance

7. Inductance

7. voltage levels

7. capacitance

7. RCD disconnection time

7. specialised tests (such as speed, sound, light, temperature)

S8 Maintain electrical equipment, in accordance with **two** of the following quality and accuracy standards:

8. BS 7671/IET wiring regulations

8. other BS and/or ISO standards

8. company standards and procedures

8. equipment manufacturer's requirement

Knowledge and understanding
The apprentice must know and understand:

K1	the health and safety requirements, and safe working practices and procedures required for the electrical maintenance activities undertaken
K2	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)
K3	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
K4	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)
K5	the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy
K6	the procedure for obtaining drawings, job instructions, related specifications, replacement parts, materials and other consumables necessary for the maintenance activities
K7	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
K8	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)
K9	the general principles of how the equipment they have maintained functions, and the working purpose of individual units/components and how they interact
K10	the various maintenance diagnostic techniques and aids that can be used (such as fault reports, visual checks, measuring, movement and alignment checks, testing)
K11	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)
K12	how to use a range of fault diagnostic equipment to investigate the problem
K13	the care, handling and application of electrical measuring instruments
K14	the different types of cabling used in the maintenance activities, and their methods of termination
K15	the techniques used to dismantle/assemble electrical equipment (such as unplugging, de-soldering, removal of screwed, clamped and crimped connections)
K16	methods of removing and replacing cables and wires in wiring enclosures without causing damage to existing cables
K17	the use of BS 7671/IET wiring, and other regulations, when selecting wires and cables and when carrying out tests on systems
K18	the different earthing systems and their applications such as TN-S, TN-C-S, TT and IT
K19	why electrical bonding/earthing is critical, and why it must be both mechanically and electrically secure
K20	methods of attaching identification markers/labels to removed components or cables, to assist with re-assembly

K21 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)

K22 methods of checking that components are fit for purpose, and the need to replace `lifed' items (such as seals and gaskets overload protection devices)

K23 how to check that tools and equipment are free from damage or defects, and are in a safe and usable condition

K24 the importance of completing documentation and/or reports following the maintenance activity

K25 the importance of making `off-load' checks before proving the equipment with the electrical supply on

K26 how to use appropriate lifting and handling equipment in the maintenance activity

K27 the problems that can occur during the electrical maintenance activity, and how they can be overcome

K28 when to act on their own initiative and when to seek help and advice from others

K29 the importance of leaving the work area in a safe and clean condition on completion of the maintenance activities (such as returning hand tools and test equipment to is designated location, cleaning the work area, and removing and disposing of waste)

Unit 009 Maintaining electrical equipment/systems

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	1.0
Date approved	4th July 2015
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **customer.services@enginuity.org** quoting Trailblazer Advanced Manufacturing Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 010 Wiring and testing electrical equipment and circuits

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-010
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 use and terminate 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 your own actions and for the quality and accuracy of the work that you 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 Standard 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 paragraph 3 plus five of the activities listed in paragraph 5 in the Skills Section.

Performance Requirements

The apprentice must be able to:

P1 **work safely at all times, complying with health and safety legislation, regulations including The Electricity at Work Regulations and other relevant guidelines**

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

P3 **plan the wiring and testing activities before you start them**

P4 **use appropriate sources to obtain the required specifications, circuit diagrams and test information**

P5 **obtain the correct tools and equipment for the wiring and testing operations, and check that they are in a safe and usable condition**

P6 **mount and secure the electrical components safely and correctly, to meet specification requirements**

P7 **install and terminate the cables to the appropriate connections on the components**

P8 **use appropriate test methods and equipment to check that the completed circuit is safe and meets all aspects of the specification**

P9 **deal promptly and effectively with problems within your control, and seek help and guidance from the relevant people if you have problems that you cannot resolve**

P10 **leave the work area in a safe and tidy condition on completion of the wiring and testing activities**

Skills Requirements

The apprentice must be able to:

S1 **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 including The Electricity of Work Regulations and associated guidance documentation

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 apply procedures and precautions to eliminate electrostatic discharge (ESD) hazards (where applicable)

1.7 return all tools and equipment to the correct location on completion of the wiring and testing activities

S2 Wire circuits using all of the following types of cables:

2. single core

2. multicore

2. PVC twin and earth

2. armoured

Plus two more from the following:

2. flexible (such as cotton covered, rubber or thermosetting)

2. data/communication

2. ribbon cables

2. fibre-optics

2. screened

2. coaxial

2. wiring loom/harness

S3 Connect all of the following electrical modules/components to produce circuits:

3. isolators

3. protective devices (must include fuses such as HBC and HRC and circuit breakers)

3. contactors

3. motor starters
3. motors
3. transformers
3. residual current device (RCD)

Plus eight of the following:

3. overloads
3. blowers
3. cable connectors
3. switches
3. lamp holders
3. sockets
3. panel lamps
3. luminaires
3. sensors
3. ballast chokes
3. actuators
3. solenoids
3. consumer units
3. junction boxes
3. relays
3. terminal blocks
3. alarm devices
3. instruments
3. electronic modules/units
3. control devices
3. pumps

3. panels or sub-assemblies

3. heaters

3. other electrical components

S4 **Apply wiring methods and techniques to include all of the following:**

4. positioning and securing of equipment and components

4. levelling and alignment of components

4. determining and calculating current rating and lengths of cables required

4. securing by using mechanical fixings (such as screws, nuts and bolts)

4. laying in cables without twisting or plaiting

4. feeding cables into conduit without twisting or plaiting

4. leaving sufficient slack for termination and movement

S5 **Carry out eight of the following cable termination activities:**

5. stripping cable sheaths without damage to conductor insulation

5. terminating mineral insulated cables

5. removing cable insulation

5. sealing/protecting cable connections

5. connecting accessories (such as plugs, sockets multi-way connectors

5. attaching suitable cable identification

5. making mechanical/screwed/clamped connections

5. crimping (such as spade end, loops, tags and pins)

5. soldering and de-soldering

5. securing wires and cables (such as clips, plastic strapping, lacing, harnessing)

5. terminating armoured cables

5. heat shrinking (devices and boots)

5. earth bonding

5. cable glands and grips

S6 **Wire up three of the following electrical systems:**

6. **lighting circuits**

6. air conditioning control circuits

6. power circuits

6. refrigeration control circuits

6. motor start and control

6. heating/boiler control circuits

6. power generation and control circuits

6. instrumentation and control circuits

6. emergency lighting systems

6. alarm systems (such as fire, intruder, process control)

6. communication systems

6. electro-pneumatic or electro-hydraulic control circuits

6. computer systems

6. other control circuits (such as pumps, fans, blowers, extractors)

6. other specific electrical circuits

S7 **Use all the following test instruments during the wiring and testing activities:**

7. multimeter

7. insulation resistance tester

7. earth-loop impedance tester

7. polarity tester/indicator

7. RCD tester

7. voltmeter/indicator

7. other specific test/proving equipment (where applicable)

S8 **Carry out checks and adjustments, appropriate to the equipment and circuits being wired, to include all of the following:**

8. making visual checks (such as completeness, signs of damage, incorrect termination)

8. movement checks (such as loose fittings and connections)

8. testing that the equipment operates to the circuit specification

8. check/test load current

Plus six more checks/tests from the following:

8. carrying out fault finding techniques (such as half-split, input/output, unit substitution)

8. protective conductor impedance

8. power rating

8. insulation resistance values

8. polarity

8. frequency values

8. continuity

8. resistance

8. inductance

8. voltage levels

8. capacitance

8. RCD disconnection time

8. specialised tests (such as speed, sound, light, temperature)

S9 **Produce electrical circuits in accordance with two of the following standards:**

9. BS 7671/IET wiring regulations

9. other BS and/or ISO standards

9. company standards and procedures

Knowledge and understanding
The apprentice must know and understand:

K1 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)

K2 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

K3 the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy

K4 what constitutes a hazardous voltage and how to recognise victims of electric shock

K5 how to reduce the risks of a phase to earth shock (such as insulated tools, rubber mating and isolating transformers)

K6 the interpretation of circuit diagrams, wiring diagrams, and other relevant specifications (including BS and ISO schematics, wiring regulations, symbols and terminology)

K7 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

K8 the general principles of operation of the equipment/circuits they have produced, and the purpose of the individual modules/components used and how they interact

K9 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)

K10 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)

K11 the application and use of circuit protection equipment (such as fuses and other overload protection devices, trips, residual current device (RCD)

K12 the different earthing systems and their applications such as TN-S, TN-C-S, TT and IT

K13 why electrical bonding/earthing is critical, and why it must be both mechanically and electrically secure

K14 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)

K15 methods of mounting and securing electrical equipment/components to various surfaces (such as the use of nuts and bolts, screws and masonry fixing devices)

K16 checking that the positions selected for mounting the components do not interfere with or damage existing services (such as cable harnesses, pipework or electricity supplies)

K17 methods of laying in or drawing cables into conduit, trunking and

K18 traywork systems, and the need to ensure the cables are not twisted or plaited

K19 why airflow is an important factor to consider when installing cables and wires and how this is calculated.

K20 the techniques used to terminate electrical equipment (such as plugs and sockets; soldering; screwed, clamped and crimped connections, glands and sealed connectors)

K21 the use of BS7671/IET wiring regulations when selecting wires and cables and when carrying out tests on systems

K22 methods of attaching markers/labels to components or cables to assist with identification (such as colour coding conductors, using coded tabs)

K23 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)

K24 why equipment is checked so that it is electrically safe (such as PAT testing), and the implications if this is not undertaken

K25 how to check that tools and equipment are free from damage or defects, and are in a safe, (such as PAT tested), calibrated and in a usable condition

K26 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)

K27 the care, handling and application of electrical test and measuring instruments (such as multimeter, insulation resistance tester, loop impedance test instruments)

K28 applying 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

K29 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

K30 how to set the instrument's zero readings; obtaining instrument readings and comparing them with circuit parameters

K31 the problems that can occur with the wiring and testing operations, and how these can be overcome

K32 the fault-finding techniques to be used if the equipment fails to operate correctly (such as half split, unit substitution and input/output)

K33 when to act on their own initiative and when to seek help and advice from others

K34 the importance of leaving the work area in a safe and clean condition on completion of the wiring and testing activities (such as returning hand tools and test equipment to is designated location, cleaning the work area, and removing and disposing of waste)

Unit 010 Wiring and testing electrical equipment and circuits

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	4th July 2014
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **customer.services@enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 011 Wiring and testing programmable controller based systems

Level:	Level 2
GLH:	150
Relationship to NOS:	EUCL2F-011
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 prepare for the programmable controller wiring and testing activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how you intend to carry out the activities and the sequence of operations they intend to use. It involves connecting and wiring up the equipment and the development, editing, inputting, testing and de-bugging of simple programs. They will be expected to connect peripheral components and communication links, and to load/download process controller programs, check them for errors, and create back-up copies of completed programs. Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the programmable controller 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 safely the appropriate wiring and connection techniques and procedures for programmable controller equipment. They will understand the programmable controller wiring and testing process, and its application, and will know about the controller and peripherals being wired and tested, and the 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 wiring and testing activities (especially those for ensuring the equipment is correctly isolated), and when using the various tools and test 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 Standard Requirements In order to prove their ability to combine different wiring and testing operations, at least one of the PLC systems worked on must be of a significant nature, and must cover a minimum of five of the items listed in paragraph 3 in the Skills Section.

Performance Requirements

The apprentice must be able to:

P1 **work safely at all times, complying with health and safety legislation, regulations including The Electricity at Work Regulations and other relevant guidelines**

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

P3 **plan the programmable controller wiring and testing activities before they start them**

P4 **use appropriate sources to obtain the required circuit diagrams, wiring, programming and test information**

P5 **obtain the correct tools and equipment for the wiring and testing operations, and check that they are in a safe and usable condition**

P6 **position and secure the programmable controller components and peripheral devices safely and correctly, to meet specification requirements**

P7 **connect and terminate the cables to the appropriate connections on the components**

P8 **develop programmable controller programs, using the appropriate techniques and programming language**

P9 **use appropriate test methods and equipment to check and prove the program integrity**

P10 **deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve**

P11 **leave the work area in a safe and tidy condition on completion of the wiring and testing activities**

Skills Requirements

The apprentice must be able to:

S1 **Carry out all of the following during the wiring and testing of the programmable controller equipment:**

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

1.2 ensure the safe isolation of services during the wiring activities

1.3 follow job instructions, wiring drawings and test procedures at all times

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 programmable controller 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 installation activities

S2 Connect and test equipment for one of the following types of programmable controller systems:

2. monitoring system

2. combination system

2. process/product control system

2. diagnostic system

2. other specific system

S3 Connect up and test one of the following types of programmable controller equipment/components:

3. rack mounted controller units

3. modular controller units

Plus eight from the following:

3. sensors (such as inductive, proximity, temperature, colour, optical)

3. actuators (such as pneumatic or hydraulic)

3. printers panels and sub-assemblies

3. switches (such as emergency stop, limit, pressure)

3. valves (such as pneumatic or hydraulic)

3. electrical wires and cable connections

3. safety interlocks

3. signal transmission components/cables

3. motor starters

3. overload protection devices

3. barcode scanners

3. PC peripheral devices

3. Analogue to digital modules

3. PID (proportional, integral, derivative) controller

3. other devices

S4 **Apply wiring and connection methods and techniques, to include all of the following:**

4. locating and securing equipment in the correct positions

4. attaching suitable cable identification

4. making mechanical/screwed/clamped connections

4. routeing and securing wires and cables

4. stripping cable insulation/protection

4. crimping (such as tags and pins)

4. connecting all input and output devices

4. soldering and de-soldering connections (where applicable)

4. using heat shrinking devices or boots (where applicable)

4. sealing and protecting cable connections (where applicable)

S5 **Develop programs which use one of the following, applicable to the type of controller and programming software:**

5. ladder and logic diagrams

5. function block diagrams

5. statement/instruction lists

5. state logic

5. structured text

5. sequential function charts

5. other specific programming language

S6 **Prove and edit the programmable logic controller program, using both the following:**

6. **edit facilities**

6. program full run

Plus five from the following

6. single block/sub routine run

6. program save/store facilities

6. data input facilities

6. search facilities

6. program override controls

6. graphic displays

6. taking test measurements

6. using monitoring mode

6. using process simulation techniques (forcing contacts on/off)

6. counter and timer settings

S7 **Use three of the following test instruments during the wiring and testing activities:**

7. multimeter

7. voltmeter/indicator

7. programming devices (such as loader terminal, hand held programmer, personal computer)

7. network testing equipment

7. other specific test equipment

S8 **Carry out all of the following on completion of the programming activity:**

8. check and review program content

8. edit programs using the correct procedure (where appropriate)

8. check that the program is correctly titled and referenced

8. ensure that programs are stored safely and correctly in the correct format

8. create a separate backup copy of the program in case of file corruption

S9 **Use all of the following diagnostic techniques, tools and aids:**

9. visual checks (such as signs of damage, missing parts, wear/deterioration)

9. movement checks (such as loose fittings and connections)

9. fault finding techniques (such as input/output, half-split, unit substitution)

9. diagnostic aids (such as manuals, flow charts, logic diagrams, troubleshooting guides)

9. test instrumentation measurement (such as continuity, voltage, resistance, current)

9. controller error warning lights/displays

S10 **Wire up and test programmable controllers, in accordance with two of the following standards:**

10.1 equipment manufacturer's specification/operation range

10.2 BS7671/IET wiring regulations

10.3 other BS and/or ISO standards

10.4 company standards and procedures

Knowledge and understanding
The apprentice must know and understand:

K1 the health and safety requirements, and safe working practices and procedures required when wiring and testing programmable controller equipment

K2 the hazards associated with wiring and testing programmable controller equipment, and with the tools and equipment used (such as live electrical components, process controller interface, misuse of tools, using damaged or badly maintained tools and equipment, not following laid-down procedures), and how they can be minimised

K3 the importance of wearing appropriate protective clothing and equipment (PPE), and of keeping the work area safe and tidy

K4 the methods and procedures used to minimise the chances of infecting a computer with a virus

K5 the implications if the computer they are using does become infected with a virus and who to contact if it does occur

K6 what constitutes a hazardous voltage and how to recognise victims of electric shock

K7 how to reduce the risks of a phase to earth shock (such as insulated tools, rubber mating and isolating transformers)

K8 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

K9 the interpretation of circuit and wiring diagrams, and specifications used for the wiring and testing activities (including BS and ISO schematics, wiring regulations, symbols and terminology)

K10 the general principles of operation of the programmable controller equipment/circuits being connected and tested, and the purpose of the individual modules/components used (such input and output devices)

K11 the techniques used to connect programmable controller equipment (such as plugs, soldering, screwed, clamped and crimped connections) and if the controller is sinking or sourcing the required current to operate the input/output devices

K12 the use of BS 7671/IET wiring, and other regulations, when selecting wires and cables, and when carrying out tests on systems

K13 how to conduct any necessary checks to ensure the accuracy and quality of the wiring (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)

K14 the main programmable controller types that are available, and the importance of understanding that a different programmable controller may use completely different codes for similar functions

K15 the programming languages commonly used with programmable controller based systems (such as ladder, statement lists, logic function blocks, Boolean algebra)

K16 the common programmable controller numbering systems (such as binary, octal, decimal, hexadecimal, binary coded decimal (BCD))

K17 the different programming codes used to identify factors such as sensor inputs, actuator and other outputs, process management and auxiliary functions

K18 the information and data required in order to produce a complete and accurate programmable controller program, and how to translate the operating criteria into logic programming format

K19 the factors to be taken into account when producing programs (including the type of programmable controller (modular, rack mounted) and its control capabilities); safety considerations and the product/environment being controlled by the process

K20 the methods and procedures used to check that the completed program will control the required parameters safely, accurately and efficiently (such as checking the program for errors against expected performance with regard to sequence of operations; checking that programmed instructions cover all operational requirements; using monitoring devices and test measurements to check inputs and outputs; using techniques such as `force on- force off' to simulate process conditions; checking that failsafe devices and system emergency stops are operating correctly)

K21 how to identify system errors, and how to search a program within the programmable controller for specific elements and rectify the causes of the errors

K22 how to save the completed programs in the appropriate format, and the need to store the program safely and correctly, away from contaminants and possible corruption

K23 how to back up completed or edited programs, and the implications if this is not carried out effectively

K24 the fault-finding techniques to be used when the equipment fails to operate correctly

K25 the problems that can occur with the wiring and testing operations, and how these can be overcome

K26 when to act on their own initiative and when to seek help and advice from others

K27 the importance of leaving the work area in a safe and clean condition on completion of the wiring and testing activities (such as returning hand tools and test equipment to is designated location, cleaning the work area, and removing and disposing of waste)

Unit 011 Wiring and testing programmable controller based systems

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	4th July 2014
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 012 Producing mechanical assemblies

Level:	Level 2
GLH:	150
Relationship to NOS:	EUCL2F-012
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 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 Standard Requirements In order to prove their ability to combine different assembly operations, at least one of the assemblies produced must be of a significant nature, and must contain a minimum of six of the components listed in paragraph 3 in the Skills Section.

Performance Requirements

The apprentice must be able to:

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

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

P3 **plan the assembly activities before they start them**

P4 **obtain and prepare the appropriate components, tools and equipment**

P5 **use the appropriate methods and techniques to assemble the components in their correct positions**

P6 **secure the components using the specified connectors and securing devices**

P7 **check the completed assembly to ensure that all operations have been completed and that the finished assembly meets the required specification**

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

P9 **leave the work area in a safe and tidy condition on completion of the assembly activities**

Skills Requirements

The apprentice must be able to:

S1 **Carry out all of the following during the assembly activities:**

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

follow job instructions, assembly drawings and procedures

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

check that tools and measuring instruments to be used are within calibration date

use lifting and slinging equipment in accordance with health and safe guidelines and procedures (where appropriate)

ensure that the components used are free from foreign objects, dirt o other contamination

return all tools and equipment to the correct locations on completion the assembly activities

S2 **Produce assemblies using eight of the following methods and techniques:**

assembling of components by expansion/contraction

applying sealants/adhesives

fitting (such as filing, scraping, lapping or polishing)

electrical bonding of components

securing by using mechanical fasteners/threaded devices

assembling of products by pressure

setting and adjusting

applying bolt locking methods

aligning components

drilling

shimming and packing

riveting

pinning

reaming

blue-bedding of components

torque setting

balancing components

S3 **Assemble products to meet the required specification, using twelve of the following types of component:**

3. 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. other specific component

S4 **Secure the components using both of the following categories of fastening devices:**

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

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

Plus two more from the following:

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

4. spring clips (such as external circlips, internal circlips, special clips)

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

S5 **Assemble products using two of the following assembly aids and equipment:**

5. workholding devices

5. shims and packing

5. lifting and moving equipment

5. rollers or wedges

5. specialised assembly tools/equipment

5. supporting equipment

5. jigs and fixtures

S6 **Carry out the required quality checks, to include eight from the following, using appropriate equipment:**

6. positional accuracy

6. alignment

6. freedom of movement

6. function

6. component security

6. bearing/shaft end float

6. completeness

6. operating/working clearances

6. dimensions

6. freedom from damage or foreign objects

6. orientation

6. torque settings

S7 **Produce mechanical assemblies which comply with all of the following:**

7. all components are correctly assembled and aligned in accordance with the specification

7. moving parts are correctly adjusted and have appropriate clearances

7. where appropriate, assemblies meet required geometric tolerances (such as square, straight, angles free from twists)

7. all fastenings have appropriate washers and are tightened to the required torque

7. where appropriate, bolt locking methods are applied

Knowledge and understanding
The apprentice must know and understand:

K1 the health and safety requirements, and safe working practices and procedures required for the assembly activities undertaken

K2 the importance of wearing appropriate protective clothing and equipment (PPE), and of keeping the work area safe and tidy

K3 the hazards associated with the assembly activities (such as 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

K4 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

K5 the procedure for obtaining the required drawings, job instructions and other related specifications

K6 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

K7 how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing

K8 how to prepare the components in readiness for the assembly activities (such as visually checking for defects, cleaning the components, removing burrs and sharp edges)

K9 the general operating principles of mechanical assembly(s) they have produced such as a pump, gearbox, cylinder or valve and the purpose and function of the components and materials used (including component identification systems such as codes and component orientation indicators)

K10 the assembly/joining methods, techniques and procedures to be used, and the importance of adhering to these procedures

K11 how the components are to be aligned, adjusted and positioned prior to securing, and the tools and equipment to be used for this

K12 the various mechanical fastening devices that are used (such as nuts, bolts, machine screws, cap screws, clips, pins, locking and retaining devices)

K13 the importance of using the specified components and joining devices for the assembly, and why they must not use substitutes

K14 where appropriate, the application of sealants and adhesives within the assembly activities, and the precautions that must be taken when working with them

K15 how to conduct any necessary checks to ensure the accuracy, position, security, function and completeness of the assembly (such as 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)

K16 how to detect assembly defects, and what to do to rectify them (such as ineffective joining techniques, foreign objects, component damage)

K17 the methods and equipment used to transport, lift and handle components and assemblies

K18 how to check that the tools and equipment to be used are correctly calibrated and are in a safe and serviceable condition

K19 the importance of ensuring that all tools are used correctly and within their permitted operating range

K20 the importance of ensuring that all tools, equipment and components are accounted for and returned to their correct location on completion of the assembly activities

K21 problems that could occur with the assembly operations, and the importance of informing appropriate people of non-conformances

K22 when to act on their own initiative and when to seek help and advice from others

K23 leaving the work area in a safe and clean condition on completion of the assembly activities (such as removing and storing power leads, returning hand tools and equipment to the designated location, cleaning the work area and removing and disposing of waste)

Unit 012 Producing mechanical assemblies

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	4th July 2014
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 013 Preparing and using lathes for turning operations

Level:	Level 2
GLH:	150
Relationship to NOS:	EUCL2F-013
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 carry out turning operations 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 Standard 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 scope 5 in the skills requirement section.

Performance Requirements

The apprentice must be able to:

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

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

P3 plan the machining activities before they start them

P4 obtain and prepare the appropriate materials, tools and equipment

P5 grind lathe tools and drills to meet the required component specification

P6 mount and set the required workholding devices, work piece and cutting tools

P7 set and adjust the machine tool speeds and feeds to achieve the component specification

P8 use the machine tool controls safely and correctly, in line with operational procedures

P9 measure and check that all dimensional and geometrical aspects of the component are to the specification

P10 deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

P11 shut down the equipment to a safe condition on completion of the machining activities

Skills Requirements

The apprentice must be able to:

S1 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

S2 Machine components made from **all** of the following types of material:

2. ferrous

2. non ferrous

2. non metallic

S3 Mount, secure and machine components using **all** of the following workholding devices:

3. three-jaw chucks with hard jaws

3. three-jaw chucks with soft jaws

3. four-jaw chucks

3. collet chucks

Plus **two** from the following:

3. drive plate and centres

3. magnetic or pneumatic devices

3. fixtures

3. fixed steadies or traveling steadies

3. faceplates

3. special purpose workholding devices (such as wax chucks)

S4 Mount and use **eight** of the following types of tool:

4. turning

4. knurling

4. recessing/grooving

4. twist/core drills

4. thread forming tools

4. facing

4. parting off

4. chamfering

4. reamers

4. dies

4. boring

4. forming

4. centre drills

4. taps

S5 Produce machined components which combine different operations and have features that cover **all** of the following:

5. flat faces

5. stepped diameters

5. drilled holes

5. chamfers

5. parallel diameters

5. tapered diameters

5. reamed holes

5. grooves/undercuts

5. bored holes

Plus **four** more of the following:

5. internal threads (taps)

5. external threads (dies)

5. eccentric diameters

5. knurls or special finishes

5. profile forms

5. parting off

5. external threads (screw cutting using formed tooling)

5. Internal threads (screw cutting using formed tooling)

S6 Carry out the necessary checks for accuracy, to include **all** of the following:

6. external diameters
6. bore/hole size/fit
6. surface finish
6. parallelism
6. angle/taper
6. linear dimensions (such as lengths, depths)
6. grooves/undercuts (such as position, width, depth)

Plus **two** more of the following:

6. internal diameters
6. concentricity
6. eccentricity
6. ovality
6. thread fit

S7 Use **all** of the following measuring equipment during the machining and checking activities:

7. external micrometers
7. dial test indicators (DTI)
7. vernier/digital/dial callipers
7. surface finish equipment (such as comparison plates, machines)

Plus **six** more of the following

7. rules
7. bore/hole gauges
7. internal micrometers
7. thread gauges (such as ring, plug, profile)
7. depth micrometers
7. plug gauges

7. depth verniers

7. radius/profile gauges

7. slip gauges

7. protractors

7. coordinate measuring machine (CMM)

S8 Produce components to **all** of the following quality and accuracy standards, as applicable to the operation:

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

8. general dimensional tolerance +/- 0.15mm or +/- 0.006”

8. there must be one or more specific dimensional tolerances within +/- 0.05mm or +/- 0.002”

8. surface finish 63 µin or 1.6µm

8. reamed / bored holes within H8

8. screw threads BS medium fit

8. angles within +/- 0.5 degree

Knowledge and understanding
The apprentice must know and understand:

K1	the safe working practices and procedures to be followed when preparing and using lathes (such as ensuring the correct isolation of the machine before mounting workholding devices; fitting and adjusting machine guards, ensuring that the workpiece is secure and that tooling is free from the workpiece before starting the machine)
K2	the hazards associated with the turning operations (such as 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
K3	the personal protective equipment (PPE) to be worn for the turning activities (such as correctly fitting overalls and safety glasses; ensuring that, if they have long hair, it is tied back or netted; and removing any jewellery or other items that can become entangled in the machinery)
K4	the safety mechanisms on the machine (such as emergency stop buttons, emergency treadle brakes), and the procedure for checking that they function correctly
K5	the correct operation of the machine controls in both hand and power modes, how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
K6	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
K7	planning and preparing to carry out the machining operations (such as 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)
K8	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 (to include first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing)
K9	the main features of the lathe and the accessories that can be used (such as saddle, capstan/turret head, compound slide, tailstock, taper turning attachments, profile attachments, fixed and travelling steadies)
K10	how to position and secure workholding devices to the machine spindle, and the checks to be made (such as 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)
K11	the effects of clamping the workpiece in a chuck/workholding device, and how this can cause damage or distortion in the finished components
K12	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)
K13	how to mount and secure the cutting tools in the tool holding devices (such as front or rear tools posts; mounting drills in chucks or by the use of morse taper sockets; the importance of ensuring that the tool is at the correct centre height and that tool overhang is kept to a minimum)
K14	how to check that cutting tools are in a safe and usable condition and how to handle and store tools safely/correctly
K15	the methods and techniques to hand grind lathe tools and drills for different applications
K16	the effects of backlash in machine slides and screws, and how this can be overcome

K17 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

K18 factors that affect the selection of cutting feeds and speeds, and the depth of cut that can be taken (such as 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)

K19 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

K20 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)

K21 how to check that the measuring equipment is within current calibration dates and that the instruments are correctly zeroed; measuring internal and external dimensions (such lengths, diameters, depths, slots, hole positions, angles, profiles); measuring geometric features (such flatness, squareness, parallelism, concentricity, ovality); how to check surface finish (such as by using comparison blocks or instruments)

K22 the problems that can occur with the turning activities (such as defects caused by incorrectly ground tools, inappropriate feeds/speeds, damage by workholding devices), and how these can be overcome

K23 when to act on their own initiative and when to seek help and advice from others

K24 the importance of leaving the work area and machine in a safe condition on completion of the turning activities (such as correctly isolated, cutting tools removed, cleaning the machine and removing and disposing of waste)

Unit 013 Preparing and using lathes for turning operations

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 2.0
Date approved	11th December 2015
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing and Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **customer.services@enginuity.org** quoting Trailblazer Advanced Manufacturing and Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review date	2017

Unit 014 Preparing and using milling machines

Level:	Level 2
GLH:	150
Relationship to NOS:	EUCL2F-014
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 carry out the milling operations on 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 Standard 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 scope 5 in the skills requirement section.

Performance Requirements

The apprentice must be able to:

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

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

P3 plan the machining activities before they start them

P4 obtain and prepare the appropriate materials, tools and equipment

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

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

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

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

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

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

Skills Requirements

The apprentice must be able to:

S1 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

S2 Machine components made from **all** of the following types of material:

2. ferrous

2. non ferrous

2. non metallic

S3 Mount, secure and machine components, using **both** of the following workholding devices:

3. fixed vice (must include setting/clocking up to ensure it is square)

3. direct clamping to machine table

Plus **two** of the following:

3. magnetic or pneumatic devices

3. swivel or universal vice

3. angle plates

3. chucks

3. fixtures

3. vee block and clamps

3. indexing device

3. other to be specified by the employer

S4 Mount and use **six** of the following types of milling cutters/tools:

4. face mills

4. slot cutters

4. twist/core drills

4. slab/cylindrical cutters

4. slitting saws

4. reamers

4. end mills

4. vee cutters

4. boring bars

4. slot drills

4. taps

4. side and face cutters

4. other form cutters

S5 Produce machined components that combine different operations and have features that cover **all** of the following:

5. flat faces

5. parallel faces

5. open ended slots

5. square faces

5. steps/shoulders

5. enclosed slots

5. drilled holes

Plus **two** more of the following:

5. angular faces

5. reamed holes

5. bored holes

5. indexed or rotated forms

5. recesses

5. tee slots

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

S6 Carry out the necessary checks for accuracy, to include **all** of the following:

6. linear dimensions

6. surface finish

6. depths

6. slots (such as position, width, depth)

6. flatness

6. angles (where appropriate)

6. squareness

6. hole size/fit (where appropriate)

S7 Use **all** the following measuring equipment during the machining and checking activities:

7. rules

7. squares

7. external micrometers

7. dial test indicators (DTI)

7. vernier/digital/dial callipers

7. surface finish equipment (such as comparison plates, machines)

Plus **three** more of the following

7. feeler gauges

7. bore/hole gauges

7. internal micrometers

7. slip gauges

7. depth micrometers

7. radius/profile gauges

7. depth verniers

7. protractors

7. coordinate measuring machine (CMM)

S8 Produce components to **all** of the following quality and accuracy standards, as applicable to the operation:

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

8. general dimensional tolerance +/- 0.15mm or +/- 0.006”

8. there must be one or more specific dimensional tolerances within +/- 0.05mm or +/- 0.002”
8. flatness and squareness within 0.125mm per 25mm or 0.005” per inch
8. reamed / bored holes within H8
8. surface finish 63 µin or 1.6µm
8. angles within +/- 1 degree

Knowledge and understanding
The apprentice must know and understand:

K1 the safe working practices and procedures to be followed when preparing and using milling machines (such as ensuring the correct isolation of the machine before mounting cutters and workholding devices; fitting and adjusting machine guards, ensuring that the workpiece is secure and that cutters are free from the workpiece before starting the machine)

K2 the hazards associated with the milling operations (such as 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

K3 the personal protective equipment (PPE) to be worn for the milling activities (such as correctly fitting overalls and safety glasses; ensuring that, if they have long hair, it is tied back or netted; and removing any jewellery or other items that can become entangled in the machinery)

K4 the safety mechanisms on the machine (such as emergency stop buttons, emergency brakes), and the procedure for checking that they function correctly

K5 the correct operation of the machine controls in both hand and power modes, how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency

K6 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

K7 planning and preparing to carry out the machining operations (such as 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)

K8 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 (to include first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing)

K9 the main features of the milling machine, and the accessories that can be used (such as vertical heads, indexing devices)

K10 how to position and secure workholding devices to the machine table, and the checks to be made (such as 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)

K11 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

K12 the various milling operations that can be performed, and the types of cutters that are used (such as face mills, slab/cylindrical cutters, side and face cutters, end mills, slot drills, form cutters, twist drills)

K13 how to mount and secure the cutting tools in the tool holding devices and to the machine spindle (such as 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)

K14 how to position the workpiece in relation to the milling cutters to give conventional or climb milling conditions

K15 how to check that the milling cutters are in a safe and usable condition, and how to handle and store cutters safely

K16 the effects of backlash in machine slides and screws, and how this can be overcome

K17 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

K18 factors that affect the selection of cutting feeds and speeds, and the depth of cut that can be taken (such as type of material, type of tool used, operations being performed, workholding method/security of workpiece, condition of machine, finish and tolerance required)

K19 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

K20 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)

K21 how to check that the measuring equipment is within current calibration dates and that the instruments are correctly zeroed; measuring linear dimensions (such as lengths, depths, slots, positions, angles, profiles); measuring geometric features (such as flatness, squareness, parallelism); how to check surface finish (such as by using comparison blocks or instruments)

K22 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

K23 when to act on their own initiative and when to seek help and advice from others

K24 the importance of leaving the work area and machine in a safe condition on completion of the milling activities (such as correctly isolated, cutting tools removed, cleaning the machine and removing and disposing of waste)

Unit 014 Preparing and using milling machines

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 2.0
Date approved	11th December 2015
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing and Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact customer.services@enginuity.org quoting Trailblazer Advanced Manufacturing and Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review date	2017

Unit 015 Preparing and using semi-automatic MIG, MAG and flux cored arc-welding equipment

Level:	Level 2
GLH:	150
Relationship to NOS:	EUCL2F-015
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 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 Standard 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.

Performance Requirements

The apprentice must be able to:

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

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

P3 **plan the welding activities before they start them**

P4 **obtain and prepare the appropriate welding equipment and welding consumables**

P5 **prepare and support the joint, using the appropriate methods**

P6 **tack weld the joint at appropriate intervals, and check the joint for accuracy before final welding**

P7 **weld the joint to the specified quality, dimensions and profile**

P8 **use appropriate methods and equipment to check the quality, and that all dimensional and geometrical aspects of the weld are to the specification**

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

P10 **shut down and make safe the welding equipment on completion of the welding activities**

Skills Requirements

The apprentice must be able to:

S1 **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

S2 Use manual/semi-automatic welding and related equipment to include one of the following:

2. MIG

2. MAG

2. Flux cored wire welding equipment

S3 Use consumables appropriate to the material and application, to include: one of the following wire types:

3. solid wire

3. cored wire

Plus one of the following types of shielding gas:

3. inert

3. active

S4 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. fillet lap joints

4. corner joints

4. Tee fillet joints

4. butt joints

S5 Produce joints as follows: one type of material from the following:

5. carbon steel

5. stainless steel

5. aluminium

and two forms of material from the following:

5. plate

5. sheet (less than 3mm)

5. pipe/tube

5. section

5. other forms

S6 **Weld joints in good access situations in two of the following BS EN ISO 6947 positions:**

6. Flat (PA)

6. Vertical upwards (PF)

6. Horizontal vertical (PB)

6. Vertical downwards (PG)

6. Horizontal (PC)

S7 **Check that the welded joint conforms to the specification, by checking all of the following:**

7. dimensional accuracy

7. size and profile of weld

7. number of runs

7. alignment/squareness

S8 **Carry out non-destructive testing of the welds, using one of the following:**

8. dye penetrant

8. fluorescent penetrant

8. magnetic particle

S9 **Carry out destructive tests on weld specimens using one of the following:**

9. macroscopic examination

9. nick break test

9. bend tests (such as face, root or side, as appropriate)

S10 **Identify all of the following weld defects:**

1(lack of continuity of the weld

1(uneven and irregular ripple formation

1(incorrect weld size or profile

Plus four more of the following:

1(undercutting

1(internal cracks

1(overlap

1(surface cracks

1(inclusions

1(lack of fusion

1(porosity

1(lack of penetration

S11 Produce welded joints which meet all of the following (with reference to BS 4872 Part 1 Weld test requirements):

1. welds meet the required dimensional accuracy

1. 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

1. the weld contour is linear, of uniform profile, free from excessive undulations, with regular and even ripple

1. the welds are adequately fused, and there is minimal undercut, overlap and surface inclusions

1. joins at stop/start positions merge smoothly, with no pronounced hump or crater in the weld surface

1. tack welds are blended in to form part of the finished weld, without excessive hump

1. 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

1. the weld surface is free from cracks, and substantially free from porosity, shrinkage cavities and trapped slag

1. the weld surface and adjacent parent metal is substantially free from arcing or chipping marks

Knowledge and understanding
The apprentice must know and understand:

K1 the safe working practices and procedures to be followed when preparing and using MIG, MAG or flux cored wire arc welding equipment (such as general workshop safety; appropriate personal protective equipment (PPE); fire prevention; protecting other workers from the effects of the welding arc; safety in enclosed/confined spaces; fume extraction/control)

K2 the hazards associated with MIG, MAG or flux cored-wire arc welding (such as live electrical components; poor earthing; the electric arc; fumes and gases; spatter; hot slag and metal; grinding and mechanical metal/slag removal; elevated working; enclosed spaces; slips, trips and falls), and how they can be minimised

K3 the personal protective equipment to be worn for the welding activities (such as correctly fitting overalls; leather aprons, welding gloves/gauntlets; safety boots; head/eye shield with correct shade of filter)

K4 the correct handling and storage of gas cylinders (such as manual handling and use of cylinder trolley, leak detection procedures, relevant BCGA codes of practice, cylinder identification, gas pressures, cylinder and equipment safety features)

K5 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

K6 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

K7 the semi-automatic MIG, MAG or flux cored wire arc welding process (such as basic principles of fusion welding, power sources, the major parts of the welding equipment and their function)

K8 types, selection and application of electrode wires (such as solid and cored)

K9 reasons for using shielding gases, and the types and application of the various gases

K10 gas pressures and flow rates (in relation to the type of material being welded)

K11 the types of welded joints to be produced (such as lap joints, corner joints, tee joints and butt welds)

K12 terminology used for the appropriate welding positions

K13 how to prepare the materials in readiness for the welding activity (such as 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)

K14 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)

K15 tack welding size and spacing (in relation to material thickness)

K16 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)

K17 the techniques of operating the welding equipment to produce a range of joints in the various joint positions (such as fine adjustment of parameters; correct manipulation of the welding gun; blending in stops/starts and tack welds)

K18 methods/modes of metal transfer and their uses (such as dip, globular, free flight, spray and pulsed)

K19 how to close down the welding equipment safely and correctly

K20 how to control distortion (such as welding sequence; deposition technique)

K21 problems that can occur with the welding activities (such as causes of distortion and methods of control; effects of welding on materials and sources of weld defects), and how these can be overcome

K22 the safe working practices and procedures to be adopted when preparing the welds for examination (such as handling hot materials, using chemicals for cleaning and etching, using equipment to fracture welds)

K23 how to prepare the welds for examination (such as removing surface irregularities; cleaning the weld, polishing and making saw cuts on welds to be break tested)

K24 how to check the welded joints for uniformity, alignment, position, weld size and profile

K25 the various procedures for visual examination of the welds for cracks, porosity and slag inclusions (such as dye penetrant, fluorescent penetrant; magnetic particle testing)

K26 the various procedures for carrying out destructive tests on the welds (such as macroscopic examination, bend tests, nick break tests)

K27 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)

K28 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

K29 when to act on your own initiative and when to seek help and advice from others

K30 the importance of leaving the work area and equipment in a safe condition on completion of the welding activities (such as isolation of electrical supplies; safely storing welding cables and electrode holders; storing electrodes; removing and disposing of waste)

Unit 015 Preparing and using semi-automatic MIG, MAG and flux cored arc-welding equipment

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	4th July 2014
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 016 Assembling and testing electronic circuits

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-016
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 carry out 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 Standard 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 paragraph 5 in the Skills Section.

Performance Requirements

The apprentice must be able to:

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

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

P3 **plan the electronic assembly, wiring and testing activities before they start them**

P4 **use appropriate sources to obtain the required specifications, circuit diagrams, component assembly and test information**

P5 **obtain the correct tools and equipment for the assembly and test operations, and check that they are in a safe and usable condition**

P6 **use the appropriate methods and techniques to assemble the components in their correct positions**

P7 **secure the components, using the specified connectors, securing devices and soldering techniques**

P8 **wire and terminate cables to the appropriate connections on the circuit boards**

P9 **use appropriate test methods and equipment to check that the completed assembly is safe and meets all aspects of the specification**

P10 **deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that their cannot resolve**

P11 **leave the work area in a safe and tidy condition on completion of the electronic assembly and testing activities**

Skills Requirements

The apprentice must be able to:

S1 **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

S2 Assemble one of the following circuit types:

2. single-sided circuit

2. thick film circuit

2. thin film circuit

2. flexible circuit

2. double-sided circuit

2. hybrid circuit

S3 Assemble electronic components using two of the following:

3. manual soldering techniques

3. surface mount techniques

3. mechanical fixing methods

S4 Assemble circuits using four of the following tools:

4. heat shunts/tweezers

4. component forming devices

4. mechanical fasteners (screwdriver, spanners)

4. snipe or long nosed pliers

4. wire strippers

4. anti-static packaging, mats and straps

4. sleeving pliers

4. side or end cutters

4. specialised assembly tools/equipment

S5 **Assemble circuits to the required specification, to include using fifteen of the following types of component:**

5. fixed resistors

5. variable resistors

5. potentiometers

5. encoders or resolvers

5. transistors

5. inverters or servo controllers

5. thyristors

5. edge connectors

5. thermistors

5. light dependant resistors (LDR)

5. analogue or digital integrated circuits

5. wiring pins/tags/wire links

5. fixing spacers

5. fixed capacitors

5. variable capacitors

5. insulators

5. surface mount packages

5. rectifiers

5. small heat sinks

5. electrolytic capacitors

5. switches

5. cables

5. diodes

5. Zener diodes

5. light emitting diodes (LEDs)

5. mini transformers

5. decoders

5. protection devices

5. cable connectors

5. regulators

5. relays

5. inductors

5. other specific electronic components

S6 **Assemble electronic components to produce five of the following types of circuit:**

6. audio amplifiers

6. filters

6. regulated power supplies

6. signal converters

6. microprocessor based applications (such as PIC chips)

6. logic function controls

6. signal generators

6. comparators

6. display circuits

6. counter/timers

6. power amplifiers

6. ADC and DAC hybrid circuits

6. oscillators

6. motor control

6. sensor/actuator circuit (such as linear, rotational, temperature, photo-optic, flow, level, pressure)

6. digital circuit (such as process control, microprocessor, logic devices, display devices)

6. signal processing circuit (such as frequency modulating/ demodulating, amplifiers, filters)

6. alarms and protection circuits

6. other specific circuit

S7 **Carry out visual checks on the completed circuits, to include all of the following:**

7. soldered joints are clean, shiny, free from solder spikes, bridges, holes, excess solder and flux

7. components are correctly mounted for best physical support, and are correctly orientated

7. excess component leads have been trimmed off to the standard required

7. circuit tracks are free from faults (such as lifting, breaks, bridges, hot spots)

7. there are no obvious signs of damage, to components or to the substrate

7. all required connectors, wire links, spacers and other ancillary items are in place

S8 **Use five of the following types of test equipment:**

8. multimeter

8. signal generator

8. oscilloscope

8. signal tracer

8. logic probe/clip

8. stabilised power supplies

8. logic analyser

8. measuring bridges

8. pulse sequencing analyser

8. software diagnostic programs

8. counter/timers

8. data communications test set

8. signature analysers

8. bus exerciser/analyser

8. protocol analyser

S9 **Carry out checks, adjustments and fault rectification where appropriate to the circuits being assembled, to include six of the following:**

9. logic states

9. pulse width/rise time

9. inductance

9. dc voltage/current levels

9. open/short circuit

9. frequency modulation/demodulation

9. ac voltage/current levels

9. resistance

9. amplification

9. clock/timer switching

9. capacitance

9. signal noise/interference levels

9. oscillations

9. waveform analysis

9. attenuation

S10 **Produce electronic circuits in accordance with one of the following:**

1(BS or ISO standards and procedures

1(customer standards and requirements

1(company standards and procedures

1(other international standards

Knowledge and understanding
The apprentice must know and understand:

K1 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)

K2 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

K3 the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy

K4 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)

K5 what constitutes a hazardous voltage and how to recognise victims of electric shock

K6 how to reduce the risks of a phase to earth shock (such as insulated tools, rubber matting and isolating transformers)

K7 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

K8 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

K9 the various types of circuit boards used (such as printed circuit boards, thin film, thick film and flexible film circuitry)

K10 how to recognise, read the values and identify polarity and any other orientation requirements for all electronic components being used in the assemblies (such as capacitors, diodes, transistors, integrated circuit chips, and other discrete through-hole or surface-mounted components)

K11 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)

K12 the general principles of operation of the electronic circuits they have assembled, and the purpose of the individual modules/components within the circuits and how they interact

K13 the application and use of circuit protection equipment (such as fuses and other overload protection devices)

K14 the preparation requirements for components to be used in the assembly (such as pre-forming component pins/legs)

K15 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)

K16 methods of attaching markers/labels to components or cables to assist with identification (such as colour coding conductors, using coded tabs)

K17 the use of calculations, and regulations, when selecting wires and cables and when carrying out tests on electronic circuits

K18 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)

K19 the tools and equipment used in the electronic assembly activities (including the use of cable stripping tools, crimping tools, soldering irons, specialist assembly tools)

K20 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

K21 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)

K22 checking that test equipment is safe to use (such as condition of power cables, using suitably fused test probes, clips and leads); how to check that equipment is within current calibration approval dates and PAT tested; checking 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

K23 connecting 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

K24 making adjustments to circuit components; making decisions on circuit performance and faulty components; removal and replacement of faulty components

K25 the fault-finding techniques to be used when the equipment fails to operate correctly (such as half split, unit substitution and input/output)

K26 the problems that can occur with the assembling and testing operations, and how these can be overcome

K27 when to act on their own initiative and when to seek help and advice from others

K28 the importance of leaving the work area in a safe and clean condition on completion of the electronic assembly and testing activities (such as returning hand tools and test equipment to the designated location, cleaning the work area, removing and disposing of waste)

Unit 016 Assembling and testing electronic circuits

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	4th July 2014
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 017 Maintaining electronic equipment /systems

Level:	Level 2
GLH:	150
Relationship to NOS:	EUCL2F-017
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 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 Standard 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 five of the activities listed in paragraph 4 plus the removal and replacement/refitting of seven of the components identified in paragraph 5 in the Skills Section.

Performance Requirements

The apprentice must be able to:

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

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

P3 **plan the maintenance activities before they start them**

P4 **obtain all the information they need for the safe removal and replacement of the equipment/system components**

P5 **obtain and prepare the appropriate tools and equipment**

P6 **apply appropriate maintenance diagnostic techniques and procedures**

P7 **use the appropriate methods and techniques to remove and replace the required components**

P8 **carry out tests on the maintained equipment, in accordance with the test schedule/defined test procedures**

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

P10 **leave the work area in a safe and tidy condition on completion of the maintenance activities**

Skills Requirements

The apprentice must be able to:

S1 **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

S2 Carry out maintenance/repair activities on three of the following types of electronic equipment:

2. power supplies (such as switched mode, series regulation, shunt regulation)

2. motor control systems (such as closed loop servo/proportional control, inverter control)

2. sensor/actuator circuit (such as linear, rotational, temperature, photo-optic, flow, level, pressure)

2. digital circuit (such as process control, microprocessor, logic devices, display devices)

2. signal processing circuit (such as frequency modulating/demodulating, amplifiers, filters)

2. alarms and protection circuits

2. ADC and DAC hybrid circuits

S3 Use four of the following maintenance diagnostic techniques, tools and aids:

3. fault finding techniques (such as six point, input/output, half-split, unit substitution)

3. diagnostic aids (such as manuals, flow charts, troubleshooting guides, maintenance records)

3. information gathered from the person who reported the fault

3. visual checks (such as signs of damage, overheating, missing parts, wear/deterioration)

3. movement checks (such as loose fittings and connections)

3. monitoring equipment or gauges

3. test instrumentation measurement (such as voltage, resistance, current, waveform)

S4 Carry out all of the following maintenance techniques and procedures during the repair activities:

4. removing excessive dirt and grime

4. dismantling/disconnecting equipment to the required level

4. disconnecting and reconnecting wires and cables

4. checking the condition/deterioration of components

4. soldering and de-soldering

4. repairing circuit board tracks

4. removing and replacing electronic units/circuit boards

4. removing and replacing electronic components

4. making adjustments to components and/or connections

4. re-assembling of units or sub-assemblies

S5 **Replace/refit a range of electronic components, to include twelve of the following:**

- **5.** cables and connectors
- **5.** rectifiers
- **5.** surface mount packages
- **5.** printed circuit boards
- **5.** encoders or resolvers
- **5.** integrated circuits
- **5.** fixed resistors
- **5.** variable resistors
- **5.** potentiometers
- **5.** thyristors
- **5.** transistors
- **5.** regulators
- **5.** decoders
- **5.** light dependant resistor (LDR)
- **5.** thermistors
- **5.** diodes
- **5.** Zener diodes
- **5.** opto-electronics/optical fibre components
- **5.** light emitting diodes (LEDs)
- **5.** analogue or digital integrated circuits
- **5.** fixed capacitors
- **5.** electrolytic capacitors
- **5.** variable capacitors
- **5.** sensors
- **5.** switches

5. edge connectors

5. heat sinks

5. wiring pins/tags/wire links

5. mini transformers

5. protection devices

5. inverters or servo controllers

5. relays

5. inductors

S6 **Use the correct joining/connecting techniques to deal with three of the following types of connection:**

6. push-fit connectors

6. crimped connections

6. soldering or de-soldering

6. zero insertion force (zif) connectors

6. clip assemblies

6. adhesive joints/assemblies

6. threaded connections

6. edge connectors

S7 **Use five of the following types of test equipment:**

7. multimeter

7. signal generator

7. oscilloscope

7. signal tracer

7. logic probe/clip

7. stabilised power supplies

7. logic analyser

7. measuring bridges

7. pulse sequencing analyser

7. software diagnostic programs

7. counter-timers

7. data communications test set

7. signature analysers

7. bus exerciser/analyser

7. protocol analyser

S8 **Carry out checks and tests on the maintained equipment, to include both of the following:**

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

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

Plus three more from the following:

8. logic states

8. pulse width/rise time

8. inductance

8. dc voltage/current levels

8. open/short circuit

8. frequency modulation/demodulation

8. ac voltage/current levels

8. resistance

8. amplification

8. clock/timer switching

8. capacitance

8. signal noise/interference levels

8. oscillations

8. wave form analysis

8. attenuation

S9 **Carry out maintenance activities on electronic equipment, in accordance with one or more of the following:**

9. organisational guidelines and codes of practice

9. equipment manufacturer's operation range

9. BS and ISO standards

Knowledge and understanding
The apprentice must know and understand:

K1 the health and safety requirements, and safe working practices and procedures required for the electronic maintenance activities undertaken

K2 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)

K3 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

K4 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)

K5 the importance of wearing appropriate protective clothing/equipment (PPE), and of keeping the work area safe and tidy

K6 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

K7 the procedure for obtaining drawings, job instructions, related specifications, replacement parts, materials and other consumables necessary for the maintenance activities

K8 how to extract information from job instructions, drawings and data (such as circuit diagrams, specifications, manufacturers' manuals, test procedures and other documents needed to carry out repairs)

K9 the procedures and precautions to be adopted to eliminate electrostatic discharge (ESD) hazards

K10 the general principles of how the electronic circuit that they have built functions, and the working purpose of individual units/components and how they interact

K11 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)

K12 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)

K13 checking that test equipment is safe to use (such as condition of power cables, using suitably fused test probes, clips and leads); how to check that equipment is within current calibration approval dates and PAT tested; checking 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

K14 connecting 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

K15 the application of Ohm's Law and relevant calculations (including units of electronic measurement and their multiples and sub-multiples)

K16 the use of calculations and regulations, when selecting wires and cables and when carrying out tests on electronic circuits

K17 making adjustments to circuit components; making decisions on circuit performance and faulty components; removal and replacement of faulty components

K18 how to check that the replacement components meet the required specification/operating conditions (such as values, tolerance, current-carrying capacity, ambient temperatures, connection orientation)

K19 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

K20 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); how to check that they are in a safe and usable condition

K21 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)

K22 the importance of making de-energised checks before proving the equipment with the electrical supply on

K23 how to make adjustments to components/assemblies to ensure that they function correctly

K24 the documentation and/or reports to be completed following the maintenance activity, and the importance of ensuring that these reports are completed accurately and legibly

K25 problems that can occur with the electronic equipment maintenance activity, and how they can be overcome

K26 when to act on their own initiative and when to seek help and advice from others

K27 the importance of leaving the work area in a safe and clean condition on completion of the maintenance activities (such as returning hand tools and test equipment to is designated location, cleaning the work area, removing and disposing of waste)

Unit 017 Maintaining electronic equipment /systems

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	4th July 2014
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 018 Preparing and using industrial robots

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-018
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 Produce, load and prove programs on industrial robot controllers, and 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 required to produce the control programs and check/prove the program. They will also be required to adjust/edit the robot program, following proving/editing procedures to achieve the control specification. They must ensure that any edited programs are saved and backed up safely and correctly. In preparing the robot, they will be expected to select the appropriate workholding devices, and to mount and secure them in the appropriate location. They will also be required to select the appropriate tools or accessories, and to mount and secure them to the robot arm. They will need to ensure that all the tools/accessories have been allocated a relevant tool number, and that the relevant data on their co-ordinates and datum positions is entered into the robot's operating program. Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for preparing and using industrial robots. They will need to take account of any potential difficulties or problems that may arise with the robot related 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 robot programming and operating techniques safely. They will understand the robotic process, and its application, and will know about the sensors and actuators used in the process, the programming, editing and proving process, workholding devices, tooling/accessories and setting-up procedures, 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 industrial robots, and with associated tools and equipment. They will be required to demonstrate safe working practices for any robotic cell they are working on, 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 Standard Requirements In order to prove their ability to combine different processes and operations, at least one of the activities carried out must be of a significant nature, and must cover a minimum of four of the activities listed in paragraph 6 plus five of the operations identified in paragraph 8 in the Skills Section

Performance Requirements

The apprentice must be able to:

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

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

P3 **plan the programming activities before they start them**

P4 **determine an operational sequence that avoids wasted robot arm movements and tool/accessory changes**

P5 **produce industrial robot control programs, in the appropriate formats, containing all the relevant and necessary data for the engineering activity to be carried out**

P6 **load/input the program to the robot controller, and check the program for errors using the approved procedures**

P7 **make sure that codes and other references used in the programs are applicable to the type of controller used**

P8 **save and store the program, in line with organisational procedures**

P9 **mount and set the required workholding devices and robot tooling**

P10 **run the operating program, and check and adjust the operating parameters to achieve the component specification**

P11 **measure and check that all dimensional and geometrical aspects of the component are to the specification**

P12 **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**

P13 **shut down the equipment to a safe condition on completion of the robotic activities**

Skills Requirements

The apprentice must be able to:

S1 **Apply all of the following checks and practices during the robot 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 check that all the teach pendant/computer equipment is correctly connected, and is in a safe and usable working condition (such as cable undamaged, safely routed and PAT tested)

1.3 power up the equipment and activate the programming software

1.4 set up the computer system to produce the program

1.5 ensure that the correct process input/output and control data to produce the program is obtained and checked for currency and validity

1.6 store completed program media safely and correctly, away from contaminants or possible corruption

S2 **Prepare and use one of the following types of industrial robot:**

2. Cartesian (gantry)

2. SCARA

2. articulated

2. parallel

2. other specific type

S3 **Prepare, load and prove programs using one of the following types of robot programming methods:**

3. positional commands (x, y, z)

3. teach pendant

3. off-line programming

3. other specific method

S4 **Produce robot programs for one of the following engineering applications:**

4. welding

4. logistics movement/control

4. surface coating

4. packaging

4. gluing/sealing

4. stud welding

4. machine loading/unloading

4. assembly

4. other specific activity

S5 **Select and set up one of the following types of robot end effectors for the engineering application of:**

5. welding guns

5. spot welders

5. spray guns

5. glue/sealing gun

5. grippers

5. drills

5. vacuum devices

5. other specific tooling

S6 **Develop programs that contain all of the following:**

6. safe start and stop positions

6. all necessary positional information

6. type of motion (such as joint interpolated, linear, circular)

6. preparatory commands and process management/auxiliary functions

6. repetitive programs (such as sub-routines, canned cycles, labels, function blocks)

6. speed/acceleration parameters

6. sensor information

6. programs downloaded from the appropriate and approved source

S7 **Prove the robot program using four of the following:**

7. single block run

7. full dry run

7. search facilities

7. edit facilities

7. program override controls

7. data input facilities

7. all modes (such as auto, T1, T2 and remote)

S8 **Carry out operations for one of the applications identified in section 4, to include all of the following:**

8. checking that all safety mechanisms are in place and that the equipment is set correctly for the required operations

8. positioning work in relation to the robot parameters (such as securing in the workholding device)

8. running the operating program in accordance with operating procedures

8. checking that all operations are carried out safely and correctly

8. editing programs using the correct procedure (where appropriate)

8. examining the completed work visually and/or using suitable test/measuring instruments, gauges or checking fixtures, as appropriate to the operations performed (where applicable)

8. determining if the completed setup completes the operations to the required specification, including repeatability and accuracy

Knowledge and understanding
The apprentice must know and understand:

K1 the safe working practices and procedures to be followed when developing and proving industrial robot operating programs

K2 the hazards associated with using industrial robots (such as automatic/sudden movements of arm, power operated accessories), and how they can be minimised

K3 the importance of wearing the appropriate protective clothing and equipment (PPE), and of keeping the work area clean and tidy

K4 the safety mechanisms on the robot and operating envelope (such as emergency stop buttons, movement/hazard sensors), and the procedure for checking that they function correctly

K5 how to stop the robot in both normal and emergency situations, and the procedure for restarting after an emergency

K6 the importance of applying the appropriate behaviours in the workplace and the implications for the apprentice and the business if these are not adhered to

K7 the correct operation of all available modes (such as automatic operation, teach pendant, program operating and control buttons)

K8 how to drive the robot in each type of coordinate frame (such as tool, global, joint, user)

K9 how to drive the robot at different speeds, including jog mode

K10 the main robot types that are available, and the importance of understanding that a different robot may use a completely different syntax for similar functions

K11 the information and data required in order to produce complete and accurate robot programs

K12 how to extract and interpret general and technical data and information from different sources (such as drawings, computer models, symbols and conventions, BS or ISO standards) in order to produce the robot program

K13 the factors to be taken into account when producing robot programs (including the type of robot and its control capabilities, safety, the product/environment being controlled)

K14 how to produce effective and efficient programs to avoid unnecessary operations (such as using function blocks and canned cycles, to reduce program size)

K15 the methods and procedures used to check that the completed program will perform safely, accurately and efficiently (such as conducting trial runs, using single block run, dry run and speed override controls)

K16 how to save the completed programs in the appropriate format, and the importance of storing program safely and correctly, away from contaminants and possible corruption

K17 how to back up completed or edited programs, and the implications if this is not carried out effectively

K18 the methods and procedures used to minimise the chances of infecting a computer with a virus

K19 the implications if the computer they are using does become infected with a virus and who to contact if it does occur

K20 the problems that can occur with the downloading and running of the robot program, and how these can be overcome

K21 the various workholding devices that are used for robot applications, and the methods of positioning and setting them in relation to the robot's operating parameters (such as jigs and fixtures)

K22 the various tools and end effector equipment that are used for the particular robot operations (such as mechanical grippers, welding torches, stud guns, spray guns, drilling attachments)

K23 why they need to ensure that tools are positioned correctly in relationship to the robot's reference points and tool centre points

K24 the importance of checking that the tool change positions (where appropriate) are clear of the workpiece and can be safely and quickly achieved

K25 the need to ensure that all guards are in place and that the interlock systems are in correct working order

K26 running the robot operating program and checking that all operations are carried out safely and correctly

K27 how to check that the finished operations meet the work specification

K28 typical problems that can occur with the programming, loading and editing activities, and what to do if they occur

K29 when to act on their own initiative and when to seek help and advice from others

K30 the importance of leaving the work area and machine in a safe condition on completion of the activities (such as correctly isolated, operating programs closed or removed, cleaning the machine, and removing and disposing of waste)

Unit 018 Preparing and using industrial robots

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
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Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
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Grading System	Pass/Fail
Review Date	2017

Unit 019 General turning, milling and welding applications

Level:	Level 2
GLH:	180
Relationship to NOS:	EUCL2F-019
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 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 your 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 Standard 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).

Performance Requirements

The apprentice must be able to:

Turning and Milling

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

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

P3 **plan the machining activities before they start them**

P4 **obtain and prepare the appropriate materials, tools and equipment**

P5 **grind lathe tools and drills to meet the required component specification**

P6 **mount and set the required workholding devices, workpiece and cutting tools**

P7 **set and adjust the machine tool speeds and feeds to achieve the component specification**

P8 **use the machine tool controls safely and correctly, in line with operational procedures**

P9 **measure and check that all dimensional and geometrical aspects of the component are to the specification**

P10 **deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve**

P11 **shut down the equipment to a safe condition on completion of the machining activities**

Welding

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

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

P3 **plan the welding activities before they start them**

P4 **obtain and prepare the appropriate welding equipment and welding consumables**

P5 **prepare and support the joint, using the appropriate methods**

P6 **tack weld the joint at appropriate intervals, and check the joint for accuracy before final welding**

P7 **weld the joint to the specified quality, dimensions and profile**

P8 **use appropriate methods and equipment to check the quality, and that all dimensional and geometrical aspects of the weld are to the specification**

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

P10 **shut down and make safe the welding equipment on completion of the welding activities**

Skills Requirements

The apprentice must be able to:

S1 **Carry out all of the following 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 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

S2 **Machine two different types of material from the following:**

2. ferrous

2. non ferrous

2. non metallic

S3 **Use four of the following workholding methods and techniques:**

- **3.** three-jaw chuck
- **3.** collet chuck
- **3.** four-jaw chuck
- **3.** machine vice
- **3.** clamping direct to milling machine table
- **3.** indexing device
- **3.** other work holding/supporting methods (such as vee blocks, parallels, drive plate and centres)

S4 **Carry out turning operations to include all of the following:**

- **4.** mounting the workpiece in an appropriate workholding device
- **4.** mounting cutting tools in tool holders to give the correct centre height
- **4.** selecting and setting appropriate feeds and speeds
- **4.** facing off
- **4.** producing chamfers
- **4.** producing tapered diameters
- **4.** producing parallel diameters
- **4.** centre drilling and drilling a hole
- **4.** producing stepped diameters
- **4.** reaming or boring a hole
- **4.** producing and/or maintaining internal and external threads
- **4.** producing grooves/undercuts
- **4.** producing radii
- **4.** parting off
- **4.** knurling

S5 **Carry out milling operations, to include all of the following:**

5. mounting the workpiece in an appropriate workholding device

5. mounting cutting tools on appropriate arbors or direct to the machine spindle

5. selecting and setting appropriate feeds and speeds

5. producing flat and square faces

5. producing an enclosed slot (such as a key way)

5. producing parallel faces

5. producing an open ended slot

5. producing angular faces

5. centre drilling and drilling a hole

5. reaming a hole

5. producing a tapped hole

S6 **Carry out the necessary checks for accuracy, to include all of the following:**

6. linear dimensions (such as length, depth and width)

6. external and internal diameters

6. hole size and position

6. thread size and fit

6. squareness

6. angles

6. position

6. parallelism

6. surface finish

S7 **Use all the following during the machining activities:**

7. external micrometers

7. vernier/digital/dial calliper

7. protractors

7. dial test indicators (DTI)

7. squares

Plus four more of the following:

7. rules

7. bore/hole gauges

7. squares

7. slip gauges

7. radius/profile gauges

7. depth micrometers

7. thread gauges

7. depth verniers

7. feeler gauges

7. surface finish equipment (such as comparison plates, machines)

7. coordinate measuring machine (CMM)

S8 **Produce components within all of the following standards, as applicable to the process:**

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

8. general dimensional tolerance +/- 0.25mm or +/- 0.010”

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

8. flatness and squareness 0.05mm per 25mm or 0.002″ per inch

8. angles within +/- 0.5 degree

8. screw threads to BS Medium fit

8. reamed holes within H8

8. surface finish 63µin or 1.6 µm

S9 **Carry out all of the following during the welding activities:**

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

9. 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. return all tools and equipment to the correct location on completion of the fabrication activities

S10 **Use one material from the following:**

- 10 carbon steel
- 10 stainless steel
- 10 aluminium
- 10 plate
- 10 sheet (less than 3mm)
- 10 pipe/tube
- 10 section
- 10 other forms

S11 **Use manual welding and related equipment, to include one of the following welding processes:**

- 11 MMA
- 11 MIG
- 11 MAG
- 11 TIG
- 11 Flux cored wire welding
- 11 manual oxy/fuel gas welding

S12 **Produce two of the following welded joints of at least 150mm long, with at least one stop and start included:**

- 12 fillet lap joints
- 12 corner joints
- 12 tee fillet joints
- 12 butt joints

S13 **Weld joints in good access situations in two of the following BS EN ISO 6947 positions:**

- 13 Flat (PA)
- 13 Vertical upwards (PF)
- 13 Horizontal vertical (PB)
- 13 Vertical downwards (PG)
- 13 Horizontal (PC)

S14 **Check that the welded joint conforms to the specification, by checking all of the following:**

- 14 dimensional accuracy
- 14 size and profile of weld
- 14 alignment/squareness

S15 **Carry out testing of the welds, using one of the following:**

- 15 dye or fluorescent penetrant
- 15 nick break test
- 15 bend tests (such as face, root or side, as appropriate)

S16 **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 welds meet the required dimensional accuracy
- 16 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 the weld contour is linear, of uniform profile, free from excessive undulations, with regular and even ripple
- 16 the welds are adequately fused, and there is minimal undercut, overlap and surface inclusions
- 16 joins at stop/start positions merge smoothly, with no pronounced hump or crater in the weld surface

16 tack welds are blended in to form part of the finished weld, without excessive hump

16 the weld surface is free from cracks, and substantially free from porosity, shrinkage cavities and trapped slag

16 the weld surface and adjacent parent metal is substantially free from arcing or chipping marks

Knowledge and understanding
The apprentice must know and understand:

General

K1 the health and safety requirements, and safe working practices and procedures required for the turning, milling and welding activities undertaken (such as wearing the required protective clothing and equipment (PPE), using the appropriate guarding, fire prevention, safety in combined spaces, fume extraction and control and keeping the work area safe and tidy

K2 the hazards associated with the activities (such as use of power tools, trailing leads or hoses, damaged or badly maintained tools and equipment, using files with damaged or poor fitting handles, using machine tools and welding equipment, live electrical components, hot spatter/slag, elevated working), and how they can be minimised

K3 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

K4 how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken

K5 how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing

K6 when to act on your own initiative and when to seek help and advice from others

K7 the importance of leaving the work area and equipment in a safe and clean condition on completion of the machining and welding activities

Turning and Milling

K8 methods of holding the workpiece for the turning and milling activities (such as machine vice, chuck, collets or clamped directly to the machine table)

K9 the various turning operations that can be performed (such as parallel, stepped and tapered external diameters, drilled, bored and reamed holes, internal and external screw threads)

K10 the various milling operations that can be performed (such as flat, parallel, square and angled surfaces; open ended and enclosed slots, drilled and reamed holes)

K11 how to mount and secure the cutting tools in the tool holding devices (such as 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)

K12 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

K13 factors that affect the selection of cutting feeds and speeds, and the depth of cut that can be taken (such as type of material, size of material, operations being performed, workholding method/security of workpiece, condition of machine, finish and tolerance required)

K14 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

K15 how to check the workpiece and the measuring equipment that is used (such as rules, micrometers, verniers, gauges and surface finish comparison equipment)

K16 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

(such as lengths, diameters, depths, slots, hole positions, angles, profiles); measuring geometric features (such flatness, squareness, parallelism, concentricity, ovality); how to check surface finish (such as by using comparison blocks or instruments)

K17 problems that can occur with the turning and milling activities (such as defects caused by poor setting up of equipment and tooling, incorrect speeds and feeds) and how these can be overcome

Welding

K18 where applicable, the correct handling and storage of gas cylinders (such as manual handling and use of cylinder trolley, leak detection procedures, relevant BCGA codes of practice, cylinder identification, gas pressures, cylinder and equipment safety features)

K19 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)

K20 types, selection and application of electrode/wires and other consumables

K21 the types of welded joints to be produced (such as lap joints, corner joints, tee joints and butt welds)

K22 terminology used for the appropriate welding positions

K23 how to prepare the materials in readiness for the welding activity (such as 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)

K24 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)

Unit 019 General turning, milling and welding applications

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	4th July 2014
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 020 Forming and assembling pipework systems

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-020
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 cover a broad range of basic pipe fitting competences 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. **Specific Standard 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 scope 9. 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.

Performance Requirements

The apprentice must be able to:

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

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

P3 plan the pipe fitting activities before they start them

P4 cut the pipes to the appropriate lengths making allowances for bending and attachment of fittings

P5 bend and form the pipes using the appropriate tools and equipment for the types and sizes of pipe

P6 assemble and secure the pipework, using the correct fittings and joining techniques

P7 check the completed assembly to ensure that all operations have been completed and that the finished pipe assembly meets the required specification

P8 test the completed pipe assembly, using the appropriate techniques, tools and equipment

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

P10 leave the work area in a safe and tidy condition on completion of the assembly activities

Skills Requirements

The apprentice must be able to:

S1 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

S2 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

S3 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

S4 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

S5 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

S6 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

S7 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**

S8 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

S9 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)

S10 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

S11 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

S12 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 Requirements

The apprentice must know and understand:

K1	the health and safety requirements, and safe working practices and procedures required for the pipe fitting activities undertaken
K2	the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy
K3	the hazards associated with the pipe fitting activities (such as 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
K4	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
K5	the procedure for obtaining the required drawings, job instructions and other related specifications
K6	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
K7	How to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
K8	principles and methods of marking out pipework, and the type of equipment used (such as direct marking, use of templates, use of set wires)
K9	how to prepare the pipes in readiness for the marking out activities (visually checking for defects, cleaning the materials, removing burrs and sharp edges)
K10	how to determine the overall length of the pipework required, taking into account allowances for pipe fittings and (where appropriate) screwed connections
K11	the tools and equipment used in the cutting and preparing the pipes (such as saws, pipe and tube cutters)
K12	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
K13	the methods used to hand bend and form the pipe (including the use of bending springs, hand bending machines, fillers, heating methods)
K14	how to produce the various bends required (such as angled bends, dog-leg sets, bridge sets and expansion loops)
K15	the reasons for incorporating expansion loops in a system, and where they should be positioned
K16	the preparation of pipework and fittings for the assembly operation (such as checking for damage, removing foreign objects, dirt and swarf from bore of pipe, removing burrs)
K17	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)
K18	the different types of fittings available, such as screwed fittings, soldered fittings, compression fittings, push fit fittings and glued/cemented fittings
K19	how to produce screw threads on the pipe ends, and the tools and equipment that can be used (such as stocks and dies, pipe threading machines)
K20	methods used to seal screwed joints (such as tapes and sealing compounds)
K21	the use of flanges to connect pipes; use of gaskets; and torque loading of flange bolts
K22	the methods used to prepare pipe ends and fittings for soldering or brazing, and why it is necessary to ensure that these preparations are carried out

K23 the various types of soldered connectors available (such as solder ring types and capillary fittings)

K24 the methods used to solder the joints, and how to recognise when the fitting is correctly soldered

K25 the precautions to be taken when using gas torches to form the joint, and the effect of overheating the joint

K26 the methods used to prepare pipe ends and fittings when using adhesives, and why it is necessary to ensure that these preparations are carried out

K27 the methods used to cement the joints, and how to recognise when the fitting is correctly secured

K28 the various adhesives and sealing compounds that are used on non-metallic pipework

K29 the precautions to be taken when using the adhesives, cements and sealing compounds (such as adequate ventilation, fume extraction, away from naked flames, avoiding skin contact)

K30 the use of compression fittings; how the pipes are sealed; and the effects of over tightening the fittings

K31 the use of push-fit connectors, and their advantages and disadvantages

K32 how to identify the correct orientation of fittings with regard to flow, and the consequences of incorrect orientation

K33 the supporting methods that are used when assembling pipework, and the type of fittings that are used

K34 methods of testing pipework systems for leaks (using air, water or hydraulic testing methods)

K35 the extent of their own responsibility and whom they should report to if they have problems that they cannot resolve

K36 the importance of leaving the work area in a safe and clean condition on completion of the pipework assembly activities (such as removing and storing power leads, returning hand tools and equipment to is designated location, cleaning the work area and removing and disposing of waste)

Unit 020 Forming and assembling pipework systems

Supporting Information

Developed by	Advanced Manufacturing and Engineering Employer Trailblazer Group
Version number	Version 1.0
Date approved	17th February 2015
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing and Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Trailblazer Advanced Manufacturing and Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading system	Pass/Fail
Review date	2017

Unit 021 Preparing and proving CNC machine tool programs

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-021
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 cover a broad range of basic computer numerical control (CNC) programming competences 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 Standard 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 scope 5 in the skills requirement section.

Performance Requirements

The apprentice must be able to:

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

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

P3 plan the programming activities before they start them

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

P5 develop component programs using appropriate programming codes and techniques

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

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

P8 save and store the program in line with organisational procedures

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

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

Skills Requirements

The apprentice must be able to:

S1 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

S2 Prepare and prove programs for **one** of the following types of CNC machine tool:

2.1 two axis machine

2.2 multiple axis machines (4 or more)

2.3 three axis machine

2.4 machining centres

S3 Produce CNC programs using **one** of the following methods:

3.1 entered directly into the machine controller

3.2 using computer software

S4 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)

S5 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

S6 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

S7 Prove the part program using **six** of the following:

7.1 single block mode

7.2 graphic displays/modelling/simulation

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

S8 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 (where applicable)

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 apprentice must know and understand:

K1 the safe working practices and procedures to be followed when developing and proving CNC machine tool programs

K2 the hazards associated with using CNC machine tools (such as 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

K3 the importance of wearing the appropriate protective clothing and equipment (PPE), and of keeping the work area clean and tidy

K4 the safety mechanisms on the machine (such as emergency stop buttons, emergency brakes), and the procedure for checking that they function correctly

K5 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

K6 the correct operation of the various hand and automatic modes of machine control (such as program operating and control buttons)

K7 how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency

K8 how to use and extract information from engineering drawings or data and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken

K9 how to interpret first and third angle drawings, imperial and metric systems of measurement, absolute and incremental systems, workpiece zero/reference points and system of tolerancing

K10 the computer coding language used in CNC programs (with regard to machine axes, positional information, machine management and auxiliary functions)

K11 how to prepare part programs (using operational sequences and machining techniques that avoid unnecessary tool/cutter movements or tool changes)

K12 the use of features that enable reductions in program size and input time (such as canned cycles, subroutines and labels)

K13 the function keys and operating system of the machine computer control system being operated

K14 how to set machine datums for each of the machine axes being used

K15 how to set the machine control system in the programming and editing mode, download (input) and upload (output) modes

K16 how to deal with error messages and faults on the program or equipment

K17 how to access the program edit facility, in order to enter tooling data (such as tool datums, positions, lengths, offsets and radius compensation)

K18 the use of tool posts, magazines, carousels and turrets, and how to identify the tools in relationship to the operating program

K19 how to conduct trial runs (using single block run, dry run and feed and spindle speed override controls)

K20 factors that may affect the feeds and spindle speeds being used, and why they may need to be adjusted from the programmed values (such as condition of material, workholding method, tooling used, tolerance and finish to be achieved)

K21 the checks to be made before allowing the CNC machine to operate in full program run mode

K22 how to save the completed programs in the appropriate format, and the need to store programs and storage devices safely and correctly, away from contaminants and possible corruption

K23 typical problems that can occur with the programming, loading and editing activities, and what to do if they occur

K24 the methods and procedures used to minimise the chances of infecting a computer with a virus

K25 the implications if the computer they are using does become infected with a virus and who to contact if it does occur

K26 when to act on their own initiative and when to seek help and advice from others

K27 the importance of leaving the work area and machine in a safe condition on completion of the activities (such as correctly isolated, operating programs closed or removed, cleaning the machine and removing and disposing of waste)

Unit 021 Preparing and proving CNC machine tool programs

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 2.0
Date approved	11th December 2015
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing and Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Trailblazer Advanced Manufacturing and Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading system	Pass/Fail
Review Date	2017

Unit 022 Producing sheet metal components and assemblies

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-022
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 cover a broad range of basic sheet (up to and including 3 mm) metalworking competences 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 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. **Specific Standard 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 scope 7 plus **three** of the features listed in scope 9. 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.

Performance Requirements

The apprentice must be able to:

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

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

P3 plan the sheet metalworking activities before they start them

P4 obtain the appropriate tools and equipment for the sheet metalworking operations, and check that they are in a safe and usable condition

P5 mark out the components for the required operations, using appropriate tools and techniques

P6 cut and shape the materials to the required specification, using appropriate tools and techniques

P7 use the appropriate methods and techniques to assemble and secure the components in their correct positions

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

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

P10 leave the work area in a safe and tidy condition on completion of the fitting activities

Skills Requirements

The apprentice must be able to:

S1 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

S2 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

S3 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

S4 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

S5 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

S6 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

S7 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

S8 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

S9 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

S10 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)

S11 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

S12 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

The apprentice must know and understand:

K1 the health and safety requirements, and safe working practices and procedures required for the sheet metalworking activities undertaken

K2 the personal protective clothing and equipment (PPE)to be worn when carrying out the sheet metal activities (such as leather gloves, eye protection, ear protection), and the importance of keeping the work area safe and tidy

K3 the correct methods of moving or lifting sheet materials

K4 safe working practices and procedures to be observed when using manual and power operated tools

K5 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

K6 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

K7 the procedure for obtaining the required drawings, job instructions and other related specifications

K8 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

K9 how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing

K10 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)

K11 how to select and establish a suitable datum; the importance of ensuring that marking out is undertaken from the selected datum, and the possible effects of working from a different datum

K12 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)

K13 ways of laying out the marking-out shapes or patterns to maximise use of materials

K14 the tools and techniques available for cutting and shaping sheet metal (such as tin snips, bench shears, guillotines, portable power tools, bench drills, saws)

K15 the use and care of tools and equipment (including checks that must be made to ensure that the tools are fit for purpose - such as sharp, undamaged, plugs and cables secure and free from damage, PAT tested, machine guards or safety devices operating correctly)

K16 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

K17 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)

K18 methods of stretching and shrinking materials, and the tools, equipment and techniques used for this

K19 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)

K20 ways of limiting distortion, marking, creases, flats (in curved sections)

K21 the characteristics of the various materials used (with regard to the bending and forming process)

K22 how the materials are to be prepared for the forming operations, and why some materials may require a heating process prior to forming

K23 the importance of using tools or equipment only for the purpose intended; the care that is required when using the tools or equipment; the proper way of preserving tools or equipment between operations

K24 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)

K25 the preparations to be carried out on the components prior to assembling them

K26 how to set up and align the various components, and the tools and equipment that are used for this

K27 methods of temporarily holding the joints together to aid the assembly activities (such as clamps, rivet clamps)

K28 inspection techniques that can be applied to check that shape (including straightness) and dimensional accuracy are to specification and within acceptable limits

K29 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

K30 when to act on their own initiative and when to seek help and advice from others

K31 the importance of leaving the work area and equipment in a safe and clean condition on completion of the sheet metal activities (such as storing power leads, isolating machines, cleaning the equipment and removing and disposing of waste)

Unit 022 Producing sheet metal components and assemblies

Supporting Information

Developed by	Advanced Manufacturing and Engineering Employer Trailblazer Group
Version number	Version 1.0
Date approved	17th February 2015
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing and Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Trailblazer Advanced Manufacturing and Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 023 Maintaining and testing process instrumentation and control devices

Level:	Level 2
GLH:	150
Relationship to NOS:	EUCL2F-023
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 demonstrate a broad range of competences covering the maintenance of process instrumentation and control devices. These competences will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or they 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 instrumentation and control 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 instrumentation and control equipment being maintained, such as pressure, flow, level and temperature instruments, fiscal monitoring equipment, fire and gas detection and alarm systems, industrial weighing systems, speed measurement and control systems, vibration monitoring equipment, nucleonics and radiation measurement, telemetry systems and emergency shutdown 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 also be expected to cover a range of maintenance activities, such as isolating and locking off, disconnecting, removing and reconnecting instruments and faulty peripheral components, setting and adjusting

components, and 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 instrumentation 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 safely the appropriate maintenance techniques and procedures for process instrumentation and control equipment. They will understand the instrumentation maintenance process, and its application, and will know about the instrumentation and systems being maintained, and the 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.

Specific Unit Requirements

In order to prove their ability to combine different process instrumentation and control maintenance operations, at least one of the instrumentation maintenance activities carried out must be of a significant nature, and must cover a minimum of **eight** of the activities listed in scope 4.

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.

Performance Requirements

The apprentice must be able to:

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

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

P3 plan the maintenance activities before they start them

P4 obtain all the information they need for the safe removal and replacement of the instruments and/or sensors

P5 obtain and prepare the appropriate tools and equipment

P6 apply appropriate maintenance diagnostic techniques and procedures

P7 use the appropriate methods and techniques to remove and replace the required instruments/sensors

P8 carry out tests on sensing elements and associated instruments

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

P10 leave the work area in a safe and tidy condition on completion of the maintenance activities

Skills Requirements

The apprentice must be able to:

S1 Carry out **all** of the following during the instrumentation 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 where appropriate, ensure the safe isolation of instruments (such as electrical, pneumatic, process)

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 equipment/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

S2 Carry out maintenance activities on **two** of the following types of instrumentation and control systems:

2.1 pressure

2.2 speed measurement

2.3 fluid level

2.4 noise

2.5 fluid flow

2.6 vibration monitoring

2.7 temperature measurement

2.8 nucleonic and radiation measurement

2.9 fire detection

2.10 telemetry systems

2.11 gas detection

2.12 weight measurement

2.13 emergency shutdown

2.14 alarm systems

2.15 environmental

2.16 other specific system

S3 Use **four** of the following maintenance diagnostic techniques, tools and aids:

3.1 fault finding techniques (such as 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, leaks, 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)

S4 Carry out **all** of the following instrumentation maintenance activities:

4.1 removing excessive dirt and grime

4.2 replacing all `lifed' items (such as seals, gaskets)

4.3 taking electrostatic discharge (ESD) precautions (where appropriate)

4.4 replacing instruments/devices in the system

4.5 setting, aligning and adjusting components

4.6 disconnecting supply/signal connections

4.7 tightening fastenings to the required torque

4.8 removing instruments from the system

4.9 re-connecting instrumentation pipework and power supply

4.10 dismantling equipment to the required level

4.11 labelling/marking of components

4.12 checking signal transmission is satisfactory

4.13 checking components for serviceability

4.14 replacing or repairing damaged/defective components (such as electrical, mechanical and back-up batteries)

4.15 functionally testing the maintained equipment

S5 Set up and test sensing elements and/or stand-alone instruments, to include **three** of the following:

5.1 pressure (such as bourdon tube gauge, capsule/diaphragm gauge, pressure transducers)

5.2 temperature (such as thermocouple, resistance thermometers, liquid in steel thermometer)

5.3 flow (such as differential pressure systems, balanced flow meters, positive displacement)

5.4 level (such as displacer systems, purged dip leg, capacitance probes, differential pressure systems, ultrasonic probes)

5.5 other instruments/sensing elements (such as fire or gas detection, noise or vibration, speed or weight)

S6 Use **four** of the following types of instrumentation test and calibration equipment:

6.1 signal sources

6.2 pressure sources

6.3 logic probes

6.4 standard test gauges

6.5 comparators

6.6 temperature baths

6.7 analogue or digital meters

6.8 manometers

6.9 workshop potentiometers

6.10 digital pressure indicators

6.11 current injection devices

6.12 dead weight testers

6.13 calibrated flow meters

6.14 calibrated weights

6.15 insulation testers

6.16 special-purpose test equipment

S7 Maintain instrumentation and control systems, in accordance with **one** or more of the following:

7.1 organisational guidelines and codes of practice

7.2 equipment manufacturer's operation range

7.3 BS and ISO standards

Knowledge Requirements

The apprentice must know and understand:

K1	the health and safety requirements, and safe working practices and procedures required for the instrumentation maintenance activities undertaken
K2	the isolation and lock-off procedure or permit-to-work procedure that applies to the system and instruments being worked on, and how to check that any stored energy in pipework and instruments has been released
K3	the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy
K4	hazards associated with carrying out instrumentation and control maintenance activities (such as live electrical components, process controller interface, stored pressure/force, misuse of tools, using damaged or badly maintained tools and equipment, not following laid-down maintenance procedures), and how to minimise them
K5	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)
K6	the procedures and precautions to be adopted to eliminate electrostatic discharge (ESD)
K7	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
K8	how to obtain and interpret information from job instructions and other documents needed for the maintenance activities (such as drawings, circuit and physical layouts, charts, specifications, manufacturers' manuals, history/maintenance reports, symbols and terminology, BS and ISO wiring regulations)
K9	the basic principles of operation of the instrumentation being maintained (to include pressure, temperature, level and flow instrument sensors)
K10	how to identify the various instrument sensors (including how to identify their markings, calibration information, component values, operating parameters and working range)
K11	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)
K12	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)
K13	how to select and use a range of fault diagnostic equipment to investigate the problem
K14	the care, handling and application of instrumentation and control measuring instruments
K15	the reasons for making sure that control systems are isolated or put into manual control, and that appropriate trip locks or keys are inserted, before removing any sensors or instruments from the system, and the consequences of failing to do this
K16	the techniques used to dismantle/remove the equipment (such as release of pressures/force, proof marking to aid assembly, plugging exposed pipe/component openings, dealing with soldered joints, screwed, clamped and crimped connections)
K17	methods of attaching identification marks/labels to removed components or cables, to assist with reassembly
K18	methods of checking that components are fit for purpose, and the need to replace batteries, boards and other failed items
K19	the correct way of re-fitting instruments to avoid faulty readings (such as caused by head correction, poor flow past the sensor, blockages, incorrect wiring, poor insulation or incorrect materials)

K20	how to carry out visual checks of the instruments (such as security of joints and physical damage)
K21	the need to carry out tests and calibration checks on the various sensing elements and stand-alone instruments, and the use of standard calibration charts and tables
K22	the types and application of standard test equipment (such as pressure sources, deadweight tester, temperature baths, signal sources and comparators)
K23	how to check that tools and equipment are free from damage or defects and are in a safe, calibrated, PAT tested and usable condition
K24	the approved methods of carrying out the tests on each type of instrument/sensor; setting instrument zero readings; obtaining instrument readings and comparing them with the circuit parameters; making adjustments to instrument/circuit components
K25	the generation of maintenance documentation and/or reports following the maintenance activity
K26	the problems that can occur during the maintenance of the instrumentation and control system, and how they can be overcome
K27	the organisational procedure to be adopted for the safe disposal of waste of all types of materials
K28	when to act on their own initiative and when to seek help and advice from others
K29	the importance of leaving the work area in a safe and clean condition on completion of the maintenance activities (such as returning tools and test equipment to is designated location, cleaning the work area, and removing and disposing of waste)

Unit 023 Maintaining and testing process instrumentation and control devices

Supporting Information

Developed by	Advanced Manufacturing and Engineering Employer Trailblazer Group
Version number	Version 1.0
Date approved	17th February 2015
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing and Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **Customer.Services@enginuity.org** quoting Trailblazer Advanced Manufacturing and Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 024 Producing components by rapid prototyping techniques

Level:	Level 2
GLH:	110
Relationship to NOS:	EUCL2F-024
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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: Cover a broad range of basic competences that they need to produce components by rapid prototyping techniques. 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. They will be expected to prepare for the rapid prototyping 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 equipment in readiness for the required operations, to start a pre-prepared build and to have an understanding of imported stereo lithography (STL) files required for the build. In producing the components, they will need to set up the machine operating functions, parameters and safety devices, and to produce the components using safe and correct operating procedures. Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for using the rapid prototyping software and for operating the rapid prototyping equipment. 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 operate rapid prototyping machines safely. They will understand the rapid prototyping equipment used, 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 rapid prototyping 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.

Performance Requirements

The apprentice must be able to:

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

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

P3 select the type of rapid prototyping machine to be used

P4 identify material specification before they start

P5 check material availability

P6 load/input the program file to the machine controller, and check the program for errors using the approved procedures

P7 check that all safety mechanisms are in place, and that the equipment is set correctly for the required operations

P8 produce the required components, using appropriate manufacturing methods and techniques

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

P10 shut down the equipment to a safe condition on completion of the rapid prototyping activities

Skills Requirements

The apprentice must be able to:

S1 Prepare the system and data for operation by carrying out **all** of the following:

1.1 check that all the equipment is in a safe and usable working condition (such as undamaged, safety devices in place and operational)

1.2 obtain sufficient quantities of all required materials and checking use by dates

1.3 obtain all the necessary data, documentation and specifications for the components to be produced

1.4 download the correct build files to produce the components

1.5 check that data files are suitable for the application

1.6 apply safe working practices and procedures at all times

S2 Set up the rapid prototyping equipment, to include carrying out **all** of the following:

2.1 powering up the equipment and activating the appropriate software

2.2 importing files from system

2.3 loading materials

2.4 checking/setting equipment operating parameters

S3 Produce components using **one** of the following types of rapid prototyping equipment:

3.1 stereo lithography apparatus (SLA)

3.2 selective laser melting (SLM)

3.3 fused deposition modelling (FDM)

3.4 3D printing (thermojet)

3.5 selective laser sintering (SLS)

3.6 laminated object manufacturing (LOM)

3.7 direct metal laser sintering (DMLS)

3.8 digital light process (DLP)

3.9 other specific prototyping equipment

S4 Produce components made from **one** of the following materials:

4.1 photo-polymer resin

4.2 wax

4.3 laminated paper

4.4 plastics

4.5 metal

4.6 polyurethane

S5 Unload the components from the rapid prototyping equipment, to include carrying out **all** of the following:

5.1 removing the part from remaining raw material

5.2 removing the part from supports (where applicable)

5.3 pre-cleaning

5.4 infiltrate (when required)

5.5 packing to avoid damage

5.6 storing

5.7 complete all relevant documentation (such as material batch number, CAD file name, date of manufacture, operator's name, quality report)

S6 Produce components which comply with **all** the following quality and accuracy requirements:

6.1 correctly formed

6.2 checked against model specification

6.3 free from manufacturing defects

6.4 satisfactory visual appearance/finish

Knowledge Requirements

The apprentice must know and understand:

K1	the safe working practices and procedures to be observed when setting and operating rapid prototyping equipment (such as care when working with laser beams; machine guards; ventilation and fume extraction; machine safety devices)
K2	how to start and stop the machine in normal and emergency situations, and how to close the machine down on completion of activities
K3	the hazards associated with operating rapid prototyping machines (such as dangers from laser beams; live electrical components; materials; fumes/gases), and how they can be minimised
K4	the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy
K5	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
K6	the importance of ensuring that the machine is isolated from the power supply before working with the equipment
K7	the methods and procedures used to minimise the chances of infecting a computer with a virus
K8	the implications if the computer they are using does become infected with a virus and who to contact if it does occur
K9	the basic principles of rapid prototyping relevant to the machine being used
K10	the benefits and limitations of the different types of rapid prototyping equipment
K11	the rapid prototyping techniques used, and how to differentiate between the different processes (including the advantages and disadvantages)
K12	the finishing techniques that are required, and how they are applied to the different rapid prototyping processes
K13	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
K14	how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
K15	how to import appropriate files (STL) from a data system into the rapid prototyping software
K16	setting up the rapid prototyping equipment to achieve the component specification (such as electrical and optical conditions; focal distance; forming speed)
K17	how to place the machine in the correct operating mode, and how to access the program edit facility, in order to make minor adjustments for production
K18	the different materials used to produce components by the rapid prototyping process, and how the various materials used will affect the operating conditions that can be applied relevant to the machine being used
K19	the reasons why certain materials are suitable for producing components by the rapid prototyping process
K20	the importance of knowing when components can be unloaded from the machine in relation to the different rapid prototyping processes
K21	the importance of handling and storing materials correctly and linking to the correct documentation
K22	problems and defects that can occur in components produced by rapid prototyping processes, how these can occur, and what preventative actions are needed to overcome them

K23 when to act on their own initiative and when to seek help and advice from others

K24 the importance of leaving the machine in a safe condition on completion of the rapid prototyping activities (such as correctly isolated, operating programs closed or removed, cleaning the machine, and removing and disposing of waste)

Unit 024 Producing components by rapid prototyping techniques

Supporting Information

Developed by	Advanced Manufacturing and Engineering Employer Trailblazer Group
Version number	Version 1.0
Date approved	17th February 2015
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing and Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **Customer.Services@enginuity.org** quoting Trailblazer Advanced Manufacturing and Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 029 Using computer software packages to assist with engineering activities

Level:	Level 2
GLH:	80
Relationship to NOS:	EUC2F-029
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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: Cover a broad range of basic competences that they need, to operate a computer and use a variety of software packages to assist with engineering activities, such as report writing, stock/stores control, costing activities and electronic mail. 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 Brief This EUC identifies the training and development required in order that the apprentice can demonstrate that they are competent in being able to cover a broad range of basic pipe fitting competences the working environment. The types of software package used will include the computer operating system, word processing, databases, spreadsheets, graphics packages and electronic mail. They will be expected to check that all power leads and peripheral connecting leads from their workstation are correctly and securely connected to the appropriate terminations, and that they are safely routed so as not to cause a trip hazard. They will use the correct procedure to power up and operate the computer and peripheral hardware, to access the appropriate software packages and to create and maintain suitable work folders and files. On completion of the activities, they will be expected to shut down the software and computer system, using the correct procedures, to return all documentation, reference manuals or specifications to the designated 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 working with the computer equipment. They will need to take account of any potential difficulties or problems that may arise with the computer hardware, software or activities undertaken, 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 operating procedures and techniques safely. They will understand the computer system and software packages used, and their application, and will know about the various tools and techniques used to carry out the various activities, to the required depth to provide a sound basis for carrying out the activities correctly. They will understand the safety precautions required when working with the computer 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.

Performance Requirements

The apprentice must be able to:

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

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

P3 **check that all connections to the computer and peripherals are correctly connected and in a safe working condition**

P4 **power up the equipment, using the correct operating procedures**

P5 **use appropriate sources to obtain the required information for the activities to be undertaken**

P6 **access the correct application software for the activities undertaken**

P7 **use appropriate techniques to create files and documents, in the required formats, that are sufficiently and clearly detailed**

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

P9 **shut down the computer system to a safe condition on completion of the activities**

Skills Requirements

The apprentice must be able to:

S1 Prepare the computer 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, where appropriate, log in as a user

1.3 check that all peripheral devices are operating correctly (such as keyboard, mouse, light pen, web camera, digitiser/tablet, scanner, printer/plotter)

1.4 create and maintain folders and files, in accordance with organisational procedures

S2 Use **all** of the following software packages:

Word-processing: Produce **three** of the following types of documentation:

2.1 standard letter

2.2 work timetable

2.3 memorandum

2.4 layouts/templates

2.5 facsimile

2.6 macros

2.7 curriculum vitae (CV)

2.8 project report

2.9 instruction manual

2.10 other specific application

Database: Create and use a database for **two** of the following applications:

2.11 personnel details list

2.12 plant maintenance information

2.13 address list (such as for mail merging)

2.14 fault diagnosis information

2.15 customer/sales details

2.16 stock control (such as tools or consumables)

2.17 other specific application

Spreadsheet: Create and use spreadsheets for **two** of the following applications:

2.18 budgeting

2.19 wages

2.20 cost analysis (such as transport, photocopying, materials)

2.21 project costing

2.22 other specific application

Graphics: Use graphics software to produce **two** of the following types of documentation:

2.23 preparing visual aids for a presentation

2.24 producing logbook entries

2.25 producing advertising material

2.26 producing technical information

2.27 other specific application

Electronic communication: Use **two** of the following methods:

2.28 company e-mail system

2.29 mobile text messaging

2.30 internet e-mail

2.31 web camera chat/conferencing

S3 Carry out **all** of the following whilst using the software packages:

3.1 ensure that they have all the required information/data for the activities to be carried out

3.2 open or create a suitable word processing file/format document which will display the information effectively

3.3 create a suitable spreadsheet/worksheet which contains a suitable number of cells and rows of the required width

3.4 where appropriate, enter formulae at the relevant point within the worksheet

3.5 use graphs which are representative of the information to be shown

3.6 create a suitable database with appropriate alpha/numeric fields and search facilities

3.7 use a font style and size of text in keeping with organisational codes and specific job requirements

3.8 enter alpha and numeric data/text accurately into the correct location

3.9 select and use appropriate text features (such as bold, italics, colour, underline)

3.10 import and export information to and from other files or software packages

3.11 correct routine errors or mistakes in operation

3.12 edit documents, using appropriate techniques for the package being used (such as using sort, search and replace, spelling and grammar checks)

S4 Save and store files in appropriate locations, to include carrying out **all** of the following:

4.1 create a group of folders or directories in which related files can be stored

4.2 check that the file/document is correctly titled and referenced

4.3 determine the size of the file/document, and check for sufficient space on the storage device for saving it

4.4 save the file/document to an appropriate storage medium (such as hard drive, DVD, external storage device)

4.5 where appropriate, create a separate backup copy and place it in safe storage

4.6 produce a hard copy printout of the file/document

S5 Use computer software packages in compliance with **one** or more of the following:

5.1 organisational guidelines

5.2 statutory regulations and codes of practice

5.3 computer software standards

5.4 BS and ISO standards

The apprentice must know and understand:

K1 **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, also PAT test is in date**

K2 **the importance of good housekeeping arrangements (such as cleaning down work surfaces; storage devices, manuals and unwanted items of equipment into safe storage; leaving the work area in a safe and tidy condition)**

K3 **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**

K4 **the correct start-up and shutdown procedures to be used for the computer systems**

K5 **the methods and procedures used to minimise the chances of infecting a computer with a virus**

K6 **the implications if the computer they are using does become infected with a virus and who to contact if it does occur**

K7 **identification of the correct software package from the menu or operating systems environment; the various techniques that are available to access and use the software (such as mouse, menu or tool bar, light pens, digitisers and tablets, printers or plotters, and scanners)**

K8 **the use of software manuals or help facilities and related documents to aid efficient operation of the relevant software system**

K9 **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)**

K10 **the various software packages that are used within an engineering environment (such as word processing, databases, spreadsheets, graphic design and drawing packages, and electronic communication)**

K11 **the use of personal access codes, and logging on/off procedures that are required**

K12 **the various standard document formats that are used (such as letters, memoranda, facsimile, technical reports)**

K13 **how to create and set up a spreadsheet/worksheet, and how to determine and set out the required number of cells, rows, cell width**

K14 **how to create a database record, and how to determine and set out the required alpha/numeric fields of the correct size and type**

K15 **how to enter alpha/numeric and formulaic data, using keyboards, mouse and menu/tool bar facilities**

K16 **how to use highlighting/enhancement features and techniques**

K17 **how to edit documents using sort, search and edit facilities, spelling and grammar checks**

K18 **how to create tables, charts and graphs**

K19 **how to import and export files to and from other locations and other software packages**

K20 **how to save and store files/documents (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/document)**

K21 **the need to create backup copies, and to file them in a separate and safe location away from contamination and possible corruption**

K22 **how to produce hard copies of the documents that they have been working on**

K23 **when to act on their own initiative and when to seek help and advice from others**

K24 **the importance of leaving the work area and equipment in a safe condition on completion of the activities (such as correctly isolated, removing and disposing of waste)**

Unit 029 Using computer software packages to assist with engineering activities

Supporting Information

Developed by	Advanced Manufacturing and Engineering Employer Trailblazer Group
Version number	Version 1.0
Date approved	17th February 2015
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing and Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **Customer.Services@enginuity.org** quoting Trailblazer Advanced Manufacturing and Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 030 Producing CAD models (drawings) using a CAD system

Level:	Level 2
GLH:	110
Relationship to NOS:	EUC2F-030
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 cover a broad range of basic competences that they need, to set up and operate a computer aided drawing (CAD) system to produce detailed three-dimensional models for 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. They will be given a specific `model' brief or a request for a change/modification to a model, and they will be required to access these requirements and to extract all necessary information in order to carry out the modelling operations. They will need to select the appropriate equipment and modelling software to use, based on the type and complexity of the drawing functions to be carried out. They will be expected to produce models in a 3D modelling environment, and to print 2D and 3D prints or plots. On completion of the modelling 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 3D modelling and

	conventional mechanical and production engineering drawings. They will understand the modelling CAD system and software used, and its application, and will know about the various tools and techniques used to produce the models and 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 modelling/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 Standard Requirements** In order to prove their ability to combine different 3D modelling features, at least one of the models/drawings produced must be of a significant nature. It must involve a minimum of **five** of the operations listed in scope 7 in the skills section, and must include a minimum of **seven** of the features listed in scope 8 in the skills section.

Performance Requirements
The apprentice must be able to:

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

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

P3 **plan the modelling activities before they start them**

P4 **use appropriate sources to obtain the required information for the model to be created**

P5 **access and use the correct modelling software**

P6 **use appropriate techniques to create models that are sufficiently and clearly detailed**

P7 **use codes and other references that follow the required conventions**

P8 **make sure that models are checked and approved by the appropriate person**

P9 **save the models in the appropriate file type and location**

P10 **produce hard copies of the finished models, with sufficient detail to allow production**

P11 **deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve**

P12 **shut down the CAD system to a safe condition on completion of the modelling activities**

Skills Requirements
The apprentice must be able to:

S1 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 and PAT tested)

1.2 power up the equipment and activate the appropriate modelling software

1.3 set up and check that all peripheral devices are connected and correctly operating (such as keyboard, mouse, light pen, digitiser/tablet, scanner, printer, plotter)

1.4 set up the modelling environment and select a suitable template/folder

1.5 set the drawing datum at a convenient point (where applicable)

1.6 create a modelling template to the required standards, which includes all necessary detail (such as title, file/drawing number, material, date)

S2 Use **five** of the following to obtain the necessary data to produce the required model:

2.1 model brief/request

2.2 specifications

2.3 change order/modification request

2.4 regulations

2.5 manuals

2.6 sample component

2.7 calculations

2.8 previous models/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

S3 Take into account **five** of the following, as appropriate to the model being produced:

3.1 function

3.2 cost

3.3 physical space

3.4 quality

3.5 lifetime of the product

3.6 operating environment

3.7 manufacturing method

3.8 tolerances

3.9 interfaces

3.10 ergonomics

3.11 clearance

3.12 safety

3.13 materials

3.14 aesthetics

S4 Carry out **all** of the following before producing the engineering model:

4.1 ensure that the data and information they have is complete and accurate

4.2 review the data and information to identify the model requirements

4.3 recognise and deal with problems (such as lack of, or incorrect, information and technical issues)

S5 Use **one** of the following modelling tools:

5.1 surface modelling

5.2 solid modelling

5.3 wire frame modelling

S6 Use **all** of the following CAD operations to highlight design areas in the modelling environment:

6.1 pan

6.2 isometric

6.3 zoom

S7 Produce models which include the use of **eight** the following from the part feature menu:

7.1 extrude

7.2 solid model

7.3 mirror

7.4 revolve

7.5 wire frame

7.6 radius

7.7 hide

7.8 rib

7.9 rectangular pattern

7.10 fillet

7.11 cut/remove

7.12 circular pattern

7.13 shell

7.14 other specific feature

S8 Modify parts in the assembly environment using the following feature:

8.1 constrained parts and assemblies

Plus **eight** more from the following:

8.2 straight lines

8.3 insertion of standard components

8.4 hidden detail

8.5 dimensions

8.6 symbols and abbreviations

8.7 hatching and shading

8.8 angular surfaces

8.9 curved surfaces

8.10 parts lists

8.11 text

8.12 circles or ellipses

8.13 material colour

8.14 surface texture

8.15 other specific detail

S9 Produce a model for export to **one** of the following manufacturing systems:

9.1 CNC machine

9.2 3D printer

9.3 other specific system

S10 Save and store models in appropriate locations, to include carrying out **all** of the following:

10.1 ensure that their model has been checked and that it complies to their company QA procedure

10.2 check that the model is correctly titled, referenced and annotated

10.3 save the model to an appropriate storage medium (such as hard drive, DVD, external storage device)

10.4 create a separate backup copy, and place it in safe storage

10.5 register and store the models in the appropriate company information system (where appropriate)

10.6 record and store any changes to the models in the appropriate company information system (where appropriate)

S11 Produce models which comply with **one** or more of the following:

11.1 organisational guidelines

11.2 statutory regulations and codes of practice

11.3 CAD software standards

11.4 BS and ISO standards

11.5 other international standard

Knowledge and understanding
The apprentice must know and understand:

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

K2 the importance of good housekeeping arrangements (such as cleaning down work surfaces; putting storage devices, manuals and unwanted items of equipment into safe storage; leaving the work area in a safe and tidy condition)

K3 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

K4 the relevant sources and methods for obtaining any required technical information relevant to the model being produced (such as drawing briefs, specification sheets, request for changes or modifications to models; technical information such as limits and fits, contraction allowances, bearing selection, surface finish)

K5 identification of the correct 3D 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)

K6 the correct start-up and shutdown procedures to be used for the computer systems

K7 how to access the specific computer modelling software to be used, and the use of the help file to aid efficient operation of the relevant drawing system

K8 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)

K9 the documentation required for particular applications (such as design briefs, specification sheets, request for change orders)

K10 types of drawings that may be produced by the modelling software

K11 how to set up the viewing screen to show multiple views of the component to help with drawing creation (to include isometric front and side elevations)

K12 the national, international and organisational standards and conventions that are used for the models/drawings

K13 the application and use of modelling tools (such as for straight lines, curves and circles; how to add dimensions and text to drawings)

K14 how to access, recognise and use a wide range of standard components and symbol libraries from the CAD equipment

K15 the applications of different 3D modelling programmes (such as surface, solid and wire frame)

K16 how to produce models with sufficient information to allow them to be successfully exported to the manufacturing system used

K17 the need for document control (such as ensuring that completed models are approved, labelled and stored on a suitable storage medium)

K18 why it is necessary to be able to recall previous issues of modified models

K19 the need to create backup copies, and to file them in a separate and safe location , also filing and storing hard copies for use in production

K20 how to produce hard copies of the drawings, and the advantages and disadvantages of printers and plotters

K21 when to act on their own initiative and when to seek help and advice from others

K22 the importance of leaving the work area and equipment in a safe condition on completion of the drawing activities (such as correctly isolated, removing and disposing of waste)

Unit 030 Producing CAD models (drawings) using a CAD system

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 2.0
Date approved	11th December 2015
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing and Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **Customer.Services@enginuity.org** quoting Trailblazer Advanced Manufacturing and Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 031 Producing electrical or electronic engineering drawings using a CAD system

Level:	Level 2
GLH:	110
Relationship to NOS:	EUC2F-031
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 cover a broad range of basic competences that they need 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, and 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. **Specific Standard 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 scope 6 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

Performance Requirements

The apprentice must be able to:

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

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

P3 plan the drawing activities before they start them

P4 use appropriate sources to obtain the required information for the drawing to be created

P5 access and use the correct drawing software

P6 use appropriate techniques to create drawings, in the required formats, that are sufficiently and clearly detailed

P7 use codes and other references that follow the required conventions

P8 make sure that the drawings are checked and approved by the appropriate person

P9 save the drawings in the appropriate medium and location

P10 produce hard copies of the finished drawings

P11 deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

P12 shut down the CAD system to a safe condition on completion of the drawing activities

Skills Requirements

The apprentice must be able to:

S1 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)

S2 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

S3 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)

S4 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)

S5 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)

S6 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

S7 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

S8 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

The apprentice must know and understand:

K1	the specific safety precautions to be taken when working with computer systems (to include safety guidance relating to the use of visual display unit (VDU) equipment and work station environment (such as lighting, seating, positioning of equipment), repetitive strain injury (RSI); the dangers of trailing leads and cables; how to spot faulty or dangerous electrical leads, plugs and connections)
K2	good housekeeping arrangements (such as cleaning down work surfaces; putting storage devices, manuals and unwanted items of equipment into safe storage; leaving the work area in a safe and tidy condition)
K3	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
K4	the methods and procedures used to minimise the chances of infecting a computer with a virus
K5	the implications if the computer they are using does become infected with a virus and who to contact if it does occur
K6	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)
K7	the functionality of the circuit being drawn, and its interrelationship with other circuits and assemblies
K8	the correct start-up and shutdown procedures to be used for the computer systems
K9	identification of 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)
K10	the use of software manuals and related documents to aid efficient operation of the relevant drawing system
K11	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)
K12	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)
K13	the national, international and organisational standards and conventions that are used for the drawings
K14	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)
K15	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)
K16	how to access, recognise and use a wide range of standard components and symbol libraries from the CAD equipment
K17	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)
K18	an understanding of the electrical or electronic equipment and circuits being worked on, and the function of the individual components within the circuits
K19	the selection of the various components and cables being used (with regard to their operating ranges and current carrying capacity)

K20 the use of specific regulations and standard reference tables when selecting components and cables

K21 how power cables might affect/corrupt signal transmission, and the need to consider this in siting and routing cables

K22 the basic calculations that may be required to be carried out to verify the acceptability of components and circuits (such as Ohm's Law)

K23 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)

K24 the need to create backup copies, and to file them in a separate and safe location

K25 how to produce hard copies of the drawings, and the advantages and disadvantages of printers and plotters

K26 when to act on their own initiative and when to seek help and advice from others

K27 the importance of leaving the work area and equipment in a safe condition on completion of the drawing activities (such as correctly isolated, removing and disposing of waste)

Unit 031 Producing electrical or electronic engineering drawings using a CAD system

Supporting Information

Developed by	Advanced Manufacturing and Engineering Employer Trailblazer Group
Version number	Version 1.0
Date approved	17th February 2015
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing and Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **Customer.Services@enginuity.org** quoting Trailblazer Advanced Manufacturing and Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 032 Producing engineering project plans

Level:	Level 2
GLH:	80
Relationship to NOS:	EUC2F-032
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 cover a broad range of basic competences that they need to produce detailed plans for an engineering project. 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. They will be expected to prepare for the project planning activity by obtaining all necessary information, drawings, specifications and documentation. In producing the project plan, they will need to clearly identify what has to be done, the processes required to achieve this, the materials, component or consumables required, detailed instructions/operation sequence required, the estimated timescales and costs involved, the quality control requirements, and how they will evaluate and prove that the finished project has met its aims. Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the project planning activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the project planning 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 engineering project planning principles. They will understand the project planning techniques and procedures used, and their application, and will know about the engineering equipment, materials and consumables that will be required, to the required depth to provide a sound basis for carrying out the activities and

	producing project plans that will lead to a successful project outcome. They will understand the safety precautions required when carrying out the project planning operations. 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.

Performance Requirements
The apprentice must be able to:

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

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

P3 **determine the scope of the project and the processes required to achieve it**

P4 **collect all the information needed to prepare the project plan**

P5 **determine the resources required**

P6 **identify the specific operations to be carried out, and determine their sequence**

P7 **identify health and safety issues, and safe working practices and procedures that must be followed**

P8 **estimate timescales required and costs to complete the project**

P9 **prepare a detailed project plan which accurately reflects the project aims and objectives**

P10 **obtain approval for the project plan from the appropriate people**

P11 **deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve**

Skills Requirements
The apprentice must be able to:

S1 Produce detailed engineering project plans for **one** of the following:

1.1 manufacturing operations

1.2 maintenance of equipment

1.3 installation of equipment

1.4 research and development

1.5 testing and trialling

1.6 modification or repair

1.7 cleaning of equipment

1.8 process procedures

S2 Prepare for the project planning activity by carrying out **all** of the following:

2.1 determine and set the aims and objectives of the project

2.2 obtain all essential information and data needed to produce the project plans

2.3 collect relevant information on the engineering requirements, operations, methods and resources

2.4 determine the availability of the resources required

2.5 ensure that health and safety regulations and safe working practices are taken into account

2.6 present the engineering plans in the appropriate formats

S3 Determine the resource requirements, to include **five** of the following:

3.1 people required who have the necessary skills and knowledge

3.2 the raw materials required (such as types of material, forms of material, amounts of material)

3.3 mechanical fasteners required (such as nuts, bolts, rivets, cable clips)

3.4 bought-in standard components required (such as bearings, electrical or electronic components, fluid power components)

3.5 equipment required (such as hand tools, power tools, machinery, lifting and handling equipment)

3.6 measuring or test equipment required (such as mechanical measuring, electrical measuring)

3.7 consumable materials required (such as welding accessories, masking mediums, oil)

3.8 any outside support services required (such as material treatments like hardening or plating)

3.9 special/specific safety equipment required (such as fume extraction)

S4 Produce detailed work instructions of the specific processes required, to include **all** of the following:

4.1 details of the drawing/specification to be used (such as drawing number, maintenance manual)

4.2 specific materials required for this part of the process/operation

4.3 the specific tools and equipment required for each operation being carried out

4.4 the specific operations to be carried out

4.5 the specific sequence in which the operations must be carried out

4.6 the specific time to produce/complete the operations

4.7 quality control checks that need to be implemented

S5 Produce engineering project plans that include **both** of the following:

The use of a Gantt Chart showing estimates of the timeframe for the project, to include all of the following:

5.1 start time of the project

5.2 outcomes to be achieved at milestones

5.3 completion date of the project

And an estimate of the likely costs of the project, to include all of the following:

5.4 material costs (to include raw, consumable, bought-in)

5.5 labour costs (based on the estimated working time and a fixed manufacturing cost figure)

5.6 overhead costs

S6 Prepare engineering project plans that include all of the following:

6.1 the aims and objectives of the engineering project being undertaken

6.2 description of the activities to be carried out

6.3 the sequence in which the activities will take place

6.4 the documentation to be used (such as drawings, specifications, quality assurance)

6.5 tooling requirements (such as jigs, fixtures, cutting tools, moulds)

6.6 resources required

6.7 the timescales to be met

6.8 any special requirements that must be met (such as details of health and safety issues)

6.9 outcomes in terms of quality, cost and delivery (when needed)

6.10 people involved, and their responsibilities (such as decision maker, individuals that must be consulted/informed, people who can give advice)

6.11 how the project will be proved and evaluated

S7 Ensure that project plans include any relevant regulations, standards and guidelines, including **all** of the following:

7.1 health and safety requirements

7.2 BS and ISO standards and procedures

7.3 company policy and procedures

S8 Record and present the plans to the appropriate people, using the following methods:

8.1 verbal report

Plus **one** more method from the following

8.2 written or typed report

8.3 specific company documentation

8.4 computer based presentation

The apprentice must know and understand:

K1 how to access information on health and safety regulations and guidelines relating to the engineering activities to be used and project plans being produced

K2 the implications of not taking account of legislation, regulations, standards and guidelines when producing the engineering project plans

K3 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

K4 how to obtain information on the engineering requirements, and the type of information that is available (such as customer specifications and instructions, quality control requirements, product drawings/specification, manufacturing methods)

K5 how to access and use the appropriate information and documentation systems

K6 the types of data that should be included in the engineering project plans (such as aims and objectives of the project, activities to be carried out, sequence in which they must be carried out, timescales, resource requirements, health and safety issues)

K7 how to extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work being planned

K8 the materials, formats, codes and conventions that are used in preparing the engineering project plans

K9 the main project planning methods and techniques in use, and what problems could occur with them

K10 the factors to be taken into account when preparing the project plans, especially those covering working conditions and safety

K11 the main types of resource involved with the various types of engineering activity (such as raw materials, bought- in components, plant and equipment, lifting and handling equipment, tooling and measuring and test equipment)

K12 the obvious (and hidden) costs of resources/activities

K13 the normal timescales for carrying out specific engineering activities, and how and why they vary

K14 how to arrive at an estimate of timescales for the project, and the need to set milestones for achievement

K15 how to estimate the likely costs of the project (including the cost of raw materials, people and overheads)

K16 the products (or assets) involved in the activity being planned, and how to determine their availability

K17 the development of the engineering project plans (to include both master documents and working instructions, along with their purpose, content and status)

K18 how to write project plans that specify quality, cost and delivery requirements (including allocation of responsibilities and milestone targets)

K19 how to prepare the plans (to include the structure, style, clarity and compliance with relevant standards)

K20 the process used in the organisation to validate the engineering plans produced

K21 the procedures for changing the plans, and why control procedures are used

K22 the procedures and process for project plan approval, and why these procedures and processes are used

K23 the importance of maintaining records, what needs to be recorded and where records are kept

K24 why contingency plans need to be drawn up

K25 the different ways of presenting information to different people

K26 the importance of providing the right information at the right time

K27 typical of problems that can occur during the implementation of the plan, and how these problems can be rectified

K28 when to act on their own initiative and when to seek help and advice from others

Unit 032 Producing engineering project plans

Supporting Information

Developed by	Advanced Manufacturing and Engineering Employer Trailblazer Group
Version number	Version 1.0
Date approved	17th February 2015
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing and Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **Customer.Services@enginuity.org** quoting Trailblazer Advanced Manufacturing and Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 033 Preparing and using grinding machines

Level:	Level 2
GLH:	150
Relationship to NOS:	EUC2F-033
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 cover a broad range of basic grinding competences 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 grinding operations may be carried out on horizontal or vertical surface grinding machines, cylindrical or universal grinding machines. They will be expected to prepare for the grinding activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required grinding activities and the sequence of operations they intend to use. They will be required to prepare for the grinding activities by mounting, positioning and correctly setting a range of workholding devices, to mount the workpiece and use grinding techniques appropriate to the type of material, type of grinding wheel, workpiece rigidity and operations being performed. They will be expected to grind components that combine a number of different features, such as flat faces, parallel faces, faces square to each other, angular faces, steps and slots or parallel, stepped and tapered diameters, faces, bores and special forms/profiles. During, and on completion of, the grinding 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 grinding 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 grinding activities, they will be expected to remove the 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 grinding activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the grinding

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 grinding techniques safely. They will understand the grinding 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 grinding 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 Standard Requirements
In order to prove their ability to combine different grinding operations, at least one of the machined components produced must be of a significant nature, and must have a minimum of **three** of the features listed in scope 5 in the skills requirements section.

Performance Requirements

The apprentice must be able to:

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

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

P3 plan the grinding activities before they start them

P4 obtain and prepare the appropriate materials, tools and equipment

P5 mount and set the required workholding devices, and set and secure the workpiece

P6 set and adjust the machine tool speeds and feeds to achieve the component specification (where appropriate)

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

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

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

P10 shut down the equipment to a safe condition on completion of the grinding activities

Skills Requirements

The apprentice must be able to:

S1 Ensure that they apply **all** of the following checks and practices at all times during the grinding 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 grinding wheels are maintained in a suitable/safe condition
- 1.5 make sure the work area is maintained and left in a safe and tidy condition

S2 Grind components made from **two** of the following types of material:

- **2.1** ferrous

2.2 non ferrous

2.3 non metallic

S3 Mount, secure and machine components using **two** of the following workholding devices:

3.1 magnetic chuck or blocks

3.2 angle plates

3.3 chucks

3.4 fixed vice

3.5 vee block and clamps

3.6 centres

3.7 swivel or universal vice

3.8 fixtures

3.9 mandrels

S4 Prepare grinding wheels to include the following:

4.1 dressing and `truing up' grinding wheels

Plus **one** from:

4.2 relieving the wheel sides

4.3 wheel forming (such as chamfers, radii, angular forms, profiles)

S5 Produce ground components that combine different operations and have features that cover **five** of the following:

5.1 flat faces

5.2 parallel diameters

5.3 parallel faces

5.4 stepped diameters

5.5 faces square to each other

5.6 tapered diameters

5.7 vertical faces

5.8 counterbores

5.9 angular faces

5.10 tapered bores

5.11 steps and shoulders

5.12 parallel bores

5.13 slots

5.14 profile forms

S6 Carry out the necessary checks for accuracy, to include **all** of the following:

6.1 dimensions

6.2 parallelism

6.3 surface texture

Plus **two** more from the following

6.4 flatness

6.5 profile

6.6 concentricity

6.7 squareness

6.8 angle/taper

6.9 ovality/lobbing

S7 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 **three** more of the following:

7.5 squares

7.6 feeler gauges

7.7 internal micrometers

7.8 bore/hole gauges

7.9 depth micrometers

7.10 slip gauges

7.11 depth verniers

7.12 radius/profile gauges

7.13 comparators (external or internal)

7.14 protractors

7.15 coordinate measuring machine (CMM)

S8 Produce components to **all** of the following quality and accuracy standards, as applicable to the operation:

8.1 components to be free from false grinding cuts, wheel marks, burrs and sharp edges

8.2 general dimensional tolerance +/- 0.125mm or +/- 0.005”

8.3 there must be one or more specific dimensional tolerances within +/- 0.025mm or +/- 0.001”

8.4 flatness and squareness within 0.025mm per 25mm or 0.001” per inch

8.5 surface texture 8 µin or 0.2µm

8.6 angles/tapers within +/- 30 minutes

Knowledge and understanding
The apprentice must know and understand:

K1 the safe working practices and procedures to be followed when preparing and using grinding machines (such as ensuring the correct isolation of the machine before mounting the workholding devices and workpiece; fitting and adjusting machine guards and dust extraction equipment, ensuring that the workpiece is secure and grinding wheels are free from damage and clear of the workpiece before starting the machine)

K2 the hazards associated with the grinding operations (such as revolving/moving parts of machinery, sparks/airborne particles, bursting grinding wheels, insecure components, burrs and sharp edges on component), and how they can be minimised

K3 the personal protective equipment (PPE) to be worn for the grinding activities (such as correctly fitting overalls and safety glasses; ensuring that, if they have long hair, it is tied back or netted; and removing any jewellery or other items that can become entangled in the machinery)

K4 the safety mechanisms on the machine, and the procedure for checking that they function correctly

K5 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

K6 the correct operation of the machine controls in both hand and power modes, how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency

K7 planning and preparing to carry out the grinding operations (such as obtaining the component drawing, determining the machines required, selecting workholding methods and devices, selecting grinding wheels, determining a suitable sequence of operations, determining quality checks to be made and equipment to be used)

K8 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 (to include first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing)

K9 the main features of the grinding machine, and the accessories that can be used

K10 the range of workholding methods and devices that are used on grinding machines (such as magnetic chucks and blocks, vices, angle plates, fixtures, centres, mandrels, collets and chucks)

K11 how to position and secure workholding devices and the workpiece to the machine table, and the checks to be made (such as ensuring that all seating/location faces are clean and undamaged, the device is suitably aligned using instruments or tenons, as appropriate, checking that all bolts or other securing devices are tightened securely)

K12 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

K13 the various grinding operations that can be performed, and the types of grinding wheels that are used (such as surface grinding using solid, segmented and cup wheels; cylindrical grinding wheels and internal grinding wheels)

K14 how to check that the grinding wheels are in a safe and serviceable condition (such as free from damage, cracks, correctly balanced)

K15 the importance of `truing up' and dressing wheels to prevent glazing and burning of the workpiece, and methods of forming the wheels to the required profile (such as use of pantograph, diamond dressing units)

K16 the effects of backlash in machine slides and screws, and how this can be overcome

K17 the techniques of taking trial cuts and checking dimensional accuracy; the application of roughing and finishing cuts and the effect on wheel life, surface finish and dimensional accuracy

K18 factors that affect the selection of grinding feeds and speeds, and the depth of cut that can be taken (such as type of material, type of grinding wheel, operations being performed, workholding method/security of workpiece, condition of machine, finish and tolerance required)

K19 the application of cutting fluids with regard to a range of different materials, and why some materials do not require cutting fluids to be used

K20 how to recognise grinding faults, and how to identify when grinding wheels need dressing

K21 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)

K22 how to check that the measuring equipment is within current calibration dates and that the instruments are correctly zeroed; measuring linear dimensions (such as diameters, lengths, depths, slots, positions, angles, profiles); measuring geometric features (such flatness, squareness, parallelism); how to check surface finish (such as by using comparison blocks or instruments)

K23 the problems that can occur with the grinding activities (such as defects caused by glazed wheels, inappropriate feeds/speeds, damage by workholding devices), and how these can be overcome

K24 when to act on their own initiative and when to seek help and advice from others

K25 the importance of leaving the work area and machine in a safe condition on completion of the grinding activities (such as correctly isolated, cleaning the machine and removing and disposing of waste)

Unit 033 Preparing and using grinding machines

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	1.0
Date approved	31/1/16
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing and Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **Customer.Services@enginuity.org** quoting Trailblazer Advanced Manufacturing and Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 034 Preparing and using CNC turning machines

Level:	Level 2
GLH:	140
Relationship to NOS:	EUC2F-034
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 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 are 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 appropriate 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, and 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 scope 5 in the skills requirement section.

Performance Requirements
The apprentice must be able to:

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

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

P3 plan the CNC machining activities before they start them

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

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

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

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

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

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

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

Skills Requirements
The apprentice must be able to:

S1 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

S2 Position and secure workpieces, using **three** 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

S3 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

S4 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

S5 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

5.6 screw threads using formed tooling (external or internal)

Plus **four** more from the following:

5.7 tapered diameters

5.8 external profiles

5.9 parting-off

5.10 undercuts

5.11 reamed holes

5.12 eccentric diameters

5.13 bored holes

5.14 internal profiles

5.15 tapped holes

S6 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

S7 Machine components made from **all** of the following types of material:

7.1 ferrous

7.2 non ferrous

7.3 non metallic

S8 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

8.5 concentricity/coaxiality

8.6 thread fit

Plus **four** more from the following:

8.7 internal diameters

8.8 bore/hole size/fit

8.9 grooves/undercuts (such as position, width, depth)

8.10 angle/taper

8.11 eccentricity

8.12 ovality

S9 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 **six** 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)

S10 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 +/- 0.15mm or +/- 0.006”

10.3 there must be one or more specific dimensional tolerances within +/- 0.05mm or +/- 0.002”

10.4 surface finish 63 µin or 1.6µm

10.5 reamed / bored holes within H8

10.6 screw threads BS medium fit

10.7 angles/tapers within +/- 0.5 degree

Knowledge and understanding
The apprentice must know and understand:

K1	the safe working practices and procedures to be followed when preparing and using CNC lathes (such as ensuring the correct isolation of the machine before mounting workholding devices and tooling; fitting and adjusting machine guards; ensuring that the workpiece is secure and tooling is free from the workpiece before starting the machine)
K2	the hazards associated with the using CNC lathes, (such as 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
K3	the personal protective equipment (PPE) to be worn for the CNC turning activities (such as correctly fitting overalls and safety glasses; ensuring that, if they have long hair, it is tied back or netted; and removing any jewellery or other items that can become entangled in the machinery)
K4	the safety mechanisms on the machine (such as emergency stop buttons, emergency brakes), and the procedure for checking that they function correctly
K5	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
K6	the correct operation of the various hand and automatic modes of machine control (such as program operating and control buttons)
K7	how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
K8	how to use and extract information from engineering drawings or data and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken
K9	how to interpret first and third angle drawings, imperial and metric systems of measurement, absolute and incremental systems, workpiece zero/reference points and system of tolerancing
K10	the computer coding language used in CNC programs, with regard to machine axes, positional information, machine management and auxiliary/miscellaneous functions
K11	how to set the machine controller in the program and editing mode, and how to enter or download the prepared program
K12	how to deal with error messages and faults on the program or equipment
K13	the range of workholding methods and devices that are used on CNC lathes
K14	why it is important to set the workholding device in relationship to the machine datums and reference points
K15	the methods of setting the workholding devices, and the tools and equipment that can be used
K16	the range of cutting tools that are used on CNC lathes, and typical applications
K17	how to check that the cutting tools are in a safe and serviceable condition
K18	the use of tungsten carbide, ceramic and diamond indexible tips, and the factors that determine their selection and use (such as the condition of material supplied, hardness of the material, the cutting characteristics of the material, tolerances to be achieved, component surface finish and specifications)
K19	the various tool holding devices that are used, and the methods of correctly mounting and securing the cutting tools to the tool holders
K20	the advantages of using pre-set tooling, and how to set the tooling by using setting jigs/fixtures

K21 the use of tool posts, magazines and carousels, and how to position and identify the tools in relationship to the operating program

K22 how to place the machine into the correct operating mode, and how to access the program edit facility in order to enter tooling data (such as tool datums, positions, lengths, offsets and radius compensation)

K23 how to conduct trial runs using single block run, dry run, and feed and speed override controls

K24 the items that they need to check before allowing the machine to operate in full program run mode

K25 factors that affect the feeds and speeds that can be used, and why these may need to be adjusted from the program setting (such as type and condition of material, workholding method, tooling used, tolerance and finish to be achieved)

K26 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

K27 how to save the completed programs in the appropriate format, and the importance of storing programs and storage devices safely and correctly, away from contaminants and possible corruption

K28 typical problems that can occur with the CNC turning activities, and what to do if they occur

K29 when to act on their own initiative and when to seek help and advice from others

K30 the importance of leaving the work area and machine in a safe condition on completion of the activities (such as correctly isolated, operating programs closed or removed, cleaning the machine, ensuring that any spilt cutting fluids are correctly dealt with and disposing of waste)

Unit 034 Preparing and using CNC turning machines

Supporting Information

Developed by	Advanced Manufacturing and Engineering Employer Trailblazer Group
Version number	1.0
Date approved	31/1/16
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing and Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **Customer.Services@enginuity.org** quoting Trailblazer Advanced Manufacturing and Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 035 Preparing and using CNC milling machines

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-035
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 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 are 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 appropriate 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, and 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 scope 5 in the skills requirement section.

Performance Requirements

The apprentice must be able to:

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

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

P3 plan the CNC machining activities before they start them

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

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

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

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

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

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

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

Skills Requirements

The apprentice must be able to:

S1 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

S2 Position and secure workpieces, using **all** of the following workholding methods and devices:

2.1 machine vices

2.2 direct clamping to machine table

2.3 chucks

Plus **two** others from the following:

2.4 pneumatic or magnetic table

2.5 fixtures

2.6 ancillary indexing devices

2.7 angle plate

2.8 other workholding devices

S3 Select and mount **all** of the following types of milling cutters to the appropriate tool holding device:

3.1 face mills

3.2 slot drills

3.3 twist/core drills

Plus **one** from the following:

3.4 special profile cutters

3.5 boring tools

3.6 reamers

3.7 end mills

S4 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

S5 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

5.6 parallel faces

5.7 square faces

5.8 drilled holes on pitched circles

Plus **three** more from the following:

5.9 external profiles

5.10 tapped holes

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

S6 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

S7 Machine components made from **all** of the following types of material:

7.1 ferrous

7.2 non ferrous

7.3 non metallic

S8 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

8.5 squareness

8.6 parallelism

8.7 concentricity

Plus **two** more from the following:

8.8 Angles

8.9 Recesses

8.10 hole size/fit

8.11 thread fit

S9 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)

9.5 slip gauges

9.6 vernier protractors

Plus **four** more of the following:

9.7 rules

9.8 bore/hole gauges

9.9 internal micrometers

9.10 thread gauges

9.11 depth micrometers

9.12 plug gauges

9.13 depth verniers

9.14 radius/profile gauges

9.15 coordinate measuring machine (CMM)

S10 Produce components to **all** of the following quality and accuracy standards, as applicable to the operation:

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

10.10 general dimensional tolerance +/- 0.15mm or +/- 0.006”

10.11 there must be one or more specific dimensional tolerances within +/- 0.05mm or +/- 0.002”

10.12 surface finish 63 µin or 1.6µm

10.13 Reamed / bored holes within H8

10.14 screw threads BS medium fit

10.15 angles/tapers within +/- 0.5 degree

10.16 flatness and squareness 0.001” per inch or 0.025mm per 25mm

Knowledge and understanding

The apprentice must know and understand:

K1	the safe working practices and procedures to be followed when preparing and using CNC milling machines (such as ensuring the correct isolation of the machine before mounting workholding devices and tooling; fitting and adjusting machine guards; ensuring that the workpiece is secure and that tooling is free from workpiece before starting the machine)
K2	the hazards associated with the using CNC milling machines (such as 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
K3	the personal protective equipment (PPE) to be worn for the CNC milling activities (such as correctly fitting overalls and safety glasses; ensuring that, if they have long hair, it is tied back or netted; and removing any jewellery or other items that can become entangled in the machinery)
K4	the safety mechanisms on the machine (such as emergency stop buttons, emergency brakes), and the procedure for checking that they function correctly
K5	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
K6	the correct operation of the various hand and automatic modes of machine control (such as program operating and control buttons)
K7	how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
K8	how to use and extract information from engineering drawings or data and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken
K9	how to interpret first and third angle drawings, imperial and metric systems of measurement, absolute and incremental systems, workpiece zero/reference points and system of tolerancing
K10	the computer coding language used in CNC programs (with regard to machine axes, positional information, machine management and auxiliary functions)
K11	how to set the machine controller in the program and editing mode, and how to enter or download the prepared program
K12	how to deal with error messages and faults on the program or equipment
K13	the range of workholding methods and devices that are used on CNC milling machines
K14	why it is important to set the workholding device in relationship to the machine axis and reference points
K15	the methods of setting the workholding devices, and the tools and equipment that can be used
K16	the range of milling cutters/cutting tools that are used on CNC milling machines, and their typical applications
K17	how to check that the cutting tools are in a safe and serviceable condition
K18	the use of tungsten carbide, ceramic and diamond indexible tips, and the factors which will determine their selection and use (such as the condition of material supplied, hardness of the material, the cutting characteristics of the material, tolerances to be achieved, component surface finish and specifications)

K19 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

K20 the advantages of using pre-set tooling, and how to set the tooling by using setting jigs/fixtures

K21 the use of tool magazines and carousels, and how to position and identify the tools in relationship to the operating program

K22 how to place the machine into the correct operating mode, and how to access the program edit facility in order to enter tooling data (such as tool datums, positions, lengths, offsets and radius compensation)

K23 how to conduct trial runs (using single block run, dry run, and feed and speed override controls)

K24 the items that they need to check before allowing the machine to operate in full program run mode

K25 factors that affect the feeds and speeds that can be used, and why these may need to be adjusted from the program setting (such as type and condition of material, workholding method, tooling used, tolerance and finish to be achieved)

K26 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

K27 how to save the completed programs in the appropriate format, and the importance of storing programs and storage devices safely and correctly, away from contaminants and possible corruption

K28 typical problems that can occur with the CNC milling activities, and what to do if they occur

K29 when to act on their own initiative and when to seek help and advice from others

K30 the importance of leaving the work area and machine in a safe condition on completion of the activities (such as correctly isolated, operating programs closed or removed, cleaning the machine, and ensuring that any spilt cutting fluids are correctly dealt with and disposing of waste)

Unit 034 Preparing and using CNC turning machines

Supporting Information

Developed by	Advanced Manufacturing and Engineering Employer Trailblazer Group
Version number	1.0
Date approved	31 January 2017
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing and Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **Customer.Services@enginuity.org** quoting Trailblazer Advanced Manufacturing and Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 036 Preparing and using CNC machining centres

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-036
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 select the appropriate workholding devices, and to mount and secure them to the machine. They will also 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 are 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 machining 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 machining activities, they will be expected to remove appropriate 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 machining activities undertaken. They will need to take account of any potential difficulties or problems that may

	arise with the machining 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 machining techniques safely. They will understand the CNC machining centre 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 machining activities to the required specification. They will understand the safety precautions required when working with the CNC machining centre, 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 Standard Requirements In order to prove their ability to combine different features, 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 scope 5 in the skills requirement section.

Performance Requirements
The apprentice must be able to:

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

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

P3 plan the CNC machining activities before they start them

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

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

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

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

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

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

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

Skills Requirements
The apprentice must be able to:

S1 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 the work area is maintained and left in a safe and tidy condition

S2 Position and secure workpieces, using **three** of the following workholding methods and devices:

2.1 clamping direct to machine table

2.2 collet chucks

2.3 indexing/rotating device

2.4 machine vice

2.5 jigs and fixtures

2.6 magnetic or pneumatic devices

2.7 chucks with hard jaws

2.8 faceplates

2.9 angle plate

2.10 chucks with soft jaws

2.11 other workholding devices

S3 Select and mount the appropriate tool holding device and **eight** of the following types of cutting tool:

3.1 turning tools

3.2 thread cutting tools

3.3 face mills

3.4 slot drills

3.5 boring tools

3.6 centre drills

3.7 slotting cutters

3.8 grinding wheels

3.9 facing tools

3.10 twist/core drills

3.11 slitting saws

3.12 taps

3.13 profiling tools

3.14 reamers

3.15 end mills

3.16 dies

3.17 parting-off tool

3.18 recessing/undercutting tools

S4 Prepare the tooling for operation, by carrying out **all** of the following activities, as applicable to the machine type:

4.1 positioning tools in the correct position in the tool posts, turrets, magazine or carousel

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

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

4.4 pre-setting tooling by using setting jigs/fixtures

4.5 setting tool datum

4.6 saving changes to the program

S5 Produce machined components that combine different operations, and have features that cover **twelve** of the following:

5.1 parallel diameters

5.2 internal screw threads

5.3 drilled holes linearly pitched

5.4 stepped diameters

5.5 parting-off

5.6 drilled holes on pitched circles

5.7 tapered diameters

5.8 chamfers and radii

5.9 indexed or rotated forms

5.10 eccentric diameters

5.11 tapered holes

5.12 internal profiles

5.13 drilled holes

5.14 flat faces

5.15 external profiles

5.16 reamed holes

5.17 square faces

5.18 open ended slots

5.19 bored holes

5.20 parallel faces

5.21 enclosed slots/recesses

5.22 tapped holes

5.23 angular faces

5.24 grooves/undercuts

5.25 external screw threads

5.26 shoulders and steps

5.27 special forms (such as concave, convex)

S6 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 (cutter start/stop, coolant flow)

6.8 programs have been saved in the appropriate format

S7 Machine components made from **all** of the following types of material:

7.1 ferrous

7.2 non ferrous

7.3 non metallic

S8 Carry out the necessary checks for accuracy, to include **eight** of the following:

8.1 external diameters

8.2 slots (such as position, width, depth)

8.3 internal diameters

8.4 concentricity

8.5 linear dimensions (such as lengths, depths)

8.6 eccentricity

8.7 bore/hole size/fit

8.8 flatness

8.9 surface finish

8.10 parallelism

8.11 angle/taper

8.12 squareness

8.13 thread fit

8.14 ovality

8.15 grooves/undercuts (such as position, width, depth)

S9 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 **six** more of the following:

9.5 rules

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

9.7 internal micrometers

9.8 plug gauges

9.9 depth micrometers

9.10 radius/profile gauges

9.11 depth verniers

9.12 protractors

9.13 slip gauges

9.14 bore/hole gauges

9.15 coordinate measuring machine (CMM)

S10 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 +/- 0.15mm or +/- 0.006”

10.3 there must be one or more specific dimensional tolerances within +/- 0.05mm or +/- 0.002”

10.4 surface finish 63 µin or 1.6µm

10.5 reamed / bored 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 apprentice must know and understand:

K1	the safe working practices and procedures to be followed when preparing and using CNC machining centres (such as ensuring the correct isolation of the machine before mounting workholding devices and tooling; fitting and adjusting machine guards; ensuring that the workpiece is secure and that tooling is free from the workpiece before starting the machine)
K2	the hazards associated with the using CNC machining centres (such as automatic machine operations, power operated workholding devices, 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
K3	the personal protective equipment (PPE)to be worn for the CNC machining activities (such as correctly fitting overalls and safety glasses; ensuring that, if they have long hair, it is tied back or netted; and removing any jewellery or other items that can become entangled in the machinery)
K4	the safety mechanisms on the machine (such as emergency stop buttons, emergency brakes), and the procedure for checking that they function correctly
K5	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
K6	the correct operation of the various hand and automatic modes of machine control (such as program operating and control buttons)
K7	how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
K8	how to use and extract information from engineering drawings or data and related specifications (to include symbols and conventions to appropriate BS or ISO standards in relation to work undertaken
K9	how to interpret first and third angle drawings, imperial and metric systems of measurement, absolute and incremental systems, workpiece zero/reference points and system of tolerancing
K10	the computer coding language used in CNC programs (with regard to machine axes, positional information, machine management and auxiliary functions)
K11	how to set the machine controller in the program and editing mode, and how to enter or download the prepared program
K12	how to deal with error messages and faults on the program or equipment
K13	the range of workholding methods and devices that are used on CNC machining centres
K14	why it is important to set the workholding device in relationship to the machine datum/axis and reference points
K15	the methods of setting the workholding devices, and the tools and equipment that can be used
K16	the range of cutting tools that are used on CNC machining centres, and their typical applications
K17	how to check that the cutting tools are in a safe and serviceable condition
K18	the use of tungsten carbide, ceramic and diamond indexible tips, and the factors that determine their selection and use (the condition of material supplied, hardness of the material, the cutting characteristics of the material, tolerances to be achieved, component surface finish and specifications)

K19 the various tool holding devices that are used, and the methods of correctly mounting and securing the cutting tools to the tool holders

K20 the advantages of using pre-set tooling, and how to set the tooling by using setting jigs/fixtures

K21 the use of tool posts, magazines and carousels, and how to position and identify the tools in relationship to the operating program

K22 how to place the machine into the correct operating mode, and how to access the program edit facility in order to enter tooling data (such as tool datums, positions, lengths, offsets and radius compensation)

K23 how to conduct trial runs (using single block run, dry run and feed and speed override controls)

K24 the items that they need to check before allowing the machine to operate in full program run mode

K25 factors that affect the feeds and speeds that can be used, and why these may need to be adjusted from the program setting (such as type and condition of material, workholding method, tooling used, tolerance and finish to be achieved)

K26 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

K27 how to save the completed programs in the appropriate format, and the importance of storing programs and storage devices safely and correctly, away from contaminants and possible corruption

K28 typical problems that can occur with the CNC machining activities, and what to do if they occur

K29 when to act on their own initiative and when to seek help and advice from others

K30 the importance of leaving the work area and machine in a safe condition on completion of the activities (such as correctly isolated, operating programs closed or removed, cleaning the machine, and ensuring that any spilt cutting fluids are correctly dealt with and disposing of waste)

Unit 036 Preparing and using CNC machining centres

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	1.0
Date approved	31 January 2016
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing and Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **Customer.Services@enginuity.org** quoting Trailblazer Advanced Manufacturing and Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 037 Carrying out heat treatment of engineering materials

Level:	Level 2
GLH:	90
Relationship to NOS:	EUCL2F-037
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 apply specified heat treatment processes to engineering materials/components. 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. They will be expected to prepare for the heat treatment activities by obtaining all necessary information, documentation, materials, tools and equipment, and to plan how they intend to carry out the required heat treatment activities. They will be required to prepare the appropriate equipment to use, based on the heat treatment process and materials to be treated. They will be expected to use the specified or appropriate techniques to prepare the materials and equipment in readiness for the application of the treatments. The heat treatment activities will include the application of treatments such as flame hardening, case hardening, carburising, tempering, annealing and normalising, as applicable to the task. Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the heat treatment activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the activities, materials and equipment, 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 heat

	treatment techniques and procedures safely. They will understand the heat treatment 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 heat treatment operations, and when using the associated 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.

Performance Requirements
The apprentice must be able to:

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

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

P3 plan the heat treatment activities before they start them

P4 prepare the materials in readiness to receive the appropriate heat treatment

P5 check that the heat treatment equipment is set up and maintained at satisfactory operating conditions

P6 carry out the heat treatment process, using appropriate techniques and procedures

P7 check that the finished material achieves the required characteristics and meets the heat treatment specification

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

P9 shut down the heat treatment equipment to a safe condition on completion of the activities

P10 leave the work area in a safe condition on completion of the heat treatment activities

Skills Requirements
The apprentice must be able to:

S1 Carry out **all** of the following during the heat treatment 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 and heat treatment process specifications and procedures

1.3 ensure that the equipment is correctly prepared for the heat treatment operations being performed

1.4 store all tools and equipment on completion of the heat treatment activities

1.5 dispose of waste and excess materials, in line with agreed organisational procedures

S2 Carry out **three** of the following heat treatment processes:

- **2.1** flame hardening
- **2.2** carburising
- **2.3** annealing
- **2.4** case hardening
- **2.5** tempering
- **2.6** normalising/stress relieving

S3 Apply heat treatments to **two** different types of material from the following:

- **3.1** low carbon steel
- **3.2** chilled cast iron
- **3.3** copper
- **3.4** high carbon steel
- **3.5** welded fabrications
- **3.6** silver/tool steel
- **3.7** other materials (specify)

S4 Prepare the components for the heat treatment activities, by carrying out **two** of the following:

- **4.1** removing scale
- **4.2** masking
- **4.3** pre-heating
- **4.4** degreasing/cleaning
- **4.5** polishing area to be tempered

S5 Use **two** of the following methods of heating the components:

- **5.1** furnace
- **5.2** gas torches

5.3 blacksmith's forge

5.4 salt/chemical baths

S6 Use **two** of the following methods of quenching/cooling the material:

6.1 fresh water

6.2 oil

6.3 sand

6.4 salt water

6.5 air

6.6 leave in the furnace to cool

S7 Carry out the heat treatment activities to include **all** of the following:

7.1 lighting up the furnace/forge or torch, using approved procedures

7.2 setting the equipment to maintain the correct conditions (such as soak time, temperature)

7.3 checking that the components are correctly prepared for the required heat treatment activities (such as dry, at the correct temperature, correctly polished or masked, packed with carbon enriched material)

7.4 checking that there is sufficient cooling medium (so that it will not overheat or reach flash point)

7.5 loading the components safely into the heat source/solution

7.6 ensuring that components are left for the required induction period

7.7 removing the components from the heat source/solution safely and correctly

7.8 quenching/cooling the components, using the appropriate medium and technique

S8 Carry out simple checks on the heat treated components, to include **two** of the following:

8.1 visual checks for cracks or distortion

8.2 NDT tests (such as dye penetrant, magnetic particle, ultrasonic)

8.3 simple physical checks to confirm that hardening or annealing has been achieved (such as grinding wheel spark tests, file test)

8.4 specific hardness tests (such as Vickers, Brinell)

S9 Carry out heat treatment processes which comply with **all** of the following:

9.1 the final heat treated material is in line with the specification or job requirements

9.2 the heat treated material is free from defects

9.3 the heat treatment process meets customer/company requirements

Knowledge and understanding

The apprentice must know and understand:

K1 the specific health and safety precautions which must be taken when carrying out heat treatment processes (such as wearing protective clothing and protective equipment, using fume extraction equipment)

K2 the hazards associated with carrying out heat treatment processes (such as handling hot materials, using heat treatment solutions, fume inhalation, splashes from hot oil or liquids, fire and explosive mixtures), and how they can be minimised

K3 the personal protective equipment (PPE) to be used; how to obtain it and check that it is in a safe and usable condition (such as leather aprons, eye protection, overalls, face masks, breathing equipment)

K4 the importance of ensuring that fume extraction equipment is operating effectively, and that good housekeeping and fire prevention procedures are observed

K5 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

K6 the importance of following job instructions and defined heat treatment procedures

K7 how to obtain the required information on heat treatment temperatures, tempering colours, soak times and quenching/cooling methods to be used

K8 the various types of material that can be flame hardened, case hardened, tempered, normalised and annealed

K9 the material preparation methods and techniques to be undertaken prior to applying the heat treatments (such as removing scale, oil and dirt; masking surfaces to contain the case hardening or carburising deposits; polishing surfaces to be tempered; packing or coating the components with a carbon enriched material; pre-heating before immersion into a salt bath)

K10 the specific heat treatment process to be carried out, and the types of application for which they are best suited (such as flame hardening, case hardening, carburising, annealing, tempering and normalising)

K11 the basic principles of operation of the specific heat treatment process being carried out

K12 how to prepare the equipment for the heat treatment activities (such as setting furnace or salt bath controls to give correct temperature; the procedure for lighting and extinguishing the blacksmith's forge; setting up gas torches; ensuring that suitable tongs/handling devices are available)

K13 the visual checks to be made on the components prior to carrying out the surface treatment activities (such as checking that they are dry, have been pre-heated or are correctly masked up)

K14 the need to make certain that all components and jigs are completely free of water or other solvents prior to immersing them in a hot solution, and the potential consequences of failing to check this

K15 the methods used to hold/secure components in a heat treatment solution (such as wires, hooks, jigs)

K16 the importance of monitoring the equipment settings and process solutions during the heat treatment process

K17 heating the components to the correct temperature for the process being carried out (such as hardening temperatures for various carbon contents; soak times at set temperatures for carburising, annealing or normalising; temperatures and colours for various tempering applications), and why these must be adhered too

K18 the quenching and cooling methods to be used (such as fresh water, salt water, oil, sand, air and leaving the components in the furnace to cool naturally)

K19 the need to maintain quenching oil at a temperature below its flash point

K20 how to check the finished work after heat treatment (such as visual checks for cracks or distortion; using simple file or spark tests to check that hardening or annealing has been achieved; the use of dye penetrant and magnetic particle tests; the use of specialised hardness tests)

K21 the problems that can occur with the heat treatment operations, and how these can be overcome

K22 when to act on their own initiative and when to seek help and advice from others

K23 the importance of leaving the work area and equipment in a safe and clean condition on completion of the heat treatment activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Unit 037 Carrying out heat treatment of engineering materials

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	1.0
Date approved	31 January 2016
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing and Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **Customer.Services@enginuity.org** quoting Trailblazer Advanced Manufacturing and Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 038 Producing mechanical engineering drawings using a CAD system

Level:	Level 2
GLH:	110
Relationship to NOS:	EUCL2F-038
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 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 and 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 scope 7 in the skills requirement section.

Performance Requirements
The apprentice must be able to:

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

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

P3 plan the drawing activities before they start them

P4 use appropriate sources to obtain the required information for the drawing to be created

P5 access and use the correct drawing software

P6 use appropriate techniques to create drawings, in the required formats, that are sufficiently and clearly detailed

P7 use codes and other references that follow the required conventions

P8 make sure that drawings are checked and approved by the appropriate person

P9 save the drawings in the appropriate medium and location

P10 produce hard copies of the finished drawings

P11 deal promptly and effectively with problems within their control and seek help and guidance from the relevant people if they have problems that they cannot resolve

P12 shut down the CAD system to a safe condition on completion of the drawing activities

Skills Requirements
The apprentice must be able to:

S1 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 and check that all peripheral devices are connected and correctly operating (such as keyboard, mouse, light pen, digitiser/tablet, scanner, printer, plotter)

1.4 set up the drawing system to be able to produce the drawing to the appropriate scale

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.)

S2 Use **five** 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

S3 Take into account **five** 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

S4 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)

S5 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

S6 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

S7 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

S8 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)

S9 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 standards

Knowledge and understanding

The apprentice must know and understand:

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

K2 good housekeeping arrangements (such as cleaning down work surfaces; storage devices, manuals and unwanted items of equipment into safe storage; leaving the work area in a safe and tidy condition)

K3 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

K4 the methods and procedures used to minimise the chances of infecting a computer with a virus

K5 the implications if the computer they are using does become infected with a virus and who to contact if it does occur

K6 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 limits and fits, contraction allowances, bearing selection, surface finish)

K7 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

K8 the functionality of the component being drawn, and its interrelationship with other components and assemblies

K9 the correct start-up and shutdown procedures to be used for the computer systems

K10 identification of the correct drawing software package from the menu or operating environment; the various techniques that are available to access and use the CAD software (such as mouse, menu or tool bar, pens, digitisers and tablets, printers or plotters, and scanners)

K11 the use of software manuals and related documents to aid efficient operation of the relevant drawing system

K12 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)

K13 types of drawings that may be produced by the software (such as first and third angle drawings, sectional elevations, isometric or oblique drawings)

K14 how to set up the viewing screen to show multiple views of the drawing to help with drawing creation (to include isometric front and side elevations)

K15 the national, international and organisational standards and conventions that are used for the drawings

K16 how to set up the drawing template parameters (such as layers of drawings, scale, paper size, colour setup, line types, dimension system and text styles)

K17 the application and use of drawing tools (such as for straight lines, curves and circles; how to create hatching and shading on drawings; how to add dimensions and text to drawings; producing layers of drawings)

K18 how to access, recognise and use a wide range of standard components and symbol libraries from the CAD equipment

K19 the need for document control (such as ensuring that completed drawings are approved, labelled and stored on a suitable storage medium)

K20 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)

K21 the need to create backup copies, and to file them in a separate and safe location

K22 how to produce hard copies of the drawings, and the advantages and disadvantages of printers and plotters

K23 when to act on their own initiative and when to seek help and advice from others

K24 the importance of leaving the work area and equipment in a safe condition on completion of the drawing activities (such as correctly isolated, removing and disposing of waste)

Unit 038 Producing mechanical engineering drawings using a CAD system

Supporting Information

Developed by	Advanced Manufacturing Engineering Employer Trailblazer Group
Version number	1.0
Date approved	31 January 2016
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing and Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **Customer.Services@enginuity.org** quoting Trailblazer Advanced Manufacturing and Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 039 Assembling, wiring and testing electrical panels/components mounted in enclosures

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-039
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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, 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. Specific Standard 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 scope 2 plus six of the activities listed in scope 5. 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.

Performance Requirements

The apprentice must be able to:

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

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

P3 plan the electrical assembly, wiring and testing activities before they start them

P4 use appropriate sources to obtain the required specifications, circuit diagrams, components, assembly and test

P5 obtain the correct tools and equipment for the assembly and test operations, and check that they are in a safe and usable condition

P6 use the appropriate methods and techniques to assemble the components in their correct positions

P7 secure the components, using the specified connectors and securing devices

P8 wire and terminate cables to the appropriate connections on the components

P9 use appropriate test methods and equipment to check that the completed assembly is safe and meets all aspects of the specification

P10 deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

P11 leave the work area in a safe and tidy condition on completion of the electrical assembly and testing activities

Skills Requirements
The apprentice must be able to:

S1 **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

S2 **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

S3 **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

S4 **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

S5 **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

S6 **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

S7 **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 apprentice must know and understand:

K1 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)

K2 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

K3 the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy

K4 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)

K5 what constitutes a hazardous voltage and how to recognise victims of electric shock

K6 how to reduce the risks of a phase to earth shock (such as insulated tools, rubber matting and isolating transformers)

K7 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

K8 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

K9 the basic principle of operation of the equipment/circuits being assembled and wired, and the purpose of individual components within the circuit

K10 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)

K11 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)

K12 preparations to be undertaken on the components and enclosure, prior to the mounting activities

K13 how the components are to be aligned and positioned prior to securing, and the tools and equipment that are used

K14 how to identify any orientation requirements, values or polarity for the components used in the electrical wiring activities

K15 methods of attaching identification markers/labels during electrical assembly activities

K16 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)

K17 why electrical bonding/earthing is critical, and why it must be both mechanically and electrically secure

K18 the use of BS7671/IET wiring, and other regulations, when selecting wires and cables and when carrying out tests on electrical circuits

K19 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)

K20 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

K21 the problems that can occur with the wiring and testing operations, and how these can be overcome

K22 when to act on their own initiative and when to seek help and advice from others

K23 the importance of leaving the work area in a safe and clean condition on completion of the electrical assembly and wiring activities (such as returning hand tools and test equipment to the designated locations, cleaning the work area, removing and disposing of waste)

Unit 039 Assembling, wiring and testing electrical panels/components mounted in enclosures

Supporting Information

Developed by	Advanced Manufacturing and Engineering Employer Trailblazer Group
Version number	1.0
Date approved	31 January 2016
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing and Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **Customer.Services@enginuity.org** quoting Trailblazer Advanced Manufacturing and Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 040 Forming and assembling electrical cable enclosure and support systems

Level:	Level 2
GLH:	130
Relationship to NOS:	EUCL2F-040
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers Advanced Manufacturing and Engineering Sector 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 form and assemble metallic and non-metallic systems, and will cover the selection of the appropriate materials, cutting and bending/forming the appropriate pieces that make up the enclosure. They will need to assemble the prepared pieces, using a range of connection devices and to position, align and secure them in the correct locations, using the specified/appropriate techniques, wall/screen penetration and fastening devices. Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the cable enclosure forming and assembly activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the 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 cutting, bending forming and installation techniques and procedures safely. They will understand the forming and assembly methods and procedures used, and their application, and will know about the various enclosure systems and components used to produce the assemblies, 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 and installation activities, especially those for handling long lengths of conduit or trunking. 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 Standard Requirements In order to prove their ability to combine different cable enclosure forming and assembly operations, at least one of the cable enclosure and support systems produced must be of a significant nature, and must contain a minimum of four of the features listed in scope 4 in the skills requirement section.

Performance Requirements

The apprentice must be able to:

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

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

P3 plan the assembly and installation of the cable enclosure system before they start

P4 obtain the correct tools and equipment for the cutting, forming and assembly operations, and check that they are in a safe and usable condition

P5 cut and form the cable enclosure components to the required size and shape, using appropriate tools and techniques

P6 assemble the cable enclosure system, using the appropriate connectors

P7 mount and secure the cable enclosure components safely and correctly to meet the specification requirements

P8 check the completed assembly to ensure that all operations have been completed, and that the finished assembly is secure and meets the required specification

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

P10 leave the work area in a safe and tidy condition on completion of the forming and assembly activities

Skills Requirements

The apprentice must be able to:

S1 Carry out **all** of the following during the electrical cable enclosure forming 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 follow job instructions and assembly/installation drawings at all times

1.3 ensure that the electrical cable enclosure system is kept free from foreign objects, dirt or other contamination

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

S2 Form and assemble **two** of following types of electrical cable enclosures/support systems:

2.1 metal conduit systems

2.2 non-metallic conduit systems

2.3 metal trunking system

2.4 non-metallic trunking systems

2.5 traywork systems

S3 **Construct cable enclosures/support system components, to include carrying out all of the following:**

3.1 selecting the correct type and size of conduit, trunking or traywork (with regard to number of cables and climatic conditions)

3.2 cutting the materials to the correct lengths (taking into account allowances for bends or joints required)

3.3 removing all burrs and sharp edges

3.4 producing external threads on conduit

3.5 producing or fabricating bends, up to and including 90°

3.6 producing or fabricating bends over 90°

3.7 making tee/multiple junctions in trunking/traywork (where applicable)

3.8 producing or fabricating offsets

3.9 producing or fabricating bridge/saddle sets

S4 Assemble cable enclosure/support systems that include **all** of the following:

4.1 bends/elbows (solid or inspection type)

4.2 horizontal runs

4.3 boxes (such as circular or square, terminal or multi branch)

4.4 vertical drops

Plus **three** more from the following:

4.5 straight connectors/couplings

4.6 conversion units and adaptors

4.7 tee pieces (such as solid or inspection type)

4.8 cross over units (such as bridge or saddle sets)

4.9 reducers

4.10 off sets

S5 Apply **all** of the following installation methods and techniques:

5.1 marking out the location of the trunking, traywork or conduit

5.2 positioning and securing the trunking, traywork or conduit using mechanical fixings

5.3 drilling and preparing holes for the trunking, traywork or conduit

5.4 levelling and alignment of the wiring enclosures and components

S6 Check the completed assembly, to include carrying out **all** of the following:

6.1 checking for level and alignment

6.2 checking that all connections are secure

6.3 checking that sufficient supports are used and that they are correctly spaced

6.4 checking that correct outlets are used (such as for sockets, switches, light fittings, wire junction and inspection fittings)

S7 Produce cable enclosure/support systems in accordance with **one** or more of the following standards:

7.1 BS 7671/IET wiring regulations

7.2 Other BS and/or ISO standards

7.3 7.2 company standards and procedures

Knowledge and understanding
The apprentice must know and understand:

K1	the specific safety practices and procedures that they need to observe when forming and assembling cable enclosure/support systems (including any specific legislation, regulations or codes of practice for the activities, equipment or materials)
K2	the hazards associated with forming and assembling cable enclosure/support systems, and with the tools and equipment used (such as using bending and forming equipment, handling long lengths of pipe and trunking, using solvents and adhesives), and how they can be minimised
K3	the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy
K4	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
K5	the interpretation of circuit and wiring diagrams, and specifications used for the installation (including BS and ISO schematics, wiring regulations, symbols and terminology)
K6	the various types of electrical cable enclosure and support systems used, and their typical applications
K7	the factors to be taken into account when choosing metallic or non-metallic systems, and the effects of ambient temperatures within conduit and trunking systems
K8	marking out lengths to be cut, taking into account any allowances (such as for bending, screwing, gluing)
K9	methods of holding workpieces without damaging them (such as the use of a pipe vice)
K10	the tools and equipment used in the cutting, bending and forming operations (such as the use of conduit bending machines, threading equipment, hot air torches and bending springs)
K11	methods of producing bends and sets in conduit materials (such as 90° bends, offsets, bridge sets)
K12	methods of bending plastic conduit (such as using hot air guns and springs)
K13	how to produce fabricated bends in trunking and traywork section material (such as bends, tee junctions, double and saddle sets)
K14	the methods of forming screw threads on ends of conduit, and of using appropriate tools to remove all sharp edges and burrs
K15	the various fittings used to assemble conduit, trunking and traywork systems (including screwed fittings, cemented fittings, straight connectors, bends, tees, inspection fittings, light, power and control outlet boxes)
K16	the importance and use of inspection fittings (such as elbows and junction boxes)
K17	the problems to look for when checking finished components/installations (such as dimensional checks, position and angle of bends/sets, out of alignment, loose connections, insufficient supports, damaged threads, deformed pipe around area of bend, burrs and sharp edges that could damage cables, ensuring that trunking lengths are free from swarf or other obstructions before connecting into the system)
K18	how to join the system components (such as using screw fittings, cemented fittings, fabricated components, nuts and bolts)
K19	how to check alignment of components (including use of plumb bobs, levels and by visual means)
K20	the methods of supporting and securing the components (such as position and spacing of supporting brackets and devices, using pipe clips, saddles and supports)

K21 drilling masonry, and the types and application of masonry fixing devices used in installation work

K22 the need to ensure that components are clear of services (such as gas, water or electricity) before drilling walls

K23 the problems that can occur with the installation operations, and how these can be overcome

K24 when to act on their own initiative and when to seek help and advice from others

K25 the importance of leaving the work area in a safe and clean condition on completion of the assembly/installation activities (such as returning tools and equipment to its designated location, cleaning the work area, and removing and disposing of waste)

Unit 040 Forming and assembling electrical cable enclosure and support systems

Supporting Information

Developed by	Advanced Manufacturing and Engineering Employer Trailblazer Group
Version number	1.0
Date approved	31 January 2016
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing and Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **Customer.Services@enginuity.org** quoting Trailblazer Advanced Manufacturing and Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 041 Preparing and using electro-discharge machines

Level:	Level 2
GLH:	150
Relationship to NOS:	EUCL2F-041
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing Engineering 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 prepare and use electro-discharge machines, such as spark erosion and wire erosion machines (manual or CNC), in accordance with approved procedures. This involves selecting the appropriate work holding devices, mounting and positioning them to the machine in the correct location for the type of operation being carried out. They will be expected to select the appropriate electrodes or wires to use, check them for defects, and mount and secure them to the relevant parts of the machine. They will then check that the machine is ready for the operations to be performed, and that the required components, consumables and measuring equipment are available. They will be expected to produce a range of component shapes, such as internal and external profiles, that have flat, square, parallel, and tapered faces, square/rectangular forms, concave and convex forms, holes, slots, radii/arcs, cavities and special forms. They must operate the machine in line with safe working practices and approved procedures, and continuously monitor the erosion operations, making any necessary adjustments to settings in order to ensure that the work output is to the required quality and accuracy. Their responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. They will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

	Their underpinning knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying procedures for electro-discharge machining. They will have an understanding of the electro-discharge process and its application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification. They will understand the safety precautions required when setting and working with the machine, 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 a strong work ethic, positive attitude, team player, dependability, responsibility, honesty, integrity motivation and commitment.

Performance Requirements
The apprentice must be able to:

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

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

P3 plan the activities before they start them

P4 determine what has to be done and how the machine will be set to achieve this

P5 mount and set the workpiece and tooling

P6 set the machine tool operating parameters to achieve the component specification

P7 check that all safety mechanisms are in place and that the equipment is set correctly for the required operations

P8 manipulate the machine tool controls safely and correctly in line with operational procedures

P9 produce components to the required specification

P10 carry out quality sampling checks at suitable intervals

P11 deal promptly and effectively with error messages or equipment faults that are within their control and report those that cannot be solved

P12 shut down the equipment to a safe condition on conclusion of the activities

Skills Requirements
The apprentice must be able to:

S1 Ensure they apply **all** of the following checks and practices at all times during electro-discharge machining activities

1.1 obtain and use the appropriate documentation (such as job instructions, drawings, 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 follow safe practice/approved setting up procedures at all times

1.4 ensure that machine guards are in place and are correctly adjusted

1.5 where appropriate, seek any necessary instruction/training on the operation of the machine

1.6 hold components securely, without distortion

1.7 ensure that the appropriate fluids are at the appropriate levels

1.8 follow the defined operating procedures and apply safe working practices and procedures at all times

1.9 adjust machine settings, as required, to maintain the required accuracy

1.10 ensure that the components produced meet the required specification for quality and accuracy

1.11 leave the work area and machine in a safe and appropriate condition on completion of the activities

S2 Operate **one** of the following electro-discharge machines:

2.1 spark erosion machine (manual or CNC)

2.2 wire erosion machine (manual or CNC)

S3 Position and secure workpieces to machine table, to include **two** of the following:

3.1 clamping direct to machine table

3.2 angle plate

3.3 chucks (such as 3 or 4 jaw)

3.4 pneumatic or magnetic table

3.5 vee block and clamps

3.6 ancillary indexing device

3.7 machine vice (such as plain, swivel, universal)

3.8 fixtures

S4 Select and mount electrodes for roughing and finishing, to include **one** of the following:

4.1 plain electrodes

4.2 hollow electrodes

4.3 profile electrodes

4.4 wire

S5 Machine components made from **one** of the following types of material:

5.1 ferrous

5.2 non ferrous

S6 Set up the machine in accordance with instructions and specifications, to include **all** of the following (as applicable to the machine selected and components produced:

6.1 electrical conditions (such as current density, spark frequency)

6.2 alignment of electrodes

6.3 wire tension

6.4 feeds and speeds

6.5 correct threading of wire through wire guides and feed mechanisms

6.6 wire speeds

6.7 fluid flow rates

6.8 filtration equipment

6.9 ventilation and fume extraction

6.10 safety mechanisms/devices

S7 Rough and machine components which cover **four** of the following:

7.1 flat faces

7.2 concave forms

7.3 profile forms

7.4 square/rectangular forms

7.5 square faces

7.6 convex forms

7.7 cavities

7.8 angular faces

7.9 parallel faces

7.10 holes

7.11 radii/arcs

7.12 engraving

7.13 threads

7.14 slots

7.15 other special forms or features

S8 Use appropriate gauges or instruments to carry out the necessary checks, during production, for accuracy of **three** of the following:

8.1 dimensions

8.2 parallelism

8.3 squareness

8.4 profile

8.5 position

8.6 angle/taper

8.7 surface texture

S9 Produce components with dimensional accuracy, form and surface texture within **all** of the following quality and accuracy standards as is applicable to the operations performed:

9.1 dimensional tolerance equivalent to BS EN 20286 or BS Grade 9

9.2 components to be free from false starts, and sharp edges

9.3 angles within +/- 0.5 degree

9.4 surface finish 32 µin; 0.8 µm; 18VDI

Knowledge and understanding
The apprentice must know and understand:

K1 the specific safety precautions / working practices to be taken when setting up and operating workholding devices and electrodes or wires on electro-discharge machines

K2 the hazards associated with setting and operating electro-discharge machines (such as moving parts of machinery, electrical components, handling dielectrics, fumes), and how to minimise them and reduce any risks

K3 operation of the machine controls in both hand and power modes, and how to stop the machine in an emergency

K4 the importance of ensuring that the machine is isolated from the power supply before mounting electrodes, wires and workholding devices

K5 the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy

K6 how to handle and store electrodes and wires safely and correctly

K7 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

K8 how to extract and use information from engineering drawings or data and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken

K9 how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing

K10 how to use imperial and metric systems of measurement

K11 terminology used in electro-discharge machining in relation to the activities undertaken

K12 the effects of clamping the work piece in a chuck/work holding device, and how this can cause distortion in the finished components

K13 the type of fluids that are used; filtration requirements; and precautions to be taken when handling and using them

K14 the various erosion operations that are used to produce the required forms, and the types of electrodes or wires used

K15 the importance of checking the position and alignment of the workpiece before commencing the erosion operations, and the tools and equipment that are used

K16 factors which affect the selection of electrode or wire feeds and speeds (such as material type, finish and tolerance required)

K17 the application of roughing and finishing cuts, and the effect on electrode life, surface finish and dimensional accuracy

K18 how to recognise erosion faults and identify when electrodes need changing

K19 the quality control procedures used, inspection checks to be carried out, and the equipment to be used

K20 problems that can occur with setting up the electrodes or wires, workholding devices, and machine operating parameters, and what to do if problems occur

K21 the extent of their own authority and to whom they should report if they have problems that they cannot resolve

Unit 041 Preparing and using electro-discharge machines

Supporting Information

Developed by	Advanced Manufacturing Engineering Trailblazer Group
Version number	1.0
Date approved	31 January 2016
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Trailblazer Advanced Manufacturing Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 042 Preparing and using manual TIG or plasma-arc welding equipment

Level:	Level 2
GLH:	150
Relationship to NOS:	EUCL2F-042
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Automotive Engineering 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 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.

Performance Requirements
The apprentice must be able to:

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

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

P3 **plan the welding activities before they start them**

P4 **obtain and prepare the appropriate welding equipment and welding consumables**

P5 **prepare and support the joint, using the appropriate methods**

P6 **tack weld the joint at appropriate intervals, and check the joint for accuracy before final welding**

P7 **weld the joint to the specified quality, dimensions and profile**

P8 **use appropriate methods and equipment to check the quality, and that all dimensional and geometrical aspects of the weld are to the specification**

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

P10 **shut down and make safe the welding equipment on completion of the welding activities**

Skills Requirements
The apprentice must be able to:

S1 **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

S2 Use manual welding and related equipment, to include one of the following welding processes:

2.1 TIG

2.2 Plasma-arc

S3 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

S4 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)

S5 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

S6 **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)

S7 **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

S8 **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

S9 **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)

S10 **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

S11 **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

Knowledge and understanding
The apprentice must know and understand:

K1 the safe working practices and procedures to be followed when preparing and using TIG or plasma-arc welding equipment (such as general workshop safety; appropriate personal protective equipment (PPE); fire prevention; protecting other workers from the effects of the welding arc; safety in enclosed/confined spaces; fume extraction/control)

K2 the hazards associated with TIG and plasma-arc welding (such as live electrical components; poor earthing; the electric arc; fumes and gases; hot metal; welding in enclosed spaces; slips, trips and falls), and how they can be minimised

K3 the personal protective equipment to be worn for the welding activities (such as correctly fitting overalls; leather aprons, welding gloves/gauntlets; safety boots; head/eye shield with correct shade of filter)

K4 the correct handling and storage of gas cylinders (such as manual handling and use of cylinder trolley, leak detection procedures, relevant BCGA codes of practice, cylinder identification, gas pressures, cylinder and equipment safety features)

K5 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

K6 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

K7 the manual TIG or plasma-arc welding process (such as basic principles of fusion welding; the major parts of the welding equipment and their function)

K8 types, selection and application of filler wires and welding electrodes

K9 reasons for using shielding gases, and the types and application of the various gases

K10 gas pressures and flow rates (in relationship to the type of material being welded)

K11 the types of welded joints to be produced (such as lap joints, corner joints, tee joints and butt welds)

K12 terminology used for the appropriate welding positions

K13 how to prepare the materials in readiness for the welding activity (such as 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)

K14 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)

K15 tack welding size and spacing (in relationship to material thickness)

K16 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)

K17 the techniques of operating the welding equipment to produce a range of joints in the various joint positions (such as fine adjustment of parameters; correct manipulation of the torch; blending in stops/starts and tack welds)

K18 how to control distortion (such as welding sequence; deposition technique)

K19 problems that can occur with the welding activities (such as causes of distortion and methods of control; effects of welding on materials and sources of weld defects), and how these can be overcome

K20 how to close down the welding equipment safely and correctly

K21 the safe working practices and procedures to be adopted when preparing the welds for examination (such as handling hot materials, using chemicals for cleaning and etching, using equipment to fracture welds)

K22 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)

K23 how to check the welded joints for uniformity, alignment, position, weld size and profile

K24 the various procedures for visual examination of the welds for cracks, porosity and slag inclusions (such as dye penetrant, fluorescent penetrant; magnetic particle testing)

K25 the various procedures for carrying out destructive tests on the welds (such as macroscopic examination, bend tests, nick break tests)

K26 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)

K27 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

K28 when to act on their own initiative and when to seek help and advice from others

K29 the importance of leaving the work area and equipment in a safe condition on completion of the welding activities (such as isolation of electrical supplies, safely storing equipment and consumables, removing and disposing of waste)

Unit 042 Preparing and using manual TIG or plasma-arc welding equipment

Supporting Information

Developed by	Advanced Manufacturing Engineering Trailblazer Group
Version number	1.0
Date approved	31 January 2016
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing and Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **Customer.Services@enginuity.org** quoting Trailblazer Advanced Manufacturing and Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2017

Unit 043 Preparing and using CNC fabrication equipment

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-044
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 prepare and use CNC fabrication equipment, including machines such as shearing, punching, forming and bending; plasma, laser and gas cutting. They will be expected to select the appropriate workholding devices, and to mount and secure them to the machine. They will also be required to select the appropriate cutting heads or forming tools, to mount and secure them to the appropriate tool holding devices, and to place the cutting/forming tools in the relevant positions within the tool-posts, 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 are 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 straight cuts, square and rectangular profiles, curved profiles, internal profiles, louvers, swages, holes radially and linearly pitched, bends of various angles and curved plates. During, and on completion of, the machining 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 machining activities, they will be expected to remove appropriate tools and workholding devices, and to leave the machine and work area in a safe and tidy condition.

	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. Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the CNC fabrication machining activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the machining 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 fabrication machine setting and operating techniques safely. They will understand the CNC machining 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 activities to the required specification. They will understand the safety precautions required when working with the CNC fabrication machines, 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.

Performance Requirements
The apprentice must be able to:

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

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

P3 plan the CNC fabricating activities before they start them

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

P5 mount, set and secure the required workholding devices, workpiece and tooling

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

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

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

P9 deal promptly and effectively with problems within their control, and seek

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

Skills Requirements
The apprentice must be able to:

S1 **Ensure that they apply all of the following checks and practices at all times during the CNC fabrication 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 **ensure that machine guards are in place and are correctly adjusted**

1.3 **ensure that components are held securely (without damage or distortion)**

1.4 **ensure that tooling is maintained in a suitable/safe condition**

1.5 **make sure that the work area is maintained and left in a safe and tidy condition**

S2 **Prepare one of the following CNC fabrication machines in readiness for production:**

- **2.1** **shearing machine**
- **2.2** **bending machine**
- **2.3** **laser cutting**
- **2.4** **punching machine**
- **2.5** **plasma cutting**
- **2.6** **gas cutting**
- **2.7** **water cutting**
- **2.8** **forming machine**

S3 **Position and secure workpieces, using two of the following workholding methods and devices:**

- **3.1** jigs and fixtures
- **3.2** pneumatic/magnetic devices
- **3.3** clamps and stops
- **3.4** other workholding devices

S4 **Select and mount, in the appropriate holding device, one of the following types of cutting/forming tool:**

- **4.1** shearing blades
- **4.2** forming tools
- **4.3** bending tools
- **4.4** hole punching tools
- **4.5** nibbling tools
- **4.6** cutting heads/nozzles

S5 **Prepare the tooling by carrying out all of the following activities, as applicable to the machine type:**

5.1 pre-setting tooling, using setting jigs/fixtures

5.2 setting tool datums

5.3 mounting tools in the correct position in the tool-posts, turrets, magazine or carousel

5.4 checking that tools have a specific tool number in relationship to the operating program

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

5.6 saving changes to the program

S6 **Set up the machine to produce components, combining several different operations and covering four of the following:**

6.1 straight cuts

6.2 holes radially pitched

6.3 multi-bend platework

6.4 square/rectangular profiles

6.5 louvres

6.6 curved plates

6.7 curved profiles

6.8 swages

6.9 bends of various angles

6.10 internal profiles

6.11 bends at 90°

6.12 holes linearly pitched

6.13 other specific operations

S7 **Confirm that the machine and program operate safely and correctly, by checking all of the following:**

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

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

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

7.4 tool offsets are correctly entered into the machine controller

7.5 tool cutter paths are executed safely and correctly

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

7.7 programs have been saved in the appropriate format

S8 **Produce components using one of the following types of material:**

8.1 **ferrous**

8.2 non-ferrous

8.3 stainless

8.4 special alloys

8.5 other specific materials

S9 **Carry out the necessary checks for accuracy of three of the following:**

9.1 linear dimensions

9.2 flatness/freedom from excessive distortion

9.3 position of features

9.4 accuracy of louvres and swages

9.5 accuracy of profiles

S10 **Produce components that meet all of the following:**

10.1 dimensional accuracy is within specification tolerance

10.2 components are free from deformity, burrs and sharp edges

10.3 profiles conform to specification/template requirements

Knowledge and understanding
The apprentice must know and understand:

K1 the specific safety precautions to be taken when setting up workholding devices and tooling on CNC fabrication machines

K2 how to start and stop the machine, in normal and emergency situations

K3 the importance of ensuring that the machine is isolated from the power supply before mounting the cutting and forming tools and workholding devices

K4 the importance of wearing the appropriate protective clothing and equipment (PPE), and of keeping the work area safe and tidy

K5 the hazards associated with working on CNC fabrication equipment (such as moving machinery, automatic machine operation, handling of cutting and forming tools, lifting and handling workholding devices, handling sheet materials), and how they can be minimised

K6 how to handle and store cutting and forming tools, and programs, safely and correctly

K7 **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**

K8 how to use and extract information from engineering drawings or data and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken

K9 how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing

K10 how to carry out currency/issue checks of the specifications they are working with

K11 the range of workholding methods and devices that are used on CNC fabrication machines

K12 why it is important to set the workholding device/workpiece in relationship to the machine datums and reference points

K13 the methods of setting the workholding devices/workpieces, and the tools and equipment that can be used

K14 the range of cutting and forming tools that are used on the CNC fabrication machine

K15 how to check that the cutting and forming tools are in a safe and serviceable condition

K16 the various tool holding devices that are used, and the methods of correctly mounting and securing the cutting and forming tools to the tool holders

K17 the advantages of using pre-set tooling, and how to set the tooling by using setting jigs/fixtures

K18 the use of tool-posts, magazines and carousels, and how to position and identify the tools in relationship to the operating program

K19 how to set and secure the workpiece to the machine/workholding device; the effects of clamping the workpiece; and how material removal can cause warping/distortion of the finished workpiece

K20 how to place the machine into the correct operating mode, and how to access the program edit facility in order to enter tooling data (such as tool datums, positions, lengths, offsets and radius compensation)

K21 how to interpret the visual display and the various messages displayed

K22 the function of error messages, and what to do when an error message is displayed

K23 how to find the correct restart point in the program, when the machine has been stopped before completion of the program

K24 the operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons)

K25 how to operate the machine using single-block run, full program run and feed/speed override controls

K26 how to make adjustments to the program operating parameters

K27 how to conduct trial runs using single block run, dry run, and feed and speed override controls

K28 the items that they need to check before allowing the machine to operate in full program run mode

K29 how the various types of materials used will affect the feeds/speeds that can be used

K30 typical problems that can occur with the setting up and operating of the machine and workholding devices, and what to do if they occur

K31 how to save the completed or edited programs in the appropriate format, and the need to store programs and storage devices safely and correctly, away from contaminants and possible corruption

K32 when to act on their own initiative and when to seek help and advice from others

K33 the importance of leaving the work area and machine in a safe condition on completion of the activities (such as correctly isolated, operating programs closed or removed, cleaning the machine, ensuring that any spilt cutting fluids are correctly dealt with, and removing and disposing of waste)

Unit 043 Preparing and using CNC fabrication equipment

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	1.0
Date approved	15th April 2016
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2018

Unit 044 General welding applications

Level:	Level 2
GLH:	150
Relationship to NOS:	EUCL2F-043
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 prepare the welding equipment and to ensure that all the leads/cables, electrode holder, hoses, torches shielding gas system, hoses, wire feed mechanisms and workpiece earthing arrangements are securely connected and free from damage (where applicable). They will also need to obtain and check that all the work holding equipment and manipulating devices are 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 visual examination, 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 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 welding techniques and procedures safely. They will understand the welding processes, and their application, and will know about the equipment, materials, consumables and destructive / non-destructive tests, 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 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.

Performance Requirements
The apprentice must be able to:

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

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

P3 plan the welding activities before they start them

P4 obtain and prepare the appropriate welding equipment and welding consumables

P5 prepare and support the joint, using the appropriate methods

P6 tack weld the joint at appropriate intervals, and check the joint for accuracy before final welding

P7 weld the joint to the specified quality, dimensions and profile

P8 use appropriate methods to check the quality, and that all dimensional and geometrical aspects of the weld are to the specification

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

P10 shut down and make safe the welding equipment on completion of the welding activities

P11 leave the work area in a safe and tidy condition on completion of the manufacturing activities

Skills Requirements
The apprentice must be able to:

S1 **Carry out all of the following during the welding 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 the condition of, and correctly connect, welding leads, earthing arrangements, electrode holder, welding gun / torch, hoses, shielding gas, and wire feed mechanisms (where applicable)

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

S2 **Use manual welding and related equipment, for one of the following welding processes:**

2.1 manual metal-arc (MMA)

2.2 MIG/MAG/Flux Cored Arc

2.3 TIG /Plasma Arc

S3 **Produce two of the following welded joints of at least 150mm long, with a minimum of one stop and start included:**

3.1 fillet lap joints

3.2 tee fillet joints

3.3 butt joints

Plus the following welded joint

3.4 **corner joint**

S4 **Produce joints as follows:**

One type of material from the following

4.1 carbon steel

4.2 stainless steel

Plus one form of material from the following:

4.3 sheet (less than 3mm)

4.4 pipe/tube

4.5 plate

4.6 other forms

4.7 section

S5 **Weld joints in good access situations, in three of the following BS EN ISO 6947 positions:**

5.1 Flat (PA)

5.2 Vertical upwards (PF)

5.3 Horizontal vertical (PB)

5.4 Vertical downwards (PG)

5.5 Horizontal (PC)

S6 **Identify all of the following weld defects:**

6.1 lack of continuity of the weld

6.2 uneven and irregular ripple formation

6.3 incorrect weld size or profile

6.4 undercutting

6.5 overlap

6.6 lack of fusion

6.7 porosity

6.8 lack of penetration

Plus one from the following

6.9 surface cracks

6.10 internal cracks

6.11 inclusions

S7 **Produce welded joints which meet all of the following (with reference to BS 4872 Part 1 Weld test requirements):**

7.1 welds are adequately fused and have a uniform profile, free from excessive undulations, with regular and even ripple formation

7.2 the weld surface is free from cracks and substantially free from porosity, shrinkage cavities and trapped slag

7.3 joins at stop/start positions merge smoothly, with no pronounced hump or crater in the weld surface

7.4 tack welds are blended in to form part of the finished weld, without excessive hump

Knowledge and understanding
The apprentice must know and understand:

K1 the health and safety requirements, and safe working practices and procedures required for the welding activities undertaken (such as general workshop safety; appropriate personal protective equipment (PPE); fire prevention; protecting other workers from the effects of the welding arc; safety in enclosed/confined spaces; fume extraction/control)

K2 the personal protective clothing and equipment (PPE) to be worn when carrying out the welding activities (such as leather gloves/gauntlets, leather aprons, eye protection (head/eye shield with correct shade of filter), ear protection, safety boots), and the importance of keeping the work area safe and tidy

K3 the hazards associated with welding activities (such as live electrical components; poor earthing; the electric arc; fumes and gases; hot metal; welding in enclosed spaces; slips, trips and falls), and how they can be minimised

K4 the correct handling and storage of gas cylinders (such as manual handling and use of cylinder trolley, leak detection procedures, relevant BCGA codes of practice, cylinder identification, gas pressures, cylinder and equipment safety features)

K5 **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**

K6 how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken

K7 the manual welding process (such as basic principles of fusion welding, the major parts of their welding equipment and their function)

K8 the types of welded joints to be produced (such as lap joints, corner joints, tee joints, butt, single and multi-run welds)

K9 types, selection and application of filler wires and welding electrodes

K10 reasons for using shielding gases, the types and application of the various gases (include the importance of ensuring correct gas pressures and flow rates)

K11 terminology used for the appropriate welding positions

K12 how to prepare the materials in readiness for the welding activity by ensuring that they are free from excessive surface contamination (such as rust, scale, paint, oil/grease and moisture)

K13 why the edges to be welded need to be correctly prepared (such as made flat, square or bevelled)

K14 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)

K15 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)

K16 tack welding size and spacing (in relationship to material thickness)

K17 the techniques of operating the welding equipment to produce a range of joints in the various joint positions (such as fine adjustment of parameters; correct manipulation of the torch or welding gun; striking and initiating the arc; correct manipulation and welding speed of electrode; blending in stops/starts and tack welds)

K18 methods/modes of metal transfer and their uses (such as dip, globular, free flight, spray and pulsed)

K19 how to control distortion (such as welding sequence; deposition technique)

K20 problems that can occur with the welding activities (such as causes of distortion and methods of control; effects of welding on materials and sources of weld defects), and how these can be overcome

K21 how to close down the welding equipment safely and correctly

K22 the safe working practices and procedures to be adopted when preparing the welds for examination (such as handling hot materials, using chemicals for cleaning and etching, using equipment to fracture welds)

K23 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)

K24 how to check the welded joints for uniformity, alignment, position, weld size and profile

K25 the various procedures for visual examination of the welds for cracks, porosity and slag inclusions (such as dye penetrant, fluorescent penetrant; magnetic particle testing)

K26 the various procedures for carrying out destructive tests on the welds (such as macroscopic examination, bend tests, nick break tests)

K27 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)

K28 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

K29 when to act on their own initiative and when to seek help and advice from others

K30 the importance of leaving the work area and equipment in a safe condition on completion of the welding activities (such as isolation of electrical supplies, safely storing equipment and consumables, removing and disposing of waste

Unit 044 General welding applications

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	1.0
Date approved	22 April 2016
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2018

Unit 045 Producing tool and die assemblies

Level:	Level 2
GLH:	150
Relationship to NOS:	EUCL2F-045
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing Engineering 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 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 assemblies. 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 tool and die 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 Standard 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 seven of the components listed in scope 3 in the Skills Section.

Performance Requirements
The apprentice must be able to:

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

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

P3 **plan the assembly activities before they start them**

P4 **obtain and prepare the appropriate components, tools and equipment**

P5 **use the appropriate methods and techniques to assemble the components in their correct positions**

P6 **secure the components using the specified connectors and securing devices**

P7 **ensure that components are free from foreign objects, dirt or other contamination**

P8 **check the completed assembly to ensure that all operations have been completed and that the finished assembly meets the required specification**

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

P10 **leave the work area in a safe and tidy condition on completion of the assembly activities**

Skills Requirements
The apprentice must be able to:

S1 **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**

S2 **Carry out at least one of the following assembly activities:**

Tool assembly activities using two of the following types of tool

2.1 single stage tools

2.2 combination/composite tools

2.3 two-plate tools

2.4 unscrewing tools

2.5 three-plate tools

2.6 split tools

2.7 prototype tools

2.8 assembly tools

2.9 multi-stage tools

2.10 compound tools

2.11 form tools

2.12 draw tools

2.13 progression tools

2.14 transfer tools

Die assembly activities using two of the following types of die:

2.15 draw die (such as cushion, single action, double action, inverted double action)

2.16 trim

2.17 **flange**

2.18 **combination**

2.19 **pierce**

2.20 **re-strike**

2.21 **pressure (high or low)**

2.22 **transfer**

2.23 **pultrusion**

2.24 **stamping**

2.25 **progression**

2.26 **extrusion**

S3 **Produce assemblies using appropriate methods and techniques:**

Tools or dies using seven of the following methods and techniques

3.1 **assembling of components by expansion/contraction**

3.2 **aligning components**

3.3 **applying sealants/adhesives**

3.4 **fitting (such as filing, scraping, lapping or polishing)**

3.5 **electrical bonding of components**

3.6 **securing by using mechanical fasteners/threaded devices**

3.7 **assembling of products by pressure**

3.8 **torque setting**

3.9 **setting working clearances**

3.10 **drilling**

3.11 **reaming**

3.12 **applying bolt locking methods**

3.13 **matched components**

3.14 shimming and packing

3.15 riveting

3.16 blue-bedding of components

3.17 soldering / brazing

3.18 fusion (non-critical joints)

S4 Produce assemblies to meet the required specification for at least one type of the following assemblies

Assemble tools to meet the required specification, to include the use of nine of the following components:

4.1 bolsters

4.2 top plate

4.3 pierce punches

4.4 scrap chutes

4.5 retaining pins

4.6 wear plates

4.7 locators

4.8 supports

4.9 air cylinders

4.10 springs (gas/coil/rubber)

4.11 stripper plates

4.12 clamps

4.13 guide bushes

4.14 guides (bushes/pillars/pins)

4.15 bearings

4.16 ejectors

4.17 assembling of components by expansion/contraction

4.18 aligning components

4.19 fitting (such as filing, scraping, lapping or polishing)

4.20 torque setting

4.21 securing by using mechanical fasteners/threaded devices

4.22 assembling of products by pressure

4.23 setting working clearances

4.24 drilling

4.25 reaming

4.26 matched components

4.27 applying bolt locking methods

4.28 shimming and packing

4.29 blue-bedding of components

Plus **four** of the following sub-assemblies to meet the required specification, if assembling injection mould tool assemblies

4.30 ejector system

4.31 cooling system

4.32 venting system

4.33 gate system

4.34 runner system

4.35 core inserting system

4.36 heater systems

4.37 guides and slides

4.38 pneumatic/hydraulic cylinders

4.39 injection system

4.40 sliding cores

4.41 safety equipment (such as sensors and switches)

4.42 unscrewing systems

Assemble dies to meet the required specification, to include the use of seven of the following components:

4.43 upper or lower die shoe

4.44 keeper plates

4.45 panel bucks

4.46 location pins and bushes

4.47 gas springs

4.48 air pins

4.49 guide plates

4.50 compression springs

4.51 hold-off cones

4.52 feed plates

4.53 pierce steels

4.54 profiled plates/blocks

4.55 positive returns

S5 Produce assemblies, using two of the following assembly aids and equipment:

5.1 workholding devices

5.2 lifting and moving equipment

5.3 specialised assembly tools/equipment

5.4 jigs and fixtures

5.5 shims and packing

5.6 supporting equipment

5.7 jacks

5.8 rollers or wedges

S6 **Carry out the required quality checks, to include eight from the following, using appropriate equipment:**

6.1 **positional accuracy**

6.2 **freedom of movement**

6.3 **component / mould tool security**

6.4 **completeness**

6.5 **dimensions**

6.6 **orientation**

6.7 **alignment**

6.8 **function**

6.9 **profile/form**

6.10 **bearing end float**

6.11 **operating/working clearances**

6.12 **leak test**

6.13 **freedom from damage or foreign bodies**

S7 **Produce assemblies which comply with one of the following quality and accuracy standards:**

7.1 **BS, ISO or BSEN standards and procedures**

7.2 **company standards and procedures**

7.3 **customer standards and requirements**

7.4 **specific system requirements**

Knowledge and understanding
The apprentice must know and understand:

K1 **the health and safety requirements, and safe working practices and procedures required for the assembly activities undertaken**

K2 **the importance of wearing appropriate protective clothing and equipment (PPE), and of keeping the work area safe and tidy**

K3 **the hazards associated with the assembly activities (such as 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**

K4 **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**

K5 **the procedure for obtaining the required drawings, job instructions and other related specifications**

K6 **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**

K7 **how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing**

K8 **how to prepare the components in readiness for the assembly activities (such as visually checking for defects, cleaning the components, removing burrs and sharp edges)**

K9 **the general operating principles of tool and die assembly(s) and the purpose and function of the components and materials used (including component identification systems such as codes and component orientation indicators)**

K10 **preparations to be undertaken on the components prior to fitting them into the assembly**

K11 **the assembly/joining methods, techniques and procedures to be used, and the importance of adhering to these procedures**

K12 **how the components are to be aligned, adjusted and positioned prior to securing, and the tools and equipment to be used for this**

K13 **the various mechanical fastening devices that are used (such as nuts, bolts, machine screws, cap screws, clips, pins, locking and retaining devices)**

K14 **the importance of using the specified components and joining devices for the assembly, and why they must not use substitutes**

K15 **where appropriate, the application of sealants and adhesives within the assembly activities, and the precautions that must be taken when working with them**

K16 **how to conduct any necessary checks to ensure accuracy, position, security, function, and completeness of the assembly (such as 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)**

K17 **how to detect assembly defects, and what to do to rectify them (such as ineffective joining techniques, foreign objects, component damage)**

K18 **the methods and equipment used to transport, lift and handle components and assemblies**

K19 **how to check that the tools and equipment to be used are correctly calibrated and are in a safe and serviceable condition**

K20 **the importance of ensuring that all tools are used correctly and within their permitted operating range**

K21 **the importance of ensuring that all tools, equipment and components are accounted for and returned to their correct location on completion of the assembly activities**

K22 **problems that could occur with the assembly operations, and the importance of informing appropriate people of non-conformances**

K23 **when to act on their own initiative and when to seek help and advice from others**

K24 **leaving the work area in a safe and clean condition on completion of the assembly activities (such as removing and storing power leads, returning hand tools and equipment to the designated location, cleaning the work area and removing and disposing of waste)**

Unit 045 Producing tool and die assemblies

Supporting Information

Developed by	Advanced Manufacturing Engineering Employer Trailblazer Group
Version number	V1.0
Date approved	12th July 2016
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing Engineering Sector. These assessment requirements are set out in the Advanced Manufacturing Engineering Qualification Assessment Strategy available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Trailblazer Advanced Manufacturing Engineering Qualification Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	2018

Unit 046 Producing Composite Mouldings using Pre-Preg Techniques

Level:	Level 2
GLH:	140
Relationship to NOS:	EUC2F-046
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the AME 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 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 S6.

Performance Requirements
The apprentice must be able to:

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

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

P3 **Plan the moulding/laminating activities before they start them**
Prepare the moulds, jigs or formers ready for the manufacturing operations

P4 **Mix and prepare the required materials**

P5 Carry out the moulding/laminating activities, using the correct methods and techniques

P6 **Remove the mouldings from the formers, and trim/finish them to specification**

P7 **Check that all the required operations have been completed to specification**

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

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

Skills requirements
The apprentice must be able to:

S1 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

S2 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

S3 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

S4 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

S5 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

S6 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

S7 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)

S8 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)

S9 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

S10 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)

S11 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

S12 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)

S13 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

S14 Remove composite moulding and carryout all of the following:

14.1. visually check that the moulding is complete and free from defects

14.2. use appropriate equipment/gauges to check for dimensional accuracy (such as overall dimensions, thickness of material/moulding, geometric features)

14.3. mark out the mouldings for trimming of excess material

14.4. cut/trim the mouldings using appropriate tools and equipment (such as cutting wheels/discs, routers, saws)

14.5. carry out repairs (where appropriate)

14.6. finish the mouldings, using appropriate tools and equipment (such as rubbing blocks, diamond files, disc or belt sanders, pencil grinders)

14.7. polish the mouldings using appropriate tools and equipment (such as wet sanding, cutting compounds)

S15 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 apprentice must know and understand:

K1 **the hazards associated with carrying out pre-preg laminating techniques, and with the composite materials, consumables, tools and equipment used, and how to minimise these and reduce any risks**

K2 **the specific environmental conditions the must be observed when producing composite mouldings (e.g. temperature, humidity, fume/dust extraction systems and equipment)**

K3 **the quality procedures used in the workplace to ensure production control (in relation to currency, issue, meeting specification) and the completion of such documents**

K4 **the conventions and terminology used for pre-preg laminating techniques (e.g. material orientation, material identification, material templates, ply lay-up, pressure plates, vacuum bagging, cure cycles, exotherm)**

K5 **the different types of resins, reinforcement, catalysts, accelerators and additives used, and their applications**

K6 **the different types of fibre materials, fabrics, orientations, their combinations and applications**

K7 **the building up of laminates (including orientation and balance of plies) to minimise spring and distortion in composite mouldings**

K8 **the different core, insert and filler materials, and their applications**

K9 **the identification of materials by product codes**

K10 **the different types of production tooling used for producing composite mouldings, and their applications**

K11 **the correct methods of storage, thawing and handling of pre-preg materials (including monitoring temperature, storage life and out-life)**

K12 **the methods used in the application of pre-preg materials to tooling surfaces (including methods of tailoring and cutting)**

K13 **the correct methods of storage and handling of ancillary and consumable materials**

K14 **the selection and use of ancillary and consumable materials (e.g. release films, breather fabrics, bagging films, tapes) to meet performance requirements (e.g. temperature and compatibility)**

K15 **the tools and equipment used in the pre-preg laminating activities, and their care, preparation and control procedures**

K16 **the problems that can occur during the lay-up process (including modifications to the ply lay-up, and defects such as contamination and distortion)**

K17 **the cure cycles (including temperature and pressure ramps, dwell times, post curing)**

K18 **the need for monitoring the cure cycle (using thermocouples, probes, chart recorders and data logs)**

K19 **the care and safe handling of production tooling and composite mouldings throughout the production cycle**

K20 **the production controls used in the work area, and actions to be taken for unaccounted items**

K21 **how the composite moulding relates to its own quality documents, and the production tooling used**

Unit 046 Producing Composite Mouldings using Pre-Preg Techniques

Supporting Information

Developed by	AME Employer Trailblazer Group
Version number	Version 1
Date approved	10th April 2014
Assessment Requirements	Assessment requirements for this have been developed by employers for the occupational competency units and qualifications for AME Engineering. These assessment requirements are set down in the AME Engineering Employer Occupational Unit Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored 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
Grading System	Pass/Fail
Review Date	2017

Unit 047 Carrying out repairs on composite mouldings

Level:	Level 2
GLH:	140
Relationship to NOS:	EUC2F-047
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the AME 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 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.

Performance Requirements
The apprentice must be able to:

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

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

P3 Follow the relevant drawings and documentation for the moulding to be repaired

P4 Complete any preparation required prior to undertaking the repair

P5 Carry out the repairs within agreed timescale using approved materials and components and methods and procedures

P6 Carry out any checks required confirming the repaired moulding meets the specified operating conditions

P7 Deal promptly and effectively with problems within their control and report those that cannot be solved

P8 Dispose of waste and excess materials in line with agreed organisational procedures

P9 Produce accurate and complete records of all repair work carried out using organisational procedures and documentation

Skills requirements
The apprentice must be able to:

S1 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

S2 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

S3 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

S4 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

S5 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**

S6 Repair defects using techniques/materials applicable to one of the following resin types:

- **6.1. polyester**
- **6.2. epoxy**

S7 Repair defects using techniques/materials applicable to one of the following fibre types:

- **7.1. glass**
- **7.2. carbon**

S8 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

S9 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

S10 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

S11 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 apprentice must know and understand:

K1 **the health and safety precautions to be taken and procedures used when working with composite materials, consumables, tools and equipment in the specific work area**

K2 **the hazards associated with carrying out composite repair activities and with the composite materials, consumables, tools and equipment used and how to minimise these and reduce any risks**

K3 **the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables**

K4 **the specific environmental conditions that must be observed when repairing composite mouldings (such as temperature, humidity, fume/dust extraction systems and equipment)**

K5 **how to identify and use information from engineering drawings and related documentation, to include symbols and conventions to appropriate BS, ISO or BSEN standards in relation to work undertaken**

K6 **the quality procedures used in the workplace to ensure production control (in relation to currency, issue, meeting specification) and the completion of such documents**

K7 **the basic conventions and terminology used when repairing composite mouldings (such as dis-bonds, de-lamination, resin injection, resin voids, core potting, repair patches)**

K8 **the methods used to repair composite mouldings**

K9 **the methods used to cure bonded repairs and their applications**

K10 **the importance of carrying out dimensional/tolerance checks on completion of the repair activity**

K11 **why repairs may affect the structural integrity of the composite moulding**

K12 **the procedure used to determine if additional testing (such as joint integrity, strength testing) is required following a repair**

K13 **the correct methods of storing and handling composite materials**

K14 **the tools and equipment used for various activities associated with repairing composite mouldings**

K15 **the documentation to be completed during and/or on completion of the repair activity**

Unit 047 Carrying out repairs on composite mouldings

Supporting Information

Developed by	AME Employer Trailblazer Group
Version number	1
Date approved	10th July 2014
Assessment Requirements	Assessment requirements for this have been developed by employers for the occupational competency units and qualifications for AME. These assessment requirements are set down in the AME Employer Occupational Unit Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored 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
Grading System	Pass/Fail
Review Date	2017

Unit 048 General machining, fitting and assembly applications

Level:	Level 2
GLH:	120
Relationship to NOS:	EUC2F-048
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This standard covers a broad range of basic machining, fitting and assembly competences that will prepare you 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. You will be expected to carry out practical exercises in order to gain an understanding of how these machining, fitting and assembly 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, you will use appropriate tools and equipment to mark out the material for the features to be produced, and then to use hand tools, portable power tools, machine tools and shaping, fitting and assembly techniques appropriate to the operations being performed. These activities will include sawing, filing, drilling, turning, milling and assembly. During, and on completion of, the operations, you 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. You will need to be able to recognise when the activities 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, you will be expected to return all tools and equipment that you have used to the correct location, and to leave the work area in a safe and tidy condition. Your responsibilities will require you to comply with health and safety requirements and organisational policy and procedures for the activities undertaken. You 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. You will work under a high level of supervision, whilst taking responsibility for your own actions and for the quality and accuracy of the work that you carry out.

	Your underpinning knowledge will provide an understanding of your work, and will enable you to apply appropriate machining, fitting and assembly techniques and procedures safely. You will understand the machining, fitting and assembly 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. You will understand the safety precautions required when carrying out the various machining, fitting and assembly techniques, and when using hand tools and machinery. You will be required to demonstrate safe working practices throughout, and will understand the responsibility you owe to yourself 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.

Performance Requirements
The apprentice must be able to:

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

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

P3 **determine what has to be done and how you are going to do it**

P4 **obtain the appropriate tools and equipment for the manufacturing operations**

P5 **mark out the components for the required operations, using appropriate tools and techniques**

P6 **cut and shape the materials to the required specification, using appropriate tools and techniques**

P7 **use appropriate methods and techniques to assemble and secure the components in their correct positions**

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

P9 **deal promptly and effectively with problems within your control, and seek help and guidance from the relevant people if you have problems that you cannot resolve**

P10 **leave the work area in a safe and tidy condition on completion of the manufacturing activities**

Knowledge and understanding
The apprentice must know and understand:

K1 **the health and safety requirements, and safe working practices and procedures required for the machining, fitting and assembly activities undertaken (such as wearing appropriate protective clothing and equipment (PPE), using machine guards, and of keeping the work area safe and tidy**

K2 **the hazards associated with the activities (such as use of power tools, trailing leads or hoses, damaged or badly maintained tools and equipment, using files with damaged or poor fitting handles, using machine tools), and how they can be minimised**

K3 **how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken**

K4 **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**

K5 **how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing**

K6 **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)**

K7 **how to select and establish a suitable datum; the importance of ensuring that marking out is undertaken from the selected datum, and the possible effects of working from a different datum**

K8 **use of marking-out conventions when marking out the workpiece (such as datum lines, cutting guidelines, square and rectangular profiles, circular and radial profiles, angles, holes linearly positioned, boxed and on pitch circles)**

K9 **the various fitting activities to be carried out (such as how to file flat, square and curved surfaces and achieve a smooth surface finish; how to select saw blades for different materials, and how to set the saw blades for different operations; how to produce screw threads on workpieces using hand dies; how to determine the drill size for tapped holes, and the importance of using the taps in the correct sequence)**

K10 **how to prepare drilling machines for operations (such as adjustment of table height and position; mounting and securing drills, in chucks or Morse taper sockets; setting and adjusting spindle speeds; setting and adjusting guards/safety devices)**

K11 **methods of holding the workpiece for the hand fitting, turning and milling activities (such as in a bench vice, machine vice, chuck, collets or clamped directly to the machine table)**

K12 **the assembly methods, techniques and procedures to be used; how the components are to be aligned, adjusted and positioned prior to securing them, and the tools and equipment that is used**

K13 **the various mechanical fastening devices that are used (such as nuts, bolts, machine screws, cap screws, clips, pins, locking and retaining devices)**

K14 **the various turning operations that can be performed (such as parallel, stepped and tapered external diameters, drilled, bored and reamed holes, internal and external screw threads, special profiles)**

K15 **the various milling operations that can be performed (such as flat, parallel, square and angled surfaces; open ended and enclosed slots, special forms, drilled and bored holes)**

K16 **how to mount and secure the cutting tools in the tool holding devices (such as front or rear tools posts; mounting cutters on long or stub arbors; mounting drills in chucks or by the use of morse taper sockets; the need to ensure that the tool is sharp and secure)**

K17 **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**

K18 **factors that affect the selection of cutting feeds and speeds, and the depth of cut that can be taken (such as type of material, size of material, operations being performed, workholding method/security of workpiece, condition of machine, finish and tolerance required)**

K19 **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**

K20 **how to check the workpiece and the measuring equipment that is used (such as rules, micrometers, Verniers, gauges and surface finish comparison equipment)**

K21 **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 (such as lengths, diameters, depths, slots, hole positions, angles, profiles); measuring geometric features (such flatness, squareness, parallelism, concentricity, ovality); how to check surface finish (such as by using comparison blocks or instruments)**

K22 **when to act on your own initiative and when to seek help and advice from others**

K23 **the importance of leaving the work area and equipment in a safe and clean condition on completion of the machining and fitting activities (such as isolating machines, removing and returning cutting tools, cleaning the equipment, and removing and disposing of waste)**

Scope/range related to performance criteria
You 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. Cut and shape two different types of material from the following:

2.1 **low carbon/mild steel**

2.2 **stainless steel**

2.3 **plastic/nylon/synthetic**

2.4 **high carbon steel**

2.5 **aluminium/aluminium alloys**

2.6 **composite**

2.7 **cast iron**

2.8 **brass/brass alloys**

2.9 **other specific material**

3. Use three of the following workholding devices:

3.1 **bench vice**

3.2 **three-jaw chuck**

3.3 **collet chuck**

3.4 **machine vice**

3.5 **four-jaw chuck**

3.6 **drive plate and centres**

3.7 **clamps (such as toolmaker's)**

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

4.1 **preparing/determining suitable datums from which to mark out (such as choosing a machine face or filing a flat face as a datum)**

4.2 **applying a marking medium to enhance clarity of the marking out**

4.3 **using an appropriate method of marking out (such as direct marking using instruments, use of templates or tracing/transfer methods)**

4.4 **using a range of marking out equipment (such as rules, squares, scribers, Vernier instruments)**

4.5 **marking out a range of features (such as datum/centre lines, square/rectangular profiles, circles/radial profiles, hole positions)**

5. Use a range of hand fitting methods, to include all of the following:

5.1 **cutting out the rough profile using saws (such as hacksaw, band saw)**

5.2 **filing flat and square**

5.3 **filing a curved profile**

5.4 **drilling holes**

5.5 **cutting a screw thread (such as by tapping or dieing)**

6. Produce mechanical assemblies, using six of the following methods and techniques:

6.1 **assembling components having interference fits (such as by pressure, expansion or contraction)**

6.2 **securing components using threaded fasteners (such as nuts, bolts, machine screws, cap screws)**

6.3 **securing components using spring clips (such as external circlips, internal circlips, special clips)**

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

6.5 **securing components using rivets (such as countersunk, roundhead, blind, special purpose types)**

6.6 **applying sealing compounds or adhesives**

6.7 **electrical bonding of components**

6.8 **setting and adjusting components to give correct working parameters (such as shimming and packing)**

6.9 **torque setting of nuts and bolts**

7. Carry out turning operations to include all of the following:

7.1 **mounting the workpiece in an appropriate workholding device**

7.2 **mounting cutting tools in tool holders to give the correct centre height**

7.3 **selecting and setting appropriate feeds and speeds**

7.4 **facing off**

7.5 **producing tapered diameters**

7.6 **producing parallel diameters**

7.7 **centre drilling and drilling a hole**

7.8 **producing stepped diameters**

7.9 **reaming or boring a hole**

8. Carry out milling operations, to include all of the following:

8.1 **mounting the workpiece in an appropriate workholding device**

8.2 **mounting cutting tools on appropriate arbors or direct to the machine spindle**

8.3 **selecting and setting appropriate feeds and speeds**

8.4 **producing flat and square faces**

8.5 **producing an enclosed slot**

8.6 **producing parallel faces**

8.7 **producing an open ended slot**

8.8 **producing angular faces**

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

9.1 **linear dimensions (such as lengths, depths)**

9.2 **profiles**

9.3 **diameters (such as external, internal)**

9.4 **hole size and position**

9.5 **flatness**

9.6 **thread size and fit**

9.7 **squareness**

9.8 **surface finish**

9.9 **angles**

10. Use the following measuring equipment during the checking activities:

10.1 **external micrometers**

10.2 **surface finish equipment (such as comparison plates, machines)**

10.3 **Vernier/digital/dial calliper**

Plus four more of the following:

10.4 **rules**

10.5 **bore/hole gauges**

10.6 **squares**

10.7 **slip gauges**

10.8 **protractors**

10.9 **radius/profile gauges**

10.10 **depth micrometers**

10.11 **thread gauges**

10.12 **depth Verniers**

10.13 **dial test indicators (DTI)**

10.14 **feeler gauges**

10.15 **coordinate measuring machine (CMM)**

11. Produce components within 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 **dimensional tolerance +/- 0.25mm or +/- 0.010”**

11.3 **flatness and squareness 0.05mm per 25mm or 0.002″ per inch**

11.4 **angles within +/- 1 degree**

11.5 **screw threads to BS Medium fit**

11.6 **reamed holes within H8**

11.7 **surface finish 63µin or 1.6 µm**

Unit 048 General machining, fitting and assembly applications

Supporting Information

Developed by	SEMTA (now Enginuity)
Version number	3
Date approved	March 2017
Indicative review date	April 2020
Validity	Current
Status	Original
Originating organisation	SEMTA (now Enginuity)
Original URN	SEMPEO2-65
Relevant occupations	Engineering and manufacturing technologies; Engineering
Suite	Performing Engineering Operations Suite 2
Key words	engineering; engineering operations; machining; fitting; assembly; manufacturing; hand sawing; filing; drilling; turning

Unit 049 General fabrication and welding applications

Level:	Level 2
GLH:	120
Relationship to NOS:	EUC2F-049
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This standard covers a broad range of basic fabrication, assembly and welding competences that will prepare you 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. You will be expected to carry out practical exercises in order to gain an understanding of how these fabrication, assembly and welding activities are undertaken, the type of equipment used and the manufacturing techniques and operating and safety procedures that are required. In carrying out the activities, you will use appropriate tools and equipment, based on the type and thickness of material and the operations to be carried out. You will need to mark out the material for the features to be produced, and then to use hand tools, portable power tools and machines to produce a variety of shapes, profiles and forms. You will also be expected to produce fabrication assemblies using mechanical fastening devices; self secured joints, and thermal joining methods. During, and on completion of, the operations, you 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. You will need to be able to recognise when the activities 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, you will be expected to return all tools and equipment that you have used to the correct location, and to leave the work area in a safe and tidy condition.

	Your responsibilities will require you to comply with health and safety requirements and organisational policy and procedures for the fabrication, assembly and welding activities undertaken. You 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. You will work under a high level of supervision, whilst taking responsibility for your own actions and for the quality and accuracy of the work that you carry out. Your underpinning knowledge will provide an understanding of your work, and will enable you to apply appropriate fabrication, assembly and welding techniques and procedures safely. You will understand the cutting, forming, assembly and welding processes, and their 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. You will understand the safety precautions required when carrying out the fabrication activities, and when using the various tools and equipment, especially those involved in using guillotines and bending/forming equipment. You will be required to demonstrate safe working practices throughout, and will understand the responsibility you owe to yourself 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.

Performance criteria
You must be able to:

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

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

P3 determine what has to be done and how you are going to do it

P4 obtain the appropriate tools and equipment for the fabrication and welding operations

P5 mark out the components for the required operations, using appropriate tools and techniques

P6 cut and form the materials to the required shape and specification, using appropriate tools and techniques

P7 use the appropriate methods and techniques to assemble and secure the components in their correct positions

P8 produce components to required specification

P9 measure and check that all dimensional and geometrical aspects of the component are to the specification

P10 deal promptly and effectively with problems within your control, and seek help and guidance from the relevant people if you have problems that you cannot resolve

P11 leave the work area in a safe and tidy condition on completion of the manufacturing activities

Unit 049 General fabrication and welding applications

K1 the health and safety requirements, and safe working practices and procedures required for the fabrication and welding activities undertaken

K2 the personal protective clothing and equipment (PPE) to be worn when carrying out the fabrication and welding activities (such as leather gloves, eye protection, ear protection), and the importance of keeping the work area safe and tidy

K3 the hazards associated with carrying out fabrication and welding activities (such as handling sheet materials; using dangerous or badly maintained tools and equipment; operating guillotines and bending machines; using hand and bench shears; the electric arc; fumes and gases; spatter; hot slag and metal), and how they can be minimised

K4 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

K5 how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken

K6 how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing

K7 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)

K8 how to select and establish a suitable datum; the importance of ensuring that marking out is undertaken from the selected datum, and the possible effects of working from a different datum

K9 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)

K10 the tools and techniques available for cutting and shaping sheet materials (such as tin snips, bench shears, guillotines, portable power tools, bench drills, saws)

K11 the use and care of tools and equipment (including checks that must be made to ensure that the tools are fit for purpose and tested - such as sharp, undamaged, plugs and cables secure and free from damage, machine guards or safety devices operating correctly)

K12 hand tools used in fabrication forming activities, and typical operations that they are used for (such as hammers, stakes, formers, sand bags)

K13 **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)**

K14 **how to set up the various machines to produce the required forms (such as setting up of rolls; setting fingers on bending machines; setting forming tools for swaging)**

K15 **the characteristics of the various materials used, with regard to the bending and forming process**

K16 **how the materials are to be prepared for the forming operations, and why some materials may require a heating process prior to forming**

K17 **the various methods of securing the assembled components (the range of mechanical fastening devices that are used (such as nuts and bolts, 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)**

K18 **the preparations to be carried out on the components prior to assembling them**

K19 **how to set up and align the various components, and the tools and equipment to be used**

K20 **methods of temporarily holding the joints together to aid the assembly activities (such as clamps, rivet clamps)**

K21 **basic principles of fusion welding and the types of welded joints to be produced (such as lap joints, corner joints, tee joints and butt welds)**

K22 **the various welding techniques that can be used, and their typical applications (such as manual metal arc (MMA), MIG/MAG, TIG and manual oxy/fuel gas welding)**

K23 **types, selection and application of filler wires and welding electrodes**

K24 **inspection techniques that can be applied to check that shape (including straightness) and dimensional accuracy are to specification and within acceptable limits**

K25 **the problems that can occur with the fabrication and welding activities (such as defects caused by incorrectly set or blunt shearing blades), and how these can be overcome**

K26 **when to act on your own initiative and when to seek help and advice from others**

K27 **the importance of leaving the work area and equipment in a safe and clean condition on completion of the fabrication and welding activities (such as isolating machines, cleaning the equipment, and removing and disposing of waste)**

Unit 049 General fabrication and welding applications

1. Carry out all of the following during the fabrication and welding 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, serviceable condition and tested (such as extension leads, powered hand tools and welding equipment cables, welding plant hoses, the striking faces of chisels and hammers, guillotines, shears and forming machines)**

1.3 **check that all measuring equipment to be used is within calibration date**

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

2. Use two appropriate materials from the following:

2.1 **hot rolled mild steel**

2.2 **stainless steel**

2.3 **copper**

2.4 **cold rolled mild steel**

2.5 **aluminium**

2.6 **lead**

2.7 **coated mild steel (such as primed, tinned, galvanised)**

2.8 **brass**

2.9 **titanium**

3. Mark out materials, using methods and techniques which include all of the following:

3.1 **preparing/determining suitable datums from which to mark out**

3.2 **applying a marking medium to enhance clarity of the marking out (such as chalk, bluing or paint)**

3.3 **using an appropriate method of marking out (such as direct marking using instruments, use of templates or tracing/transfer methods)**

3.4 **using a range of marking-out equipment (such as rules/tapes, straight edge, squares, scribers, dividers or trammels, protractors, punch)**

3.5 **marking out a range of features (such as datum/centre lines, square/rectangular profiles, circles/radial profiles, hole positions, cutting and bending detail)**

4. Cut and form material to the marked-out shape, using six of the following hand tools:

4.1 **tin snips**

4.2 **stakes and formers**

4.3 **bench shears**

4.4 **trepanning**

4.5 **saws (such as hand, mechanical, band)**

4.6 **files**

4.7 **hand power tools (such as drill, nibbling, saw)**

4.8 **pneumatic tools**

4.9 **hammers/panel beating equipment**

4.10 **free hand thermal cutting (such as gas or plasma)**

5. Cut and form material to the marked-out shape, using all of the following machine tools:

5.1 **guillotine**

5.2 **pillar or bench drill**

5.3 **bending machine (hand or powered)**

Plus two more from the following:

5.4 **press**

5.5 **trepanning machine**

5.6 **punch/cropping machine**

5.7 **wheeling machine**

5.8 **nibbling machine**

5.9 **jenny/wiring machine**

5.10 **rolling machine (hand or powered)**

5.11 **swaging machine**

6. Perform cutting and forming operations to produce four of the following shapes:

6.1 **straight cuts**

6.2 **external curved contours**

6.3 **round holes**

6.4 **cut-ins (straight and curved)**

6.5 **internal curved contours**

6.6 **square holes**

6.7 **notches**

Plus four of the following:

6.8 **bends/upstands**

6.9 **swages**

6.10 **square-to-round trunking**

6.11 **folds/safe edges**

6.12 **curved panels**

6.13 **ribbed components**

6.14 **tray/box sections**

6.15 **cylindrical sections**

6.16 **wired edges**

7. Assemble fabricated components, using four of the following methods:

7.1 **temporary tack welding**

7.2 **adhesive bonding**

7.3 **soldering or brazing**

7.4 **mechanically fastened (such as bolts, screws)**

7.5 **resistance spot welding**

7.6 **self securing joints (such as knocked up, paned down, swaged, joggled)**

7.7 **riveting (such as hollow or solid)**

8. Use manual welding and related equipment, to include one of the following welding processes:

8.1 **manual metal-arc (MMA)**

8.2 **MIG/MAG**

8.3 **TIG**

8.4 **manual oxy/fuel gas welding**

9. Produce two of the following welded joints of at least 150mm long, with at least one stop and start included:

9.1 **fillet lap joints**

9.2 **corner joints**

9.3 **Tee fillet joints**

9.4 **butt joints**

10. Produce fabricated components and assemblies which meet all of the following:

10.1 **all dimensions are within +/- 3.0mm or +/- 0.125”**

10.2 **finished components meet the required shape/geometry (such as squareness, straightness, angularity and being free from twists)**

10.3 **completed components are free from excessive tooling marks, deformation, cracking, sharp edges, slivers or burrs**

10.4 **all components are correctly assembled, and have secure and firm joints**

10.5 **welds are adequately fused and have a uniform profile, free from excessive undulations, with regular and even ripple formation**

10.6 **the weld surface is free from cracks and substantially free from porosity, shrinkage cavities and trapped slag**

Unit 049 General fabrication and welding applications

Supporting Information

Developed by	SEMTA (now Enginuity)
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Date approved	March 2017
Indicative review date	April 2020
Validity	Current
Status	Original
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Original URN	SEMPEO2-66
Relevant occupations	Engineering and manufacturing technologies; Engineering
Suite	Performing Engineering Operations Suite 2
Key words	engineering; engineering operations; fabrication; welding applications; manufacturing; hand tools; power tools; shapes; profiles; forms

Unit 050 General electrical and electronic engineering applications

Level:	Level 2
GLH:	120
Relationship to NOS:	EUC2F-050
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the AME 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 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.

Performance and skills requirements
The apprentice must be able to:

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

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

P3 **Plan the electrical and electronic wiring and testing activities before they start them**

P4 **Use appropriate sources to obtain the required specifications, circuit diagrams and test information**

P5 **Obtain the correct tools and equipment for the wiring and testing operations, and check that they are in a safe and usable condition**

P6 **Mount and secure the electrical and electronic components safely and correctly, to meet specification requirements**

P7 **Install and terminate the cables to the appropriate connections on the components**

P8 **Use appropriate test methods and equipment to check that the completed circuit is safe and meets all aspects of the specification**

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

P10 **Leave the work area in a safe and tidy condition on completion of the wiring and testing activities**

Skills requirements
The apprentice must be able to:

S1 **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**

S2 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)**

S3 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**

S4 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**

S5 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**

S6 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**

S7 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**

S8 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 apprentice must know and understand:

K1 **the specific safety practices and procedures that they need to observe when wiring and testing electrical and electronic circuits (including any specific legislation, regulations or codes of practice for the activities, equipment or materials)**

K2 **the hazards associated with wiring and testing electrical and electronic circuits and equipment, and with the tools and equipment used (e.g. heat, toxic fumes, spilled/splashed chemicals/solder, static electricity, using sharp instruments for stripping cable insulation, connecting clips/probes into circuits), and how they can be minimised**

K3 **what constitutes a hazardous voltage and how to recognise victims of electric shock**

K4 **how to reduce the risks of a phase to earth shock**

K5 **the basic principles of operation of the equipment/circuits being produced, and the purpose of the individual modules/components used**

K6 **the different types of cabling and their application (e.g. multicore cables, single core cables, solid and multi- stranded cables, steel wire armoured (SWA), mineral insulated (MI), screened cables, data/communications cables, fibre-optics)**

K7 **the application and use of a range of electrical components (such as plugs, switches, sockets, lighting and fittings, junction boxes, consumer units, relays, solenoids, transformers, sensors and actuators)**

K8 **the application and use of circuit protection equipment (such as fuses and other overload protection devices, trips, residual current device (RCD))**

K9 **the various types of circuit boards used (such as printed circuit boards, thin film, thick film and flexible film circuitry)**

K10 **how to recognise, read the values and identify polarity and any other orientation requirements for all electronic components being used in the assemblies (such as capacitors, diodes, transistors, integrated circuit chips, and other discrete through-hole or surface-mounted components)**

K11 **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**

K12 **Describe the techniques used to terminate electrical and electronic components and equipment (such as plugs and sockets; soldering; screwed, clamped and crimped connections, glands and sealed connectors)**

K13 **the tools and equipment used in the wiring activities (including the use of cable stripping tools, crimping tools, soldering irons and torches, gland connecting tools)**

K14 **the importance of conducting inspections and checks before connecting to the supply (e.g. visual examination for loose or exposed conductors, excessive solder or solder spikes which may allow short circuits to occur, strain on terminations, insufficient slack cable at terminations, continuity and polarity checks, insulation checks)**

K15 **the care, handling and application of electrical and electronic test and measuring instruments (e.g. multimeter, insulation resistance tester, loop impedance test instruments, oscilloscopes, signal generators and logic probes)**

K16 **how to identify suitable test points within the circuit, and how to position the test instruments into the circuit so as to ensure the correct polarity and without damaging the circuit components**

K17 **how to set the instrument zero readings; obtaining instrument readings and comparing them with circuit parameters**

K18 **the problems that can occur with the wiring and testing operations, and how these can be overcome**

Unit 050 General electrical and electronic engineering applications

Supporting Information

Developed by	AME Employer Trailblazer Group
Version number	Version 1
Date approved	10th April 2014
Assessment Requirements	Assessment requirements for this have been developed by employers for the occupational competency units and qualifications for AME Engineering. These assessment requirements are set down in the AME Engineering Employer Occupational Unit Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored 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
Grading System	Pass/Fail
Review Date	2017

Unit 051 General maintenance engineering applications

Level:	Level 2
GLH:	120
Relationship to NOS:	EUC2F-051
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This standard covers a broad range of basic maintenance competences required for the maintenance of engineering equipment and systems. This will prepare you 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. You will be expected to prepare for the maintenance activities by obtaining all necessary information, documentation, tools and equipment, and to plan how you intend to carry out the required maintenance activities and the sequence of operations you intend to use. You will be required to select the appropriate equipment to use, based on the maintenance operations to be carried out and the type of equipment being maintained. The maintenance activities will involve the application of fault finding techniques to identify and locate faults on mechanical, electrical/electronic, fluid power and process controller equipment. You will be expected to use a variety of fault location methods and procedures, such as gathering information from the person who reported the fault, using recognised fault finding techniques and diagnostic aids, measuring, inspecting and operating the equipment. You will then be expected to dismantle, remove and replace or repair the faulty units or components, on a variety of engineering systems or equipment. You will be expected to cover a range of maintenance activities, such as draining and removing fluids, isolating equipment, releasing stored energy, 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 of the maintained equipment. Your responsibilities will require you to comply with health and safety requirements and organisational policy and procedures for the maintenance activities undertaken. You 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. You will work under a high level of supervision, whilst taking responsibility for your own actions and for the quality and accuracy of the work that you carry out. Your underpinning knowledge will provide an understanding of your work, and will enable you to apply appropriate maintenance techniques and procedures safely. You will understand the maintenance process, and its application, and will know about the equipment being maintained, the equipment components, tools and consumables used, to the appropriate depth to provide a sound basis for carrying out the activities to the required specification. You will understand the safety precautions required when carrying out the maintenance activities, and when using maintenance tools and equipment. You will be required to demonstrate safe working practices throughout, and will understand the responsibility you owe to yourself 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.

Performance criteria
You must be able to:

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

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

P3 plan the maintenance activities before you start them

P4 obtain all the information you need for the safe removal and replacement of the equipment components

P5 obtain and prepare the appropriate tools and equipment

P6 maintain the engineering equipment

P7 apply appropriate fault finding techniques, tools and aids to locate the faults

P8 use the appropriate methods and techniques to remove and replace the required components

P9 carry out tests on the maintained equipment, in accordance with the test schedule/defined test procedures

P10 deal promptly and effectively with problems within your control, and seek help and guidance from the relevant people if you have problems that you cannot resolve

P11 leave the work area in a safe and tidy condition on completion of the maintenance activities

Knowledge and understanding
You need to know and understand:

K1 **the health and safety requirements, and safe working practices and procedures required for the maintenance activities undertaken**

K2 **the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy**

K3 **hazards associated with carrying out maintenance activities on engineering equipment and systems (such as handling oils, greases, stored energy/force, live electrical components, process controller interface, misuse of tools, using damaged or badly maintained tools and equipment, not following laid-down maintenance procedures), and how to minimise them**

K4 **the system isolation procedures or permit-to-work procedure that applies**

K5 **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**

K6 **how to obtain and interpret drawings, specifications, manufacturers' manuals and other documents needed in the maintenance process**

K7 **the procedure for obtaining drawings, job instructions, related specifications, replacement parts, materials and other consumables necessary for the maintenance activities**

K8 **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**

K9 **the basic principles of how the equipment functions, operation sequence, the working purpose of individual units/components and how they interact**

K10 **how to use the various diagnostic aids to help identify the location of the fault**

K11 **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)**

K12 **how to evaluate sensory information (sight, sound, smell, touch)**

K13 **how to use a range of fault diagnostic equipment to investigate the problem**

K14 **the methods and techniques used to dismantle and reassemble mechanical equipment (such as release of pressures/force; proof marking to aid reassembly; removing/replacing mechanical fasteners - nuts, bolts, clips and pins); removing components by extraction or pressing)**

K15 **methods and techniques used to dismantle and reassemble electrical/electronic equipment (such as unplugging, soldering and de-**

soldering, removal and replacement of screwed, clamped and crimped connections)

K16 methods and techniques used to dismantle and reassemble fluid power and process control instrumentation equipment (such as isolation of equipment; release of pressures/force; disconnecting and reconnecting pipes and hoses)

K17 the methods and procedures used to check programmable controllers (such as checking the program for errors against the required performance with regard to the sequence of operations and programmed instructions; using monitoring devices and test measurements to check inputs and outputs; using techniques such as `force on - force off' to simulate process conditions; checking that fail safe devices and system emergency stops are operating correctly)

K18 methods of checking that components are fit for purpose; how to identify defects and wear characteristics; and the need to replace `lifed' items

K19 the use of BS 7671/IET wiring and other regulations when selecting wires and cables, and when carrying out tests on systems

K20 how to check that tools and equipment are free from damage or defect, are in a safe and usable condition; are within calibration and test dates, and are configured correctly for the intended purpose

K21 the importance of making `off-load' checks before running the equipment under power

K22 the importance of completing maintenance documentation and/or reports following the maintenance activity

K23 the problems that can occur during the maintenance activity, and how they can be overcome

K24 when to act on your own initiative and when to seek help and advice from others

K25 the importance of leaving the work area and equipment in a safe and clean condition on completion of the maintenance activities (such as returning hand tools and test equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Additional Information

Scope/range related to performance criteria
You 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/test 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. Use appropriate dismantling and re-assembly techniques to deal with three of the following technologies:

Mechanical equipment: Carry out all of the following:

2.1 **draining and replenishing fluids**

2.2 **removing and refitting major mechanical components (such as shafts, gear mechanisms, bearings, clutches)**

2.3 **removing and refitting/replacing locking and retaining devices**

2.4 **proof marking components to aid reassembly**

2.5 **replacing lifed consumable items (such as filters, oils/lubricants)**

2.6 **removing and refitting minor mechanical units/sub-assemblies(such as guards, cover plates, pulleys and belts)**

2.7 **setting, aligning and adjusting replaced units**

Electrical equipment: Carry out all of the following:

2.8 **isolating the power supply**

2.9 **removing and replacing major electrical components (such as motors, switch/control gear)**

2.10 **disconnecting and reconnecting wires/cables**

2.11 **removing and replacing minor electrical components (such as relays, sensing devices, limit switches)**

2.12 **attaching cable end fittings (such as crimped and soldered)**

2.13 **making de-energised checks before powering up**

Fluid power equipment: Carry out all of the following:

2.14 **chocking/supporting cylinders/rams/components**

2.15 **removing and replacing major components (such as pumps, cylinders, valves, actuators)**

2.16 **releasing stored pressure**

2.17 **removing and replacing hoses/pipes**

2.18 **setting and adjusting replaced components**

2.19 **removing and replacing consumable or lifted components (such as filters, gaskets, dust seals)**

2.20 **making de-energised checks before re-pressurising the system**

Programmable controller based equipment: Carry out all of the following:

2.21 **de-activating and resetting program controller**

2.22 **checking and reviewing program format and content**

2.23 **disconnecting and reconnecting wires/cables**

2.24 **editing programs using the correct procedure (where appropriate)**

2.25 **removing and replacing input/output interfacing**

2.26 **removing and replacing program logic peripherals**

Process Instrumentation: Carry out all of the following:

2.27 **isolating instruments/sensing devices**

2.28 **re-connecting instrumentation pipework and power supply**

2.29 **disconnecting supply/signal connections**

2.30 **removing and replacing instruments in the system**

2.31 **checking that signal transmission is satisfactory**

2.32 **replacing all `lifed' consumable items (such as seals, gaskets, dust covers)**

Electronic Equipment: Carry out all of the following:

2.33 **isolating equipment from the power supply**

2.34 **removing and replacing electronic components**

2.35 **dismantling/disconnecting equipment to the required level**

2.36 **soldering and de-soldering**

2.37 **disconnecting and reconnecting wires and cables**

2.38 **removing and replacing electronic units/circuit boards**

2.39 **making de-energised checks before powering up**

3. Carry out checks and tests to help diagnose problems, and confirm that the maintained equipment performs to specification, to include two of the following:

3.1 **making visual checks (such as signs of leakage, damage, missing parts, overheating, wear/deterioration)**

3.2 **the use of fault finding techniques (such as six point, half-split, input/output, unit substitution)**

3.3 **the use of diagnostic aids (such as manuals, flow charts, troubleshooting guides, maintenance records)**

Plus two more from the following:

3.4 **mechanical checks (such as correct operation of moving parts, correct working clearance of parts, belt/chain tension, bearing loading, torque loading of fasteners)**

3.5 **electrical checks (such as continuity, polarity, protective conductor resistance values, voltage levels, load current, inductance)**

3.6 **electronic checks (such as resistance, capacitance, waveform, frequency values, amplification, signal noise/interference levels, logic states)**

3.7 **process control checks (such as pressure, flow, level, temperature, weight, sequence/timing)**

3.8 **controller checks (such as forcing contacts on and off, logic states, checking that fail safe devices and system emergency stops are operating correctly)**

4. Maintain engineering equipment and systems, in compliance with one of the following:

4.1 **organisational guidelines and codes of practice**

4.2 **equipment manufacturer's operation range**

4.3 **BS and/or ISO standards**

Unit 051 General maintenance engineering applications

Supporting Information

Developed by	SEMTA (now Enginuity)
Version number	3

Date approved	March 2017
Indicative review date	April 2020
Validity	Current
Status	Original
Originating organisation	SEMTA (now Enginuity)
Original URN	SEMPEO2-68
Relevant occupations	Engineering and manufacturing technologies; Engineering
Suite	Performing Engineering Operations Suite 2
Key words	engineering; engineering operations; maintenance engineering; manufacturing; fault finding techniques; mechanical; electrical; electronic; fluid power; process controller

Unit 052 Carrying out aircraft detail fitting activities

Level:	Level 2
GLH:	140
Relationship to NOS:	EUC2F-052
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 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.

Performance requirements

The apprentice must be able to:

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

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

P3 **plan the aircraft detail fitting activities before they start them**

P4 **obtain the appropriate tools and equipment for the aircraft detail fitting operations, and check that they are in a safe and usable condition**

P5 **mark out the components for the required operations, using appropriate tools and techniques**

P6 **cut and shape the materials to the required specification, using appropriate tools and techniques**

P7 **bend and form the materials, using the appropriate tools and equipment**

P8 **assemble and secure the components, using the correct fastening devices and joining techniques**

P9 **measure and check that all dimensional and geometrical aspects of the component are to the specification**

P10 **deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve**

P11 **leave the work area in a safe and tidy condition on completion of the fitting activities**

Skills requirements
The apprentice 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 i 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 apprentice must know and understand:

K1 **the health and safety requirements, and safe working practices and procedures required for the aircraft detail fitting activities undertaken**

K2 **the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy**

K3 **the hazards associated with the aircraft detail fitting activities (such as 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**

K4 **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**

K5 **the procedure for obtaining the required drawings, job instructions and other related specifications**

K6 **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**

K7 **how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing**

K8 **how to identify the materials to be used; material identification systems; codes used and grain flow indicators**

K9 **principles of marking out, and the equipment used in the aerospace industry**

K10 **how to clean and prepare the surfaces to be marked out ensuring, where appropriate, that grain flow is taken into account**

K11 **how to calculate bending allowances when marking out**

K12 **how to select and establish suitable datums; the importance of ensuring that marking out is undertaken from the selected datums, and the possible effects of working from different datums**

K13 **how to mark out the workpiece (including datums; cutting guidelines; square and rectangular profiles; circular and radial profiles; angles; holes which are linearly positioned, boxed and on pitch circles)**

K14 **the various methods of pattern development that can be used (such as parallel line; radial line; triangulation), and typical applications of each method**

K15 **ways of laying out the marking-out shapes or patterns to maximise use of materials**

K16 **the need for clear and dimensional accuracy in marking out to specification and drawing requirements**

K17 **the importance of using tools only for the purpose intended; the care that is required when using the equipment and tools; the proper way of storing tools and equipment between operations**

K18 **the shaping methods and techniques that can be used to produce a range of shapes/profiles on the various section materials (such as sawing, shearing, drilling, filing, abrading), and the sequence in which the operations will need to be carried out**

K19 **how to select saw blades for different applications and materials, and methods of setting saw blades for cutting externally and internally (such as hand saws, mechanical saws, band saws)**

K20 **the various shearing methods that can be used (such as tin snips, bench shears, guillotines, cropping machines and nibbling machines)**

K21 **the range of hand tools and associated equipment that is used to produce a variety of shapes, bends, curved surfaces, dished profiles**

K22 **the range of bending and forming machines to be used (such as fly presses, bending machines, rolling machines, flanging machines)**

K23 **how to set up a bending machine to produce a range of forms (such as right-angled bends, angled bends, tray sections, channel sections)**

K24 **how to set up pinch/pyramid forming rolls to produce a variety of forms (such as curved profiles, cylinders, cones)**

K25 **how to produce flanges on curved/cylindrical components (using machines and hand tools)**

K26 **methods of drilling and finishing holes in sheet and stock materials (such as drills, reamers, countersinks, hole saws)**

K27 **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**

K28 **the preparations and or treatments that may need to be carried out on the materials before and after the cutting and shaping operations**

K29 **the purpose and use of joint sealing agents and anti-electrolysis barriers, and the precautions to be taken when using them**

K30 **how to conduct any necessary checks to ensure the accuracy and quality of the components produced**

K31 **the problems that can occur with the cutting, shaping and forming operations, and how these can be overcome**

K32 **when to act on their own initiative and when to seek help and advice from others**

K33 **the importance of leaving the work area in a safe and clean condition on completion of the aircraft detail fitting activities (such as removing and storing power leads, isolating machines, removing and returning drills, cleaning the equipment and removing and disposing of waste)**

Unit 052 Carrying out aircraft detail fitting activities

Supporting Information

Developed by	Aerospace and Aviation Employer Trailblazer Group
Version number	Version 2
Date approved	1st July 2014
Assessment Requirements	Assessment requirements for this have been developed by employers for the occupational competency units and qualifications for Aeronautical Engineering. These assessment requirements are set down in the Aeronautical Engineering Employer Occupational Unit Assessment Strategy available from Semta (now Enginuity).
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored 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
Grading System	Pass/Fail
Review Date	2017

Unit 053 Installing aircraft mechanical fasteners

Level:	Level 2
GLH:	110
Relationship to NOS:	EUC2F-053
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Engineering 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 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 S2.

Performance and skills requirements
The apprentice must be able to:

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

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

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

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

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

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

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

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

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

Skills requirements
The apprentice must be able to:

S1. 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**

S2. 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**

S3. 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**

S4. 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**

S5. 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**

S6. 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**

S7. 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 apprentice must know and understand:

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

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

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

K4 **the process for the control of materials, and the need for component control and quarantine**

K5 **the methods of identifying the mechanical fasteners to be used (e.g. material identification systems, codes used and grain flow indicators)**

K6 **why they must obtain design approval before removing and replacing faulty fasteners**

K7 **the purpose and use of joint sealing agents and anti-electrolysis barriers, and the precautions to be taken when using them**

K8 **the regulations concerning electrical bonding and anti-electrolysis barriers**

K9 **the various types and range of screwed fasteners used on aircraft fittings, and the methods of installing them**

K10 **the types and applications of aircraft rivets, and the advantages of hollow rivets over solid rivets**

K11 **the reasons for using screw fastenings rather than rivets**

K12 **the purpose and use of a countersink cage**

K13 **the various locking devices used with fastenings**

K14 **the purpose and use of locating dowels, gripping pins and gauges, when carrying out fastening operations**

K15 **the procedures to be adopted when removing rivets and other fasteners**

K16 **the term `quilting', its occurrence and avoidance**

K17 **bolt break-offs, and where they occur**

K18 **how to check that riveting guns, power tools and attachments are in a safe and usable condition, and the action to be taken in the event of identifying defective equipment**

K19 **the types of gauges used to measure angles, depths, countersinks and torque**

K20 how and why tools are calibrated, and how to check that the tools they are using are within calibration dates

K21 the importance of conducting the necessary checks to ensure the accuracy and quality of the installations produced

K22 the problems that can occur with the installation of the mechanical fasteners, and how these can be overcome

Unit 053 Installing aircraft mechanical fasteners

Supporting Information

Developed by	Advanced manufacturing & Engineering Employer Trailblazer Group
Version number	Version 1
Date approved	10th April 2014
Assessment Requirements	Assessment requirements for this have been developed by employers for the occupational competency units and qualifications for Aeronautical Engineering. These assessment requirements are set down in the Aeronautical Engineering Employer Occupational Unit Assessment Strategy
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored 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
Grading System	Pass/Fail
Review Date	2017

Unit 054 Restoring Mechanical Components to Usable Condition by Repair

Level:	Level 2
GLH:	230
Relationship to NOS:	EUCL2F-054
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 skills and knowledge needed to restore mechanical components to usable condition by repair, In accordance with approved procedures. They will be required to restore a range of mechanical components and equipment to operational condition, by repairing assemblies/sub-assemblies and components, by reworking the surface, recutting threads, or by the replacement of worn parts. They will also be required to select the appropriate equipment to use, based on the nature of the repair, the operations that will need to be carried out and the accuracy to be achieved. In producing the components, they will be expected to use a range of hand tools, machine tools, portable power tools and shaping and fitting techniques, appropriate to the type of material and repair being performed. These activities will include such processes as sawing (hand, band), drilling, reaming, grinding (hand or pedestal), filing, scraping or lapping, threading (internal or external), machining (turning, milling) and thermal processes. Their responsibilities will require them to comply with organisational policy and procedures for the repairing activities undertaken, and to report any problems with these activities or with the tools, equipment or materials used, that they cannot personally resolve or are outside your permitted authority, to the relevant people. They will be expected to work to instructions, alone or in conjunction with others, taking personal responsibility for their own actions, and for the quality and accuracy of the work that they carry out. The underpinning knowledge will be sufficient to provide a sound basis for their work, and will provide an informed approach to applying component repair procedures. They will have an understanding of the function and operating conditions of the components being repaired, in sufficient depth to determine if a suitable repair can be made and to ensure that the repairs carried out are safe and practical in operation. They will also understand

	the organisational policy on repairing components, and its application. They will understand the safety precautions required when carrying out the repairing activities, especially those for isolating the equipment. They will also understand their responsibilities for safety and the importance of 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.

Performance Requirements
The apprentice must be able to:

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

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

P3. Follow the relevant specifications for the component to be repaired

P4. Prepare the component for repair

P5. Carry out the repairs within agreed timescale using approved materials and components and methods and procedures

P6. Ensure that the repaired component meets the specified operating conditions

P7. Produce accurate and complete records of all repair work carried out

Skills Requirements
The apprentice must be able to:

S1 Carry out **all** of the following activities during the repairing activity:

1.1. undertake the repairing activities to cause minimal disruption to normal working
1.2. adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment and other relevant safety regulations
1.3. use the correct issue of drawings, job instructions and procedures
1.4. check that tools and equipment to be used are fit for purpose
1.5. use correct lifting techniques and equipment (where appropriate), in accordance with health and safety guidelines and procedures
1.6. ensure that repaired components are clean, and free from contamination and foreign objects
1.7. record the repair, using appropriate methods or documentation
1.8. dispose of waste items in a safe and environmentally acceptable manner
1.9. leave the work area in a safe and tidy condition

S2 Carry out **four** of the following types of repair:

2.1 recondition a unit by replacement of worn components
2.2 sleeving of worn components
2.3 make a temporary fix
2.4 bushing/plugging of worn holes
2.5 dressing internal/external threads
2.6 rework a fit (such as shimming, packing)
2.7 joining/bonding mating surfaces
2.8 rework a component finish/shape (using techniques such as filing, scraping, grinding, lapping)
2.9 other specific repair procedures

S3 Carry out repairs on mechanical components, using **four** of the following methods:

3.1 sawing (hand or band)
3.2 drilling
3.3 reaming
3.4 grinding (hand or pedestal)
3.5 filing
3.6 scraping or lapping
3.7 tapping/cutting threads
3.8 machining (turning, milling)
3.9 thermal processes (such as brazing, welding, metal spraying)

S4 Carry out repairs to mechanical equipment, in accordance with **one** of the following:

4.1 organisational guidelines and codes of practice
4.2 equipment manufacturer's operation range
4.3 BS, ISO and/or BSEN standards

S5 Complete **one** of the following records, and pass it to the appropriate person:

5.1 job cards
5.2 permit to work/formal risk assessment
5.3 maintenance log and action report
5.4 company-specific documentation

Knowledge and understanding
The apprentice must know and understand:

K1 Describe the health and safety requirements of the area in which the repairing activity is to take place, and the responsibility these requirements place on them
K2 Describe the isolation procedure or permit-to-work procedure that applies
K3 Describe the specific health and safety precautions to be applied during the repairing procedure, and their effects on others
K4 Describe the importance of wearing protective clothing and other appropriate safety equipment (PPE) during the repairing activities
K5 Describe the hazards associated with the repair/restoration operations being carried out (such as sawing (hand, band), drilling, reaming, grinding (hand or machine), filing, scraping or lapping, threading (internal or external), turning, milling and thermal processes), and how they can be minimised
K6 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
K7 Explain how to obtain and interpret information from job instructions and other documentation used in the repairing activities (such as drawings, specifications, manufacturers' manuals, maintenance schedules symbols and terminology)
K8 Describe the methods, techniques and company procedures to be followed for repairing mechanical equipment
K9 Describe the types of repairs that can be made to components in order to prolong their useful life (such as bushing/plugging of worn holes, recutting threads, joining mating surfaces by thermal process)
K10 Explain how to use a range of hand tools (such as files, scrapers, threading devices)
K11 Explain how to select saw blades (for different materials and different operations)
K12 Explain the types and application of portable power tools that can be used for the repairing operations
K13 Explain how to confirm that portable power tools and extension cables are in a safe, tested and usable condition
K14 Describe the operating requirements of the machine tools and accessories being used (such as guards, workholding devices, speeds and feeds, specific statutory regulations such as Abrasive Wheels Regulations)
K15 Explain how to handle and store tools and equipment, safely and correctly
K16 Describe the application of cutting fluids
K17 Describe the company recording procedures to be used following a repair, and how to apply them
K18 Describe the problems associated with repairing mechanical components, and how to resolve them
K19 Describe the extent of their own authority and to whom they should report if they have a problem that they cannot resolve

Unit 054 Restoring Mechanical Components to Usable Condition by Repair

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	February 2015
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	320 GLH
Review Date	March 2018

Unit 055 Assembling Fluid Power Components to Mechanical Equipment

Level:	Level 2
GLH:	490
Relationship to NOS:	EUCL2F-055
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 and fit fluid power components (such as pneumatic, hydraulic, or vacuum) to mechanical equipment, in accordance with approved procedures. They will be required to check the specified components are available and fit for purpose, to obtain all relevant and current documentation, to obtain the tools and equipment required for the assembly operations and to check that they are in a safe and usable condition. In carrying out the fitting and assembly operations, they will be required to follow company procedures and specified assembly techniques, in order to assemble the required components. Their assembly activities will also include making all necessary checks and adjustments, to ensure the fluid power components are correctly positioned and aligned, that moving parts have the correct working clearances, all fasteners are tightened to the correct torque and that the assembled parts are checked for completeness. Their responsibilities will require them to comply with organisational policy and procedures for the assembly activities undertaken, and to report any problems with the assembly activities, materials or equipment that you cannot personally resolve, or are outside their permitted authority, to the relevant people. They will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out. Their underpinning knowledge will be sufficient to provide a good understanding of their work, and will provide an informed approach to applying fluid power assembly

	techniques and procedures. They will understand the mechanical product being assembled, and its application, and will know about the equipment, relevant components and joining techniques, 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 assembly activities. 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.

Performance Requirements
The apprentice must be able to:

P1 Work safely at all times, complying with health and safety and other relevant regulations,
P2 Demonstrate the required behaviours in line with the job role and company objectives
P3 Follow the relevant instructions, assembly drawings and any other specifications
P4 Ensure that the specified components are available, prepared and that they are in a usable condition
P5 Use the appropriate methods and techniques to assemble and fit the components in their correct positions
P6 Secure the components using the specified connectors and securing devices
P7 Check the completed assembly to ensure that all operations have been completed and the finished assembly meets the required specification
P8 Complete the required production documentation
P9 Deal promptly and effectively with problems within their control and report those that cannot be solved

Skills requirements
The apprentice must be able to:

S1. Carry out **all** of the following during the assembly activities:
- 1.1 obtain and use the appropriate documentation (such as job instructions, drawings, 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 check that tools and measuring instruments to be used are fit for service
- 1.4 ensure that components and pipes used are free from damage, foreign objects, dirt or other contamination
- 1.5 use appropriate and approved fitting and assembly techniques at all times
- 1.6 leave the work area in a safe and appropriate condition on completion of the activities

S2. Assemble and fit components for **one** of the following types of fluid power systems:
- 2.1 pneumatic
- 2.2 vacuum
- 2.3 hydraulic
- 2.4 electro-fluid power systems

S3. Prepare and fit **four** of the following fluid power components and materials to mechanical equipment:
- 3.1 power generation components (such as motors, pumps, compressors, intensifiers)
- 3.2 fluid conditioning components (such as filters, lubricators, separation units, heaters/driers, cooler units)

3.3 storage devices (such as reservoirs, accumulators)
3.4 monitoring components (such as sensors, meters, gauges and indicators)
3.5 pipe work (such as rigid pipe, flexible pipe, hoses)
3.6 connection devices (such as manifolds, couplings, cables and wires)
3.7 control components (such as valves, actuators/cylinders, regulators)

S4. Carry out the quality checks using appropriate equipment, to include **four** of the following:
4.1 dimensions
4.2 correct direction and flow
4.3 electrical continuity
4.4 positional accuracy
4.5 leak or pressure tests
4.6 completeness
4.7 alignment
4.8 component security
4.9 function
4.10 pipe work (free from ripple and creases)

S5. Produce fluid power assemblies which comply with **one** of the following quality and accuracy standards:
5.1 BS, ISO or BSEN standards and procedures
5.2 customer standards and requirements
5.3 company standards and procedures
5.4 specific system requirements

Knowledge and understanding
The apprentice must know and understand:

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

K2 Describe the health and safety requirements of the work area in which they are carrying out the assembly activities, and the responsibility these requirements place on them

K3 Describe the COSHH regulations with regard to the substances used in the fluid power assembly process

K4 Describe the hazards associated with assembling fluid power system components, and how to minimise them and reduce any risks

K5 Describe the personal protective equipment and clothing (PPE) to be worn during the assembly activities

K6 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

K7 Explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken

K8 Describe the general principles of fluid power, and the purpose and function of the components and materials used

K9 Describe the preparations to be undertaken on the components prior to fitting them onto the assembly

K10 the fitting and assembly methods and procedures to be used, and the importance of adhering to these procedures

K11 Explain how the components are to be aligned, adjusted and positioned prior to securing, and the tools and equipment that are used

K12 Describe the importance of using the specified components for the assembly, and why they must not use substitutes

K13 Describe the quality control procedures to be followed during the assembly operations

K14 Explain how to detect assembly defects/faults (such as ineffective joining techniques, foreign objects, component damage), and what to do to rectify them

K15 Describe the methods and equipment used to transport, lift and handle components and assemblies

K16 Explain how to check that the tools and equipment to be used are in a safe and serviceable condition

K17 Describe the importance of ensuring that all tools are used correctly and within their permitted operating range

K18 Describe the problems that can occur with the assembly operations, and what to do if they occur

K19 Describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve

Unit 055 Assembling Fluid Power Components to Mechanical Equipment

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	February 2016
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	490 GLH
Review Date	March 2019

Unit 056 Assembling Electrical or Electronic Components to Mechanical Equipment

Level:	Level 2
GLH:	490
Relationship to NOS:	EUCL2F-056
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 electrical or electronic components to mechanical equipment, in accordance with approved procedures. They will be required to check that specified components are available and fit for purpose, to obtain all relevant and current documentation, to obtain the tools and equipment required for the assembly operations and to check that they are in a safe and usable condition. In carrying out the assembly operations, they will be required to follow company procedures and specified assembly techniques, in order to fit the electrical or electronic components to the mechanical assembly. The assembly activities will also include making all necessary checks and adjustments, to ensure that the electrical or electronic components are correctly orientated, positioned and secured correctly. They must also check that any cables and wires are routed correctly and are tidy in appearance, and that connections are mechanically sound and checked for electrical continuity. Their responsibilities will require them to comply with organisational policy and procedures for the assembly activities undertaken, and to report any problems with the assembly activities, materials or equipment that they cannot personally resolve, or are outside your permitted authority, to the relevant people. They will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out. Their underpinning knowledge will be sufficient to provide a good understanding of their work, and will provide an informed approach to applying electrical or electronic fitting and assembly techniques and procedures. They will have an

	understanding of the product being assembled and its application, and will know about the equipment, relevant components and joining techniques, 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 assembly activities. 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.

Performance Requirements

The apprentice must be able to:

P1 Work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines
P2 Demonstrate the required behaviours in line with the job role and company objectives
P3 Follow the relevant instructions, assembly drawings and any other specifications
P4 Ensure that the specified components are available and that they are in a usable condition
P5 Use the appropriate methods and techniques to fit the components in their correct positions
P6 Secure the components using the specified connectors and securing devices
P7 Check the completed assembly to ensure that all operations have been completed and the finished assembly meets the required specification
P8 Complete the required production documentation
P9 Deal promptly and effectively with problems within their control and report those that cannot be solved

Skills Requirements
The apprentice must be able to:

S1. Carry out **all** of the following during the assembly activities:

1.1 obtain and use the appropriate documentation (such as job instructions, drawings, 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 use lifting and slinging equipment (where appropriate) in accordance with health and safety guidelines and procedures
1.4 check that tools and measuring instruments to be used are fit for service
1.5 use appropriate and approved fitting and assembly techniques at all times
1.6 ensure that the components used are free from damage, foreign objects, dirt or other contamination
1.7 leave the work area in a safe and appropriate condition on completion of the activities

S2. Fit electrical or electronic components using **all** of the following techniques:

2.1 routeing cables and wires
2.2 mounting/securing components
2.3 cable fixings and fasteners

S3. Terminate and join cables/wires to components using **two** of the following:

3.1 screwed connections
3.2 clamped connections
3.3 soldering
3.4 crimping
3.5 cable protection devices (such as sleeving or grommets)

S4. Fit **four** of the following electrical components on the mechanical equipment:

4.1 cable enclosures (such as conduit, trunking, tray work)
4.2 circuit connection devices (such as plugs, sockets)
4.3 monitoring components (such as sensors)
4.4 power generation components (such as motors, transformers)
4.5 control components (such as relays, solenoids, switches)
4.6 cables and wires
4.7 electronic modules
4.8 circuit protection devices
4.9 lamps/lighting
4.10 instrumentation units
4.11 other specific components

S5. Carry out the required checks using the correct tools and equipment, to include **four** of the following:

5.1 position
5.2 completeness
5.3 electrical continuity
5.4 alignment
5.5 free from damage or foreign objects
5.6 component security

S6. Produce mechanical assemblies which comply with **one** of the following standards:

6.1 BS, ISO or BSEN standards and procedures
6.2 customer standards and requirements
6.3 company standards and procedures
6.4 specific system requirements

Knowledge and understanding
The apprentice must know and understand:

K1 Describe the specific safety precautions to be taken while carrying out the assembly (including any specific legislation, regulations or codes of practice relating to the activities, equipment or materials)
K2 Describe the health and safety requirements of the work area in which they are carrying out the assembly activities, and the responsibility these requirements place on them
K3 Describe the COSHH regulations with regard to the substances used in the assembly process
K4 the hazards associated with assembling electrical or electronic components to mechanical equipment, and how to minimise them and reduce any risks
K5 Describe the personal protective equipment and clothing (PPE) to be worn during the assembly activities
K6 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
K7 Explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
K8 Describe the general principles of electrical and electronic fitting techniques
K9 Describe the purpose and function of the components, including identification systems (such as colour codes, symbols, manufacturers specification)
K10 Describe the preparations to be undertaken on the electrical or electronic components prior to fitting them into the assembly
K11 Describe the correct component handling procedures, including any relevant handling equipment
K12 Describe the assembly and securing methods and procedures to be used, and the importance of adhering to these
K13 Explain how the components are to be positioned, aligned and secured, and the tools and equipment that are used
K14 Describe the importance of using the specified electrical or electronic components and securing devices for the assembly, and why they must not use substitutes
K15 Describe the quality control procedures to be followed during the assembly operations
K16 Explain how to conduct any necessary checks to ensure the accuracy, position, security, function, completeness and electrical continuity of the assembly
K17 Explain how to detect assembly defects (such as ineffective joining techniques, component damage), and what to do to rectify them
K18 Explain how to check that the tools and equipment to be used are in a safe and serviceable condition
K19 Describe the importance of ensuring that all tools are used correctly and within their permitted operating range
K20 Describe the importance of ensuring all tools, equipment and components are accounted for and returned to their correct location on completion of the assembly activities
K21 Describe the problems that can occur with the assembly operations, and what to do if they occur

K22 Describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve

Unit 054 Restoring Mechanical Components to Usable Condition by Repair

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	February 2016
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	490 GLH
Review Date	March 2019

Unit 057 Assembling Pipework Components to Mechanical Equipment

Level:	Level 2
GLH:	490
Relationship to NOS:	EUCL2F-057
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 and fit pipework components to mechanical equipment, in accordance with approved procedures. They will be required to check that specified components are available and fit for purpose, to obtain all relevant and current documentation, to obtain the tools and equipment required for the assembly operations and to check that they are in a safe and usable condition. In carrying out the assembly operations, they will be required to follow company procedures and specified assembly techniques, in order to assemble the pipework and components and to fit them to the mechanical equipment. The assembly activities will also include making all necessary checks and adjustments to ensure that the pipework and components are correctly orientated, positioned and aligned and that all fasteners are tightened to the correct torque and the assembled parts are checked for completeness. Their responsibilities will require them to comply with organisational policy and procedures for the assembly activities undertaken, and to report any problems with the assembly activities, materials or equipment that they cannot personally resolve, or are outside their permitted authority, to the relevant people. They will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out. Their underpinning knowledge will be sufficient to provide a good understanding of their work, and will provide an informed approach to applying pipework fitting and assembly techniques and procedures. They will have an understanding of the mechanical product being assembled, and its application, and will know about the equipment, relevant components and

	joining techniques, 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 assembly activities. 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.

Performance Requirements

The apprentice must be able to:

P1 Work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines
P2 Demonstrate the required behaviours in line with the job role and company objectives
P3 Follow the relevant instructions, assembly drawings and any other specifications
P4 Ensure that the specified components are available and that they are in a usable condition
P5 Use the appropriate methods and techniques to assemble the components in their correct positions
P6 Secure the components using the specified connectors and securing devices
P7 Check the completed assembly to ensure that all operations have been completed and the finished assembly meets the required specification
P8 Complete the required production documentation
P9 Deal promptly and effectively with problems within their control and report those that cannot be solved

Skills Requirements
The apprentice must be able to:

S1. Carry out **all** of the following during the assembly activities:
- 1.1 obtain and use the appropriate documentation (such as job instructions, drawings, 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 check that tools and measuring instruments to be used are fit for service
- 1.4 ensure that components and pipes used are free from damage, foreign objects, dirt or other contamination
- 1.5 use appropriate and approved fitting and assembly techniques at all times
- 1.6 use lifting and slinging equipment (where appropriate) in accordance with health and safety guidelines and procedures
- 1.7 leave the work area in a safe and appropriate condition on completion of the activities

S2. Use appropriate techniques to assemble **two** of the following types of pipework to the mechanical equipment:
- 2.1 steel pipe
- 2.2 copper pipe
- 2.3 plastic pipe
- 2.4 flexible hoses

S3. Connect and secure pipework using **two** of the following methods:

3.1 compression
3.2 screwing
3.3 push fit
3.4 cementing/bonding
3.5 bolting
3.6 brazing
3.7 soldering

S4. Fit and secure **five** of the following pipework components:
4.1 straight connectors
4.2 tee pieces
4.3 curved/profiled sections
4.4 reduction pieces
4.5 flanges
4.6 couplings
4.7 straight sections
4.8 elbows
4.9 angular sections
plus **one** more from the following:
4.10 control components (such as valves, taps, regulators)
4.11 storage devices (such as tanks, reservoirs)
4.12 monitoring components (such as sensors, meters, gauges)
4.13 fluid distribution components (such as motors, pumps)

S5. Carry out **all** of the following quality checks using appropriate equipment, to include:
5.1 alignment
5.2 correct direction and flow
5.3 completeness
5.4 component security
5.5 positional accuracy
5.6 component quality (such as free from ripple, creases, foreign objects)

S6. Produce pipework assemblies which comply with **one** of the following quality and accuracy standards:
6.1 BS, ISO or BSEN standards and procedures
6.2 customer standards and requirements
6.3 company standards and procedures
6.4 specific system requirements

Knowledge and understanding
The apprentice must know and understand:

K1 Describe the specific safety precautions to be taken while carrying out the fitting of pipe work systems to mechanical assemblies (including any specific legislation, regulations or codes of practice relating to the activities, equipment or materials)

K2 Describe the health and safety requirements of the work area in which they are carrying out the assembly activities, and the responsibility these requirements place on them

K3 Describe COSHH regulations with regard to the substances used in the assembly process

K4 Describe he hazards associated with assembling pipe work and pipe components to mechanical equipment, and how to minimise them and reduce any risks

K5 Describe the personal protective equipment and clothing (PPE) to be worn during the assembly activities

K6 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

K7 Explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken

K8 Describe the general principles of producing pipe work assemblies, and the purpose and function of the components and materials used, including identification systems (such as colour codes)

K9 Describe the application of different pipe work assembly methods and techniques

K10 Describe the preparations to be undertaken on the pipe work prior to fitting them to the assembly

K11 Describe the pipe work assembly/joining methods and procedures to be used, and the importance of adhering to these

K12 Describe the importance of using the specified pipe work and fittings for the assembly, and why they must not use substitutes

K13 Describe the quality control procedures to be followed during the assembly operations

K14 Explain how to conduct any necessary checks to ensure the safety, accuracy, position, security, function and completeness of the pipe work assembly

K15 Explain how to identify pipe work assembly defects (such as ineffective joining techniques, component damage), and what to do to rectify them

K16 Explain how to check that the tools and equipment to be used are in a safe and serviceable condition

K17 Describe the importance of ensuring that all tools are used correctly and within their permitted operating range

K18 Describe the problems that can occur with the pipe work assembly activities, and what to do if these occur

K19 Describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve

Unit 054 Restoring Mechanical Components to Usable Condition by Repair

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	February 2016
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
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Grading System	Pass/Fail
Recommended Training and Assessment Time	490 GLH
Review Date	March 2019

Unit 058 Producing Composite Mouldings using Wet Lay-Up Techniques

Level:	Level 2
GLH:	420
Relationship to NOS:	EUCL2F-058
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 cover a broad range of basic competences they need to produce composite mouldings using wet lay-up laminating techniques. 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. They will be required 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 they 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 a 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 Standard 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 scope 7.

Performance Requirements
The apprentice must be able to:

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

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

P3 Plan the moulding/laying-up activities before they start them

P4 Prepare the moulds, jigs or formers ready for the manufacturing operations

P5 Mix and prepare the required materials

P6 Carry out the moulding or laying-up activities, using the correct methods and techniques

P7 Produce composite mouldings

P8 Remove the mouldings from the formers and trim/finish them to specification

P9 Check that all the required operations have been completed to specification

P10 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve

P11 Leave the work area in a safe and tidy condition on completion of the moulding activities

Skills Requirements
The apprentice must be able to:

S1. 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

S2. 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

S3. 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

S4. 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

S5. 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

S6. 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 rientated plies
6.6 inserts
6.7 fixtures

S7. 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

S8. 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)

S9. 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)

Unit 058 Producing Composite Mouldings using Wet Lay-Up Techniques

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	March 2017
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	420 GLH
Review Date	April 2020

Unit 059 Producing Components by Acrylic Moulding

Level:	Level 2
GLH:	320
Relationship to NOS:	EUCL2F-059
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 produce components by acrylic moulding, in accordance with approved procedures. They will be required to follow the appropriate instructions, drawings, specifications and documentation to produce the various types of components. They will be expected to produce the acrylic components using the specified moulding process and techniques. This will involve using equipment such as air circulating ovens, presses, trimming and automated cutting equipment. The products produced will include deep drawn, double curvature, convex and concave shapes. Their responsibilities will require them to comply with organisational policy and procedures for the acrylic moulding activities undertaken, and to report any problems with the moulding 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, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out. Their underpinning knowledge will be sufficient to provide a good understanding of their work, and will provide an informed approach to applying acrylic moulding techniques and procedures. They will have an understanding of the production techniques used, and their application, in adequate depth to provide a sound basis for carrying out the activities, recognising

	faults, and ensuring the work output is to the required specification. They will understand the safety precautions required when carrying out the acrylic 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.

Performance Requirements
The apprentice must be able to:

P1 Work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines
P2 Demonstrate the required behaviours in line with the job role and company objectives
P3 follow the correct component drawing or any other related specifications for the component to be produced
P4 Determine what has to be done and how this will be achieved
P5 Obtain and prepare the appropriate tools, equipment and materials
P6 Carry out the moulding activities using the correct methods and techniques
P7 Produce components to the required specification
P8 Check that all the required operations have been completed to specification
P9 Deal promptly and effectively with problems within their control and report those that cannot be solved
P10 Complete relevant production documentation

Skills Requirements
The apprentice must be able to:

S1. Carry out **all** of the following during the moulding activities:

1.1 obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation, material data sheets)
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 obtain the correct tools and equipment for the activity and ensure they are safe to use
1.4 use the correct materials and consumables, as specified in the production documentation
1.5 apply safe and appropriate acrylic moulding practices and procedures at all times
1.6 keep the work area in a safe and suitable condition

S2. Carry out **one** of the following moulding methods and techniques:

2.1 vacuum moulding
2.2 deep drawing
2.3 shape clamping
2.4 positive pressure shaping
2.5 stress relieving

S3. Carry out **four** of the following operations during the moulding process:

3.1 tool/equipment preparation
3.2 stress relieving
3.3 sheet preparation
3.4 sheet forming
3.5 trimming
3.6 de-moulding
3.7 setting and controlling temperatures

S4. Produce a range of components with **two** of the following features:
4.1 box sections
4.2 concave shapes
4.3 cylindrical section
4.4 single curvatures
4.5 convex shapes
4.6 double curvatures

S5. Produce a range of mouldings which comply with **one** of the following standards:
5.1 BS, ISO or BSEN standards and procedures
5.2 customer standards and requirements
5.3 company standards and procedures
5.4 specific material/moulding requirements

Knowledge and understanding
The apprentice must know and understand:

K1 Describe the specific safety practices and procedures that they need to observe when working with acrylics (including any specific legislation, regulations/codes of practice for the activities, equipment or materials used)

K2 Describe the health and safety requirements of the work area where they are carrying out the activities, and the responsibility these requirements place on them

K3 Describe the protective equipment (PPE) that they need to use for both personal protection and, where appropriate, protection of others

K4 Describe the hazards associated with moulding acrylic materials, and with the tools and equipment used, and how to minimise them and reduce any risks in the workplace

K5 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

K6 Describe the interpretation of drawings, standards, quality control procedures and specifications used for the moulding activity, and the currency/issue checks of the documents they are working with

K7 Describe the principles of deep drawing, concave/convex moulding, positive pressure moulding and stress relieving

K8 Describe the different methods of heating materials, and the temperature control methods

K9 Describe the sheet profiling procedures, and material trimming methods/procedures

K10 Describe the supply of acrylic sheet (such as colour, thickness, sheet size, surface texture, material protection)

K11 Describe the use of forming aids

K12 Describe the methods of sheet trimming and sheet cleaning prior to moulding

K13 Describe the preparation methods and procedures applied to the moulding surface

K14 Describe the material cleaning methods and procedures to be applied

K15 Describe the quality control procedures to followed during the moulding operations

K16 Describe the methods and techniques for lifting, handling and supporting the components/equipment/materials during the moulding activities

K17 Describe the recognition of moulding defects (such as misalignment, distortion, damage, contamination and surface defects)

K18 Describe the tools and equipment used in the moulding activities, and their calibration, care, preparation and control procedures

K19 Describe the problems that can occur with the moulding operations, and how these can be overcome

K20 Describe the recording documentation to be completed for the moulding activities undertaken

K21 Describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve

Unit 054 Restoring Mechanical Components to Usable Condition by Repair

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	February 2016
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
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Grading System	Pass/Fail
Recommended Training and Assessment Time	320 GLH
Review Date	March 2019

Unit 060 Vacuum Forming Composite Materials

Level:	Level 2
GLH:	320
Relationship to NOS:	EUCL2F-060
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 vacuum form components, in accordance with approved procedures. They will be required to follow the appropriate instructions, drawings and specifications, to produce the various types of components from thermoplastic sheet fibre reinforced thermoplastic sheet and structural foam. This will require them to use a range of air circulating ovens, vacuum forming machines, trimming equipment and various types of tooling. The components produced will have a range of features, including male shapes, female shapes, double curvatures and stiffened mouldings. Their responsibilities will require them to comply with organisational policy and procedures for the vacuum forming activities undertaken, and to report any problems with the vacuum forming activities, equipment, materials or consumables that they cannot personally resolve, or are outside their permitted authority, to the relevant people. They will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out. Their underpinning knowledge will be sufficient to provide an understanding of their work, and will provide an informed approach to applying vacuum forming procedures. They will have an understanding of the vacuum forming procedures used, and their application, and will know about the vacuum forming techniques, materials, tooling and consumables used, in adequate depth to provide a sound basis for carrying out the activities, recognising faults and ensuring the work output is to the required specification. They will understand the safety precautions required when carrying out the vacuum forming operations 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. 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.

Performance Requirements
The apprentice must be able to:

P1 Work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines
P2 Demonstrate the required behaviours in line with the job role and company objectives
P3 Confirm that the equipment is set up correctly and is ready for use
P4 Operate the machine controls safely and correctly in line with operational procedures
P5 Produce components to the required specification
P6 Carry out quality sampling checks at suitable intervals
P7 Deal promptly and effectively with problems within their control and report those that cannot be solved
P8 Shut down the equipment to a safe condition on conclusion of the machining activities
P9 Complete relevant production documentation

Skills Requirement
The apprentice must be able to:

S1. Carry out **all** of the following during the vacuum forming activities:
- 1.1 obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation, material data sheets)
- 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 obtain the correct tools and equipment for the activity and ensure they are safe to use
- 1.4 use the correct materials and consumables, as specified in the production documentation (such as colour, size, composition)
- 1.5 apply safe and appropriate vacuum forming techniques and working practices at all times
- 1.6 keep the work area in a safe and suitable condition

S2. Use **two** of the following types of equipment:
- 2.1 air circulating ovens
- 2.2 wood tooling
- 2.3 vacuum forming machines
- 2.4 trimming equipment
- 2.5 composite tooling
- 2.6 metal tooling
- 2.7 other specific equipment

S3. Carry out **three** of the following operations:

3.1 bubble blowing to minimize webbing
3.2 positioning of robbers
3.3 cleaning tooling
3.4 temperature control
3.5 trimming techniques
3.6 drying of sheet
3.7 use of intensifiers
3.8 sheet cleaning

S4. Produce a range of components with **two** of the following features:
4.1 double curvatures
4.2 female shapes
4.3 male shapes
4.4 stiffened mouldings

S5. Produce a range of components using **one** the following materials:
5.1 thermoplastic sheet (such as polycarbonate, polysulphone, acrylic, polyvinyl chloride, ABS)
5.2 fibre-reinforced thermoplastic sheet
5.3 structural foams (such as polyvinyl chloride (PVC), polymethate)

S6. Produce components which comply with **one** of the following standards:
6.1 BS, ISO or BSEN standards and procedures
6.2 customer standards and requirements
6.3 company standards and procedures
6.4 specific material/vacuum forming requirements

Knowledge and understanding
The apprentice must know and understand:

K1 Describe the specific safety practices and procedures that they need to observe when working with vacuum forming equipment (including any specific legislation, regulations/codes of practice for the activities, equipment or materials)

K2 Describe the health and safety requirements of the work area where they are carrying out the activities, and the responsibility these requirements place on them

K3 Describe the protective equipment (PPE) that they need to use for both personal protection and, where appropriate, protection of others

K4 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

K5 Describe the hazards associated with carrying out vacuum forming activities, and with the tools and equipment used, and how to minimise these and reduce any risks in the work area

K6 Describe the application of COSHH regulations in relation to the storage, use and disposal of materials and consumables used in the vacuum forming process

K7 Explain how to extract and use information from engineering drawings, and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to the work undertaken

K8 Explain how to interpret imperial and metric systems of measurement

K9 Describe the methods of sheet trimming and sheet cleaning, prior to forming

K10 Describe the preparation methods and procedures applied to the moulding surface

K11 Describe the identification of the correct male/female mould tooling

K12 Describe the methods and techniques of loading and aligning materials into the mould tooling

K13 Describe the methods and techniques for carrying out the de-moulding procedures

K14 Explain how to recognise vacuum forming defects (such as misalignment, distortion, damage, contamination and surface defects)

K15 Explain the importance of adhering to the vacuum forming cycle

K16 Describe the quality control procedures to followed during the vacuum forming operations

K17 Describe the tools and equipment used in the vacuum forming activities, and their care, preparation and control procedures

K18 Describe the problems that can occur with the vacuum forming operations, and how these can be overcome

K19 Describe the production documentation to be completed for the vacuum forming activities undertaken

K20 Describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve

Unit 054 Restoring Mechanical Components to Usable Condition by Repair

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	February 2016
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	320 GLH
Review Date	March 2019

Unit 061 Trimming Composite Mouldings using Hand Tools

Level:	Level 2
GLH:	320
Relationship to NOS:	EUCL2F-061
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 trim composite mouldings using hand tools, in accordance with approved procedures. They will be required to follow the appropriate instructions, drawings, specifications and documentation to trim various composite mouldings, using the correct trimming techniques. They will be expected to select and use the correct tools and equipment for the trimming activity. They will trim a range of composite mouldings, incorporating a variety of features, by using cutting, sanding, drilling and polishing techniques and processes. Mouldings to be trimmed will include a range of resin and fibre materials. Their responsibilities will require them to comply with organisational policy and procedures for the trimming activities undertaken, and to report any problems with the trimming 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, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out. Their underpinning knowledge will be sufficient to provide a good understanding of their work, and will provide an informed approach to applying composite moulding trimming techniques and procedures. They will have an understanding of the trimming techniques used, and their application, in adequate depth to provide a sound basis for carrying out the activities, recognising faults and ensuring the trimmed mouldings are to the required specification.

	They will understand the safety precautions required when carrying out the trimming 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.

Performance Requirements
The apprentice must be able to:

P1 Work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines
P2 Demonstrate the required behaviours in line with the job role and company objectives
P3 Follow relevant specifications for the moulding to be trimmed
P4 Obtain the appropriate tools and equipment for the shaping operations and check they are in a safe and usable condition
P5 Carry out any required preparation activities prior to undertaking the trimming operation
P6 Trim the moulding using appropriate methods and techniques
P7 Check that all the required shaping operations have been completed to the required specification
P8 Complete relevant production documentation
P9 Deal promptly and effectively with problems within their control and report those that cannot be solved

Skills Requirements
The apprentice must be able to:

S1. Carry out **all** of the following during the trimming activities:
- 1.1 obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation, material data sheets)
- 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 obtain the correct tools and equipment for the activity and ensure they are safe to use
- 1.4 follow safe and appropriate trimming techniques and working practices at all times
- 1.5 segregate and dispose of waste materials using the correct procedure
- 1.6 return all tools and equipment to the correct location on completion of the trimming activities
- 1.7 leave the work area in a safe and suitable condition on completion of the activities

S2. Carry out **all** of the following when preparing for the trimming activity:
- 2.1 check the moulding is correct and complete
- 2.2 check for any defects in the moulding
- 2.3 identify and protect the moulding in the work area

S3. Mark out the mouldings using **two** of the following methods:
- 3.1 scriber
- 3.2 moulded scribe lines
- 3.3 trimming templates
- 3.4 height gauge
- 3.5 centre punch
- 3.6 scribing jigs
- 3.7 other specific method

S4. Cut mouldings using **two** the following methods:

4.1 cutting wheels/discs
4.2 routers
4.3 saws
4.4 trim jigs

S5. Sand mouldings using **two** of the following methods:

5.1 rubbing blocks
5.2 pencil grinders
5.3 belt sanders
5.4 diamond files
5.5 disc sanders
5.6 orbital sanders

S6. Use a hand drill or pedestal drill to drill mouldings using **one** of the following methods:

6.1 drill jigs
6.2 counterbores
6.3 drill bits
6.4 hole saws
6.5 countersinks

S7. Polish mouldings using **two** of the following methods if final finish is required:

7.1 wet sanding
7.2 polishing compound
7.3 orbital sander
7.4 cutting compound
7.5 rubbing block
7.6 polisher

S8. Trim mouldings using techniques for **one** of the following resin types:

8.1 bio resin
8.2 thermoplastic
8.3 polyester
8.4 vinyl ester
8.5 epoxy
8.6 phenolic
8.7 bismaleimide
8.8 cyanate ester
8.9 other (to be specified)

S9. Trim mouldings using techniques for **one** of the following fibre types:

9.1 natural fibre
9.2 thermo plastic
9.3 glass
9.4 aramid
9.5 carbon
9.6 hybrid
9.7 other specific types

S10. Trim mouldings that require, or incorporate **five** of the following features:

10.1 straight edges
10.2 multiple holes
10.3 curved edges
10.4 multiple hole sizes
10.5 flat surfaces
10.6 countersinks
10.7 polished surfaces
10.8 counterbores
10.9 shaped surfaces
10.10 further lay-up stages
10.11 radius corners
10.12 inserts to be drilled
10.13 returns
10.14 inserts to be tapped
10.15 net edges
10.16 solid cores
10.17 joggle details
10.18 honeycomb cores
10.19 removal of join lines
10.20 edge filling/sealing

S11 Trim a range of mouldings in compliance with **one** of the following standards:

11.1 BS, ISO or BSEN standards and procedures
11.2 customer standards and requirements
11.3 company standards and procedures
11.4 recognised compliance agency/body standards

Knowledge and understanding
The apprentice must know and understand:

K1 Describe health and safety precautions to be taken and procedures used when working with composite materials, consumables, tools and equipment in the specific work area

K2 Describe the hazards associated with trimming composite materials, consumables, tools and equipment, and how to minimise these and reduce any risks in the work area

K3 Describe the protective equipment (PPE) that is needed for personal protection and, where required, the protection of others

K4 Describe the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables

K5 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

K6 Describe the specific environmental conditions the must be observed when trimming composite mouldings (such as temperature, humidity, fume/dust extraction systems and equipment)

K7 Describe the importance of setting up and using dust control measures including segregated work areas, dust extraction, working practices and use of personal protective equipment (PPE)

K8 Explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken

K9 Explain how to interpret drawings, imperial and metric systems of measurement, work piece reference points and system of tolerance

K10 Explain how to prepare for the trimming activities, and how to mark out the mouldings for the material that needs to be removed

K11 Describe the quality procedures used in the workplace to ensure production control (such as in relation to currency, issue, meeting specification) and the completion of such documents

K12 Explain the conventions and terminology used for trimming activities (such as scribe lines, sanding grades, types of cutting tools, speeds)

K13 Describe the different types of manual and power tools used in composite trimming operations

K14 Explain how the type of material being trimmed can affect the selection of cutting media, tools and speeds

K15 Describe the different types of cutting tools and abrasives used in trimming composite materials, and their application

K16 Describe the visual identification of cured and non-cured composite materials

K17 Describe the identification of defects in composite mouldings

K18 Describe the methods used in the trimming of composite mouldings

K19 Describe the sequence to be followed when preparing for trimming activities

K20 Describe the care and safe handling of composite mouldings throughout the trimming cycle

K21 Describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve

Unit 061 Trimming Composite Mouldings using Hand Tools

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	February 2016
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	320 GLH
Review Date	March 2019

Unit 062 Identifying Defects in Composite Mouldings

Level:	Level 2
GLH:	230
Relationship to NOS:	EUCL2F-062
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 identify and deal with defects in composite mouldings (such as moulds, panels, components, jigs), in accordance with approved procedures. They will be required to follow appropriate drawings, specifications and documentation to identify and deal with defects in composites mouldings. They will be able to identify a range of defects in composite mouldings, using various methods and techniques. Defects will be identified in a range of mouldings with a variety of resin and fibre materials. 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, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work they carry out. Their underpinning knowledge will be sufficient to provide a good understanding of their work, and will provide an informed approach to identifying defects in composite mouldings. They will have an understanding of composite materials, and their application, and will know about the associated defects, in adequate depth to provide a sound basis for identifying 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.

Performance Requirements

The apprentice must be able to:

P1 Work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines
P2 Demonstrate the required behaviours in line with the job role and company objectives
P3 Inspect and identify defects with regard to the composite moulding specification
P4 Assess the defects and determine action required to return the moulding to specified condition
P5 Report recommendations for action to the appropriate people promptly and in accordance with organisational procedures
P6 Record details of defects in accordance with quality assurance and control systems and procedures

Skills Requirements
The apprentice must be able to

S1. Carry out **all** of the following during the inspection activities:

1.1 obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation, material data sheets)
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

S2. Identify defects in composite mouldings using **two** of the following methods:

2.1 touch
2.2 sound
2.3 visual
2.4 mechanical equipment
2.5 other method to be specified
or **one** of the following:
2.6 non-destructive testing (NDT)
2.7 co-ordinate measuring machines
2.8 testing equipment to check features (such as tensile strength, compression, sheer, impact and peel)
2.9 other method to be specified

S3. Identify defects applicable to **one** of the following resin types:

3.1 bio resin
3.2 thermoplastic
3.3 polyester
3.4 vinyl ester
3.5 epoxy
3.6 phenolic
3.7 bismaleimide
3.8 cyanate ester
3.9 other (to be specified)

S4. Identify defects applicable to **one** of the following fibre types:

4.1 natural fibre
4.2 thermo plastic
4.3 glass
4.4 aramid
4.5 carbon
4.6 hybrid
4.7 other (to be specified)

S5. Where core materials are required identify defects applicable to **one** of the following:

5.1 solid timber
5.2 end grain balsa
5.3 rigid foam
5.4 expanding foam
5.5 coremat
5.6 honeycomb
5.7 fibrous honeycomb
5.8 aluminium honeycomb
5.9 syntactic core
5.10 expanding core
5.11 thermoplastic core
5.12 other (to be specified)

S6. 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 incorrect material
6.10 contamination
6.11 bridging
6.12 broken fibres
6.13 stray fibres
6.14 ply orientation

6.15 wrong join type
6.16 gaps at joins
6.17 incorrect overlap
6.18 wrinkles
6.19 splintering
6.20 voids
6.21 resin rich areas
6.22 fibre deviation
6.23 damaged cores
6.24 dis-bonds
6.25 excessive adhesive
6.26 wrong inserts
6.27 insert positions
6.28 porosity
6.29 local exotherm
6.30 fayed/burned area
6.31 incomplete curing
6.32 de-lamination
6.33 impact damage
6.34 puncture
6.35 gouges
6.36 holes
6.37 abrasion/erosion
6.38 fluid ingress
6.39 fractures
6.40 other (to be specified)

S7. Ensure actions recommended to rectify the defect comply with **one** of the following standards:

7.1 BS, ISO or BSEN standards and procedures
7.2 customer standards and requirements
7.3 company standards and procedures
7.4 recognised compliance agency/body standards

Knowledge and understanding
The apprentice must know and understand:

K1 Describe the health and safety precautions to be taken and procedures used when working with composite materials, consumables, tools and equipment in the specific work area

K2 Describe the hazards associated with working with composite materials, consumables, tools and equipment, and how to minimise these and reduce any risks in the work area

K3 Describe the protective equipment (PPE) that is needed for personal protection and, where required, the protection of others

K4 Describe the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables

K5 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

K6 Describe the specific environmental conditions the must be observed when handling composite mouldings (such as temperature, humidity, fume/dust extraction systems and equipment)

K7 Explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken

K8 Explain how to use imperial and metric systems of measurement, work piece reference points and system of tolerance

K9 Describe the quality procedures used in the workplace to ensure production control (such as in relation to currency, issue, meeting specification), and the completion of appropriate documents

K10 Describe the conventions and terminology used when identifying and rectifying defects
(such as dis-bonds, de-lamination, resin injection, resin voids, core potting, repair patches)

K11 Explain how to recognise the different types of defect that can occur in composite mouldings

K12 Describe the different methods used to identify defects in composite mouldings including sensory checks, hand measuring tools and machine tools

K13 Describe the factors to be taken into consideration when selecting the method to check composite moulding for defects

K14 Describe the importance of identifying defects in composite mouldings and the implications if defects are not identified during production

K15 Describe the correct methods of storage and handling of composite materials

K16 Describe tools and equipment used for checking the various composite mouldings

K17 Describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve

Unit 054 Restoring Mechanical Components to Usable Condition by Repair

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	February 2016
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	230 GLH
Review Date	March 2019

Unit 063 Applying Surface Finishes to Composite Mouldings

Level:	Level 2
GLH:	320
Relationship to NOS:	EUCL2F-063
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 apply surface finishes to composite mouldings (such as moulds, panels and components), in accordance with approved procedures. They will be required to use appropriate drawings, specifications and documentation to apply surface finishes, using the correct techniques. They will apply finishes to composite mouldings using a range of techniques and processes. A variety of surface finishes will be applied to a range of resin and fibre materials. Their responsibilities will require them to comply with organisational policy and procedures for the finishing activities undertaken, and to report any problems with the finishing 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, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they produce. Their underpinning knowledge will be sufficient to provide a good understanding of their work, and will provide an informed approach to applying finishing techniques and procedures to composite mouldings. They will have an understanding of the finishing techniques used, and their application, in adequate depth to provide a sound basis for carrying out the activities, recognising faults and ensuring the work output is to the required specification. They will understand the safety precautions required when carrying out the finishing operations 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.

Performance Requirements

The apprentice must be able to:

P1 Work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines
P2 Demonstrate the required behaviours in line with the job role and company objectives
P3 Ensure the material surfaces to be treated are suitably prepared for the finishing operations to be carried out
P4 Check that the finishing equipment and treatment solutions are set up and maintained at satisfactory operating conditions and levels
P5 Carry out the surface finishing process in accordance with operating procedures and the component specification requirements
P6 Ensure that the treated work piece achieves the required characteristics and meets the finishing specification
P7 Deal promptly and effectively with problems within their control and report those that cannot be solved
P8 Dispose of waste and excess materials in line with agreed organisational procedures
P9 Leave the finishing equipment in a safe condition on completion of the surface finishing activities

Skills Requirements
The apprentice must be able to

S1. Carry out **all** of the following during the finishing activities:
- 1.1 obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation, material data sheets)
- 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 surface treatment activities
- 1.4 confirm that all tools and equipment to be used are in a safe and usable condition
- 1.5 follow safe practice/approved composite surface treatment techniques and procedures at all times
- 1.6 segregate and dispose of waste materials using the correct procedure
- 1.7 return all tools and equipment to the correct location on completion of the surface treatment activities
- 1.8 leave the work area in a safe and appropriate condition on completion of the activities
- 1.9 complete relevant production documentation

S2. Carry out **three** of the following activities when preparing for the surface finishing activity:
- 2.1 check that mouldings are correct and complete
- 2.2 check for any defects in the mouldings
- 2.3 check that equipment is suitable for use
- 2.4 check availability of ancillary materials required
- 2.5 identify and protect the moulding in the work area

S3. Apply finishes to composite mouldings, using **one** of the following techniques:

3.1 cloth application
3.2 brush
3.3 spray
3.4 laying films
3.5 roller
3.6 other to be specified

S4. Prepare surfaces of composite mouldings, using **one** of the following methods:

4.1 surface masks
4.2 peep ply
4.3 abrading
4.4 abrasive blasting
4.5 etching
4.6 water cleaning
4.7 solvent cleaning
4.8 priming
4.9 other to be specified

S5. Apply **two** types of finish to composite mouldings from the following:

5.1 surface sealers
5.2 top coats
5.3 UV coatings
5.4 speciality coatings
5.5 primers
5.6 adhesive films
5.7 heatproof coatings
5.8 flexible coatings
5.9 other to be specified

S6. Apply finishes to composite mouldings, using **one** of the following:

6.1 one-part finishes
6.2 multiple coatings
6.3 solvent based
6.4 water based
6.5 single coatings
6.6 two-part finishes
6.7 combination coats
6.8 adhesive based
6.9 other specific finish

S7. Use **two** of the following consumable materials during the finishing operations:

7.1 abrasives
7.2 masking films
7.3 thinners
7.4 stoppers
7.5 sealers
7.6 cutting compounds
7.7 masking tapes

7.8 polishes
7.9 solvents
7.10 fillers
7.11 primers
7.12 cleaning agents
7.13 other specific consumable

S8. Apply finishes to composite mouldings which are suitable for **one** of the following resin types:
8.1 bio resin
8.2 thermoplastic
8.3 polyester
8.4 vinyl ester
8.5 epoxy
8.6 phenolic
8.7 bismaleimide
8.8 cyanate ester
8.9 other specific resin

S9. Apply finishes to composite mouldings suitable for **one** of the following fibre types:
9.1 natural fibre
9.2 thermo plastic
9.3 glass
9.4 aramid
9.5 carbon
9.6 hybrid
9.7 other specific fibre

S10. Apply finishes to a range of mouldings, which comply with **one** of the following standards:
10.1 BS, ISO or BSEN standards and procedures
10.2 company standards and procedures
10.3 customer standards and requirements
10.4 recognised compliance agency/body standards

Knowledge and understanding

The apprentice must know and understand:

K1 Describe health and safety precautions to be taken and procedures used when working with composite materials, consumables, tools and equipment in the specific work area

K2 Describe the hazards associated with composite materials, consumables, tools and equipment, and how to minimise these and reduce any risks in the work area

K3 Describe the protective equipment (PPE) that is needed for personal protection and, where required, the protection of others

K4 Describe the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables

K5 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

K6 Describe the specific environmental conditions that must be observed when applying surface treatments to composite mouldings (such as temperature, humidity, fume/dust extraction systems, equipment)

K7 Explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken

K8 Describe quality procedures used in the workplace to ensure production control (such as in relation to currency, issue, meeting specification), and the completion of appropriate documents

K9 Describe conventions and terminology used for applying finishes (such as surface keying, finish thickness, matt finish, gloss finish, treatment reactions)

K10 Describe different types of composite resin systems, fibres and reinforcements, and their merits

K11 Describe different finishes applied to composites, and their application

K12 Describe correct methods of storage, handling and disposal of finishing materials

K13 Describe methods of preparation for applying different finishes

K14 Describe the importance of having the correct mixing ratios when using surface treatments and the associated working times

K15 Describe methods of application for different finishes

K16 Describe the problems that can occur during the finishing process, including defects such as contamination

K17 Explain how defects can be overcome during the finishing activity

K18 Describe the tools and equipment used in finishing activities, and their care, preparation and control procedures

K19 Describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve

Unit 054 Restoring Mechanical Components to Usable Condition by Repair

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	February 2016
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	320 GLH
Review Date	March 2019

Unit 064 Bonding Composite Mouldings

Level:	Level 2
GLH:	230
Relationship to NOS:	EUCL2F-064
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 bond composite mouldings (such as cured panels, moulds, components and jigs), in accordance with approved procedures. They will be required to follow the appropriate instructions, drawings, specifications and documentation to bond composite materials, using the correct approved production techniques. They will produce a range of bonded composite mouldings, incorporating a variety of features and using a range of techniques and processes. Bonded mouldings produced will include a range of resin, fibre and adhesive materials. Their responsibilities will require them to comply with organisational policy and procedures for the composite bonding activities undertaken, and to report any problems with the bonding 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, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out. Their underpinning knowledge will be sufficient to provide a good understanding of their work, and will provide an informed approach to applying composite bonding techniques and procedures. They will have an understanding of the bonding techniques used, and their application, in adequate depth to provide a sound basis for carrying out the activities, recognising faults, and ensuring the work output is to the required specification. They will understand the safety precautions required when carrying out the bonding 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.

Performance Requirements

The apprentice must be able to:

P1 Work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines
P2 Demonstrate the required behaviours in line with the job role and company objectives
P3 Follow the relevant bonding procedure specification and job instructions
P4 Check that the materials to be bonded and bonding agents comply with the specification
P5 Prepare the parent materials and bonding agents in line with the bonding specification
P6 Carry out the bonding operations using the specified processes and techniques to position and bond the materials in their correct locations
P7 Ensure that any equipment used to maintain surface contact during the bonding activities is set up and used correctly
P8 Achieve bonds of the required quality and within the specified dimensional accuracy
P9 Deal promptly and effectively with problems within their control and report those that cannot be solved

Skills Requirements
The apprentice must be able to

S1 Carry out **all** of the following during the bonding 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 bonding activities
1.4 check that all tools and equipment to be used are in a safe and usable condition
1.5 follow safe practice/approved composite bonding techniques and procedures at all times
1.6 return all tools and equipment to the correct location on completion of the bonding 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

S2 Carry out **four** of the following activities when preparing for the bonding activity:

2.1 check that mouldings are correct and complete
2.2 check for any defects in the mouldings
2.3 confirm that bonding materials are within life
2.4 check availability of ancillary materials required
2.5 select the correct equipment for the activity
2.6 confirm that the equipment is suitable for use

2.7 identify and protect the moulding and bonding materials in the work area
2.8 check that bonding materials are correct and complete

S3. Bond composite mouldings, using techniques for **one** of the following:
3.1 one-part pastes
3.2 two-part pastes
3.3 film adhesives
3.4 syntactic films

S4. Prepare bonding surfaces, using **two** of the following methods:
4.1 peel plies
4.2 abrading
4.3 water cleaning
4.4 dry fitting
4.5 priming
4.6 templates
4.7 abrasive blasting
4.8 solvent cleaning
4.9 acid etching
4.10 surface masks
4.11 other specific method

S5. Use **two** of the following methods when bonding the composite mouldings:
5.1 bonding sequences
5.2 shimming materials
5.3 laying film adhesives
5.4 mixing adhesives
5.5 wetting-out by brush
5.6 applicator gun
5.7 bead sizing
5.8 fillet sizing

S6. Use **one** of the following to retain the bond during the curing process:
6.1 weighting down
6.2 pinning joins
6.3 clamping
6.4 press
6.5 vacuum bagging
6.6 bonding jigs
6.7 other specific method

S7. Cure bonded joins using **one** of the following methods:
7.1 room temperature
7.2 oven
7.3 autoclave
7.4 heated tools/moulds
7.5 heat mats
7.6 heated press
7.7 curing lamps

7.8 infrared heating
7.9 electro-magnetic inductance
7.10 micro-wave
7.11 other (to be specified)

S8. Bond composite mouldings for **one** of the following:

8.1. sandwich panels
8.2. butt joins
8.3. overlap joins
8.4. joggle joins
8.5. return joins
8.6. tongue and groove
8.7. strap join

S9. Bond composite mouldings to include **three** of the following features:

9.1. internal corners
9.2. external corners
9.3. horizontal surface
9.4. vertical surface
9.5. double curvature
9.6. concave surface
9.7. convex surfaces
9.8. joggle details
9.9. return surfaces
9.10. inserts
9.11. fixtures

S10. Use techniques for bonding **one** of the following materials to the composite moulding:

10.1. other composites
10.2. metals
10.3. ceramics
10.4. polymers
10.5. natural materials
10.6. other specific technique

S11. Bond composite mouldings using adhesives suitable for **one** of the following resin types:

11.1. bio resin
11.2. thermoplastic
11.3. polyester
11.4. vinyl ester
11.5. epoxy
11.6. phenolic
11.7. bismaleimide
11.8. cyanate ester
11.9. other specific resin

S12. Bond composite mouldings using adhesives suitable for **one** of the following fibre types:

12.1. natural fibre
12.2. thermo plastic
12.3. glass
12.4. aramid
12.5. carbon
12.6. hybrid
12.7. other specific type

S13. Bond a range of mouldings in compliance with **one** of the following standards:

13.1. BS, ISO or BSEN standards and procedures
13.2. customer standards and requirements
13.3. company standards and procedures
13.4. recognised compliance agency/body standards

Knowledge and understanding
The apprentice must know and understand:

K1 Describe health and safety precautions to be taken and procedures used when working with composite materials, consumables, tools and equipment in the specific work area
K2 Describe the hazards associated with bonding composite materials, consumables, tools and equipment, and how to minimise these and reduce any risks in the work area
K3 Describe the protective equipment (PPE) that is needed for personal protection and, where required, the protection of others
K4 Explain the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables
K5 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
K6 Describe the specific environmental conditions that must be observed when bonding composite mouldings (such as temperature, humidity, fume/dust extraction systems, equipment)
K7 Explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
K8 Explain how to use imperial and metric systems of measurement, work piece reference points and system of tolerance
K9 Describe the quality procedures used in the workplace to ensure production control (such as in relation to currency, issue, meeting specification)
K10 Describe the conventions and terminology used for bonding (such as gel points, cure times, bond thickness, bond strength, peel strength)
K11 Describe the function fibre materials, weave patterns, orientations play in the production of mouldings
K12 Describe the correct methods of storage and handling of bonding agents
K13 Describe the methods of preparation for bonding different materials
K14 Describe the methods of application for different bonding agents
K15 Describe the methods of retaining the bond during the curing process, and their merits
K16 Describe the tools and equipment used in bonding activities, and their care, preparation and control procedures
K17 Describe the importance of following the correct mixing procedures and having the correct ratios for two-part pastes and their associated working times
K18 Describe the methods used to determine if the bonded component has cured correctly
K19 Describe the identification of bonding defects
K20 Describe the common problems that can occur during the bonding process
K21 Describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve

Unit 054 Restoring Mechanical Components to Usable Condition by Repair

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	February 2016
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	230 GLH
Review Date	March 2019

Unit 065 Producing Composite Assemblies

Level:	Level 2
GLH:	420
Relationship to NOS:	EUCL2F-065
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 cover a broad range of basic competences that they need to assemble composite mouldings to produce assemblies/sub-assemblies. 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. They will be required 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, you 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 Standard 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 three of the components listed in scopes 7 and 8.

Performance Requirements

The apprentice must be able to:

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

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

P3 Plan the composite assembly activities before they start them

P4 Obtain and prepare the appropriate components, tools and equipment

P5 Use the appropriate methods and techniques to assemble the components in their correct positions

P6 Secure the components, using the specified methods and securing devices

P7 Produce composite assemblies

P8 Check the completed assembly to ensure that all operations have been completed, and that the finished assembly meets the required specification

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

P10 Leave the work area in a safe and tidy condition on completion of the composite assembly activities

Skills Requirements

The apprentice must be able to:

S1. 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, 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

S2. 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

S3. 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

S4. 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

S5. Produce composite assemblies that require two 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

S6. 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)

S7. 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)

S8. 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)

S9. 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 apprentice must know and understand:

K1 Describe the health and safety precautions to be taken and procedures used when working with composite materials, consumables, tools and equipment in the specific work area
K2 Describe the hazards associated with carrying out composite assembly activities, and with the composite materials, consumables, tools and equipment used, and how to minimise these and reduce any risks
K3 Describe the protective equipment (PPE) that is needed for personal protection and, where required, the protection of others
K4 Describe the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables
K5 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
K6 Describe the specific environmental conditions the must be observed when producing composite mouldings (such as temperature, humidity, fume/dust extraction systems and equipment)
K7 Explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
K8 Explain how to interpret drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
K9 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
K10 Describe the conventions and terminology used for assembly activities (such as metric and imperial threads, rivet specifications, clearances, types of fittings)
K11 Describe the types of component trimming/cutting methods and preparation methods available
K12 Describe the visual identification of cured composite materials
K13 Describe the assembly operations and their sequence
K14 Describe the methods for handling composite assemblies throughout the assembly activities
K15 Describe the identification and rectification of defects in composite assemblies
K16 Describe the tools and equipment used in assembly activities, and their care, preparation and control procedures
K17 Describe the problems that can occur with the production of the composite assemblies
K18 Describe the extent of their responsibility and to whom they should report if they have problems that they cannot resolve

Unit 054 Restoring Mechanical Components to Usable Condition by Repair

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	March 2017
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	420 GLH
Review Date	April 2020

Unit 066 Carrying Out Inspection Activities on Optical Components

Level:	Level 2
GLH:	420
Relationship to NOS:	EUCL2F-066
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 carry out optical inspection operations, in accordance with approved procedures, using optical inspection techniques and equipment. You will be expected to check components made from a range of optical materials, using a mixture of inspection equipment, as appropriate. They will be required to inspect a range of components that combine a number of different features, such as centre-thickness, diameters, generated blanks, optical lens form and power, angles, profiles, and with cosmetic defects. They will be required to operate the equipment in line with safe working practices and approved procedures, and to continuously monitor the equipment operations, making any necessary minor adjustments or seek help in making the adjustments, in order to ensure that the work output is to the required quality and accuracy. Their responsibilities will require them to comply with organisational policy and procedures for the optical inspection activities undertaken, and to report any problems with the optical inspection 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, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out. Their underpinning knowledge will be sufficient to provide a good understanding of their work, and will enable them to adopt an informed approach to applying optical inspection procedures. They will understand the optical inspection procedures used, and their application, and know about the equipment, materials and consumables, in adequate depth to provide a sound basis for carrying out the activities, identifying out-of-specification

	components, and ensuring accepted components meet the required specification. They will understand the safety precautions required when working with the inspection 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.

Performance Requirements
The apprentice must be able to:

P1 Work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines
P2 Demonstrate the required behaviours in line with the job role and company objectives
P3 Follow the correct specification for the product or equipment being inspected
P4 Use the correct equipment to carry out the inspection
P5 Identify and confirm the inspection checks to be made and acceptance criteria to be used
P6 Carry out all required inspections as specified
P7 Identify any defects or variations from the specification
P8 Record the results of the inspection in the appropriate format
P9 Deal promptly and effectively with problems within their control and report those that cannot be solved

Skills Requirements
The apprentice must be able to

S1. Carry out **all** of the following during the inspection activity:

1.1 obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation, material data sheets)
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 obtain and check that the required inspection equipment is within current calibration dates
1.4 use appropriate inspection techniques to check the components
1.5 determine any out-of-specification components
1.6 complete all relevant inspection documentation, accurately and legibly
1.7 apply safe working practices at all times

S2. Operate **four** types of optical inspection equipment from the following:

2.1 lens centring rig
2.2 optical measuring equipment
2.3 optical flats
2.4 centre thickness gauge
2.5 focometer test equipment
2.6 dial test indicators
2.7 microscopes
2.8 auto collimators
2.9 slip gauges
2.10 micrometers
2.11 optical spheres
2.12 vernier equipment
2.13 interferometry and phase analysis equipment
2.14 shadowgraph test equipment

2.15 other specific inspection equipment

S3. Inspect **three** types of optical component from the following:

3.1 infra-red lens
3.2 combiners
3.3 infra-red glass flats
3.4 infra-red glass domes
3.5 cylinders
3.6 glass prisms
3.7 infra-red prisms
3.8 plastic lens components
3.9 glass lens
3.10 optical mirrors
3.11 profiled optical components
3.12 other specific type of component

S4. Inspect **six** features of machined optical components from the following:

4.1 prism angles
4.2 lens diameter
4.3 cap height
4.4 truncation
4.5 concentricity
4.6 lens form error
4.7 flats form error
4.8 lens wedge
4.9 profiles
4.10 sag depth
4.11 centre thickness
4.12 flat/parallelism
4.13 focal length
4.14 lens centring
4.15 refractive index
4.16 lens power (radius)
4.17 flats power error
4.18 cosmetic defect
4.19 other specific features

S5. Use inspection methods and techniques suitable for components made from **three** different types of material:

5.1 germanium
5.2 dense flints
5.3 infra-red glass 4,5,6
5.4 zinc selenide
5.5 silicon
5.6 barium crowns
5.7 flints/light flints
5.8 barium dense flints
5.9 zinc sulphide
5.10 plastics

5.11 lanthanum crowns
5.12 optical orange filter glass
5.13 thallium ideobromide
5.14 anomalous dispersion flour crowns
5.15 optical blue filter glass
5.16 borosilicate crowns
5.17 optical neutral density glass
5.18 other specific method/technique

S6. Inspect optical components to **one** of the following:
6.1 BS, ISO or BSEN standards and procedures
6.2 customer (contractual) standards and requirements
6.3 company standards and procedures
6.4 other accepted international standards

Knowledge and understanding
The apprentice must know and understand:

K1 Describe the safe working practices and procedures to be followed while using optical inspection equipment

K2 Describe the safety mechanisms on the equipment, and the procedure for checking that they function correctly

K3 Describe the personal protective equipment (PPE) to be worn, and where this can be obtained

K4 Describe the hazards associated with carrying out optical inspection operations, and how to minimise them and reduce any risks

K5 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

K6 Describe the importance of keeping the work area clean and tidy

K7 Explain how to extract and use information from optical engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken

K8 Explain how to use imperial and metric systems of measurement, work piece reference points and system of tolerance

K9 Describe the various optical inspection operations to be performed, and types of equipment used

K10 Explain how to set or check the calibration of the equipment before inspection operations are carried out

K11 Explain how to recognise the various cosmetic defects

K12 Explain how to handle and store all inspection equipment, safely and correctly

K13 Explain how the various types of material will affect the way the inspection operation is performed

K14 Describe the effect of clamping the work piece, and how this can cause distortion in the finished component

K15 Explain how to recognise inspection equipment faults, and identify when inspection equipment needs refurbishment

K16 Describe the problems that can occur with optical inspection activities, and how they can be overcome

K17 Describe the quality control procedures used, inspection checks to be carried out, and the equipment used

K18 Describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve

Unit 066 Carrying Out Inspection Activities on Optical Components

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	February 2016
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	420 GLH
Review Date	March 2019

Unit 067 Preparing and Using Manual Metal Arc Welding Equipment

Level:	Level 2
GLH:	150
Relationship to NOS:	EUCL2F-067
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 covers a broad range of basic manual metal arc (MMA) welding competences 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 required to prepare the welding equipment and to ensure that all the leads/cables, electrode holder and workpiece earthing arrangements are securely connected and free from damage. They will also need to obtain and check that all the workholding equipment and manipulating devices are 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 the 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, 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 underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate manual metal 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. 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 Standard 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

Performance Requirements
The apprentice must be able to:

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

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

P3 Plan the welding activities before they start them

P4 Obtain and prepare the appropriate welding equipment and welding consumables

P5 Prepare and support the joint, using the appropriate methods

P6 Tack weld the joint at appropriate intervals, and check the joint for accuracy before final welding

P7 Weld the joint to the specified quality, dimensions and profile

P8 Use appropriate methods and equipment to check the quality, and check that all dimensional and geometrical aspects of the weld are to the specification

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

P10 Shut down and make safe the welding equipment on completion of the welding activities

Skills Requirements
The apprentice must be able to:

S1. Prepare for the manual metal 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 and electrode holder

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

S2. Use manual metal-arc welding and related equipment to include **either** of the following:

2.1 alternating current (AC) equipment

2.2 direct current (DC) equipment

S3. Use **two** types of electrode from the following:

3.1 rutile

3.2 cellulosic

3.3 basic

3.4 other suitable electrodes

S4. Produce three of the following welded joints, of at least 150mm long, using single or multi-run welds (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

S5. Produce joints as follows:

One type of material from the following:

5.1 carbon steel

5.2 stainless steel

And **one** form of material from the following:

5.3 sheet (less than 3mm)

5.4 pipe/tube

5.5 plate

5.6 other forms

5.7 section

S6. 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)

S7. 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

S8. 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

S9. 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)

S10. 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 surface cracks

10.6 overlap

10.7 internal cracks

10.8 inclusions

10.9 lack of fusion

10.10 porosity

10.11 lack of penetration

S11. 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 with 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 apprentice must know and understand:

K1 Describe the safe working practices and procedures to be followed when preparing and using MMA welding equipment (such as general workshop safety; appropriate personal protective equipment (PPE); fire prevention; protecting other workers from the effects of the welding arc; safety in enclosed/confined spaces; fume extraction/control)

K2 Describe the hazards associated with MMA welding (such as live electrical components; poor earthing; the electric arc; fumes and gases; spatter; hot slag and metal; grinding and mechanical metal/slag removal; elevated working; welding in enclosed spaces; slips, trips and falls), and how they can be minimised

K3 Describe the personal protective equipment to be worn for the welding activities (such as correctly fitting overalls; leather aprons, welding gloves/gauntlets; safety boots; head/eye shield with correct shade of filter)

K4 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

K5 Describe the manual metal arc welding process (such as basic principles of fusion welding, AC and DC power sources, power ranges)

K6 Explain 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

K7 Describe the types of electrodes used, and the correct control, storage and drying of electrodes

K8 the types of welded joints to be produced (such as lap joints, corner joints, tee joints, butt welds, single and multi- run welds)

K9 Describe the terminology used for the appropriate welding positions

K10 Explain how to prepare the materials in readiness for the welding activity (such as ensuring that the material is free from excessive surface contamination such as rust, scale, paint, oil/grease and moisture); ensuring that edges to be welded are correctly prepared (such as made flat, square or bevelled)

K11 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)

K12 Describe the tack welding size and spacing in relationship to material thickness

K13 Describe the checks to be made prior to welding (such as confirming the correct set-up of the joint; condition of electrical connections, welding return and earthing arrangements; checking operating parameters)

K14 Describe the techniques of operating the welding equipment to produce a range of joints in the various joint positions (such as striking and initiating the arc; fine adjustment of parameters; correct manipulation and welding speed of electrode; blending in stops/starts and tack welds)

K15 Explain how to close down the welding equipment safely and correctly

K16 Explain how to control distortion (such as welding sequence; deposition technique)

K17 Describe the problems that can occur with the welding activities (such as causes of distortion and methods of control; effects of welding on materials and sources of weld defects), and how these can be overcome

K18 Describe the safe working practices and procedures to be adopted when preparing the welds for examination (such as handling hot materials, using chemicals for cleaning and etching, using equipment to fracture welds)

K19 Explain how to prepare the welds for examination (such as removing slag, spatter and surface irregularities; cleaning the weld, polishing and making saw cuts on welds to be fracture tested)

K20 Explain how to check the welded joints for uniformity, alignment, position, weld size and profile

K21 Describe the various procedures for visual examination of the welds for cracks, porosity and slag inclusions (such as dye penetrant, fluorescent penetrant; magnetic particle testing)

K22 Describe the various procedures for carrying out destructive tests on the welds (such as macroscopic examination, bend tests, nick break tests)

K23 Describe the 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)

K24 Explain how to examine the welds after the tests and check for such defects as the degree of penetration and fusion, inclusions, porosity, cracks, undercut and overlap, uneven and irregular ripple formation

K25 Explain when to act on their own initiative and when to seek help and advice from others

K26 Describe the importance of leaving the work area and equipment in a safe condition on completion of the welding activities (such as isolation of electrical supplies; safely storing welding cables and electrode holders; storing electrodes; removing and disposing of waste)

Unit 054 Restoring Mechanical Components to Usable Condition by RepairPreparing and Using Manual Metal Arc Welding Equipment

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	March 2017
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	150 GLH
Review Date	April 2020

Unit 068 Preparing and Using Manual Oxy/fuel Gas Welding Equipment

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-068
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 cover a broad range of basic oxy/fuel gas welding equipment competences 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 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 prepare the welding equipment to ensure that the regulators, hoses, check valves, flashback arrestor and welding torch are securely connected and are free from leaks or 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 gas pressures/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 oxy/fuel gas welding techniques safely. They will understand the gas 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 oxy-fuel gas welding equipment, 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 themself and others in the workplace. 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 Standard 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.

Performance Requirements

The apprentice must be able to:

P1 Work safely at all times, complying with health and safety legislation, regulations , directives and other relevant guidelines
P2 Demonstrate the required behaviours in line with the job role and company objectives
P3 Plan the welding activities before they start them
P4 Obtain and prepare the appropriate welding equipment and welding consumables
P5 Prepare and support the joint, using the appropriate methods
P6 Weld the joint to the specified quality, dimensions and profile
P7 Weld the joint to the specified quality, dimensions and profile
P8 Use appropriate test methods and equipment to check the quality, and that all dimensional and geometrical aspects of the weld are to the specification
P9 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
P10 Shut down and make safe the welding equipment on completion of the welding activities

Skills Requirements

The apprentice must be able to:

S1. Prepare for the gas 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 regulators, hoses and check that valves are securely connected and free from leaks and damage
1.3 check/fit the correct gas nozzle to the torch
1.4 check that a flashback arrestor is fitted
1.5 set appropriate gas pressures
1.6 use the correct procedure for lighting, adjusting and extinguishing the welding flame
1.7 use appropriate and safe procedures for handling and storing of gas cylinders
1.8 prepare the work area for the welding activities (such as positioning welding screens and fume extraction)
1.9 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)
1.10 make sure the work area is maintained and left in a safe and tidy condition

S2. 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:

2.1 fillet lap joints
2.2 butt joints
2.3 Tee fillet joints
2.4 welds made without filler wire (autogenously)

2.5 corner joints

Using one of the following methods:

2.6 with filler wire

2.7 without filler wire (autogenously)

S3. Produce joints in **one** form of material from the following:

3.1 sheet (less than 3mm)

3.2 section

3.3 pipe/tube

3.4 plate

3.5 other specific form

S4. Weld joints in good access situations in **two** of the following BS EN ISO 6947 positions:

4.1 Flat (PA)

4.2 Horizontal vertical (PB)

4.3 Horizontal (PC)

4.4 Vertical upwards (PF)

4.5 Vertical downwards (PG)

S5. Check that the welded joint conforms to the specification, by checking **all** of the following:

5.1 dimensional accuracy

5.2 size and profile of weld

5.3 number of runs

5.4 alignment/squareness

S6. Carry out non-destructive testing of the welds, using **one** of the following:

6.1 dye penetrant

6.2 fluorescent penetrant

6.3 magnetic particle

S7. Carry out destructive tests on weld specimens using **one** of the following:

7.1 macroscopic examination

7.2 nick break test

7.3 bend tests (such as face, root or side, as appropriate)

S8. Identify all of the following weld defects:

8.1 lack of continuity of the weld

8.2 uneven and irregular ripple formation

8.3 incorrect weld size or profile

Plus **four** more of the following:

8.4 undercutting

8.5 surface cracks

8.6 overlap

8.7 internal cracks

8.8 inclusions

8.9 lack of fusion

8.10 porosity

8.11 lack of penetration

S9. Produce welded joints which meet **all** of the following (with reference to BS 4872 Part 1 Weld test requirements):

9.1 welds meet the required dimensional accuracy

9.2 fillet welds are equal in leg length and slightly convex in profile (where appropriate), with the size of the fillet equivalent to the thickness of the material welded

9.3 the weld contour is linear, of uniform profile, free from excessive undulations, with regular and even ripple

9.4 the welds are adequately fused, and there is minimal undercut and overlap

9.5 weld finishes are built up to the full section of the weld

9.6 joins at stop/start positions merge smoothly, with no pronounced hump or crater in the weld surface

9.7 tack welds are blended in to form part of the finished weld, without excessive hump

9.8 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

9.9 the weld surface is free from cracks, and substantially free from porosity, shrinkage cavities and trapped slag

9.10 the weld surface and adjacent parent metal is substantially free from spatter or chipping marks

Knowledge and understanding
The apprentice must know and understand:

K1 Describe the safe working practices and procedures to be followed when preparing and using manual gas welding equipment (such as general workshop safety; appropriate personal protective equipment (PPE); fire and explosion prevention, protecting other workers, safety in enclosed/confined spaces; fume extraction/control)

K2 Describe the hazards associated with manual oxy/fuel gas welding (such as naked flames, fumes and gases, explosive gas mixtures, oxygen enrichment, spatter, hot metal, elevated working, welding in enclosed spaces, slips trips and falls), and how they can be minimised

K3 Describe the personal protective equipment to be worn for the welding activities (such as correctly fitting overalls; leather aprons, welding gloves/gauntlets; safety boots; head/eye shield with correct grade of filter)

K4 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

K5 Describe the correct handling and storage of gas cylinders (such as manual handling and use of cylinder trolley, leak detection procedures, relevant BCGA codes of practice, cylinder identification, gas pressures, cylinder and equipment safety features)

K6 Explain 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

K7 Describe the manual gas welding process (such as basic principles of gas welding and related equipment; care of the equipment)

K8 Describe the consumables associated with gas welding (such as types of filler wire, fluxes, the types of gas and its supply and control)

K9 Explain how to prepare the welding equipment, and the checks to be made to ensure that it is safe and ready to use (such as connection of hoses, torch, flashback arrestors, hose check valves and regulators)

K10 Explain how to check connections for leaks, and the methods that are used

K11 Explain how to set gas working pressures; reading the gauges to establish content and pressures

K12 Describe the types of welded joints to be produced (such as lap joints, corner joints, tee joints and butt welds)

K13 Describe the terminology used for the appropriate welding positions

K14 Explain how to prepare the materials in readiness for the welding activity (such as 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)

K15 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)

K16 Describe the to tack welding size and spacing (in relation to material thickness)

K17 Describe the techniques of operating the welding equipment to produce a range of joints in the various joint positions (such as selection of nozzle, lighting and adjusting the flame, correct manipulation of torch and filler rods)

K18 Describe the safe and correct sequence for shutting down the equipment (such as sequence of turning off the gases, extinguishing the flame and closing valves on the gas supply/cylinders)

K19 Describe the control of heat input to prevent filler material and parent material faults (such as welding sequence; deposition technique)

K20 Describe the problems that can occur with the welding activities (such as causes of distortion and methods of control; effects of welding on materials and sources of weld defects), and how these can be overcome

K21 Describe the safe working practices and procedures to be adopted when preparing the welds for examination (such as handling hot materials, using chemicals for cleaning and etching, using equipment to fracture welds)

K22 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 break tested)

K23 Explain how to check the welded joints for uniformity, alignment, position, weld size and profile

K24 the various procedures for visual examination of the welds for cracks, porosity and inclusions (such as dye penetrant, fluorescent penetrant; magnetic particle testing)

K25 Describe the various procedures for carrying out destructive tests on the welds (such as macroscopic examination, bend tests, nick break tests)

K26 Describe the 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)

K27 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

K28 Explain when to act on their own initiative and when to seek help and advice from others

K29 Describe the importance of leaving the work area and equipment in a safe condition on completion of the gas welding activities (such as isolation of gas cylinders; safely storing cylinders, hoses and torches; storing filler rods; removing and disposing of waste)

Unit 068 Preparing and Using Manual Oxy/fuel Gas Welding Equipment

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	March 2017
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	140 GLH
Review Date	April 2020

Unit 069 Preparing and Using Manual Flame Brazing and Braze Welding Equipment

Level:	Level 2
GLH:	110
Relationship to NOS:	EUCL2F-069
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 cover a broad range of basic manual flame brazing and braze welding competences 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 required to prepare the manual flame brazing or braze welding equipment, and to check that all hoses and equipment are correctly connected, free from leaks or damage, and are ready for use. They will also need to obtain and check that all the workholding equipment required is in a safe and usable condition. They must operate the equipment safely and correctly, and set and adjust the brazing or braze welding conditions, in line with instructions and safe operating procedures. They will be expected to check the quality of the brazed or braze welded joints by visual examination and destructive testing techniques, as appropriate to the aspects being checked. They will need to be able to recognise brazing or braze 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 brazing or braze welding activities, they will be expected to return all tools, equipment and workholding devices to their designated location, and to leave the brazing or braze 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 brazing or braze welding activities undertaken. They will need to take account of any potential difficulties or problems

	that may arise with the brazing or braze 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 flame brazing or braze welding techniques safely. They will understand the brazing or braze 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 manual flame brazing or braze 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 Standard Requirements Brazed or braze welded joints must be at least 100mm long (except for joints in pipe or tube).

Performance Requirements
The apprentice must be able to:

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

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

P3 Plan the brazing or braze welding activities before they start them

P4 Obtain and prepare the appropriate manual flame brazing or braze welding equipment and consumables

P5 Prepare and support the joint, using the appropriate methods

P6 Tack the joint at appropriate intervals, and check the joint for accuracy before final brazing or braze welding

P7 Produce the brazed or braze welded joints of the required quality and of specified dimensional accuracy

P8 Use appropriate methods and equipment to check the quality, and that all dimensional and geometrical aspects of the joint are to the specification

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

P10 Shut down and make safe the brazing or braze welding equipment on completion of the activities

Skills Requirements
The apprentice must be able to:

S1. Prepare for the manual flame brazing or braze 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 that hoses, regulators and valves are securely connected and free from leaks and damage

1.3 check/fit the correct size gas nozzle to the torch

1.4 check that a flashback arrestor and check valves are fitted

1.5 set appropriate gas pressures

1.6 use the correct procedure for lighting, adjusting and extinguishing the flame

1.7 use appropriate and safe procedures for handling and storing of gas cylinders (where appropriate)

1.8 prepare the work area for the activities (such as positioning screens and fume extraction equipment)

1.9 prepare the materials and joint in readiness for brazing or braze welding (such as cleaning of joint faces, setting up the joint, supporting the joint)

1.10 make sure the work area is maintained and left in a safe and tidy condition

S2. Set up, check, adjust and use **both** of the following manual flame processes and related equipment:

2.1 brazing

2.2 braze welding

S3. Use specified consumables appropriate to the parent metals, to include **one** of the following:

3.1 self fluxing rods

3.2 powder/paste flux and rods

3.3 flux coated/impregnated rods

S4. Produce joints in **two** of the following materials:

4.1 copper to copper

4.2 copper to carbon

4.3 brass to brass

4.4 copper to brass

4.5 other appropriate materials

S5. Produce joints in good access situations, covering **two** of the following:

5.1 lap joints

5.2 Tee joints

5.3 corner joints

5.4 butt joints

5.5 socket joints

S6. Produce joints in the following positions:
For brazing, use **one** of the following:

6.1 horizontal flow

6.2 vertical up flow

6.3 vertical down flow

For braze welding, use **one** of the following:

6.4 flat position

6.5 horizontal-vertical position

S7. Produce joints in **both** of the following:

7.1 sheet/plate

7.2 pipe/tube

S8. Carry out destructive tests on weld specimens, using **one** of the following:

8.1 macroscopic examination

8.2 nick break test

S9. Identify all of the following brazing and braze welding defects:

9.1 lack of continuity of the brazed and braze welded joint

9.2 uneven and irregular ripple formation

9.3 incorrect joint size or profile

Plus **three** more of the following:

9.4 overlap

9.5 surface cracks

9.6 inclusions

9.7 lack of penetration

9.8 porosity

S10. Produce brazed and braze welded components which meet all of the following:

10.1 achieve the specified joint quality

10.2 meet the required dimensional accuracy within specified tolerance

10.3 are of good appearance, free from flux residues and excess filler metal

Knowledge and understanding
The apprentice must know and understand:

K1 Describe the safe working practices and procedures to be observed when working with manual flame gas brazing and braze/braze welding equipment (such as general workshop safety; appropriate personal protective equipment; fire and explosion prevention, protecting other workers, safety in enclosed/confined spaces; fume extraction/control)

K2 Describe the hazards associated with flame brazing and braze/braze welding (such as naked flames, explosive gas mixes, oxygen enrichment, fumes and gasses, hot metal, enclosed spaces), and how they can be minimised

K3 Describe the personal protective equipment (PPE) to be worn for the brazing and braze welding activities (such as correctly fitting overalls; leather aprons, eye protection with the appropriate shade of filter)

K4 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

K5 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 the correct handling and storage of gas cylinders (such as manual handling and use of cylinder trolley, leak detection procedures, relevant BCGA codes of practice, cylinder identification, gas pressures, cylinder and equipment safety features)

K6 Explain 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

K7 Describe the manual flame brazing and braze welding process (such as basic principles of the process, wetting and capillary flow, deposition of brazed beads, role of fluxes)

K8 Describe the types of filler metal and fluxes; forms of filler metal

K9 Describe the types of joints to be produced (such as lap, tee, corner, butt)

K10 Explain how to set up and support the joint (such as methods of cleaning joint faces; use of jigs and fixtures, restraining devices; self-locating joints; pre-placement of filler metal and flux)

K11 Explain how to prepare the brazing and braze welding equipment, and the checks to be made to ensure that it is safe and ready to use (such as connection of hoses, torch, flashback arrestors, hose check valves and regulators)

K12 Explain how to check the hose connections for leaks, and the methods that are used

K13 Explain how to set gas working pressures; reading the gauges to establish content and pressures

K14 Explain how to prepare the materials in readiness for the brazing and braze welding activity, ensuring that the material is free from surface contamination (such as rust, scale, paint, oil/grease and moisture); ensuring edges to be brazed/braze welded are correctly prepared (such as made flat, square)

K15 Describe the correct use of the torch to produce a range of joints (such as selection of nozzle, adjustment of the flame, application of flux and the correct manipulation of torch and filler wire)

K16 Describe the control of heat input to prevent filler material and parent material faults (such as brazing/braze welding sequence; deposition technique)

K17 Describe the safe and correct sequence for shutting down the brazing or braze welding equipment (such as sequence of turning off the gases, extinguishing the flame and closing valves on gas supply/cylinders)

K18 Describe the importance of complying with job instructions and the joining procedure specification

K19 Describe the problems that can occur with the joining activities (such as incorrect heat pattern (hot or cold spots); fluxing technique; formation of oxides during the process; distortion of the joint due to overheating), and how these can be overcome

K20 Describe the methods of removing flux residues and cleaning the finished joint

K21 Describe the safe working practices and procedures to be adopted when preparing the brazed and braze welded joints for examination (such as handling hot materials, using chemicals for cleaning, using equipment to fracture joints)

K22 Explain how to prepare the joints for examination (such as removing surface irregularities; cleaning and degreasing the brazed or braze welded joint, making saw cuts on joints to be fracture tested)

K23 Explain how to check the brazed or braze welded joints for uniformity, alignment, position, joint size and profile

K24 Describe the various procedures for carrying out destructive tests on the joints (such as macroscopic examination and nick break tests)

K25 Explain how to examine the joints after the tests and check for such defects as the degree of penetration, inclusions, porosity, cracks

K26 Explain when to act on their own initiative and when to seek help and advice from others

K27 Describe the importance of leaving the work area and equipment in a safe condition on completion of the brazing or braze welding activities (such as isolation of gas cylinders; safely storing cylinders, hoses and torches; storing filler rods; removing and disposing of waste)

Unit 069 Preparing and Using Manual Flame Brazing and Braze Welding Equipment

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	March 2017
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	110 GLH
Review Date	April 2020

Unit 070 Producing Aircraft Detail Assemblies

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-070
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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, and which will prepare you 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.

Performance Requirements

The apprentice must be able to:

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

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

P3 Plan the aircraft detail assembly activities before they start them

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

P5 Obtain the specified components and check that they are in a usable condition

P6 Use the appropriate methods and techniques to assemble the components in their correct positions

P7 Secure the components using the specified connectors and securing devices

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

P9 Check the completed assembly to ensure that all operations have been completed and that the finished assembly meets the required specification

P10 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that you cannot resolve

P11 Leave the work area in a safe and tidy condition on completion of the fitting activities

P12 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.

Skills Requirements

The apprentice must be able to:

S1. 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 tested

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

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

S2. 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 specific assemblies

S3. 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 for cosmetic appearance and skin lines
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)

S4. Carry out quality and accuracy checks which include **three** from the following:

4.1 cosmetic appearance
4.2 freedom from damage
4.3 electrical bonding and continuity
4.4 accuracy of skin lines
4.5 torque loading checks

S5. Produce assemblies which comply with **all** of the following:

5.1 all components are correctly assembled 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 apprentice must know and understand:

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

K2 Describe the importance of wearing appropriate protective clothing and equipment (PPE), and of keeping the work area safe and tidy

K3 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

K4 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

K5 Describe the procedure for obtaining the required drawings, job instructions and other related specifications

K6 Describe the importance of working to the assembly instructions and appropriate specifications

K7 Explain 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

K8 Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing

K9 Explain how to identify the components to be used; component identification systems; codes used and component orientation indicators

K10 Describe the preparations to be undertaken on the components prior to fitting them into the assembly

K11 Describe the assembly methods and procedures to be used, and the importance of adhering to these procedures

K12 Explain how the components are to be aligned and positioned, and the tools and equipment that are used (including jigs and fixtures)

K13 Describe the methods used to hold the components in their correct position prior to securing them with the appropriate fasteners

K14 Describe the various mechanical fasteners that will be used, and their method of installation (including open and blind rivets, threaded fasteners, special securing devices)

K15 Describe the importance of using the specified fasteners for the particular assembly, and why they must not use substitutes

K16 Explain what to do if the components or fastening devices are not assembled correctly, are damaged, or have other faults

K17 Explain why they must obtain design approval before removing and replacing faulty fasteners

K18 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

K19 Describe the purpose and use of joint sealing agents and anti-electrolysis barriers, and the precautions to be taken when using them

K20 Describe the quality control procedures to be followed during the assembly operations

K21 Explain how to conduct any necessary checks to ensure the accuracy and quality of the assemblies produced

K22 Explain how and why tools are calibrated, and how to check that the tools you are using are within calibration dates

K23 Describe the importance of using all tools in the correct manner and within their permitted operating range

K24 Describe the importance of ensuring that the completed assembly is free from dirt, swarf and foreign objects

K25 Describe the problems that can occur with the detail assembly operations, and how these can be overcome

K26 Explain when to act on your own initiative and when to seek help and advice from others

K27 Describe the importance of leaving the work area in a safe and clean condition on completion of the aircraft detail assembly activities (such as removing and storing power leads, isolating machines, removing and returning drills, cleaning the equipment and removing and disposing of waste)

Unit 70 Producing Aircraft Detail Assemblies

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	March 2017
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	140 GLH
Review Date	April 2020

Unit 071 Producing Platework Components and Assemblies

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-071
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 cover a broad range of basic heavy platework (above 3 mm) competences that will prepare you 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 plateworking 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 machines to produce a variety of shapes, profiles and forms. They will also be expected to produce simple platework assemblies, using mechanical fastening devices and tack welding. Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the plate working 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

	plateworking 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 plateworking activities, and when using the various tools and equipment, especially those involved in using 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 Standard Requirements In order to prove their ability to combine different platework cutting and forming operations, at least one of the assemblies produced must be of a significant nature, and must contain components with a minimum of three of the features listed in scope 6 plus three of the features listed in scope 8.

Performance Requirements
The apprentice must be able to:

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

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

P3 Plan the plateworking activities before they start them

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

P5 Mark out the components for the required operations, using appropriate tools and techniques

P6 Cut and shape the components to the required specification, using appropriate tools and technique

P7 Use the appropriate methods and techniques to assemble and secure the components in their correct positions

P8 Measure and check that all dimensional and geometrical aspects of the components are to the specifications

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

P10 Leave the work area in a safe and tidy condition on completion of the platework activities

Skills Requirements
The apprentice must be able to:

S1. Carry out all of the following during the plateworking 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 plateworking activities**

1.4 **check that all measuring equipment is within calibration date**

S2. 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**

2.4 **other specific method**

S3. 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**

S4. 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**

S5. Cut and finish material to the marked out shape, using both of the following:

5.1 **guillotine**

5.2 **drill (such as bench, pillar, radial)**

Plus two more from the following:

5.3 **abrasive disc**

5.4 **cropping machine**

5.5 **machine saw**

S6. Perform cutting operations to produce components that combine operations and cover all of the following features:

6.1 **components with parallel sides**

6.2 **components with sides square to each other**

6.3 **holes linearly pitched**

Plus two more from the following:

6.4 **components with angled sides**

6.5 **components with curved contours**

6.6 **holes radially pitched**

6.7 **bevelled edges or weld preps**

S7. Use **two** of the following types of forming equipment/techniques:

7.1 **bending machine (hand or powered)**

7.2 **presses**

7.3 **rolling machine (hand or powered)**

7.4 **heating techniques**

S8. Perform forming operations to produce components that combine operations and cover all of the following features:

8.1 bends at 90°

8.2 bends of various angles

8.3 cylinders

8.4 Plus two more of the following:

8.5 set plate ends

8.6 segments of a cylindrical tank

8.7 box square and rectangular sections

8.8 curved section or sector of an otherwise flat plate

8.9 curved plates

8.10 counter-curved sections

8.11 pipe sections

8.12 flattening or straightening plate

8.13 cones

S9. Assemble platework components using **two** of the following methods:

9.1 temporary tack welding

9.2 adhesive bonding

9.3 riveting (hot or cold)

9.4 mechanically fastened (such as bolts, screws)

S10. Use the following materials:

10.1 **flat plate**

Plus one more from the following:

10.2 **pipe/tube**

10.3 **rolled sections (angle, channel, RSJ, rail section)**

10.4 **solid bar (such as square, round, hexagonal)**

10.5 **non-ferrous materials**

S11. Produce platework components which meet all of the following:

11.1 **all dimensions are within +/- 3.0mm or +/- 0.125”**

11.2 **finished components meet the required shape/geometry**

11.3 **(such as square, straight, angles free from twists)**

11.4 **completed components are free from excessive tooling marks, deformation, cracking,**

11.5 **sharp edges, slivers or burrs**

11.6 **all components are correctly assembled, and have secure and firm joints**

Knowledge and understanding
The apprentice must know and understand:

K1 **Describe the health and safety requirements, and safe working practices and procedures required for the plateworking activities undertaken**

K2 **Describe the personal protective clothing and equipment (PPE) to be worn when carrying out the plateworking activities (such as leather gloves, eye protection, ear protection), and the importance of keeping the work area safe and tidy**

K3 **Describe the correct methods of moving or lifting long and heavy sheet and section materials**

K4 **Describe the hazards associated with carrying out heavy plateworking activities (such as handling sheet materials, using dangerous or badly maintained tools and equipment, operating guillotines, cropping and bending machines, and when using power saws, drilling machines and abrasive cutting discs), and how they can be minimised**

K5 **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**

K6 **Describe the procedure for obtaining the required drawings, job instructions and other related specifications**

K7 **Explain 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**

K8 **Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing**

K9 **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)**

K10 **Explain how to select and establish a suitable datum; the importance of ensuring that marking out is undertaken from the selected datum, and the possible effects of working from a different datum**

K11 **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)**

K12 **Describe ways of laying out the marking-out shapes or patterns to maximise use of materials**

K13 **Describe the tools and techniques available for cutting and shaping heavy plate and section materials (such as guillotines, cropping machines, abrasive discs (such as hand held portable machines and bench type radiac cutting machines), drilling machines and machine saws)**

K14 **Describe the selection and fitting of abrasive cutting discs, cutting disc identification markings, how to identify the correct type of disc for the type of material being cut; statutory regulations regarding the fitting and use of abrasive discs**

K15 **Describe the use and care of tools and equipment (including checks that must be made to ensure that the tools are fit for purpose - such as cutting blades are sharp and undamaged, setting and adjusting guillotine blades for the material thickness, ensuring machine guards, interlocks or other safety devices are operating correctly)**

K16 **Describe the various shearing machine cutting methods and techniques (such as cutting to marking out; using machine back-stops; setting plate at an angle to the machine slides)**

K17 **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)**

K18 **Explain how to set up the various machines to produce the required forms (such as setting up of rolls; releasing formed work from rolls; setting up bending machines and setting forming tools)**

K19 **Describe the ways of limiting distortion, marking, creases, flats (in curved sections)**

K20 **Describe the characteristics of the various materials used (with regard to the bending and forming process); how the materials are to be prepared for the forming operations, and why some materials may require a heating process prior to forming**

K21 **Describe the various methods of securing the assembled components; the range of mechanical fastening devices that are used (such as nuts and bolts, rivets, screws, special fasteners); tack welding methods and techniques**

K22 **Describe the preparations to be carried out on the components prior to assembling them**

K23 **Explain how to set up and align the various components, and the tools and equipment that are used for this**

K24 **Describe methods of temporarily holding the joints together to aid the assembly activities**

K25 **Describe inspection techniques that can be applied to check that shape (including straightness) and dimensional accuracy are to specification and within acceptable limits**

K26 Describe the problems that can occur with the heavy plateworking activities, and how these can be overcome (such as defects caused by incorrectly set or blunt shearing blades)

K27 Explain when to act on their own initiative and when to seek help and advice from others

K28 Describe the importance of leaving the work area and equipment in a safe and clean condition on completion of the platework activities (such as removing and storing power leads, isolating machines, cleaning the equipment, and removing and disposing of waste)

Unit 071 Producing Platework Components and AssembliesProducing Platework Components and Assemblies

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	March 2017
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	140 GLH
Review Date	April 2020

Unit 072 Cutting and Shaping Materials using Thermal Cutting Equipment

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-072
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 cover a broad range of basic competences they need for cutting and shaping plate (3mm thickness and above), rolled sections, pipe and tube using thermal cutting equipment. This will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competences in the working environment. They will be required to select the appropriate tools, materials and equipment to use, such as hand-held oxy-fuel gas cutting equipment, plasma cutting equipment, simple portable machines running on tracks, and fixed bench cutting machines. They will be expected to prepare for the cutting activities by obtaining all necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required cutting operations. They will be required to assemble and set up the appropriate equipment for the material and thickness to be cut, the type of operation to be carried out and the accuracy to be achieved. Materials to be cut and shaped may include mild steel, stainless steel, special steels and other appropriate materials, and the work will include guided cuts, vertical cuts, overhead cuts, external curved contours, round and square holes, as appropriate. Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the thermal cutting 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 thermal cutting techniques and procedures safely. They will understand the cutting process, and its application, and will know about the tools, equipment, materials 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 thermal cutting activities, and when using the various tools and equipment, especially with regard to fire and potential explosion, and the necessary safeguards for undertaking the activities safely and correctly. 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 Standard Requirements In order to prove their ability combine different thermal cutting operations, at least one of the components produced must be of a significant nature, and must involve a minimum of four of the operations listed in scope 3.

Performance Requirements

The apprentice must be able to:

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

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

P3 **Plan the thermal cutting activities before they start them**

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

P5 **Set up the thermal cutting equipment for the operations to be performed**

P6 **Where appropriate, mark out the components for the required operations, using appropriate tools and techniques**

P7 **Operate the thermal cutting equipment to produce components to the dimensions and profiles specified**

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

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

P10 **Shut down the equipment to a safe condition on conclusion of the cutting and shaping activities**

P11 **Leave the work area in a safe and tidy condition on completion of the thermal cutting activities**

Skills Requirements
The apprentice must be able to:

S1 **Confirm that the equipment is safe and fit for purpose, by carrying out all of the following checks:**

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 equipment selected is suitable for the operations to be performed**

1.3 **regulators, hoses and valves are securely connected and free from leaks and damage**

1.4 **the correct gas nozzle is fitted to the cutting torch**

1.5 **a flashback arrestor is fitted to the gas equipment**

1.6 **appropriate gas pressures are set**

1.7 **the correct procedure is used for lighting, adjusting and extinguishing the cutting flame**

1.8 **hoses are safely routed and protected at all times**

1.9 **gas cylinders are handled and stored safely and correctly**

S2 **Use the following thermal cutting method:**

2.1 hand-held oxy-fuel gas cutting equipment

Plus one more from the following:

2.2 hand-held plasma gas cutting equipment

2.3 simple, portable, track-driven cutting equipment (electrical or mechanical)

2.4 fixed bench gas cutting equipment

S3 **Perform thermal cutting operations, to include all of the following:**

3.1 **down-hand straight cuts (freehand)**

3.2 **cutting regular shapes**

3.3 **making radial cuts**

Plus three more of the following:

3.4 making straight cuts (track guided)

3.5 cutting irregular shapes

3.6 gouging/flushing

3.7 making vertical cuts

3.8 making angled cuts

3.9 bevelled edge – weld preparations

3.10 making overhead cuts

3.11 cutting chamfers

3.12 cutting out holes

S4 Produce thermal cuts in the following forms of material (metal of 3mm and above):

4.1 plate

Plus one of the following:

4.2 rolled sections

4.3 pipe/tube

4.4 structures

S5 Produce cut component profiles for one type of material from the following:

5.1 **mild steel**

5.2 **high tensile/special steel**

5.3 **stainless steel**

5.4 **other appropriate metal**

S6 Produce thermally-cut components which meet all of the following:

6.1 **dimensional accuracy is within the tolerances specified on the drawing/specification, or within +/- 3mm**

6.2 **angled/radial cuts are within specification requirements**

6.3 **cuts are clean, smooth and free from flutes**

Knowledge and understanding
The apprentice must know and understand:

K1 **Describe the specific safety precautions to be taken when working with thermal cutting equipment in a fabrication environment (including general workshop safety; protecting other workers by siting protective screens; fire and explosion prevention; safety in enclosed/confined spaces; fume control)**

K2 **Describe the personal protective clothing and equipment (PPE) to be worn when working with thermal cutting equipment (such as leather aprons and gloves, eye/ear protection)**

K3 **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**

K4 **Describe the correct methods of moving or lifting plate and section materials**

K5 **Describe the hazards associated with carrying out thermal cutting activities (including trailing hoses, naked flames, fumes and gases, explosive gas mixtures, oxygen enrichment, spatter, hot metal, enclosed spaces), and how they can be minimised**

K6 **Describe the safe working practices and procedures for using thermal equipment, in line with British Compressed Gas Association (BCGA) codes of practice (to include setting up procedures, and emergency shutdown procedures)**

K7 **Describe the procedure for obtaining the required drawings, job instructions and other related specifications**

K8 **Explain how to extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken**

K9 **Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing**

K10 **Describe the basic principles of thermal cutting, the various types of thermal cutting equipment available, and typical applications**

K11 **Describe the accessories that can be used with hand-held thermal cutting equipment to aid cutting operations (such as cutting guides, trammels, templates); arrangements for attaching cutting aids to the equipment**

K12 **Describe the gases used in thermal cutting; gas identification and colour codes; their particular characteristics and safety procedures**

K13 **Explain how to set up the thermal cutting equipment (including connection of hoses, regulators and flashback arrestors, selection of cutting torch and nozzle size in relationship to material thickness and operations performed)**

K14 **Describe the preparations prior to cutting (including checking connections for leaks, setting gas pressures, setting up the material/workpiece, and checking the cleanliness of materials used)**

K15 **Describe the holding methods that are used to aid thermal cutting, and the equipment that can be used**

K16 **Describe the setting of operating conditions (including flame control, and the effects of mixtures and pressures associated with thermal cutting)**

K17 **Describe the correct procedure for lighting and extinguishing the flame (to include lighting the cutting torch and adjusting gas controls to produce a neutral flame; methods of starting the cut and controlling the cutting speed, direction and angle of cut; the procedure for extinguishing the flame and the importance of following the procedure)**

K18 **Describe procedures to be followed for cutting specific materials, and why these procedures must always be adhered to**

K19 **Describe the problems that can occur with thermal cutting (including causes of distortion during thermal cutting and methods of controlling distortion), and how they can be avoided**

K20 **Describe the effects of oil, grease, scale or dirt on the cutting process**

K21 **Describe the causes of cutting defects, how to recognise them, and methods of correction and prevention**

K22 **Explain when to act on their own initiative and when to seek help and advice from others**

K23 **Describe the importance of leaving the work area and equipment in a safe and clean condition on completion of the thermal cutting activities (such as safely storing gas cylinders and cutting equipment, removing and disposing of waste)**

Unit 072 Cutting and Shaping Materials using Thermal Cutting Equipment

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	March 2017
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	140 GLH
Review Date	April 2020

Unit 073 Preparing and Proving CNC Fabrication Machine Tool Programs

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-073
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 cover a broad range of basic computer numerical control (CNC) fabrication machine tool programming competences, 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 fabrication machinery to be programmed will include machines such as shearing, punching, forming and bending; plasma, laser and gas cutting. They will be required to produce the component program, using manual data input or by use of a remote computer, saving the prepared program or by downloading it into the machine controller from the computer. They will be required to prepare part programs, using operational sequences and machining techniques that avoid unnecessary tool 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 cutting, punching, profiling, bending and forming. 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 fabrication machine programming and proving techniques safely. They will understand the CNC programming process, and its application, and will know about the machine operating programmes 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 fabrication machines, 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.

Performance Requirements
The apprentice must be able to:

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

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

P3 **Plan the programming activities before they start them**

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

P5 **Develop component programs, using appropriate programming codes and techniques**

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

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

P8 **Prove the program by producing sample components**

P9 **Save and store the program in line with organisational procedures**

P10 **Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people when they have problems they cannot resolve**

P11 Shut down the equipment to a safe condition on completion of the programming activities

Skills Requirements
The apprentice must be able to:

S1 **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 **obtain the correct component drawings, and check them for currency and validity**

1.3 **use the appropriate reference manuals and programming codes to suit the machine controller**

1.4 **prepare the machine controller to accept the operating program**

1.5 **input/load the prepared program into the controller safely and correctly**

1.6 **store the programs safely and correctly in the appropriate format**

1.7 **store program media safely and correctly, away from contaminants or corruption**

S2 **Prepare and prove programs for one of the following types of CNC machine tool:**

- **2. shearing machine**
- **2. bending machine**
- **2. laser cutting**
- **2. punching machine**
- **2. plasma cutting**
- **2. gas cutting**
- **2. water cutting**
- **2. forming machine**

S3 **Produce CNC programs using one of the following methods:**

- **3. entered directly into the machine controller**
- **3. using computer software**

S4 **Develop part programs that contain all of the following, as applicable to the machine type:**

- **4. all necessary positional information**
- **4. appropriate codes**
- **4. machine management commands (preparatory/auxiliary functions)**
- **4. repetitions within programs (using features such as sub-routines, canned cycles, labels)**
- **4. absolute or incremental co-ordinates**
- **4. tool/cutter change positions**
- **4. tool information (such as lengths, offsets, radius compensation)**

S5 **Develop programs to produce components combining several different operations, covering four of the following:**

5. **straight cuts**

5. **holes radially pitched**

5. **multi-bend platework**

5. **square/rectangular profiles**

5. **louvres**

5. **curved plates**

5. **curved profiles**

5. **swages**

5. **bends of various angles**

5. **internal profiles**

5. **bends at 90°**

5. **holes linearly pitched**

5. **other specific operations**

S6 **Develop part programs to produce components made from two of the following types of material:**

6. **ferrous**

6. **non-ferrous**

6. **stainless**

6. **special alloys**

6. **other specific materials**

S7 **Prove the part program using six of the following:**

7. **single block run**

7. **full dry run**

7. **program override controls (speed, feed, tool data)**

7. **graphic displays/modelling**

7. **search facilities**

7. **program save/store facilities**

7. **data input facilities**

7. **edit facilities**

S8 **Confirm that the program operates safely and correctly, by checking all of the following:**

8. **all operations are carried out to the program co-ordinates**

8. **tool change/park positions are safe and clear of the workpiece and machine equipment**

8. **the correct tools are selected at the appropriate points in the program (where applicable)**

8. **tool offsets are correctly entered into the machine controller**

8. **tool cutter head paths are executed safely and correctly**

8. **auxiliary functions operate at the correct point in the program**

8. **programs have been saved in the appropriate format**

Knowledge and understanding
The apprentice must know and understand:

K1 **Describe the safe working practices and procedures to be followed when developing and proving CNC fabrication machine tool programs**

K2 **Describe the hazards associated with using CNC fabrication machine tools (such as automatic machine operations, power operated workholding devices, moving parts of machinery, sharp cutting tools and burrs and sharp edges on components), and how they can be minimised**

K3 **Explain the importance of wearing the appropriate protective clothing and equipment (PPE), and of keeping the work area safe and tidy**

K4 **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**

K5 **Describe the safety mechanisms on the machine, and the procedure for checking that they function correctly (such as emergency stop buttons, emergency brakes)**

K6 **Describe the correct operation of the various hand and automatic modes of machine control (such as program operating and control buttons)**

K7 **Explain how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency**

K8 **Explain how to use and extract information from engineering drawings or data and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken**

K9 **Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, absolute and incremental systems, workpiece zero/reference points and system of tolerancing**

K10 **Describe the computer coding language used in CNC fabrication machine programs (with regard to machine axes, positional information, machine management and auxiliary functions)**

K11 **Explain how to prepare part programs, using operational sequences and machining techniques that avoid unnecessary tool/cutter head movements or tool changes**

K12 **Describe the use of repetitive programs and canned cycles to reduce program size and input time**

K13 **Describe the function keys and operating system of the machine computer control system being operated**

K14 **Explain how to set machine datums for each of the machine axes being used**

K15 **Explain how to set the machine controller in the program and editing mode, and how to enter or download the prepared program**

K16 **Explain how to deal with error messages and faults on the program or equipment**

K17 **Explain how to access the program edit facility in order to enter tooling data (such as tool datums, positions, lengths, offsets and radius compensation)**

K18 **Describe the use of tool posts, magazines and carousels, and how to identify the tools in relationship to the operating program**

K19 **Explain how to conduct trial runs, using single block run, dry run and feed and speed override controls**

K20 **Describe the factors affecting the feeds and speeds that can be used, and why they may need to be adjusted from the program setting (such as condition of material, workholding method, tooling used, tolerance and finish to be achieved)**

K21 **Describe the items that they need to check before allowing the machine to operate in full program run mode**

K22 **Explain how to save the completed programs in the appropriate format, and the importance of storing program safely and correctly, away from contaminants and possible corruption**

K23 **Describe the methods and procedures used to minimise the chances of infecting a computer with a virus**

K24 **Describe the implications if the computer they are using does become infected with a virus and who to contact if it does occur**

K25 **Describe typical problems that can occur with the programming, loading and editing activities, and what to do if they occur**

K26 **Explain when to act on their own initiative and when to seek help and advice from others**

K27 **Describe the importance of leaving the work area and machine in a safe condition on completion of the activities (such as correctly isolated, operating programs closed or removed, cleaning the machine, and removing and disposing of waste)**

Unit 073 Preparing and Proving CNC Fabrication Machine Tool Programsand

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	March 2017
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	140 GLH
Review Date	April 2020

Unit 074 Using Wood for Pattern, Modelmaking and Other Engineering Applications

Level:	Level 2
GLH:	150
Relationship to NOS:	EUCL2F-074
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 cover a broad range of basic hand and wood machining competences 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 required to prepare for the pattern, modelmaking or engineering woodworking activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the cutting and shaping activities and the sequence of operations they intend to use. They will be required to select the appropriate hand tools and machinery, based on the operations to be carried out and the accuracy to be achieved. The production of the components will involve roughing out the components using fixed or portable machine tools, and finishing them using hand tools. The components produced will be used to produce patterns for sand castings, moulds for composite manufacture, full size and scale models, frames, cases, storage units, furniture and other structures. During, and on completion of, the cutting and shaping 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 material and cutting and shaping 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 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.

They must operate the equipment safely and correctly, and set and adjust the brazing or braze welding conditions, in line with instructions and safe operating procedures. They will be expected to check the quality of the brazed or braze welded joints by visual examination and destructive testing techniques, as appropriate to the aspects being checked. They will need to be able to recognise brazing or braze 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 brazing or braze welding activities, they will be expected to return all tools, equipment and workholding devices to their designated location, and to leave the brazing or braze 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 woodworking 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 hand and wood machining techniques safely. They will understand the cutting and shaping 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 carrying out the cutting and shaping activities, especially those for using woodworking machines and portable 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 Standard Requirements
In order to prove their ability to combine different pattern, model or woodworking operations, at least one of the components produced must be of a significant nature, and must have a minimum of seven of the features listed in scope 8.

Performance Requirements
The apprentice must be able to:

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

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

P3 **Plan the pattern, model or engineering woodworking activities before they start them**

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

P5 **Mark out the components for the required operations, using appropriate tools and techniques**

P6 **Cut and shape the materials to the required pattern specification, using appropriate tools and techniques**

P7 **Produce components to the required specification**

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

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

P10 **Leave the work area in a safe and tidy condition on completion of the pattern, modelmaking or engineering woodworking activities**

Skills Requirements
The apprentice must be able to:

S1 **Carry out all of the following during the cutting and shaping activities:**

1.1 **obtain all the necessary information to carry out the cutting and shaping activities (drawings, specifications)**

1.2 **check that the equipment to be used are fit for purpose, and is in a safe, tested and usable condition (such as hand tools, machines and machine cutting tools)**

1.3 **ensure that the work area is free from hazards**

1.4 **ensure that all machine guards and safety devices are correctly positioned**

1.5 **check that dust extraction equipment is functioning correctly**

1.6 **set and adjust the machines to produce the components to the required specification**

1.7 **use safe and approved hand and machine shaping techniques at all times**

1.8 **maintain the cutting tools in a serviceable condition**

S2 **Identify and isolate any materials that have defects, to include all of the following:**

2.1 **structural**

2.2 **dimensional**

2.3 **cosmetic**

2.4 **distortion**

S3 **Use marking out methods and techniques, including:**

3.1 **direct marking, using instruments**

Plus one more of the following:

3.2 **use of templates**

3.3 **tracing/transfer methods**

3.4 **other specific method**

S4 **Use a range of marking out equipment, to include all of the following:**

4.1 **pencil**

4.2 **rule or tape**

4.3 **square**

4.4 **dividers, compass or trammels**

4.5 **marking knife**

4.6 **straight edge**

4.7 **protractor or sliding bevel**

4.8 **marking gauge**

S5 **Mark out material, to include all of the following features:**

5.1 **datum and centre lines**

5.2 **cutting detail**

5.3 **hole centring and outlining**

5.4 **square/rectangular profiles**

5.5 **circles**

Plus two more from the following:

5.6 **angles**

5.7 **points**

5.8 **curved profiles**

5.9 **assembly positions**

S6 **Use hand tools to cut and shape materials, to include all of the following:**

6.1 **rip saws**

6.2 **chisels/gouges**

6.3 **drills/braces**

6.4 **tenon saws**

6.5 **jack or smoothing planes**

6.6 **sanding blocks/paper**

Plus two more from the following:

6.7 **fret/bow saws**

6.8 **spokeshaves**

6.9 **portable powered hand tools**

6.10 **rebating planes**

6.11 **files/rasps**

6.12 **other specific hand tools**

S7 **Use fixed and portable machines, to include all of the following:**

7.1 **circular saw**

7.2 **planer/thicknesser**

7.3 bench or pedestal drill

Plus two more from the following:

7.4 **band saw**

7.5 **morticer/tenoner**

7.6 **spindle moulder (single or double)**

7.7 **sander (such as face, belt, bobbin)**

7.8 **combing machine**

7.9 **lathe**

7.10 **router**

7.11 **other special purpose machine**

S8 **Produce components which combine different features and cover all of the following profiles:**

8.1 **flat faces**

8.2 **angular/tapered faces**

8.3 **drilled holes**

8.4 **parallel faces**

8.5 **curved profiles**

8.6 **countersunk/counterbored holes**

8.7 **square faces**

Plus six more from the following:

8.8 **plain diameters**

8.9 **tenons**

8.10 **concave profiles**

8.11 **stepped diameters**

8.12 **mortices**

8.13 **convex profiles**

8.14 **tapered diameters**

8.15 **half lap joints**

8.16 **dovetail joints**

8.17 **slots/grooves**

8.18 **combed joints**

8.19 **rebates**

8.20 **Other specific joints/profiles**

S9 **Produce components made from four of the following materials:**

9.1 **soft woods**

9.2 **blockboard**

9.3 **hard woods**

9.4 **hardboard**

9.5 **plywood**

9.6 **fibreboard (MDF)**

S10 **Use appropriate measuring equipment and tools to check all of the following:**

10.1 **dimensions**

10.2 **angles/taper**

10.3 **profile**

10.4 **flatness**

10.5 **alignment**

10.6 **distortion/straightness**

10.7 **squareness**

10.8 **position**

S11 **Produce components which meet all of the following requirements:**

11.1 **components to be free from false tool cuts, and material defects**

11.2 **the shape and general tolerances meet the drawing or specification requirements with some dimensional tolerances within +/- 1mm or +/- 0.040”**

11.3 **flatness and squareness 0.25mm per 25mm or 0.010” per inch**

11.4 **angles within +/- 2 degrees**

11.5 **interlocking components (joints) are secure**

11.6 **components have an appropriate surface texture**

Knowledge and understanding
The apprentice must know and understand:

K1 **Describe the health and safety requirements, and safe working practices and procedures required for the pattern, modelmaking or engineering woodworking activities undertaken (including the use of hand tools; working with machinery; operation of machine safety devices; dust extraction, stopping the machine in an emergency; closing the machine down on completion of activities)**

K2 **Describe the importance of wearing appropriate protective clothing/equipment (PPE), and of keeping the work area safe and tidy**

K3 **Describe the hazards associated with cutting and shaping wood and composite materials, and with the tools and equipment that is used, (such as use of hand power tools, trailing leads or hoses, dust inhalation, damaged or badly maintained tools and equipment, using tools with damaged or poor fitting handles, handling long or wide lengths of material), and how they can be minimised**

K4 **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**

K5 **Describe the procedure for obtaining the required drawings, job instructions and other related specifications**

K6 **Explain 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**

K7 **Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing**

K8 **Explain how to identify the materials that are to be used (to include colour, grain structure, size), and the common defects that occur in the wood to be used**

K9 **Describe the types of defects that would render the materials unfit for use**

K10 **Describe the material characteristics and process considerations to be taken into account when marking out wood (such as the importance of colour matching and grain convention when using wood and wood-based materials)**

K11 **Describe the principles of marking out, and the types of equipment used (including the range of operations that the various items of marking out equipment are capable of performing)**

K12 **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, preparing the materials, removing sharp corners and edges)**

K13 **Describe the use of marking out conventions when marking out the workpiece (including datums, centre lines, cutting guidelines, square and rectangular profiles, joints, circular and curved profiles, angles, holes which are linearly positioned, boxed and on pitch circles)**

K14 **Explain how to select and establish suitable datums; the importance of ensuring that marking out is undertaken from the selected datums; and the possible effects of working from different datums**

K15 **Describe the use of geometrical construction methods applied to marking out**

K16 **Describe ways of laying out the marking out shapes or patterns to maximise the use of materials**

K17 **the various hand tools that are used to cut and shape the materials, and the range of operations they are capable of performing (such as rip saws, tenon saws, fret/bow saws; smoothing planes, jack planes, rebating planes; chisels and gouges; spokeshaves)**

K18 **Explain how to check that the hand cutting tools are in a usable and safe condition; and the procedure for sharpening and adjusting these when required**

K19 **Describe the various machines that are used in wood machining, and the range of operations they are capable of performing (such as sawing, planing, rebating, profiling)**

K20 **Describe the importance of checking that the machinery used is complete and working correctly, that the cutting tools are undamaged and are in a safe and sharp**

condition, and the procedure for changing, sharpening and adjusting these when required

K21 Describe the methods of setting up and operating the equipment and machinery, how to set up and use dust extraction equipment, and the importance of ensuring that this equipment is operating correctly

K22 Describe the importance of ensuring that all machine and portable tools are used correctly, tested and within their permitted operating range

K23 Describe the various methods used to hold the components that are being shaped, formed or dressed by hand

K24 Explain why they need to consider grain direction and construction when cutting and shaping wood and composites

K25 Describe the methods used to cut square, angular and circular/curved profiles

K26 Explain how different materials require changes to the machining methods (such as roughing and finishing cuts, changes in feed or speeds)

K27 Explain how to conduct any necessary checks to ensure the accuracy and quality of the components produced, and the type of equipment that is used

K28 Explain when to act on their own initiative and when to seek help and advice from others

K29 Describe the importance of leaving the work area in a safe and clean condition on completion of the woodworking activities (such as removing and storing power leads, isolating machines, cleaning the equipment, and removing and disposing of waste)

Unit 074 Using Wood for Pattern, Modelmaking and Other Engineering Applications

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	March 2017
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	150 GLH
Review Date	April 2020

Unit 075 Assembling Pattern, Model and Engineering Woodwork Components

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-075
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 covers a broad range of basic competences that they need to assemble pattern, model or engineering woodwork components. These will prepare them for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or they will provide a basis for the development of additional skills and occupational competences in the working environment. They will be required to prepare for the pattern, model or engineering woodworking, assembly activities by obtaining all the necessary information, documentation, components, tools and equipment required, and to plan how they intend to carry out the assembly activities and the sequence of operations they intend to use. They will be required to assemble pattern, model or engineering woodwork components, using mechanical fixing devices and adhesives. The assemblies produced will include such items as patterns for sand casting, moulds/formers for composite manufacture, furniture units, doors and door frames, transportation units, jigs/fixtures and other engineering structures/assemblies. They will be required to select the appropriate assembly tools and equipment to use, based on the operations to be performed and the types of component to be assembled, and to check that they are in a safe and serviceable condition. They will also be expected to align the components correctly, and to assemble them in the correct order, using the appropriate fixing devices and adhesives. They will need to identify and/or create any datums that will be required to locate the components during the assembly

	process. The assembly activities will also include making all necessary visual and dimensional checks, to ensure that the assembly meets the required specification, that fasteners are securely tightened, and that the completed assembly is free from damage and has an appropriate cosmetic appearance. Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the woodwork 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 woodwork assembly techniques safely. They will understand the 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 carrying out the assembly operations, especially those involved in the use of adhesives. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Performance Requirements
The apprentice must be able to:

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

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

P3 **Plan the assembly activities before they start them**

P4 **Obtain and prepare the appropriate components, tools and equipment**

P5 **Use the appropriate methods and techniques to assemble the components in their correct positions**

P6 **Secure the components, using the specified connectors and securing devices**

P7 **Check the completed assembly to ensure that all operations have been completed, and that the finished assembly meets the required specification**

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

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

Skills Requirements
The apprentice must be able to:

S1 **Carry out all of the following during the pattern, model or engineering woodwork 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 tools, 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 components used are free from damage, material defects, foreign objects, or other contamination**

1.7 **return all tools and equipment to the correct location on completion of the assembly activities**

S2 **Produce pattern, model or engineering woodwork assemblies, which include three of the following:**

2. flat backed patterns (with/without cores)

2. furniture units with doors

2. full-size models

2. irregular joint patterns (with/without cores)

2. doors and door frames

2. sectional full-size models

2. split patterns (with/without cores)

2. storage units

2. scale models

2. solid turnout coreboxes

2. frames or bulkheads

2. sectional scale models

2. split coreboxes

2. structures

2. jigs or fixtures

2. plated patterns (drags)

2. show stands or cases

2. formers

2. **plated patterns (copes)**

2. **transportation units**

2. **furniture units with drawers**

2. **furniture units without drawers and doors**

2. **consoles**

2. **other specific components**

S3 **Apply all of the following assembly methods and techniques, as appropriate for the assemblies produced:**

3. **ensuring that correct and undamaged components are used**

3. **ensuring that the correct `hand' of component is used at the appropriate position (left or right handed)**

3. **ensuring the correct orientation, position and alignment of components**

3. **using cramps and clamps to hold the components during the assembly activities**

3. **drilling and countersinking/counterboring (where appropriate)**

3. **securing components using mechanical fasteners (such as pins, screws, nails, special fasteners, dowels)**

3. **securing components by using prepared joints**

3. **securing components by using adhesives**

3. **fitting of accessories (hinges, locks, handles, catches)**

S4 **Carry out the required quality checks, to include ten from the following, using appropriate equipment:**

4. **dimensions**
4. **positional accuracy**
4. **finish**
4. **flatness**
4. **distortion/straightness**
4. **completeness**
4. **squareness**
4. **profile (where appropriate)**
4. **function (where appropriate)**
4. **alignment**
4. **fit/component security**
4. **freedom from damage**
4. **orientation**

S5 **Produce pattern, model or engineering woodwork assemblies which meet all of the following:**

5. **all components are correctly assembled and aligned in accordance with the specification**
5. **assemblies are dimensionally accurate within specification tolerances**
5. **where appropriate, assemblies meet appropriate geometric tolerances (such as square, straight, angles free from twists)**
5. **interlocking components (joints) are secure**
5. **doors and drawers are correctly aligned and open freely (where applicable)**

5. **moving parts are correctly adjusted and have appropriate clearances**

Knowledge and understanding
The apprentice must know and understand:

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

K2 **Describe the importance of wearing appropriate protective clothing/equipment (PPE) during the woodwork assembly activities, and of keeping the work area safe and tidy**

K3 **Describe the hazards associated with producing wood and composite assemblies, and with the tools and equipment used, (such as dust inhalation, use of hand power tools, trailing leads or hoses, using adhesives), and how they can be minimised**

K4 **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**

K5 **Explain how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken**

K6 **Explain how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing**

K7 **Explain how to identify the components to be used, component identification systems (such as codes and component orientation indicators, left and right handing)**

K8 **Describe the preparations to be undertaken on the components prior to fitting them into the assembly**

K9 **Describe the assembly methods and procedures to be used, and the importance of adhering to these procedures**

K10 **Describe the importance of assembling components in the correct order**

K11 **Explain how to mark out the necessary datum lines for the assembly operations**

K12 **Explain how the components are to be aligned, oriented and positioned prior to securing them, and the tools and equipment that are used for this**

K13 **Explain why some types of assembly require the use of jigs and gauges to aid the assembly**

K14 **Describe the various mechanical fasteners that will be used to secure the components, and their method of installation (such as nails, screws and special securing devices)**

K15 **Describe the application of adhesives within the assembly activities, and the precautions that must be taken when working with them**

K16 **Explain how to conduct any necessary checks to ensure the accuracy and quality of the assembly produced, and the type of equipment that is used**

K17 Explain recognising defects, blemishes, poor alignment, ineffective fasteners and damaged components within the assembly

K18 Explain how defects and variations should be dealt with, and what factors determine the actions to be taken (including the relative costs of reworking or discarding the defective item)

K19 Explain how to check that the assembly tools and equipment to be used are in a safe and serviceable condition

K20 Explain why it is important to keep the tools and equipment clean and free from damage, to practice good housekeeping of tools and equipment, and to maintain a clean and unobstructed working area

K21 Explain when to act on their own initiative and when to seek help and advice from others

K22 Describe the importance of leaving the work area in a safe and clean condition on completion of the assembly activities (such as removing and storing clamps, isolating equipment, cleaning the equipment, and removing and disposing of waste)

Unit 075 Assembling Pattern, Model and Engineering Woodwork Components

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	March 2017
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	140 GLH
Review Date	April 2020

Unit 076 Producing Composite Mouldings using Resin Flow Infusion Techniques

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-076
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 cover a broad range of basic competences that they need to produce composite mouldings using resin flow infusion techniques. 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. They will be required to prepare for the resin flow infusion 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 you intend to use. They will be expected to prepare the tooling, apply release agents and to prepare the composite materials. They will produce composite mouldings, which will incorporate a range of features. 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 resin flow infusion 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 resin flow infusion techniques and procedures safely. They will understand the moulding 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 resin flow infusion 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 Standard Requirements In order to prove their ability to combine different resin flow infusion 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 scope 6.

Performance Requirements
The apprentice must be able to:

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

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

P3 **Plan the resin infusion activities before they start them**

P4 **Prepare the moulds, jigs or formers ready for the manufacturing operations**

P5 **Check materials are fit for purpose and in life**

P6 **Carry out the resin flow infusion activities, using the correct methods and techniques**

P7 **Produce composite mouldings**

P8 **Remove the mouldings correctly and trim/finish them to specification**

P9 **Check that all the required operations have been completed to specification**

P10 **Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve**

P11 **Leave the work area in a safe and tidy condition on completion of the assembly activities**

Skills Requirements
The apprentice must be able to:

S1 **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 activities**

S2 **Prepare the tooling for production, to include carrying out all of the following:**

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

S3 **Prepare the materials for production, to include carrying out all of the following:**

3.1 obtain the correct materials for the activity

3.2 check that materials are fit for purpose and in life

3.3 cut materials to the correct size, shape and orientation

3.4 calculate the correct resin to fibre ratios

3.5 check correct quantity of resin is available

3.6 check the availability of required ancillary materials

3.7 identify and protect materials in the work area

3.8 obtain the correct infusion media and layout for the activity

S4 **Produce composite mouldings, using one of the following:**

4.1 test panel trials/tracking

4.2 partial trial runs/tracking

4.3 full scale trial runs/tracking

4.4 production runs

4.5 staged resin entry

4.6 **dry area rectification**

4.7 **vacuum regulation**

4.8 **resin flow regulation**

S5 **Produce composite mouldings incorporating two of the following:**

5.1 **butt joins**

5.2 **overlap joins**

5.3 **staggered joins**

5.4 **feathered joins**

5.5 **orientated plies**

5.6 **inverted plies**

5.7 **balancing plies**

5.8 **inserts**

5.9 **fixtures**

S6 **Produce composite 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

S7 **Produce composite mouldings, using techniques for one type of resin from:**

7.1 **bio resin**

7.2 **acrylic**

7.3 **polyester**

7.4 **vinyl ester**

7.5 **epoxy**

7.6 **phenolic**

7.7 **other (to be specified)**

S8 **Produce composite 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)**

S9 **Produce composite mouldings, using techniques for one type of reinforcement from:**

9.1 **uni-directional**

9.2 **chopped strand**

9.3 **tissues/veils**

9.4 **woven**

9.5 **braids**

9.6 **multi-axis/stitched**

9.7 **knitted**

9.8 **tapes**

9.9 **other (to be specified)**

S10 **Produce composite mouldings, using techniques for one type of core materials from:**

10.1 **solid timber**

10.2 **end grain balsa**

10.3 **coremat**

10.4 **rigid foam**

10.5 **expanding foam**

10.6 **skinned honeycomb**

10.7 **other (to be specified)**

S11 **Produce composite mouldings using techniques for three types of resin distribution media:**

11.1 **mould surface entry**

11.2 **interlaminar**

11.3 **surface meshes**

11.4 **infusion mats/fabrics**

11.5 **channelled core**

11.6 **perforated core**

11.7 **perforated hose**

11.8 **spiral wrap**

11.9 **peel ply**

11.10 **braid**

11.11 **flow channels**

11.12 **manifolds**

11.13 **networks**

11.14 **bleed plies**

11.15 **moulded vacuum bags**

S12 **Use three of the following vacuum bagging processes/methods:**

12.1 **check vacuum integrity**

12.2 **surface bagging**

12.3 **envelope bagging**

12.4 **internal bagging**

12.5 **pleats and tucks**

12.6 **reusable bagging**

12.7 **leak detection**

12.8 **leak rectification**

12.9 **catch pots/tanks**

12.10 **localised resin injection**

12.11 **use of reusable vacuum fittings**

S13 **Remove the composite mouldings and carry out all of the following:**

13.1 **visually check that the moulding is complete and free from defects**

13.2 **use appropriate equipment/gauges to check for dimensional accuracy (such as overall dimensions, thickness of material/moulding, geometric features)**

13.3 **carry out repairs (where appropriate)**

13.4 **finish the mouldings, using appropriate tools and equipment**

S14 **Produce composite mouldings in compliance with one of the following:**

14.1 **components are dimensionally accurate within specification requirements**

14.2 **finished components meet the required shape/geometry**

(such as square, straight, angle, free from twists)

14.3 **completed components are free from defects, sharp edges or slivers**

14.4 **components meet company standards and procedures**

Knowledge and understanding
The apprentice must know and understand:

K1 **Describe the health and safety precautions to be taken, and procedures used, when working with composite materials, consumables, tools and equipment in the specific work area**

K2 **Describe the hazards associated with carrying out resin flow infusion techniques, and with the composite materials, consumables, tools and equipment used, and how to minimise these and reduce any risks in the work area**

K3 **Describe the protective equipment (PPE) that is needed for personal protection and, where required, the protection of others**

K4 **Describe the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables**

K5 **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**

K6 **Describe the specific workshop environmental conditions that must be observed when producing composite mouldings using resin flow infusion techniques (such as temperature, humidity, styrene levels to threshold limits, fume/dust extraction systems and equipment)**

K7 **Explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken**

K8 **Explain how to interpret drawings/ lay-up manuals, imperial and metric systems of measurement, workpiece reference points and system of tolerancing**

K9 **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**

K10 **Describe the conventions and terminology used for resin flow infusion techniques (such as material orientation, material identification, distribution media, resin viscosity, flow paths, ply lay-up, vacuum bagging, resin and fibre weights/volumes, gel times, exotherm, bleed plies)**

K11 **Describe the different types of resins, reinforcement, catalysts, accelerators and additives used, and their applications**

K12 **Describe the different types of fibre materials, fabrics, orientations, their combinations and applications**

K13 **Describe the different core and insert materials, and their merits**

K14 **Describe the different types of resin distribution media, and their merits**

K15 **Describe the visual identification of both raw and finished composite materials**

K16 **Describe the different types of production tooling used for producing composite mouldings, and their applications**

K17 **Describe the identification and rectification of defects in production tooling**

K18 **Describe the building up laminates (including orientation and balance of plies), to minimise spring and distortion in composite mouldings**

K19 **Describe the methods of preparation for patterns, moulds and tooling (including the correct selection and use of surface sealers and release agents)**

K20 **Describe the methods for handling, preparation and application of the reinforcing fibres and fabrics**

K21 **Describe the correct methods of storage and handling of ancillary and consumable materials**

K22 **Describe the methods used in the positioning and application of the resin distribution media**

K23 **Explain how to estimate/calculate resin volume/weight required to saturate the reinforcing fibres**

K24 **Describe the mixing ratios for gel coats, resins and catalysts, and the associated working times**

K25 **Describe the tools and equipment used in the resin flow infusion activities, and their care, preparation and control procedures**

K26 **Describe the operation and importance of a vacuum check before the infusion starts**

K27 **Describe the problems that can occur during the resin flow infusion process (including defects such as contamination, incomplete wet out, vacuum leaks, flow restrictions)**

K28 **Describe the different methods and techniques used to cure composite mouldings including cure cycles and the need for monitoring**

K29 **Describe the procedures and methods used for removing mouldings from production tooling**

K30 **Describe the identification of defects in the composite mouldings (such as de-lamination, voids, contaminants)**

K31 **Describe the care and safe handling of production tooling and composite mouldings throughout the production cycle**

K32 **Describe the production controls used in the work area, and actions to be taken for unaccounted items**

K33 **Explain how the composite component relates to its own quality documents and the production tooling used**

K34 **Describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve**

Unit 076 Producing Composite Mouldings using Resin Flow Infusion Techniques

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	March 2017
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	140 GLH
Review Date	April 2020

Unit 077 Producing and Preparing Sand Moulds and Cores for Casting

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-077
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 covers a broad range of basic competences they need to produce and prepare sand moulds and cores for casting. 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. They will be required to prepare for the production of the moulds and cores 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 required to select the appropriate equipment to use, based on the type and size of the pattern, the moulding method employed, and the material to be cast. They will be expected to prepare the sand and produce the moulds using either greensand, chemically bonded gas activated sand, chemically bonded resin/catalyst activated sand or resin bonded heat activated sand. The patterns used will be loose or boarded, circular, square or irregular in shape, and will have projections and internal cavities. The moulds will be produced either in boxes or boxless, as appropriate. Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the production and preparation of the sand moulds and cores. They will need to take account of any potential difficulties or problems that may arise with the patterns, sand, additives or 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 manual sand moulding and core making techniques safely. They will understand the manual sand moulding and core making process, and its application, and will know about the equipment, materials, consumables and tests that are used to confirm that the sand is fit for purpose, 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 sand moulding activities, and when using the associated tools and equipment. They will be required to demonstrate safe working practices throughout. They will also understand their responsibilities for safety, and the importance of 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 Standard Requirements In order to prove their ability to combine different moulding techniques and procedures, at least one of the moulds produced must be of a significant nature, and must contain a minimum of one core.

Performance Requirements
The apprentice must be able to:

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

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

P3 **Plan the sand moulding and core making activities before they start them**

P4 **Obtain and prepare the appropriate tools, equipment and materials**

P5 **Ensure that the patterns are correctly prepared, sited and positioned ready for the moulding process**

P6 **Ensure that the sand is correctly mixed and milled**

P7 **Test the prepared sand to ensure that it meets the specification requirements**

P8 **Carry out the sand moulding and core making activities, using the correct methods and techniques**

P9 **Produce moulds and cores to the required specification**

P10 **Assemble and finish the moulds to the required specification**

P11 **Dispose of surplus material safely and correctly**

P12 **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**

P13 **Leave the work area in a safe condition on completion of the moulding and core making activities**

Skills Requirements
The apprentice must be able to:

S1 **Carry out all of the following during the sand moulding and core making 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 and moulding procedure specifications**

1.3 **use the correct tools and equipment for the moulding activity**

1.4 **follow the defined moulding techniques and procedures**

1.5 **ensure that the moulds produced meet the required specification for quality and accuracy**

1.6 **return all tools and equipment to the correct location on completion of the moulding and core making activities**

S2 **Prepare sand and produce moulds/cores from two of the following types of sand:**

2.1 greensand (naturally or synthetically bonded)

2.2 chemically bonded resin/catalyst

2.3 chemically bonded gas activated

2.4 resin bonded heat activated

2.5 other type of sand (specify)

S3 **Prepare the sand for the mould/core making activities, to include carrying out all of the following:**

3.1 measuring out the required amounts of sand for the operations being performed

3.2 adding the correct additives in the correct ratios

3.3 performing the mixing and milling operations safely and correctly

3.4 testing that the finished sand meets requirements (such as moisture, permeability, viscosity and strength)

S4 **Prepare the mould/coremaking equipment for use, to include carrying out both of the following:**

4.1 visually inspecting the pattern or core box for damage

4.2 applying release agents to the pattern or core box (as applicable)

S5 Produce full or half cores from both of the following types of core box:

5.1 solid turnout boxes

5.2 split boxes

S6 Produce cores using two of the following techniques:

6.1 **hand tucking and ramming**

6.2 **inserting reinforcements (such as wire or bars)**

6.3 **mechanical assistance with core consolidation**

6.4 **incorporating vents (such as pre-formed, manually applied)**

6.5 **curing and drying the cores**

S7 Produce drag and cope mould parts from patterns which are either:

7.1 loose flat back and split type

or

7.2 plated flat type and split type

S8 Produce mould parts, using one of the following methods:

8.1 use of moulding boxes

8.2 boxless, using mould location devices

S9 Assemble and finish the moulds (which must include at least one core), by carrying out all of the following:

9.1 inserting the cores (such as horizontal or vertical location)

9.2 securing the cores (using print locations, adhesives or mechanical devices)

9.3 forming runner, riser and feeder systems on the mould (such as cut and formed manually, reformed with fixed formers, preformed with loose formers)

9.4 inserting filters, chills or feeder sleeves as necessary

9.5 carrying out any repairs to the moulds/cores (such as patching up greensand moulds or cores, repairing rigid sand moulds or cores using adhesives)

9.6 applying mould coatings/dressings (such as by spray, flood, brush or dry)

S10 Prepare and close the moulds ready for casting, to include carrying out all of the following:

10.1 cleaning and removing foreign bodies and surplus sand from the mould cavity

10.2 carrying out visual checks on moulds for completeness (including all cores and freedom from cracks)

10.3 checking that runner/riser/feeder systems are clean, connected and complete

10.4 applying mould sealant, where appropriate

10.5 locating the moulds (using pins, rebates, diabolos or cores, as appropriate)

10.6 closing moulds manually or by mechanical means

10.7 securing the moulds using clamps/clips and/or weights

S11 Produce sand moulds which meet all of the following quality and accuracy standards:

11.1 complete and free from obvious defects (such as cracks, broken or damaged mould surfaces)

11.2 meet the required specification (such as shape, dimensional accuracy)

11.3 free from soft spots

Knowledge and understanding
The apprentice must know and understand:

K1 **Describe the specific safety precautions to be taken when producing and preparing sand moulds for casting (such as wearing full protective clothing and protective equipment; ensuring adequate ventilation/fume extraction and the elimination of slipping or tripping hazards)**

K2 **Describe the COSHH regulations that apply when dealing with chemically bonded sands, surface coatings, release agents and surface dressings**

K3 **Describe the hazards associated with producing and preparing sand moulds and cores for casting, including exposure to dust and fume, and how they can be minimised**

K4 **Describe the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy**

K5 **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**

K6 **Describe the types of sands and sand binder systems used in core and mould making activities (such as silica, olivine, chromite and zircon sands, and greensand, and chemically prepared sands such as gas activated, resin/catalyst activated types)**

K7 **Describe the various types of sand additives which are suitable for the sand and type of metal to be cast (such as chemicals, resins, catalyst, esters, breakdown agents, inhibitors, refractory materials, and bentonite)**

K8 **Describe the methods used to prepare greensand and chemically or resin bonded sands, using manual and machine methods**

K9 **Explain how to calculate the amount of sand required, and the ratios of sand additives that may be required**

K10 **Describe the effects on the prepared materials if the base product is passed the ‘use by' date, is added to the mix at the wrong time or at the wrong temperature, too little or too much is added to the mix, or the mixture is over mixed or over milled**

K11 **Describe the procedures for testing the prepared sand for moisture content, strength, viscosity and freedom from foreign bodies**

K12 **Describe the various types of core box that are used (such as solid turnout boxes, split boxes, multi-part, strickle and boxes containing loose pieces or prints)**

K13 **Describe the different pattern types used in the moulding process (such as loose and plated), and the jointing methods that are required for the different pattern types**

K14 **Describe the methods of positioning the patterns for correct orientation; centralising and supporting the pattern in the moulding box**

K15 **Describe the application and use of pattern release agents and core coatings or dressings**

K16 **Describe the methods of filling moulds and core boxes and compacting sands (such as manual filling and compacting and machine filling and compacting), and the precautions to be taken to ensure that the pattern doesn't become displaced during the filling and compacting activities**

K17 **Describe the methods of reinforcement and venting of the moulds and cores (such as using vent wire and rods, pre- formed shapes, pre-formed wax or nylon) and placement and use of chills and filters**

K18 **Describe the methods of mould stripping and pattern rapping; removing the pattern without damaging the mould cavity or pattern**

K19 **Describe the methods of cutting and forming downsprues, ingates, riser and feeder systems**

K20 **Describe the various methods of drying and curing cores (such as the use of ovens, CO_2 gas and catalytic action)**

K21 **Explain why it is necessary to check the moulds and cores prior to commencing core setting and mould closing operations**

K22 **Describe the defects that can occur in the moulds and cores (such as cracked surfaces, exposed reinforcements, friable surfaces, broken or weak mould and core sections, incomplete mould or cores, damaged or broken core prints and core locations, mould location devices missing or distorted, uncoated moulds or cores)**

K23 **Describe the methods of rectifying defects in moulds or cores, by patching and gluing**

K24 **Explain how to prepare the moulds, and the methods of locating and setting cores in the moulds (using core prints, chaplets, glues and sprigs)**

K25 **Describe the methods of closing and securing the moulds (using weights or clamps), and the dangers/effects of using moulds which are incorrectly closed or clamped**

K26 **Explain why it is important to keep the pattern and core box equipment clean and free from damage, to practice good housekeeping of moulding tools and equipment, and to maintain a clean working area**

K27 **Explain when to act on their own initiative and when to seek help and advice from others**

K28 **Describe the importance of leaving the work area in a safe and clean condition on completion of the sand moulding and core making activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)**

Unit 077 Producing and Preparing Sand Moulds and Cores for Casting

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	March 2017
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	140 GLH
Review Date	April 2020

Unit 078 Producing and Preparing Molten Materials for Casting

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-078
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 cover a broad range of basic competences that they need to prepare and process the materials used in the production of molten materials, to produce cast components using moulds and shells. 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. They will be required to prepare for the melting 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 required to prepare the appropriate equipment to use, based on the type and amount of molten material needed. This includes ferrous and non-ferrous alloys, plastic/polymers and liquid ceramics. They will prepare the base material for insertion into the melting furnace, and will start up the furnace, and charge the base material plus any other specified materials or additions into the melting vessel at the specified time. They will also adjust the furnace operating conditions to suit the molten material requirements. They will be expected to discharge the molten material into the receiving vessel or to other holding furnaces, as appropriate. Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the preparation and control of the melting activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the base materials, additives or equipment, 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 preparation and control procedures safely for the production of molten materials for casting. They will understand the melting techniques used, and their application, and will know about the equipment, materials, consumables and tests that are used to confirm that the process is under control, 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 melting operations, and when using the associated tools and equipment, especially those involved in handling and pouring the molten material. 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.

Performance Requirements
The apprentice must be able to:

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

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

P3 **Plan the material melting activities before they start them**

P4 **Set up the operating conditions of the melting furnace, making any necessary adjustments to maintain satisfactory operating conditions**

P5 **Obtain the required charge materials, and check that they are in a suitable condition to use**

P6 **Start up the furnace, using approved procedures, and add the materials at the appropriate time**

P7 **Carry out appropriate tests of the molten material at suitable intervals, in order to achieve the material specification**

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

P9 **Dispose of waste and excess materials safely and correctly**

P10 **Leave the work area in a safe and tidy condition on completion of the melting activities**

Skills Requirements
The apprentice must be able to:

S1 **Prepare the furnace for operation, to include all of the following, as appropriate to the equipment used:**

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, melting specifications and procedures**

1.3 **ensure that services/power supplies are connected, and operational and start-up procedures are initiated**

1.4 **check that guards/screens are in position and operational**

1.5 **check that emergency stop controls are operational**

1.6 **check that visual display panels are operational**

1.7 **ensure that supply and discharge outlets are clear and operational**

1.8 **check that furnace linings and equipment are in a safe and usable condition**

1.9 **hut down the furnace to a safe condition on completion of the melting activities**

1.1 **return all tools and equipment to the correct location on completion of the melting activities**

S2 **Prepare the materials used in the casting process, and check that they are to the required specification, to include all of the following:**

2.1 selection and preparation of the base charge materials (such as scrap, ingots, returns)

2.2 selection and preparation of any additives and additions (such as fluxes, alloys, trimming additions, inhibitors, de-oxidisers, colour – relevant for plastics and ceramics only)

2.3 selection and preparation of any fuel charge materials

S3 **Produce molten materials, using one of the following types of furnace:**

3.1 cupola

3.2 bale out

3.3 direct or indirect arc

3.4 induction (high or medium frequency)

3.5 lift out crucible

3.6 tilting crucible

3.7 rotary

3.8 other melting furnaces (specify)

S4 **Produce molten material from one of the following:**

4.1 **ferrous alloys**

4.2 **non-ferrous alloys**

4.3 **plastic/polymers**

4.4 **liquid ceramics**

S5 **Monitor the melting process, to include all of the following:**

5.1 **measuring the melt temperature (such as visually, immersion pyrometer, visual display units)**

5.2 **adjusting the operating conditions of the melting furnace (such as melting rate by changing the power or fuel input)**

5.3 **making necessary additions to the melt**

5.4 **where applicable, informing appropriate people of non-conformance of the molten material**

5.5 **confirming that the melt is ready for casting**

S6 **Carry out treatment of the melting/molten material, to include two of the following:**

6.1 **adding deoxidising agents to charge material**

6.2 **adding oxidising agents to charge material**

6.3 **adding alloying elements**

6.4 **adding nucleants**

6.5 **deoxidising molten material**

6.6 **modification of molten material**

6.7 **adding cover fluxes to charge material**

6.8 **degassing molten material**

6.9 **grain refining of molten metal**

6.10 **removal of slag/oxide skins/impurities**

S7 **Take samples of the molten material, for one of the following types of test:**

- **7.1 carbon equivalent measurement**
- **7.2 chemical analysis**
- **7.3 X-ray fluorescence spectrometry (XRF)**
- **7.4 spark emission spectrometry**
- **7.5 wedge tests**
- **7.6 tensile tests**
- **7.7 hydrogen gas content**

S8 **Discharge the molten material from the furnace into one of the following:**

- **8.1 holding furnace**
- **8.2 prepared pouring ladles**
- **8.3 prepared treatment ladles**
- **8.4 other holding/casting vessels/pigs**

Knowledge and understanding
The apprentice must know and understand:

K1 **Describe the specific safety precautions to be taken when working with melting furnaces and molten materials (such as wearing full protective clothing and protective equipment; minimisation of dust and fume, ensuring adequate ventilation/fume extraction, and the elimination of slipping or tripping hazards)**

K2 **Describe the COSHH regulations that apply when dealing with charge materials, furnace additions and additives**

K3 **Describe the hazards associated with working with melting furnaces and molten materials (such as splashes and spills of molten materials; dust and fumes; handling hot and heavy materials), and how they can be minimised**

K4 **Describe the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy**

K5 **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**

K6 **Describe the emergency procedures to be followed in the event of a malfunction of any melting furnace, holding ladle or pouring vessels in use**

K7 **Explain why it is important to keep the furnace and melting equipment clean and free from damage, to practice good housekeeping of tools and equipment, and to maintain a clean and unobstructed working area**

K8 **Describe the importance of following job instructions and defined casting procedures**

K9 **Describe manual lifting techniques and requirements on acceptable weights to be handled by hand**

K10 **Describe the various types and applications of material melting furnace that are used (such as rotary and cupola types; crucible types such as lift out, push up, bale out, and tilting; electric furnaces such as induction arc and resistance)**

K11 **Explain how to check that the furnace and its linings are in a safe and serviceable condition**

K12 **Explain how to identify the various charge materials they are to use in producing the cast components**

K13 **Describe the various forms of materials used in the melting process (such as ingots, granules, powders, bought-in scrap and scrap components for re-melting)**

K14 **Explain why it is necessary to check the amounts of materials, prior to commencing melting operations**

K15 **Describe the effects on the melting operation and the molten material if the base materials are out of date, different in content from the specification requirements, added to the furnace/melt at the wrong time or temperature, or when wet or damp, or if too little or too much is added to the melt**

K16 Describe the reasons why furnace start-up procedures are performed, and why these must always be adhered to

K17 Describe the methods of charging the furnaces, and the precautions to be taken when adding materials to molten liquids

K18 Describe the reasons for preheating some materials prior to furnace charging

K19 Describe the additions that are made to the material/metals/alloys to aid the melt or produce and/or correct the material specification

K20 Explain how to establish melting and pouring temperatures and how to set the furnace/crucible controls to give the required melt conditions

K21 Describe the methods of checking when the molten material is at the required temperature (such as by visual means, by use of fixed and optical pyrometers)

K22 Describe the actions to take if the molten material is outside the specified temperature range

K23 Describe methods of checking chemical composition by spectrographic or chemical analysis of samples from the melt

K24 Describe the defects in castings which can be directly related to the use of molten material which is outside the specified temperature range, or which is untreated, or is treated but casting is delayed, or to the use of un- skimmed metal/material

K25 Explain when to act on their own initiative and when to seek help and advice from others

K26 Describe the importance of cleaning the furnace/crucible in accordance with the furnace/crucible manufacturer's instructions

K27 Describe the importance of leaving the work area in a safe and clean condition on completion of the melting activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Unit 078 Producing and Preparing Molten Materials for Casting

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	March 2017
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	140 GLH
Review Date	April 2020

Unit 079 Producing Cast Components by Manual Means

Level:	Level 2
GLH:	130
Relationship to NOS:	EUCL2F-079
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 covers a broad range of basic competences that they need to prepare and safely cast molten materials into prepared moulds, dies, or shells, manually. It will prepare them for entry into the engineering or manufacturing sector, 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 required to prepare for the casting activities by obtaining all necessary information, documentation, materials, tools and equipment, and to plan how they intend to carry out the required casting activities. They will be required to select the appropriate equipment to use, based on the type and amount of molten material to be cast. Both single and double pours, with ferrous or non-ferrous alloys, plastic polymers and liquid ceramics are included in this standard. They will check that the moulds/dies/shells to be cast are positioned correctly, and are bushed up and secure. They must ensure that the casting ladles and any supporting or carrying frames are free from defects that could affect the safe operation of carrying and pouring the molten material. They will confirm that the molten material is at the required temperature and to the correct specification. They will collect the molten material from the source vessel or furnace, and skim or apply coagulant to the molten material to remove/contain impurities from the surface. They will then cast the moulds or dies in a safe manner, at the correct speed, and in the correct order. On completion of the casting activity, any surplus molten material will be disposed of safely and correctly in accordance with company procedures.

	Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the casting activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the casting activities, materials and equipment, 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 molten material pouring and casting procedures safely. They will understand the casting techniques used, and their application, and will know about the equipment, materials, 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 manual casting activities, especially those for transporting and pouring molten materials. They will be required to demonstrate safe working practices throughout. They will also understand your responsibilities for safety, and the importance of 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 Standard Requirements In order to prove their ability to combine different casting techniques and procedures, at least one of the components produced must be of a significant nature, and must contain two of the features listed in scope 8.

Performance Requirements
The apprentice must be able to:

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

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

P3 **Plan the casting activities before they start them**

P4 **Ensure that the moulds are correctly prepared, sited and positioned ready for the casting process**

P5 **Ensure that the molten material is at the required casting temperature**

P6 **Ensure that the molten metal conforms to the required specification**

P7 **Collect and transport the molten material safely and correctly from the furnace**

P8 **Use the appropriate technique to pour the molten material into the moulds**

P9 **Produce cast components to the required specification**

P10 **Dispose of surplus material safely and correctly**

P11 **Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve**

P12 **Leave the work area in a safe condition on completion of the casting activities**

Skills Requirements
The apprentice must be able to:

S1 **Carry out all of the following during the manual casting 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 the work area is clear of obvious hazards**

1.3 **follow job instructions, casting specifications and procedures**

1.4 **confirm that the required material handling equipment is available, and is in a safe and usable condition**

1.5 **check that any required ancillary equipment is operational (such as fume extraction equipment, inhibitor gas supply and molten material treatment equipment)**

1.6 **return all tools and equipment to the correct location on completion of the casting activities**

S2 **Check that the moulds/dies are complete and ready for casting, to include carrying out all of the following checks:**

2.1 appropriate clamps and/or weights are in position

2.2 downsprues are marked, and pouring bushes/basins are in position and free from obstructions

2.3 any necessary filters are in place

2.4 access to the moulds/dies/shells is clear

2.5 containers for surplus molten material are prepared and positioned conveniently in relation to the mould/dies/shells

S3 **Prepare the molten material ladles/handling equipment, to include carrying out all of the following:**

3.1 checking that the ladle is the correct size for the amount of material to be poured

3.2 checking that the ladle/lining is in a safe condition and is complete and dry

3.3 ensuring that any necessary pre-heating has been carried out

S4 **Collect the molten material and carry out all of the following melt checks/procedures, as appropriate to the melt:**

4.1 making temperature checks

4.2 take samples for chemical composition checks

4.3 applying coagulant material

4.4 skimming of the melt to remove slag and other impurities

4.5 using inhibitor materials or gas

S5 Produce cast components from one of the following:

5.1 ferrous alloys

5.2 non-ferrous alloys

5.3 plastics/polymers

5.4 liquid ceramics

S6 Transfer and pour the molten material into moulds/dies, using one of the following:

6.1 **single operation**

6.2 **double pour**

S7 Cast molten materials into one of the following:

7.1 sand moulds

7.2 metal moulds/dies

7.3 shells (investment process)

S8 Produce cast components which contain two of the following features

8.1 faces that are flat, square or angled to each other

8.2 have round, curved or contoured surfaces

8.3 have slots or holes

S9 Produce cast components which comply with all of the following:

9.1 complete and free from obvious defects (such as blow holes, impurities, cracks, damaged or deformed surfaces)

9.2 meet the required specification (such as shape, dimensional accuracy)

9.3 meet company standards and procedures

Knowledge and understanding
The apprentice must know and understand:

K1 **Describe the specific health and safety precautions with regard to handling and transporting molten materials (such as minimisation of dust and fume, wearing full personal protective clothing and protective equipment, and the elimination of slipping or tripping hazards)**

K2 **Describe the hazards associated with pouring molten materials (such as splashes and spills of molten materials; fumes; handling hot and heavy materials), and how they can be minimised**

K3 **Describe the personal protective equipment (PPE) to be used; how to obtain it and check that it is in a safe and usable condition**

K4 **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**

K5 **Describe the importance of ensuring that fume extraction equipment is operating effectively, and that good housekeeping and fire prevention procedures are observed**

K6 **Describe the importance of following job instructions and defined casting procedures**

K7 **Describe the emergency procedures to be followed in the event of a furnace failure or malfunction in any vessel used to transport and cast molten materials**

K8 **Describe manual lifting techniques and requirements on acceptable weights to be handled by hand**

K9 **Describe the various methods of collecting molten material from the furnace or ladle, and the different types of vessels used to hold ferrous and non-ferrous metal alloys, plastic/polymer or liquid ceramic materials**

K10 **Explain why it is sometimes necessary for the ladles to be preheated, and the effects of using wet or untreated/cold ladles**

K11 **Explain why it is important to keep the ladles and molten material handling equipment clean and free from damage, to practice good housekeeping of tools and equipment, to maintain a clean and unobstructed working area, and to dispose of surplus molten material into prepared containers or areas**

K12 **Describe the causes of surface impurities on molten materials**

K13 **Describe the reasons why some impurities float on some materials and sink in others**

K14 **Describe methods of removing impurities from the surface of the molten materials**

K15 **Describe the effects on the quality of the cast components if impurities are allowed to enter the mould/die cavity**

K16 **Explain why the temperature of the molten material should be taken prior to the transfer from holding ladle to pouring vessel**

K17 **Describe the actions they need to take if the molten material is outside the required temperature range**

K18 **Describe the checks to be carried out on the moulds/dies/shells prior to casting (such as checking that clamps or weights are correctly positioned, downsprues are marked and pouring bushes/basins are in position, necessary filters are in place and access to moulds is clear)**

K19 **Describe the importance of using the correct pouring techniques and of casting at the correct speed**

K20 **Describe methods of pouring molten material for single operations or double pour applications**

K21 **Describe the defects in cast components which can be directly related to using the incorrect pouring technique, incorrect material temperature, or untreated molten material**

K22 **Explain how to dispose of surplus molten material (such as returning material to furnace or receiver; pouring into prepared sand beds or ingot moulds)**

K23 **Explain when to act on their own initiative and when to seek help and advice from others**

K24 **Describe the importance of leaving the work area in a safe and clean condition on completion of the casting activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)**

Unit 079 Producing Cast Components by Manual Means

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	March 2017
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	130 GLH
Review Date	April 2020

Unit 080 Fettling, Finishing and Checking Cast Components

Level:	Level 2
GLH:	110
Relationship to NOS:	EUCL2F-080
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 covers a broad range of basic competences that they need, to fettle and finish cast components produced from sand moulds, metal moulds/dies, ceramic moulds or investment shells using hand and power tools. 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. They will be expected to prepare for the fettling and finishing activities by obtaining all necessary information, documentation, materials, tools and equipment, and to plan how they intend to carry out the required fettling, finishing and checking activities. They will be required to select the appropriate equipment to use, based on the shape and size of the components and the material from which they are cast. They will be expected to carry out checks on the tools and equipment, to ensure that they are in a safe and usable condition and that the abrasive wheels /discs to be used during the fettling operation are suitable for the material and operations to be carried out. The cast components could be circular, square or irregular in shape, and may have projections and internal cavities. They will remove the runners and risers/feeders, using manual or mechanical means. Other surplus material present, on both external and internal surfaces (such as joint line and core print flash) must also be removed. On completion of the fettling activities, they will be expected to check the castings for a range of visual and geometric defects.

	Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the fettling, finishing and checking activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the activities, materials and equipment, 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. fettling, finishing and checking procedures safely to cast components. They will understand the fettling, finishing and checking 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 fettling and finishing activities, and when using the associated tools and equipment. They will be required to demonstrate safe working practices throughout. They will also understand their responsibilities for safety, and the importance of 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 Standard Requirements In order to prove their ability to combine different casting fettling techniques and procedures, at least one of the components fettled must be of a significant nature, and must contain four of the features listed in scope 5.

Performance Requirements
The apprentice must be able to:

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

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

P3 **Plan the fettling, finishing and checking activities before they start them**

P4 **Remove the cast components from the moulds/dies, using appropriate tools and techniques**

P5 **Clean the cast components and, where appropriate, remove any cores**

P6 **Fettle and finish the castings to remove excess material**

P7 **Check the casting for visual defects**

P8 **Dispose of waste material safely and correctly, in line with organisational procedures**

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

P10 **Leave the work area in a safe condition on completion of the fettling and finishing activities**

Skills Requirements
The apprentice must be able to:

S1 **Carry out all of the following, in preparation for the fettling and finishing 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 the work area is clear of obvious hazards**

1.3 **obtain any necessary personal protective equipment, and check that it is in good order**

1.4 **follow job instructions, fettling and finishing specifications and procedures**

1.5 **check that the tools and equipment you need are in a safe, tested and usable condition (such as extension leads, hoses, pneumatic equipment, hand tools)**

1.6 **ensure that dust extraction and air filtering equipment is functioning correctly**

1.7 **ensure that all guards and screens are in place and in good order**

1.8 **return all tools and equipment to the correct location on completion of the fettling and finishing activities**

S2 **Remove cast components from moulds, and carry out all of the following,**

2.1 knocking castings out of the moulds

2.2 de-coring

2.3 removing castings from the moulding material

2.4 removing runner/riser/feeder systems

S3 **Fettle and finish cast components which have been produced from one of the following materials:**

3.1 ferrous alloys

3.2 non-ferrous alloys

3.3 plastics/polymers

3.4 liquid ceramics

S4 **Fettle and finish cast components, to include the use of three of the following:**

4.1 hand tools (such as wire brushes, knives, scrapers, saws, files)

4.2 slitting saw

4.3 disc/angle grinder

4.4 linishers

4.5 pedestal grinders

4.6 pneumatic chipping hammers

4.7 thermal cutters

4.8 band saw

4.9 laser cutters

4.10 other specific methods

S5 **Fettle and finish cast components that have four of the following shapes/profiles:**

5.1 circular

5.2 irregular

5.3 curved or tapered profiles

5.4 square

5.5 projections

5.6 internal cavities

S6 **Visually check cast components, and identify defects including six of the following:**

6.1 **incomplete or deformed castings**

6.2 **blow holes**

6.3 **misplaced cores**

6.4 **variable metal section thickness**

6.5 **impurity inclusions**

6.6 **mis-runs/cold shuts**

6.7 **incorrect profiles**

6.8 **shrinkage**

6.9 **undercuts on runners/risers/feeders**

6.10 **swells**

6.11 **cracks**

6.12 **poor ingate or feeder cut-off**

6.13 **cross joints**

6.14 **surface porosity**

6.15 **excessive flash**

S7 **Complete dimensional checks on cast components, to include checking five of the following features:**

7.1 flatness

7.2 taper

7.3 squareness

7.4 profiles

7.5 concentricity

7.6 angularity

7.7 straightness

7.8 roundness

Knowledge and understanding
The apprentice must know and understand:

K1 **Describe the specific health and safety precautions which must be taken when fettling and finishing cast components (such as wearing full protective clothing and protective equipment, using screens and dust extraction equipment)**

K2 **Describe the hazards associated with fettling and finishing cast components (such as handling hot castings, airborne sparks and metal particles, sharp edges on components, using power tools and abrasive discs, handling heavy materials, breathing in dust and fume, noise and vibration), and how they can be minimised**

K3 **Describe the personal protective equipment (PPE) to be used; how to obtain it and check that it is in a safe and usable condition (such as eye and ear protection, overalls, full face masks, breathing equipment)**

K4 **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**

K5 **Describe the importance of ensuring that fume extraction equipment is operating effectively, and that good housekeeping and fire prevention procedures are observed**

K6 **Describe the importance of following job instructions and defined fettling procedures**

K7 **Describe manual lifting techniques and requirements on acceptable weights to be handled by hand**

K8 **Describe the emergency procedures to be followed in the event of a malfunction of any of the equipment that they use**

K9 **Describe the factors which govern the cooling times of cast components in the moulds, prior to knocking out**

K10 **Describe the different methods that can be used to knock out and de-core moulds and shells, and how to avoid damaging the moulds and cast components**

K11 **Explain how to clean the castings and remove any cores, and the tools and equipment that can be used**

K12 **Describe the casting defects which can be directly related to the use of incorrect methods for the removal of runners/risers/feeders from castings during the knocking out process**

K13 **Explain how to remove runners and associated systems by breaking off or cutting off**

K14 **Explain how to fettle castings to remove joint line flash, runner and feeder stubs, and the amount of material that should be removed**

K15 **Describe the various hand and power tools that are used to carry out the fettling activities (such as hammers and chisels, files, grinding machines/discs, linishing equipment, knives and scrapers, thermal or laser cutters)**

K16 **Describe the checks to be made on the tools and equipment to ensure that they are in a safe and usable condition**

K17 **Describe the various workholding methods and devices used to hold the cast components during the cleaning and fettling activities**

K18 **Describe the effect on casting quality of incorrectly fettling of castings (such as under or over-dressing)**

K19 **Describe the reasons why different types of tools and equipment are used to fettle ferrous, non-ferrous and non-metallic cast components**

K20 **Explain why it is important to keep the equipment clean and free from damage, to practice good housekeeping of tools and equipment, and to maintain a clean working area**

K21 **Describe the different equipment that can be used to assist with the visual inspection of cast components (such as electronic scanning units, shadowgraph units, magnifying glasses or dye-penetrant equipment)**

K22 **Describe the different types of defects which can be detected through visual inspection (such as incomplete or deformed castings, blow holes, impurity inclusions, mis-runs/cold shuts, shrinkage, surface/sub-surface porosity, cracks, undercuts on runners/risers/feeders, poor ingate or feeder cut-off, swells, cross joints, scabs, misplaced cores, variable metal section thickness and excessive flash)**

K23 **Explain when to act on their own initiative and when to seek help and advice from others**

K24 **Describe the importance of leaving the work area in a safe and clean condition on completion of the fettling activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)**

Unit 080 Fettling, Finishing and Checking Cast Components

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	March 2017
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	110 GLH
Review Date	April 2020

Unit 081 Finishing Surfaces by Applying Coatings or Coverings

Level:	Level 2
GGLH:	90
Relationship to NOS:	EUCL2F-081
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 cover a broad range of basic competences that they need, to apply specified surface finishes by the application of coatings or coverings. 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. They will be required to prepare for the finishing activities by obtaining all necessary information, documentation, materials, tools and equipment, and to plan how they intend to carry out the required finishing activities. They will be required to select the appropriate equipment to use, based on the finishing materials to be applied and the surface area to be covered. They will be expected to use the specified or appropriate techniques to prepare the surfaces in readiness for the application of the coatings or coverings. The finishing activities will include the application of sealers and primers, paints, varnish, stain, wax or polish, sheet roll, block or tile materials, using hand tools, brushes, rollers, pads, cloths, or spray equipment, as applicable to the task. Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the preparation and finishing activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the activities, materials and equipment, 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 preparation and hand finishing techniques and procedures safely. They will understand the preparation and finishing 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 finishing operations, and when using the associated 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 Standard Requirements In order to prove their ability to combine different surface preparation and finishing activities, at least one of the finishing activities must be of a significant nature, and must cover five of the activities listed in scope 2.

Performance Requirements
The apprentice must be able to:

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

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

P3 Plan the surface finishing activities before they start them

P4 Prepare the work surfaces in readiness to receive the appropriate coating or covering

P5 Prepare the required coating or covering materials for use

P6 Apply the coatings or coverings to the surfaces, using appropriate techniques and procedures

P7 Check that the finished surface achieves the required characteristics and meets the finishing specification

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

P9 Dispose of waste material safely and correctly, in line with organisational procedures

P10 Leave the work area in a safe condition on completion of the finishing activities

Skills Requirements
The apprentice must be able to:

S1 Carry out **all** of the following during the surface finishing 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 and finishing specifications and procedures

1.3 check that the tools and finishing equipment that you need (such as brushes, rollers spray equipment, hoses, hand tools) are in a safe and usable condition

1.4 where appropriate, ensure that dust extraction and air filtering equipment is functioning correctly

1.5 provide a suitable means for curing the coating (such as heating, or air supply to assist curing)

S2 Prepare the surface to be finished, to include carrying out **six** of the following:

2.1 stripping old finishes
2.2 flattening down
2.3 filling
2.4 pre-surface treatments
2.5 cleaning/degreasing
2.6 masking up
2.7 sealing
2.8 re-activating treatments
2.9 mechanical surface preparation

S3 Prepare the coating or covering materials for application, to include carrying out **all** of the following:

3.1 obtaining the correct types and quantities of materials
3.2 ensuring that the correct mixing ratios are adhered to
3.3 checking that the prepared coating material is of the correct viscosity/consistency
3.4 ensuring that the prepared material has been left for the required induction period (if applicable)
3.5 ensuring that the prepared material is at the temperature recommended for application

Plus **one** of the following:

3.6 mixing base materials (such as primers, sealers)
3.7 preparing adhesives
3.8 mixing finishing materials (such as final colour, stain, polish)
3.9 preparing cleaning materials (such as degreasing)

S4 Apply coatings or coverings to **two** of the following materials:

4.1 wood based
4.2 composite (such as glass fibre, Kevlar)
4.3 ceramic
4.4 ferrous material
4.5 pre-painted surfaces
4.6 plaster/brick/concrete
4.7 non-ferrous material

S5 Apply liquid coatings such as primer/undercoat and finishing coats, using **four** of the following finishing materials:

5.1 sanding sealer
5.2 petroleum based
5.3 French polish
5.4 water based paints
5.5 polyurethane varnish
5.6 temporary protective coatings
5.7 oil/alkyd based paints
5.8 lacquer
5.9 mastics
5.10 synthetic paints
5.11 stain
5.12 bituminous or rubber paints
5.13 two component polyurethane paint
5.14 wax
5.15 other special finishes (specify)

or apply coverings which are decorative, insulative or protective, to include three of the following:

5.16 paper based
5.17 composite
5.18 wood
5.19 polymer based
5.20 metallic
5.21 ceramic

S6 Apply finishes to a range of surfaces, to include **four** of the following:

6.1 flat
6.2 overhead
6.3 horizontal
6.4 curved or cylindrical
6.5 vertical
6.6 corners (such as outside corners, edges, `obscured' corners)

S7 Check that the completed surface finishes or coverings comply with **all** of the following:

7.1 the final finish or covering is in line with the specification or job requirements
7.2 the final finish achieves acceptable colour match and, where applicable, gloss levels
7.3 the finished surface is free from defects (such as runs, drips, bubbles, unevenness)
7.4 the finished surface meets customer/company requirements

S8 Tidy up the work area on completion of the coating or covering activities, to include carrying out **all** of the following:

8.1 disposing of excess or unused materials, in accordance with approved procedures

8.2 cleaning containers to be reused

8.3 disposing of non-reusable containers, in accordance with approved procedures

8.4 cleaning and returning all tools and excess materials to their designated location

8.5 disposing of waste materials and used solvents, in accordance with approved procedures

Knowledge and understanding
The apprentice must know and understand:

K1 Describe the specific health and safety precautions which must be taken when preparing surfaces and applying surface coatings and coverings (such as wearing protective clothing and protective equipment, using fume and dust extraction equipment)

K2 Describe the hazards associated with preparing surfaces and applying surface coatings and coverings (such as using chemicals for cleaning activities, dust and fume inhalation, use of power tools and abrasive discs; including the hazard information to be found in manufacturers' data sheets), and how they can be minimised

K3 Describe the personal protective equipment (PPE) to be used; how to obtain it and check that it is in a safe and usable condition (such as eye protection, overalls, face masks, breathing equipment)

K4 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

K5 Describe the requirements for working in confined spaces, and safe systems of work (including required air quantities (RAQs) and local exhaust ventilation (LEV) to maintain safe conditions; the provision of adequate and safe lighting and avoidance of sources of ignition

K6 Describe the importance of ensuring that fume extraction equipment is operating effectively, and that good housekeeping and fire prevention procedures are observed

K7 Describe the importance of following job instructions and defined surface finishing procedures

K8 the surface preparation methods and techniques to be undertaken, prior to applying the coatings or coverings (such as carrying out repairs to the surface or making good any damaged or defective surfaces; stripping off old materials; using solvents to remove dirt and grease; masking surfaces to prevent overspill/spray)

K9 Describe the specific coatings or coverings to be used, and the types of surfaces for which they are best suited (such as liquid coatings, coverings in sheet, roll or tile form)

K10 Explain how to determine quantities of finishing materials required and, where applicable, mixing materials to achieve the required colour, viscosity or adhesive strength

K11 Describe the preparation methods and techniques for mixing paints, varnishes, lacquers, stains and polishes

K12 Describe the various methods of applying the required finishes (such as using brushes, rollers, paint pads, cloths, adhesive spreaders and spray equipment)

K13 Describe the safe operation of spray equipment, and the effects of air pressure variance on the spray quality

K14 Describe the time intervals that are required between coats, and why these must be adhered to

K15 Describe the use of lamps and heaters to aid the drying of the coatings or coverings

K16 Describe cleaning and maintenance procedures for the tools and equipment that are used (such as brushes, rollers, adhesive spreading tools and spray equipment)

K17 Describe the procedures for dealing with used consumables and surplus coatings or coverings safely and correctly

K18 Explain how to check and assess the finished work (such as for appearance, colour, coating thickness, coverage and adhesion)

K19 Explain how to recognition of defects (such as bubbles, contamination, runs and other surface defects)

K20 Describe the problems that can occur with the finishing operations, and how these can be overcome

K21 Explain when to act on their own initiative and when to seek help and advice from others

K22 Describe the importance of leaving the work area and equipment in a safe and clean condition on completion of the finishing activities (such as returning tools and equipment to the designated location, cleaning the work, area and removing and disposing of waste)

Unit 081 Finishing Surfaces by Applying Coatings or Coverings

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	March 2017
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact Customer.Services@Enginuity.org quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	90 GLH
Review Date	April 2020

Unit 082 Finishing Surfaces by Applying Treatments

Level:	Level 2
GLH:	90
Relationship to NOS:	EUCL2F-082
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 cover a broad range of basic competences that they need, to apply specified surface treatments on components. 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. They will be required to prepare for the finishing activities by obtaining all necessary information, documentation, materials, tools and equipment, and to plan how they intend to carry out the required finishing activities. They will be required to prepare the appropriate equipment to use, based on the surface treatment process and materials to be applied, and the surface area to be covered. They will be expected to use the specified or appropriate techniques to prepare the surfaces in readiness for the application of the treatments. The surface treatment activities will include the application of plating, anodising, powder coating, hot dip treatments and chemical treatments, as applicable to the task. Their responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the preparation and surface treatment activities undertaken. They will need to take account of any potential difficulties or problems that may arise with the surface treatment activities, materials and equipment, 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 preparation and surface treatment techniques and procedures safely. They will understand the preparation and treatment 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 surface treatment operations, and when using the associated 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.

Performance Requirements
The apprentice must be able to:

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

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

P3 Plan the surface treatment activities before they start them

P4 Prepare the work surfaces in readiness to receive the appropriate treatment

P5 Check that the surface treatment equipment and solutions are set up and maintained at satisfactory operating conditions and levels

P6 Carry out the surface treatment process, using appropriate techniques and procedures

P7 Check that the finished surface achieves the required characteristics and meets the surface treatment specification

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

P9 Shut down the surface treatment equipment to a safe condition on completion of the activities

P10 Leave the work area in a safe condition on completion of the surface treatment activities

Skills Requirements
The apprentice must be able to:

S1. Carry out **all** of the following during the surface treatment 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 and surface treatment specifications and procedures

1.3 ensure that the equipment is correctly prepared for the treatment operations being performed

1.4 carry out handling/jigging of the component (where appropriate)

1.5 clean all tools and equipment on completion of the surface treatment activities

1.6 dispose of waste and excess materials, in line with agreed organisational procedures

S2. Apply surface treatments to components by carrying out **one** of the following processes:

2.1 powder coating

2.2 electroplating

2.3 chemical treatments

2.4 hot dip treatments

2.5 anodising

2.6 phosphating

S3. Apply surface treatments to **two** different substrates from the following:

3.1 mild steel
3.2 zinc based diecastings
3.3 plastics/composite material
3.4 stainless steel
3.5 aluminium
3.6 glass
3.7 brass
3.8 previously plated substrates
3.9 copper
3.10 other materials (specify)

S4. Prepare the components for the surface treatment activities, by carrying out **three** of the following:

4.1 degreasing
4.2 rinsing
4.3 pre-heating
4.4 cleaning
4.5 masking
4.6 pickling

S5. Use **one** of the following methods for locating the work during the surface treatment process:

5.1 wiring
5.2 jigging components, which are masked prior to processing
5.3 specialised jigs
5.4 jigs with integral masking

S6. Carry out the surface treatment activities, to include carrying out **all** of the following:

6.1 start up the surface treatment equipment, using approved procedures
6.2 confirm with the authorised person that the plant is ready for carrying out the surface treatment operations
6.3 ensure that the equipment settings and process solutions are set and adjusted to maintain the correct specification (such as time, levels, temperature, current)
6.4 check that the components are correctly prepared for the required treatment activities (such as dry, at the correct temperature, correctly masked)
6.5 load components safely into the treatment plant/solutions
6.6 ensure that components are left for the required induction period (if applicable)
6.7 remove the components from the plant/solution safely and correctly
6.8 apply appropriate post treatment activities (such as curing, cooling, quenching)

S7. Apply surface treatments to **two** different types of component from the following:

7.1 irregular components with multiple surfaces
7.2 hollow/tubular components
7.3 welded/joined components
7.4 flat components

S8. Carry out checks on the treated surfaces, to include four of the following:

8.1 freedom from damage
8.2 adhesion of deposit to substrate
8.3 freedom from contamination
8.4 porosity of coating
8.5 overall coverage/completeness of the coating operations
8.6 deposit hardness
8.7 thickness of deposit/coating
8.8 brittleness of deposit
8.9 appearance of deposits (such as colour, brightness)
8.10 abrasion resistance
8.11 bend test (such as manual or mechanical)
8.12 corrosion testing
8.13 surface roughness checks

S9. Carry out surface treatment processes which comply with **all** of the following:

9.1 the final surface finish is in line with the specification or job requirements
9.2 the finished surface is free from defects
9.3 the finished surface meets customer/company requirements

Knowledge and understanding
The apprentice must know and understand:

K1 Describe the specific health and safety precautions which must be taken when preparing surfaces and applying surface treatment processes (such as wearing protective clothing and protective equipment, using fume extraction equipment)

K2 Describe the hazards associated with preparing surfaces and applying surface treatments (such as using chemicals for cleaning and coating activities, fume inhalation, splashes from hot or corrosive treatment processes), and how they can be minimised

K3 Describe the personal protective equipment (PPE) to be used; how to obtain it and check that it is in a safe and usable condition (such as eye protection, overalls, face masks, breathing equipment)

K4 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

K5 Describe the requirements for working in confined spaces and safe systems of work (including required air quantities (RAQs) and local exhaust ventilation (LEV)) to maintain safe conditions

K6 Describe the importance of ensuring that fume extraction equipment is operating effectively, and that good housekeeping and fire prevention procedures are observed

K7 Describe the importance of following job instructions and defined surface treatment procedures

K8 Describe the surface preparation methods and techniques to be undertaken prior to applying the treatments (such as stripping off old materials; using solvents to remove dirt and grease; masking surfaces to contain the deposits)

K9 Describe the specific surface treatment process to be carried out, and the types of application for which they are best suited (such as powder coating, hot dip treatments, chemical treatments, phosphating, electroplating and anodising

K10 Describe the basic principles of operation of the specific surface treatment process being carried out

K11 Describe the pre-treatments to be carried out on the components prior to the surface treatment activities (such as cleaning/degreasing, pickling, pre-heating)

K12 Describe the visual checks to be made on the components prior to carrying out the surface treatment activities (such as checking they are dry, have been pre-heated or are correctly masked up)

K13 Describe the need to make certain that all substrates and jigs are completely free of water or other solvents prior to immersing in a hot solution, and the potential consequences of failing to check this

K14 Describe the methods used to hold/secure components during the surface treatment process (such as wires, hooks, jigs)

K15 Describe the setting up of the surface treatment plant and equipment, and the operation and locations of emergency shutdown stops

K16 Describe the importance of monitoring the equipment settings and process solutions during the treatment process

K17 Describe the time intervals that the components need to be immersed, or time required between coats, and why these must be adhered to

K18 Explain how to identify surface treatment processing faults (including blistering, missed deposits, dull deposits, contamination and poor adhesion)

K19 Explain how to check and assess the finished work (such as for appearance, colour, coating thickness, coverage and adhesion)

K20 Describe the problems that can occur with the surface treatment operations, and how these can be overcome

K21 Explain when to act on their own initiative and when to seek help and advice from others

K22 Describe the importance of leaving the work area and equipment in a safe and clean condition on completion of the surface treatment activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Unit 082 Finishing Surfaces by Applying Treatments

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	March 2017
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	90 GLH
Review Date	April 2020

Unit 083 Preparing and Manoeuvring Armoured Fighting Vehicles AFVs for Maintenance and Transportation

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-083
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 carry out preparation and manoeuvring activities on military Armoured Fighting Vehicles (AFVs) in accordance with approved procedures including the Army Equipment Support Publications (AESPs). They will be required to select the appropriate tools and equipment to use, based on the activities to be carried out, and to check that they are in a safe and serviceable condition. They will be required to prepare and manoeuvre the AFV to the appropriate location, and to prepare the vehicle for maintenance operations or recovery. The manoeuvring activities will involve assisting in vehicle towing, vehicle marshalling, loading onto transport, parking and securing. Their responsibilities as the Deputy Vehicle Commander will require them to comply with organisational policy and procedures for the activities undertaken, and to report any problems that they cannot personally resolve, or are outside your permitted authority, to the relevant people. They will be expected to work with a minimum of supervision and as part of a team, communicating using hand signals and other communication devices. They must demonstrate a significant personal contribution during the team activities, in order to satisfy the requirements of this standard, and competency in all the areas required by the standard must be demonstrated. They will be expected to take personal 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 an informed approach to applying AFV preparation and manoeuvring techniques and procedures. They will have an understanding of the preparations to be carried out on the AFV, prior to moving and to have an in-depth understanding and knowledge to provide a sound basis for carrying out the activities safely and correctly.

They will understand the safety precautions required when carrying out the preparation and manoeuvring operations. 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 Standard Requirements

- The candidate must hold a full category H Driving Licence.
- The candidate must be a fully qualified AFV crewman.

Performance Requirements
The apprentice must be able to:

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

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

P3 Obtain all the information and documentation you require to start the vehicle manoeuvring activities

P4 Plan the vehicle manoeuvring activities before they start them

P5 Obtain and prepare any support equipment required to move and secure the vehicle and check that it is in a useable condition

P6 Prepare the vehicle for the manoeuvring activities to be undertaken

P7 Start the vehicle following the correct procedures as per vehicle Army Equipment Support Publication (AESPs)

P8 Carry out the manoeuvring activities using the correct procedures and work instructions

P9 Carry out the manoeuvring activities within the limits of their personal authority

P10 Deal promptly and effectively with problems within their control and seek help and guidance from the relevant people if they have problems that they cannot resolve

P11 Deport any instances where the vehicle securing and/or manoeuvring activities cannot be fully met

P12 Leave the work area in a safe and tidy condition on completion of the manoeuvring activities

P13 Dispose of waste materials in line with organisational and environmentally safe procedures

P14 Ensure that the vehicle is left in a safe and secure condition on completion of activities

P15 Complete relevant documentation on completion of the manoeuvring activities

Skills Requirements
The apprentice must be able to:

S1 Carry out **all** of the following prior to commencing the manoeuvring of AFV vehicles:

1.1 ensure the appropriate authorisation to carry out the manoeuvring activities is obtained

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

1.3 check the immediate work area is free from hazards or obstructions

1.4 check the vehicle is free from hazards or obstructions

1.5 provide and maintain safe access and working arrangements for the work to be completed

1.6 position relevant warning signs in a secure and visible location (where applicable)

S2 Prepare the AFV for movement by carrying out **all** of the following:

2.1 visually check the vehicle for signs of leakage, damage, missing parts and wear/deterioration
2.2 remove excessive dirt and grime
2.3 check the fire warning system is operating correctly
2.4 check lighting systems are operational
2.5 check fuel levels
2.6 check fluid levels (such as cooling system, hydraulic fluid reservoirs, oil levels for gearbox, steering unit and final drive)
2.7 check hull drain plugs
2.8 complete operational checks on blackout switches, convoy lights, and infrared lights where fitted
2.9 check gauges and warning lights are operating correctly
2.10 carry out press to test functions to check protected systems are operating correctly
2.11 locate covers/bungs in the appropriate locations to protect components/systems from the ingress of foreign objects or other substances

S3 Prepare the AFV for movement by securing **three** of the following components/systems:

3.1 hatches
3.2 weapon systems
3.3 turret/cupola
3.4 road wheels
3.5 other items relevant to the vehicle (such as external tool bins, engine covers, mirrors, external light guards)

S4 Manoeuvre the AFV in **all** of the following situations:

4.1 by day (using hand & verbal communication)
4.2 by night (using torch signals)
4.3 abnormal weather conditions
4.4 in confined spaces

S5 Manoeuvre, position and secure the AFV onto **one** of the following methods of transportation:

5.1 lorry/low loader
5.2 train
5.3 aircraft
5.4 boat

S6 Carry out AFV Manoeuvring Procedures - to include **all** of the following:

6.1 recovery (un ditching or de bogging)
6.2 prepare for towing cross country
6.3 prepare for tow starting

S7 Use **one** of the following when manoeuvring the AFV:

7.1 “A” Frame

7.2 straight bar

7.3 wire tow rope

7.4 kinetic energy rope

7.5 D shackles

S8 Simulate carrying out **all** of the following emergency procedures:

8.1 fire fighting on an AFV

8.2 evacuating casualties from an AFV

8.3 road traffic accident/incident

8.4 vehicle breakdown procedures

S9 Carry out **two** of the following roles when manoeuvring the AFV:

9.1 driver

9.2 controller

9.3 marshaller

Knowledge and understanding
The apprentice must know and understand:

K1. Describe the specific health and safety requirements, precautions, and safe working practices and procedures to be observed whilst preparing and manoeuvring AFVs for maintenance and transportation

K2. Describe the types of protective equipment (PPE) you need to use for both personnel protection and protection of the AFV

K3. Describe the importance of wearing appropriate protective clothing and equipment

K4. 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

K5. Describe the procedures to be followed to evacuate personnel from AFVs. Including fire evacuation

K6. Describe the hazards associated with driving and manoeuvring AFVs on the public highway

K7. Describe the procedures to be followed if AFV breaks down

K8. Describe the procedures to be followed in the event of an accident/incident

K9. Describe the authorisation process and documentation required to prepare and manoeuvre the AFV

K10. Describe the AFV system isolation procedures to be followed to secure the vehicle weapons systems and adherence to Army Equipment Support Publication (AESPs)

K11. Describe the methods used to secure components such as hatches, turret and other unsecured items

K12. Describe the checks to be carried out on the AFV before it is stated and manoeuvred including leaks, damage, wear and deterioration or missing parts

K13. Describe the AFV system “start up” and “run down” procedures to be followed before and after use

K14. Explain how to obtain and interpret manuals and other documents needed in the manoeuvring operation for AFVs

K15. Describe the principles of how the AFV functions, its operating sequence, controls, the working purpose of individual units/components and how they interact

K16. Explain how to operate and secure the vehicles communication system on AFVs

K17. Describe the hazards associated with driving, marshalling, parking AFVs especially in confined area/spaces, and how these hazards can be minimised

K18. Describe the hazards associated with towing AFVs and how these hazards can be minimised

K19. Describe the hazards associated with tow starting AFVs and how these hazards can be minimised

K20. the hazards associated with AFVs recovery and how these hazards can be minimised

K21. Describe the importance of checking that the recovery equipment used to assist in the manoeuvring of AFVs is in a usable and safe condition and the specific checks that need to be made

K22. Describe the range and types of equipment to be used when towing or recovering AFVs to include “A” frames, Straight Bar, Wire Tow Rope, Kinetic energy Rope and “D” Shackles

K23. Describe the factors to take into account when deciding which of the following should be used and why, A frame, straight bar, wire tow rope, kinetic energy rope and D shackles

K24. Describe the importance of ensuring that the AFV is secured correctly when being prepared for onward transportation and the implications if this is not carried out correctly

K25. Describe the methods used to position and secure the AFV to transport the vehicle by rails, road, air and sea

K26. Describe the problems that can occur with the AFV preparation and manoeuvring activities and how these can be overcome

K27. Describe the duties and responsibilities of the personnel used in the preparation and manoeuvring activities including the driver, controller and marshaller

K28. Describe the AFV driving and control procedures to be used when manoeuvring across country

K29. Describe the AFV driving and control procedures to be used when manoeuvring over obstacles

K30. Describe the procedures to be followed to identify and log faults found on the AFV

K31. Describe the different methods of communication used when manoeuvring and obstacle crossing for AFVs to include hand signals, torch signals and verbal orders

K32. Describe the procedure to be used to dispose of any waste materials safely and in an environmentally friendly manner

K33. Describe the importance of leaving AFVs in a safe condition on completion of the manoeuvring activities, and the correct after use procedures

K34. Describe the extent of their own responsibility and whom they should report to if they have problems that they cannot resolve

Unit 083 Preparing and Manoeuvring Armoured Fighting Vehicles AFVs for Maintenance and Transportationand

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	March 2017
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact Customer.Services@Enginuity.org quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Recommended Training and Assessment Time	140 GLH
Review Date	April 2020

Unit 084 Handing Over and Confirming Completion of Maintenance or Installation Activities

Level:	Level 2
GLH:	180
Relationship to NOS:	EUCL2F-084
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 hand over maintained and/or installed equipment, and to confirm that the equipment is now ready to run. Following the maintenance and/or installation activity, they will be required to ensure that the equipment is in a safe and operable condition. This will involve checking that all guards/covers and safety devices have been fitted, and that the equipment functions to the required specification. On handing over the equipment, they will be expected to highlight any new, current or changed operating features of the equipment, and to inform the appropriate person of any future maintenance requirements. They must also ensure that you receive confirmation that everyone involved in the handover accepts that the maintained and/or installed equipment functions to the agreed specification. Their responsibilities will require them to comply with organisational policy and procedures for the handover activities undertaken, and to report any problems with the handing over procedure that they cannot personally resolve, or are outside their permitted authority, to the relevant people. They will be expected to work to instructions, alone or in conjunction with others, taking full responsibility for their own actions, and for the quality and accuracy of the work that they carry out. Their underpinning knowledge will be sufficient to provide a sound understanding of their work, and will provide an informed approach to applying maintenance and/or installation handover procedures. They will understand the equipment being handed over, and its application, and will know about the operating procedures and potential problems, in adequate depth to provide a sound basis for carrying out the activities safely and correctly.

	They will understand the safety precautions to be observed when handing over the maintained and/or installed 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/area. 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.

Performance Requirements
The apprentice must be able to:

P1 Work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines
P2 Demonstrate the required behaviours in line with the job role and company objectives
P3 Confirm that everyone involved accepts the product or asset is in a satisfactory condition for handover to take place
P4 Clearly identify any unusual features of the condition of the product or asset
P5 Make the handover and obtain agreement between everyone involved on the precise moment of transfer of responsibility
P6 Deal promptly and effectively with problems within their control and report those that they cannot solve
P7 Make sure that clear, accurate and complete records of the handover are made

Skills Requirements

S1. Confirm that the equipment is ready to operate, by carrying out **all** of the following checks:

1.1. the maintenance and/or installation activity has been completed, and the equipment functions correctly
1.2. all safety systems or features are functioning correctly
1.3. any waste materials, safety barriers and warning signs have been removed (where appropriate)
1.4. any auxiliary systems or equipment involved are connected and operable
1.5. any environmental controls are operable (where appropriate)
1.6. others involved in using the equipment are aware that the equipment is about to be operated/used

S2. Carry out correct handover procedures for **one** type of equipment/service from the following:

2.1. mechanical equipment
2.2. electrical equipment
2.3. electronic equipment
2.4. fluid power equipment
2.5. process control/instrumentation and control equipment
2.6. engineering services
2.7. industrial refrigeration equipment
2.8. lift equipment
2.9. medical equipment
2.10. other specific equipment

S3. Carry out **all** of the following during the handover procedures:

3.1. operate/use the maintained and/or installed equipment in the presence of the appropriate person(s)
3.2. confirm that the other person/party accepts that the equipment functions satisfactorily
3.3. highlight to the appropriate person any changes in the operating procedure (where appropriate)
3.4. inform the appropriate person of any future maintenance activities that may be required
3.5. obtain agreement from the other person(s) that they now accept responsibility for the equipment to be returned to service
3.6. complete any necessary handover documentation

S4. Carry out handover procedures to **one** of the following:

4.1. production/process operator
4.2. supervisor of production/process
4.3. maintenance supervisor
4.4. customer
4.5. other specific person

S5. Carry out the handover, **either** following **two** of the following maintenance activities:

5.1. breakdown
5.2. preventative maintenance activity
5.3. scheduled servicing
5.4. modification to equipment

or

5.5. on completion of the installation activities

S6. Complete the relevant paperwork, to include **one** of the following, and pass it to the appropriate people:

6.1. job card
6.2. maintenance log and action report
6.3. company reporting procedures
6.4. other handover paperwork

Knowledge and understanding
The apprentice must know and understand:

K1 Describe the health and safety requirements of the area in which the handover is to take place, and the responsibility they place on them

K2 Describe the specific health and safety precautions to be applied during the handover procedure, and their effects on others

K3 Describe the importance of wearing protective clothing and other appropriate safety equipment (PPE) whilst operating/using the equipment during the handover operations

K4 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

K5 Describe the checking process to be followed before handing over the equipment (such as all guards/covers have been fitted on moving or rotating parts, the equipment functions correctly)

K6 Describe the correct procedure to be followed when handing over maintained and/or installed equipment

K7 Describe the procedure for involving the appropriate people when operating/using the equipment

K8 Describe the need to highlight, where appropriate, any new, current or changed operating features of the maintained or installed equipment

K9 Describe the importance of informing the appropriate person of any future maintenance requirements

K10 Describe the need to confirm that the other person understands how to use/operate the equipment before handing the equipment over to them

K11 Describe the need to ensure that the person you are handing over the equipment to accepts that it is in a satisfactory condition

K12 Describe the organisational documentation procedures to be used with regard to the handover

K13 Explain how to create and maintain effective working relationships with appropriate people (such as encouraging, helping, politeness, open discussions both ways)

K14 Describe the problems that can occur during handover, and how they can be overcome

K15 Describe the extent of their own authority and to whom they should report if they have a problem that they cannot resolve

Unit 084 Handing Over and Confirming Completion of Maintenance or Installation Activities

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	February 2015
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact Customer.Services@Enginuity.org quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard**.**
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems. This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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.
Grading System	Pass/Fail
Review Date	March 2018

Unit 085 Carrying Out Fault Location on Mechanical Equipment

Level:	Level 2
GLH:	260
Relationship to NOS:	EUCL2F-085
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 locate faults on mechanical equipment, in accordance with approved procedures. They will be required to locate faults on equipment such as machine tools, gearboxes, portable tools, engines, pumps, process control valves, compressors, process plant, conveyers and elevators, lifting and handling devices, transfer equipment, mechanical structures, workholding devices and other company-specific equipment. They will be expected to use a variety of fault location methods and procedures, such as gathering information from the person who reported the fault, using recognised fault finding techniques and diagnostic aids, measuring, inspecting and operating the equipment. Their responsibilities will require them to comply with organisational policy and procedures for the fault location activities undertaken, and to report any problems with these activities, or with the tools and equipment used, that they cannot personally resolve or are outside their permitted authority, to the relevant people. They will be expected to work to instructions, alone or in conjunction with others, taking full responsibility for their own actions, and for the quality and accuracy of the work that they carry out. Their underpinning knowledge will be sufficient to provide a sound basis for their work, and will provide an informed approach to applying fault location procedures on mechanical equipment. They will have an understanding of the basic fault location methods and techniques used, and their application. They will also know how to interpret information obtained from fault finding aids and equipment, in adequate depth to provide a sound basis for carrying out the activities.

	They will understand the safety precautions required when carrying out the fault location activities, especially those for isolating the equipment. They will also understand their responsibilities for safety, and the importance of 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.

Performance Requirements
The apprentice must be able to:

P1 Work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines
P2 Demonstrate the required behaviours in line with the job role and company objectives
P3 Review and use all relevant information on the symptoms and problems associated with the products or assets
P4 Investigate and establish the most likely causes of the faults
P5 Select, use and apply diagnostic techniques, tools and aids to locate faults
P6 Complete the fault diagnosis within the agreed time and inform the appropriate people when this cannot be achieved
P7 Determine the implications of the fault for other work and for safety considerations
P8 Use the evidence gained to draw valid conclusions about the nature and probable cause of the fault
P9 Record details on the extent and location of the faults in an appropriate format

Skills Requirements
The apprentice must be able to:

S1. Carry out **all** of the following during the fault locating activity:

1.1. plan the fault location methods and procedures in conjunction with others
1.2. obtain and use the correct issue of maintenance documentation (such as drawings, manuals, maintenance records)
1.3. adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment and other relevant safety regulations
1.4. ensure the safe isolation of equipment (such as mechanical, electricity, gas, air or fluids)
1.5. ensure that safe access and working arrangements have been provided for in the fault finding area
1.6. carry out the fault location activities, using approved procedures
1.7. identify the fault, and consider appropriate corrective action
1.8. in conjunction with others, take actions to resolve the problem
1.9. dispose of waste items in a safe and environmentally acceptable manner
1.10. leave the work area in a safe and tidy condition

S2. Carry out fault location on **two** of the following types of mechanical equipment:

2.1. gearboxes
2.2. machine tools
2.3. lifting and handling devices
2.4. transfer equipment
2.5. portable power tools
2.6. engines
2.7. pumps
2.8. process control valves
2.9. compressors

2.10. process plant
2.11. workholding devices
2.12. conveyers and elevators
2.13. mechanical structures
2.14. company-specific equipment

S3. Use **four** of the following diagnostic techniques, tools and aids to assist in locating the fault:
3.1. information gathered from the person that reported the fault
3.2. fault finding techniques (such as six point, half-split, input/output, unit substitution, emergent sequence)
3.3. diagnostic aids (such as manuals, flow charts, troubleshooting guides, maintenance records)
3.4. inspecting (such as checking for breakages, wear/deterioration, overheating, missing parts, loose fittings)
3.5. operating (such as manual switching off and on, running equipment, condition of end product)

S4. Use **two** of the following types of instruments to assist in locating faults:
4.1. measuring instruments/devices
4.2. dial test indicators
4.3. torque measuring devices
4.4. flow meters
4.5. alignment devices
4.6. self-diagnostic equipment
4.7. pressure/force indicators
4.8. other specific test/measurement instruments

S5. Locate faults that have resulted in **two** of the following breakdown categories:
5.1. intermittent problem
5.2. partial failure/out-of-specification output
5.3. complete breakdowns

S6. Complete **one** of the following maintenance records, and pass it to the appropriate person:
6.1. scheduled maintenance report
6.2. corrective maintenance report
6.3. company-specific report

Knowledge and understanding
The apprentice must know and understand:

K1 Describe the health and safety requirements of the area in which the fault location is to take place, and the responsibility these requirements place on them

K2 Describe the isolation and lock-off procedure or permit-to-work procedure that applies in the work area

K3 Describe the importance of wearing protective clothing and other appropriate safety equipment (PPE) during fault location activities

K4 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

K5 Describe hazards associated with carrying out fault location on mechanical equipment (such as moving machinery, handling oils and greases, stored pressure/force, misuse of tools), and how they can be minimised

K6 Describe the procedure to be adopted to establish the background of the fault

K7 Explain how to use the various diagnostic aids to help identify the location of the fault

K8 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)

K9 Explain how to evaluate sensory information (such as sight, sound, smell, touch)

K10 Explain how to assess evidence and evaluate the possible causes of faults/problems

K11 Explain how to use a range of fault diagnostic equipment to investigate the problem

K12 Describe the care, handling and application of mechanical measuring/test equipment (such as measuring instruments, dial test indicators, flow meters, torque measuring devices, pressure/force detectors)

K13 Explain how to check that mechanical measuring/test equipment is within calibration, and that it is free from damage and defects

K14 Explain how to obtain and interpret information from job instructions and other documents needed in the fault location process (such as drawings, charts, specifications, manufacturers' manuals, history/maintenance reports, graphical symbols)

K15 Describe the basic principles of how the mechanical equipment functions, its operating sequence, the purpose of individual units/components and how they interact

K16 Describe the problems that can occur during the fault location activity, and how they can be minimised

K17 Explain how to evaluate the likely risk to yourself and others, and the effects the fault could have on the overall process or system

K18 Describe the importance of completing the correct documentation following the fault locating activity

K19 Describe the extent of their own authority and to whom they should report if they have a problem that they cannot resolve

Unit 085 Carrying Out Fault Location on Mechanical Equipment

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	February 2015
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact Customer.Services@Enginuity.org quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	March 2018

Unit 086 Carrying Out Maintenance Activities on Mechanical Equipment

Level:	Level 2
GLH:	350
Relationship to NOS:	EUCL2F-086
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 carry out corrective maintenance activities on mechanical equipment, in accordance with approved procedures. This will involve dismantling, removing and replacing or repairing faulty components, in line with company procedures, on a variety of different types of mechanical equipment such as machine tools, gearboxes, portable tools, engines, pumps, process control valves, compressors, process plant, conveyers and elevators, lifting and handling devices, transfer equipment, mechanical structures, workholding devices and other company-specific equipment. They will be expected to cover a range of maintenance activities, such as labelling/proof marking to aid reassembly, dismantling components to the required level, setting, aligning and adjusting components, replacing `lifed' items, replenishing oils, greases or other fluids, torque loading components and making `off-load' checks before testing and starting up the maintained equipment, using appropriate techniques and procedures. Their responsibilities will require them to comply with organisational policy and procedures for the maintenance activities undertaken, and to report any problems with these activities, or with the tools and equipment used, that they cannot personally resolve or are outside their permitted authority, to the relevant people. They must ensure that all tools, equipment and materials used in the maintenance activities are removed from the work area on completion of the activities, and that all necessary job/task documentation is completed accurately and legibly. They will be expected to work to instructions, alone or in conjunction with others, taking

	personal responsibility for their own actions, and for the quality and accuracy of the work that they carry out. Their underpinning knowledge will be sufficient to provide a sound basis for their work, and will enable you to adopt an informed approach to applying mechanical maintenance procedures. They will have an understanding of dismantling and reassembly methods and procedures, and their application. They will know how the equipment functions and the purpose of individual components, in adequate depth to provide a sound basis for carrying out any maintenance, repair or adjustment. In addition, they will have sufficient knowledge of these components to ensure that they are fit for purpose and meet the specifications, thus providing a sound basis for carrying out reassembly. They will understand the safety precautions required when carrying out the maintenance activities, especially those for isolating the equipment. They will also understand their responsibilities for safety, and the importance of 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.

Performance Requirements
The apprentice must be able to:

P1 Work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines
P2 Demonstrate the required behaviours in line with the job role and company objectives
P3 Follow the relevant maintenance schedules to carry out the required work
P4 Carry out the maintenance activities within the limits of their personal authority
P5 Carry out the maintenance activities in the specified sequence and in an agreed time scale
P6 Report any instances where the maintenance activities cannot be fully met or where there are identified defects outside the planned schedule
P7 Complete relevant maintenance records accurately and pass them on to the appropriate person
P8 Dispose of waste materials in accordance with safe working practices and approved procedures

Skills Requirements
The apprentice must be able to:

S1. Carry out **all** of the following during the maintenance activity:

1.1. undertake the maintenance activities to cause minimal disruption to normal working
1.2. use the correct issue of maintenance documentation (such as drawings, manuals, maintenance records)
1.3. adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment and other relevant safety regulations
1.4. ensure the safe isolation of equipment (such as mechanical, electricity, gas, air or fluids)
1.5. ensure that safe access and working arrangements have been provided for the maintenance area
1.6. report or take action with regard to any defects that require immediate attention (such as replacing non-'lifed' components)re-connect and return the equipment to service on completion of the maintenance activities)
1.7. dispose of waste items in a safe and environmentally acceptable manner
1.8. leave the work area in a safe and tidy condition

S2. Carry out maintenance activities on **two** of the following types of equipment:

2.1. gearboxes
2.2. machine tools
2.3. lifting and handling devices
2.4. process plant
2.5. portable power tools
2.6. engines
2.7. pumps
2.8. transfer equipment
2.9. process control valves
2.10. compressors

2.11. conveyers and elevators
2.12. mechanical structures
2.13. workholding devices
2.14. company-specific equipment

S3. Maintain and/or replace **six** of the following types of components:
3.1. hoses and connectors
3.2. pulleys and belts/wires
3.3. chains and sprockets
3.4. levers and links
3.5. springs
3.6. sub-assemblies/replacement units
3.7. structural components (such as guards, fences, supports, housings)
3.8. locking and retaining devices (such as keys, pins, screw fasteners)

S4. Carry out **all** of the following maintenance activities:
4.1. dismantling equipment to the required level
4.2. labelling/proof marking of components
4.3. checking components for serviceability
4.4. replacing all 'lifed' items (such as seals, gaskets)
4.5. replacing or repairing damaged/defective components
4.6. setting, aligning and adjusting components
4.7. tightening fastenings to the required torque
4.8. making 'off-load' checks before starting up
4.9. replenishing oils, greases or other fluids
4.10. functionally testing the maintained equipment

S5. Maintain mechanical equipment, in accordance with **one** of the following:
5.1. organisational guidelines and codes of practice
5.2. equipment manufacturer's operation range
5.3. BS, ISO and/or BSEN standards

S6. Complete **one** of the following maintenance records, and pass it to the appropriate person:
6.1. job cards
6.2. permit to work/formal risk assessment
6.3. maintenance log and action report
6.4. company-specific documentation

Knowledge and understanding
The apprentice must know and understand:

K1 Describe the health and safety requirements of the area in which the maintenance activity is to take place, and the responsibility these requirements place on them

K2 Describe the isolation and lock-off procedure or permit-to-work procedure that applies

K3 Describe the specific health and safety precautions to be applied during the maintenance procedure, and their effects on others

K4 Describe the hazards associated with carrying out mechanical maintenance activities (handling oils, greases, stored pressure/force, misuse of tools, using damaged or badly maintained tools and equipment, not following laid-down maintenance procedures), and how to minimise them

K5 Describe the importance of wearing protective clothing and other appropriate safety equipment (PPE) during maintenance process

K6 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

K7 Explain how to obtain and interpret information from job instructions and other documentation used in the maintenance activities (such as drawings, specifications, manufacturers' manuals, symbols and terminology)

K8 Describe the methods and techniques used to dismantle/assemble mechanical equipment (such as release of pressures/force, proof marking, extraction, pressing, alignment)

K9 Describe methods of checking that components are fit for purpose, how to identify defects and wear characteristics, and the need to replace `lifed' items (such as seals and gaskets)

K10 Describe the basic principles of how the equipment functions, its operating sequence, the working purpose of individual units/components and how they interact

K11 Describe the uses of measuring equipment (such as micrometers, verniers, run-out devices and other measuring devices)

K12 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)

K13 Describe the importance of making `off-load' checks before running the equipment under power

K14 Explain how to check that tools and equipment are free from damage or defects, are in a safe and usable condition, and are configured correctly for the intended purpose

K15 Describe the importance of maintenance documentation and/or reports following the maintenance activity, and how to generate them

K16 Describe the equipment operating and control procedures to be applied during the maintenance activity

K17 Explain how to use lifting and handling equipment in the maintenance activity

K18 Describe the activities that can go wrong when carrying out routine maintenance, and what to do if they occur

K19 Describe the organisational procedure(s) to be adopted for the safe disposal of waste of all types of materials

K20 Describe the extent of their own authority and to whom they should report if they have a problem that they cannot resolve

Unit 086 Carrying Out Maintenance Activities on Mechanical Equipment

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	February 2015
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact Customer.Services@Enginuity.org quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review Date	March 2018

Unit 087 Carrying Out Scheduled Maintenance Activities on Mechanical Equipment

Level:	Level 2
GLH:	190
Relationship to NOS:	EUCL2F-087
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 carry out scheduled maintenance activities on mechanical equipment, in accordance with approved procedures. They will be required to carry out scheduled maintenance on a range of mechanical equipment such as machine tools, gearboxes, portable tools, engines, pumps, process control valves, compressors, process plant, conveyers and elevators, lifting and handling devices, transfer equipment, mechanical structures, workholding devices and other company-specific equipment, in order to minimise downtime and ensure that equipment performs at the optimal level and functions to specification. Their responsibilities will require them to comply with organisational policy and procedures for the maintenance tasks undertaken, and to report any problems with the maintenance process, tools or equipment used that they cannot personally resolve, or are outside their permitted authority, to the relevant people. They must ensure that all tools, equipment and materials used in the maintenance activities are removed from the work area on completion of the activities, and that all necessary job/task documentation is completed accurately and legibly. They will be expected to work to instructions, alone or in conjunction with others, taking personal responsibility for their own actions, and for the quality and accuracy of the work that they carry out. Their underpinning knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying scheduled maintenance procedures to mechanical equipment. They will have an understanding of the process of implementing scheduled maintenance tasks, the importance of carrying them out at specific times, and of recording the outcomes and actions

	taken. In addition, they will be expected to report where the outcomes identify the need for further investigation or maintenance work. They will understand the safety precautions required when carrying out the maintenance tasks, especially those for isolating the equipment. They will also understand their responsibilities for safety, and the importance of 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.

Performance Requirements
The apprentice must be able to:

P1 Work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines
P2 Demonstrate the required behaviours in line with the job role and company objectives
P3 Follow the relevant maintenance schedules to carry out the required work
P4 Carry out the maintenance activities within the limits of their personal authority
P5 Carry out the maintenance activities in the specified sequence and in an agreed time scale
P6 Report any instances where the maintenance activities cannot be fully met or where there are identified defects outside the planned schedule
P7 Complete relevant maintenance records accurately and pass them on to the appropriate person
P8 Dispose of waste materials in accordance with safe working practices and approved procedures

Skills Requirements
The apprentice must be able to:

S1. Carry out **all** of the following during the scheduled maintenance activities:

1.1. undertake the maintenance activities to cause minimal disruption to normal working
1.2. use the correct issue of drawings and maintenance documentation
1.3. adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment and other relevant safety regulations
1.4. confirm with the authorised person that the equipment is ready for carrying out the scheduled maintenance
1.5. ensure the safe isolation of equipment (such as mechanical, electricity, gas, air or fluids)
1.6. ensure that safe access and working arrangements have been provided for the maintenance area
1.7. carry out the scheduled maintenance tasks, using appropriate techniques and procedures
1.8. dispose of waste items in a safe and environmentally acceptable manner,
1.9. leave the work area in a safe and tidy condition

S2. Carry out scheduled maintenance activities on **two** of the following:

2.1. gearboxes
2.2. machine tools
2.3. lifting and handling devices
2.4. process plant
2.5. portable tools
2.6. engines
2.7. pumps
2.8. transfer equipment
2.9. process control valves
2.10. compressors

2.11. workholding devices
2.12. conveyers and elevators
2.13. mechanical structures
2.14. company-specific equipment

S3. Carry out **ten** of the following scheduled maintenance activities:
3.1. removing excessive dirt and grime
3.2. making sensory checks (such as sight, sound, smell, touch)
3.3. checking equipment for leaks
3.4. replacing 'lifed' consumables (such as fluids, gaskets and seals, hoses)
3.5. monitoring the condition/deterioration of components (such as bearings, chains, belts, gears, cams, couplings)
3.6. checking that any safety equipment or controls are operating correctly
3.7. checking the operation of instrumentation (such as gauges, sensors and indicators)
3.8. carrying out and/or checking equipment self-analysis data
3.9. making adjustments to components and connections
3.10. checking/tightening fastenings to the required torque
3.11. replenishing oils, greases or other fluids
3.12. reviewing and checking equipment operation and performance
3.13. recording the results of the scheduled maintenance activity
3.14. reporting or taking action with regard to any defects that require immediate attention (such as replacing non-'lifed' components)

S4. Maintain mechanical equipment in accordance with **one** of the following:
4.1. organisational guidelines and codes of practice
4.2. equipment manufacturer's operation range
4.3. BS, ISO and/or BSEN standards

S5. Complete **one** of the following maintenance records, and pass it to the appropriate person:
5.1. job cards
5.2. specific company documentation
5.3. permit to work/formal risk assessment

Knowledge and understanding
The apprentice must know and understand:

K1 Describe the health and safety requirements of the area in which the scheduled maintenance activities are to take place, and the responsibility these requirements place on them

K2 Describe the isolation procedure or permit-to-work procedure that applies to the equipment being maintained

K3 Describe the specific health and safety precautions to be applied during the scheduled maintenance activities, and their effects on others

K4 Describe the importance of wearing protective clothing and other appropriate safety equipment (PPE) during the maintenance activities

K5 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

K6 Describe the hazards associated with carrying out scheduled maintenance activities on mechanical equipment (such as handling oils/greases, stored pressure/force, misuse of tools), and how they can be minimised

K7 Explain how to obtain and interpret information from job instructions and other documentation used in the maintenance activities (such as drawings, specifications, manufacturers' manuals, servicing schedules, symbols and terminology)

K8 Describe the various checks to be carried out during the scheduled maintenance procedure

K9 Describe the procedure for obtaining the consumables to be used during the scheduled maintenance activity

K10 Describe the methods of checking that components are fit for purpose, and the need to replace `lifed' items

K11 Explain how to check that any replacement components meet the required specification/operating conditions

K12 Explain how to make appropriate sensory checks (such as sight, sound, smell and touch)

K13 Describe the appropriate testing instructions to be adopted during the maintenance activity

K14 Explain how to make adjustments to components/assemblies to ensure they function to specification

K15 Describe the basic principles of how the equipment functions, its operating sequence, the working purpose of individual units/components and how they interact

K16 Explain how to complete scheduled maintenance records/logs/reports, in accordance with company policy and procedures

K17 Describe the equipment operating and control procedures, and how to apply them in order to carry out scheduled maintenance

K18 Describe the problems that can occur whilst carrying out the scheduled maintenance tasks, and how they can be avoided

K19 Describe the organisational procedure(s) to be adopted for the safe disposal of waste of all types of materials

K20 Describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve

Unit 087 Carrying Out Scheduled Maintenance Activities on Mechanical Equipment

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	February 2016
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact Customer.Services@Enginuity.org quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail
Review date	March 2018

Unit 089 Stripping and Rebuilding Motorsport Vehicles Pre- Competition

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-089
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 skills and knowledge needed to prove the competences required to prepare a motorsport vehicle, in a recognised sequence and to a high standard, prior to a competition. It will prepare them for entry into the motorsport sector, creating a progression between education and employment, or it will provide a basis for the development of additional skills and occupational competencies in the working environment. The activities will involve the dismantling and removal of components, inspection and checking for faults and excessive wear and potential problems, replacement of components, and rebuilding the vehicles using hand tools, specialist tools and test equipment, in accordance with approved procedures. It covers motorsport vehicles such as single seat, rally cars, sports cars, karts, historic vehicles, motor cycles and other specific approved competition vehicles, and covers a range of equipment such as chassis and suspension, engine and transmission, steering and wheel braking systems, fuel and lubrication, electrical and other specific equipment. The preparation activities will include carrying out all necessary safety activities to lift and support the vehicle and its components, lifting and removing engine and transmission systems, breaking into hydraulic and fuel system circuits, removing springs under compression, removing and replacing faulty equipment at component or unit level, replenishing fluids, and setting and adjusting the completed system in readiness for testing. They will also be expected to use recognised methods for crack testing ferrous and non-ferrous materials/components, and to be able to inspect a motorsport vehicle within the team's guidelines. Their responsibilities will require them to comply with recognised procedures for the stripping and rebuilding activities

	undertaken, to take account of any potential difficulties or problems that may arise, and to seek appropriate help and advice in determining and implementing a suitable solution. They will be expected to work with either a high level of supervision or as a member of a team. Where team working is involved, they must demonstrate a significant personal contribution during the team activities in order to satisfy the requirements of the standard, and competence in all the areas required by the standard must be demonstrated. On completion of the activities, they must show that they can competently clean the work area that they are responsible for, including tidying up bays or garages to a standard that will reflect the professional image of the team. They must show that they can use and maintain the tools and equipment needed for the dismantling and inspection activities, and return them to their recognised storage area ready for further use. Their knowledge will provide an understanding of their work, and will enable them to apply the appropriate dismantling, inspection and rebuilding procedures safely. They will know how the equipment functions, the common faults that can occur, the purpose of the individual components and associated defects, in adequate depth to carry out the removal and replacement activities, correct faults and ensure that the equipment is replaced to the required standard. They will also have sufficient knowledge of these components to ensure that they are fit for purpose and meet the specifications. They will understand the safety precautions required when carrying out the stripping and rebuilding activities, especially those for lifting and supporting the 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

Performance Requirements – The apprentice must be able to:

P1 Work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines
P2 Demonstrate the required occupational behaviours in line with the job role and company objectives
P3 Obtain all the information they need for the motorsport vehicle preparation activities to be carried out
P4 Establish and, where appropriate, mark component orientation for re-assembly
P5 Ensure that any stored energy or substances are released safely and correctly
P6 Remove and replace the required components, using approved tools and techniques
P7 Take suitable precautions to prevent damage to components and the surrounding structure
P8 Report any instances where the removal and replacement activities cannot be fully met, or where there are identified defects outside the planned activities
P9 Complete the relevant documentation, in accordance with organisational requirements
P10 Label and store, in an appropriate location, components that require repair or overhaul

P11 Dispose of waste materials and scrap components, in accordance with safe working practices and approved procedures

Skills Requirements The apprentice must be able to:

S1. Carry out **all** of the following activities prior to stripping and rebuilding of the motorsport vehicle:

1.1. positioning and securing the vehicle, using the correct equipment
1.2. carrying out all preparatory work (such as removal of wheels, bodywork or fairings, removing dirt, oil and track debris)
1.3. checking for leaks in the braking system, clutch, cooling, steering, lubrication and fuel systems
1.4. checking for play in spherical bearings, bushes, couplings and joints
1.5. checking for excessive wear to bodywork fasteners, brake linings, clutch linings, skid plates, dog rings and gear ratios
1.6. making initial judgements as to the cause of damage and/or wear

S2. Use **three** of the following to aid the vehicle preparation:

2.1. system diagrams
2.2. equipment manuals
2.3. vehicle telemetry data
2.4. engineer's records
2.5. set-up sheets
2.6. inspection check sheets

S3. Carry out the removal and replacement activities, within the limits of their personal

authority to include **all** of the following:

3.1. disconnecting electrical connections
3.2. disconnecting and removing hoses and pipes
3.3. draining and removing fluids
3.4. proof marking/labelling of components to aid reassembly
3.5. separation of components by means of removing mechanical fasteners (such as nuts, bolts, circlips, quick-release fasteners, rivets)
3.6. inspecting components for damage and wear, and identifying all components and fasteners that require replacement
3.7. arranging and storing components in a manner that makes re-assembly as straightforward as possible
3.8. labelling (and storing in the correct location) components that require repair or overhaul
3.9. reassembly of components using mechanical fastening devices (such as nuts, bolts, quick-release fasteners, circlips, rivets)
3.10. replacement of sealing devices (such as 'O' rings, seals, gaskets, sealing compounds)
3.11. positioning, aligning, setting and adjusting replaced components (such as travel, working clearance)
3.12. tightening fastenings to the required torque, and applying bolt locking methods (such as split pins, wire locking, lock nuts)
3.13. making electrical connections and earth bonding
3.14. replacing fluids and bleeding the system

S4. Remove and replace components on **one** of the following types of motorsport vehicle:

4.1. single seater
4.2. rallying
4.3. sports cars
4.4. karts
4.5. historic
4.6. motorcycles (such as circuit and off-road)
4.7. other specific approved competition vehicle

S5. Remove and replace motorsport vehicle components from **all** of the following categories:

5.1. 'lifed' components (such as filters, gaskets, seals, bearings, securing devices, fuel cells)
5.2. pipes and pipe connecting devices (such as rigid pipe, hoses, unions/couplings,)
5.3. chassis (such as uprights, suspension systems, steering and brake callipers/discs)
5.4. mechanical controls (such as throttle, brakes, clutch, gear)
5.5. safety equipment (such as seats, belts, fire extinguishers)

Plus assist in the removal and replacement of motorsport vehicle components from **three** of the following categories:

5.6. engine and ancillary components (such as exhaust primaries and silencers, airboxes, engine mounts, filters)
5.7. transmission (such as gear ratios, gear selectors, dog rings, final drives, clutches, oil coolers, drive and prop shafts)
5.8. fuel systems (such as fuel pumps, fuel tanks, fuel collectors)
5.9. cooling systems (such as radiators, heat exchangers, header tanks)

5.10. electrical (such as voltage generation, ignition system components, engine management, data control boxes, ECUs, wiring looms, lighting)
5.11. system components (such as sensors, regulators, safety devices, gauges)

S6. Carry out **al**l of the following inspection and testing techniques:

6.1 functional testing
6.2 mechanical measurement
6.3 sensory testing (such as sight, sound smell touch) Plus **two** more of the following test procedures:
6.4 ferrous metal crack detection
6.5 non-ferrous metal crack detection
6.6 static or dynamic balancing
6.7 brake balance and pressure testing
6.8 cylinder pressure/balance tests
6.9 electrical tests
6.10 damper dynamometer testing
6.11 other specific tests

S7. Remove and replace motorsport vehicle equipment and components, in compliance with **one** or more of the following standards:

7.1 Race Association's (such as FIA, MSA)
7.2 BS or ISO standards and procedures
7.3 vehicle manufacturer's specification
7.4 customer standards and requirements
7.5 team/company standards and procedures
7.6 specific system requirements

S8. Complete the relevant paperwork, to include **one** from the following, and pass it to the appropriate people:

8.1 job sheets
8.2 computer records
8.3 vehicle preparation sheet
8.4 formal risk assessment

Knowledge and understanding
The apprentice must know and understand:

K1 Describe the specific safety practices and procedures that they need to observe when stripping and rebuilding motorsport vehicles and when using lubricants and fluids (including lifting and handling techniques; safe working practices with regard to dismantling motorsport vehicles; procedures which satisfy current regulations - such as HASAWA, COSHH, PUWER and other related legislation and guidelines)

K2 Describe the hazards associated with removing and replacing motorsport vehicle components, and with the tools and equipment used (such as the safe support of the vehicle at the correct working height and position, the safe release of fuel and other liquids, handling hydraulic fluids, misuse of tools), and how they can be minimised

K3 Describe the protective equipment that they need to use for both personal protection and protection of the vehicle

K4 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

K5 Describe the importance of good housekeeping within the working area (such as leaving the work area free of debris and used materials, cleaning and maintaining tools and equipment, returning equipment to designated storage area, leaving the work area in a safe and tidy condition), and of good personal presentation to ensure quality representation of the team or organisation

K6 Describe the preparations to be carried out on the vehicle (such as removing bodywork or fairings, cleaning away dirt, dust, oil or track debris; making visual checks of the systems and components for obvious signs of damage or excessive wear - such as bearings, bushes, bodywork, floors, fairings, leaking coolant or oil, chafing, cracks, excessive clearances); ensuring that suitable storage space is readied once the systems have been removed from the vehicle, and providing suitable containers for the storage of fasteners and other small components

K7 Explain how to use and extract information from motorsport vehicle documentation (such as vehicle manuals, system diagrams, telemetry data, engineer's records, set-up sheets, inspection reports)

K8 Describe the importance of ensuring that they use the correct and up-to-date documentation

K9 Describe the techniques used to remove components from vehicle systems without damage to the components or surrounding structure (such as release of spring pressures/force, draining of fluids, proof marking, extraction of components and the need to protect the circuit integrity by fitting blanking plugs to exposed pipes)

K10 Explain how to use a range of hand tools (such as spanners, sockets, screwdrivers, punches, drifts) to remove a range of components (such as studs, pins, circlips, rivets, seals and gaskets, bearings, gears, final drives, wings, floors, skid plates, fairings, seats); and using release agents to help free joined parts where seizure or crash damage may have occurred

K11 Describe the various mechanical fasteners to be removed and replaced, and their method of removal and replacement (such as threaded fasteners, special securing devices)

K12 Describe the various types of electrical connectors that are used, methods of

unlocking, orientation indicators and locating and locking-in of the connections

K13 Describe the methods of lifting, and supporting the components/equipment during the removal and replacement activities

K14 Describe the methods of checking the components for damage or wear (using visual methods, measurements, and crack detection techniques)

K15 Describe the need to use new components where checks during dismantling revealed such needs; fitting together new or prototype components, where a degree of initial fitting may be needed (such as filing, fettling, reaming, tapping, shimming, polishing and adjusting to achieve the required assembly specification); sealing and securing components (such as using nuts, bolts and associated fasteners, rivets, circlips, sealants and locking compounds); checking for correctness of fit and accuracy at critical stages during the rebuild and on completion of the assembly

K16 Explain how to make adjustments to components/assemblies to ensure that they function correctly (such as travel and working clearance, timing and sequence)

K17 Explain why securing devices must be tightened to the correct torque and locked, and the different methods that are used

K18 Describe the tools and equipment used in the removal and replacement activities, their calibration/care and control procedures, and the need to control and account for all tools and equipment used during the removal and replacement activity

K19 Explain how to deal with problems (such as what to do when components are damaged or worn in some way, the correct equipment or parts not available, components do not come apart as readily as expected, when to act on their own initiative and when to seek help from others)

K20 Describe the recording documentation to be completed for the activities undertaken and, where appropriate, the importance of marking and identifying specific pieces of work in relation to the documentation

K21 Describe the procedure for the safe disposal of waste materials, scrap components, hydraulic fluids, contaminated fuel

K22 Explain when to act on their own initiative and when to seek help and advice from others

K23 Describe the importance of leaving the work area and vehicle in a safe and clean condition on completion of the stripping and rebuilding activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Unit 089 Stripping and Rebuilding Motorsport Vehicles Pre- Competition

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	September 2018
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail

Unit 090 Inspecting a Motorsport Vehicle during a Competition

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-090
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 skills and knowledge needed to prove the competences required to inspect a motorsport vehicle, in a recognised sequence, and to a high standard, during a race meeting or competition. It will prepare them for entry into the motorsport sector, 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 involve inspecting a motorsport vehicle immediately before it enters the competition, and checking the vehicle for system leaks, low fluid levels, loose fastenings and fixings, arming of the fire extinguisher system, checking driver/rider safety equipment, and checking correct fuel levels, correct cold tyre and damper pressures and other potential problem areas. It covers motorsport vehicles such as single seat, rally cars, sports cars, karts, historic vehicles, motor cycles and other specific approved competition vehicles. In carrying out the activities, they will be required to use a range of inspection techniques, tools and equipment. They must be able to use recognised methods of checking components for wear, chafing, damage and 'play', within the team's guidelines. They will be expected to follow the team's procedures for inspecting the motorsport vehicle during a competition. They must also understand and use the correct coolants, oils, fluids and agents for the system being inspected. Their responsibilities will require them to comply with recognised procedures for the inspection activities undertaken, to take account of any potential difficulties or problems that may arise, and to seek appropriate help and advice in determining and implementing a suitable solution.

	They will be expected to work with either a high level of supervision or as a member of a team. Where team working is involved, they must demonstrate a significant personal contribution during the team activities in order to satisfy the requirements of the standard, and competence in all the areas required by the standard must be demonstrated. On completion of the inspection activities, they must show that they can competently clean the work area that they are responsible for, including tidying up bays or garages to a standard that will reflect the professional image of the team. They must show that they can use and maintain the tools and equipment needed for the inspection activities, and return them to their recognised storage area ready for further use. Their knowledge will be sufficient to provide a broad understanding of their work, and will enable them to apply the appropriate inspection procedures during a motorsport event or competition. They will know how the equipment functions, the common faults that can occur, the purpose of the individual components and associated defects, inadequate depth to carry out the inspection activities, identify and correct faults and ensure that the vehicle is to the required standard. They will understand the safety precautions required when carrying out motorsport inspection activities, especially those for lifting and supporting vehicles. 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.

Performance Requirements
The apprentice must be able to:

P1 Work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines
P2 Demonstrate the required occupational behaviours in line with the job role and company objectives
P3 Obtain all the information they need for the motorsport vehicle inspection activities to be carried out
P4 Plan the inspection activities before they start them
P5 Obtain and prepare tools and ancillary equipment necessary for the inspection work to be carried out
P6 Carry out the inspection activities, using approved tools and techniques, and within the limits of their personal authority
P7 Take suitable precautions to prevent damage to components and surrounding systems
P8 Report any instances where the inspection activities cannot be fully met, or where there are identified issues outside the planned activities
P9 Record the results of the inspection activities
P10 Use the evidence they have gained to during the inspection activities to improve future reliability and performance of the motorsport vehicle
P11 Tidy up on completion of the inspection activities

Skills Requirements
The apprentice must be able to:

S1. Carry out **all** of the following in preparation for the inspection of the motorsport vehicle:

1.1 ensure that there is enough time available to complete the inspection
1.2. obtain all the required tools and equipment, and check that they are in a safe and usable condition
1.3. ensure that the motorsport vehicle is safely supported on the appropriate stands
1.4. ensure that all bodywork, fairings, covers and hatches have been removed (where appropriate)
1.5. obtain and wear the correct personal protective equipment for the tasks being undertaken
1.6. obtain the appropriate fluids and lubricants
1.7. obtain the correct auxiliary engine starting devices (where appropriate)
1.8. obtain the relevant inspection documentation

S2. Inspect **one** of the following types of motorsport vehicle during a motorsport event or competition:

2.1. single seater
2.2. rallying
2.3. sports cars
2.4. karts
2.5. historic
2.6. motorcycles (such as circuit and off-road)
2.7. other specific approved competition vehicle

S3. Carry out inspections and checks, to include **ten** of the following, as appropriate to the motorsport vehicle being inspected:

3.1 using a torque wrench to spanner-check wheel nuts, bolts and other critical fastenings
3.2 ensuring that fuel tanks are filled to their correct capacity
3.3 checking that suitable tyres are fitted, that they are free from damage and are at the correct cold pressures
3.4 checking for correct oil pressure prior to engine warm-up
3.5 checking engine temperatures and pressures during warm-up
3.6 pressurising the cooling system after initial start-up
3.7 testing that the throttle operation reaches 100% opening
3.8 checking that power steering fluid levels are correct and free from leaks
3.9 checking that hydraulic brake and clutch fluids are at the correct levels, and that the brake balance is set
3.10 inflating damper bump canisters, using the appropriate gases
3.11 checking that clutch operating clearance is correct, and that gear selection is satisfactory through all gears
3.12 testing that electrical systems are operating correctly
3.13 checking spherical bearings and wheel bearings for play

S4. Carry out **three** of the following before the vehicle leaves the 'pit' area:

4.1 checking that all bodywork, fairings, wings, covers and hatches are correctly secured
4.2 checking that the driver is fitted correctly into the seat, and that seat belts are securely fastened
4.3 ensuring that the fire extinguisher bottle is full and the system is armed
4.4 ensuring that wheels are correctly torqued, and locking mechanisms are in place
4.5 ensuring that the driver has the appropriate vehicle information prior to entering the vehicle or competition (such as amount of fuel, type of tyres and pressures, track conditions, vehicle geometry changes, brake balance, brake condition)
4.6 cleaning the bodywork, fairings, windscreen and other relevant areas of the vehicle checking that the work area/vehicle track access lane is free from tools, equipment and foreign objects

S5. Complete the relevant paperwork and pass it to the appropriate person, to include **one** from:

5.1 driver/rider
5.2 team manager
5.3 chief mechanic
5.4 No.1 mechanic
5.5 other appropriate person

Knowledge and understanding
The apprentice must know and understand:

K1. Describe the specific safety practices and procedures that they need to observe when inspecting motorsport vehicles and when using lubricants and fluids (including lifting and handling techniques; safe working practices with regard to inspecting motorsport vehicles; procedures which satisfy current regulations - such as HASAWA, COSHH, PUWER and other related legislation and guidelines

K2. Describe the hazards associated with inspecting motorsport vehicles, and with the tools and equipment used, (such as the safe support of the vehicle at the correct working height and position, the safe release of fuel and other liquids, handling hot or damaged components, misuse of tools), and how they can be minimised

K3. Describe the protective equipment that they need to use for both personal protection and protection of the vehicle

K4. 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

K5. Describe the importance of good housekeeping within the working area (such as leaving the work area free of debris and used materials, cleaning and maintaining tools and equipment, returning equipment to designated storage area, leaving the work area in a safe and tidy condition), and of good personal presentation to ensure quality representation of the team or organisation

K6. Describe the need to ensure that suitable storage space is readied for all bodywork, panels, fairings and covers once the vehicle has been stopped after its initial running period and before any checks are made

K7. Describe the preparations to be carried out on the vehicle (such as removing bodywork or fairings, covers and panels, cleaning away dirt, dust, oil or track debris; making visual checks of the systems and components for obvious signs of damage, insecurity and leaks)

K8. Describe the importance of communicating with others and using inspection check sheets or other relevant documentation to ensure that the inspection is carried out in a systematic way, within the times restraints, and determining what consumables and or components may be needed

K9. Explain how the information is recorded and returned to the relevant person, once all inspection work has been completed

K10. Describe the techniques used to check components and systems without damaging the motorsport vehicle or disabling it from immediate use

K11. Explain how to use a range of hand tools (such as spanners, sockets, screwdrivers, torque wrenches, pressure gauges) to check the security of a range of vehicle systems and sub-assemblies (such as engine, transmission, suspension, steering, cooling, lubrication, electrical)

K12. Explain how to pressurise tyres, dampers, cooling systems and fuel systems; how to check for leaks and understand the specifications of fluids, fuels and lubricants to top up the vehicle systems following a leak or other problems

K13. Describe the various mechanical fasteners to be removed and replaced, and their method of removal and replacement (such as threaded fasteners, special securing devices)

K14. Explain how to make adjustments to components/assemblies to ensure that they function correctly (such as travel and working clearance, timing and sequence)

K15. Explain why securing devices need to be tightened to the correct torque and locked, and the different methods used

K16. Describe the tools and equipment used in the inspection activities, and their calibration/care and control procedures, and the need to control and account for all tools and equipment used during the inspection activities at an event or competition

K17. Explain how to deal with problems (such as what to do when components are damaged or insecure, the correct equipment, fluids or lubricants not available, when to act on their own initiative and when to seek help from others)

K18. Explain how to report any alterations that they have made, or losses of fluids, lubricants, pressures, or abnormally excessive wear of components - to the relevant person

K19. Explain how to complete the relevant documentation, stating the tasks completed and any adjustments made (such as setting of pressures, levels, geometry changes)

K20. Describe the procedure for the safe disposal of waste materials, scrap components, hydraulic fluids, contaminated fuel

K21. Explain when to act on their own initiative and when to seek help and advice from others

K22. Describe the importance of leaving the work area and vehicle in a safe and clean condition on completion of the inspection activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Unit 090 Inspecting a Motorsport Vehicle during a Competition

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	September 2018
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail

Unit 091 Diagnosing and Rectifying Faults on Motorsport Vehicle Systems during Competition

Level:	Level 2
GLH:	150
Relationship to NOS:	EUCL2F-091
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 skills and knowledge needed to prove the competences required to diagnose and rectify motorsport vehicle system faults, in a fast and efficient manner, during a race meeting or competition. It will prepare them for entry into the motorsport sector, 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 involve the application of a range of fault diagnostic techniques, tools and equipment, and the diagnosis and location of the faults to their unit and/or component parts, on a range of systems such as engine, transmission, chassis, wheel braking, suspension, steering, fuel, lubrication, cooling and electrical. They will be expected to remove the relevant components, to inspect the parts for wear or damage, to determine which (if any) parts need replacing and then to reassemble them for further use. The removal and replacement activities will include carrying out all necessary safety activities, to lift and support the vehicle and its components, lifting and removing engine and transmission systems, breaking into hydraulic and fuel system circuits, removing and replacing faulty equipment at component or unit level, replenishing fluids, and setting and adjusting the completed system. They will also be expected to carry out routine testing and functional checks of the rebuilt components to determine that the equipment performs to the specified requirements.

	Their responsibilities will require them to comply with recognised procedures for the fault diagnosis and removal and replacement activities undertaken, to take account of any potential difficulties or problems that may arise, and seek appropriate help and advice in determining and implementing a suitable solution. They will be expected to work with either a high level of supervision or as a member of a team. Where team working is involved, they must demonstrate a significant personal contribution during the team activities in order to satisfy the requirements of the standard, and competence in all the areas required by the standard must be demonstrated. They must ensure that they remove all tools and equipment from the vehicle and work area on completion of the activities, complete all necessary job/task documentation accurately and legibly, and maintain the work area to a standard that will reflect the professional image of the team. Their knowledge will be sufficient to provide a broad understanding of their work, and will enable them to apply the appropriate fault diagnosis and rectification techniques and procedures. They will know how the equipment functions, the common faults that can occur, the purpose of the individual components and associated defects, in adequate depth to carry out the fault diagnostic activities, correct faults and ensure that the equipment is replaced and functions to the required standard. They will understand the safety precautions required when carrying out the fault diagnosis, adjustments and the component removal and replacement activities, especially those for lifting and supporting the 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.

Performance Requirements
The apprentice must be able to:

P1 Work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines
P2 Demonstrate the required occupational behaviours in line with the job role and company objectives
P3 Obtain and use all the relevant information on the symptoms and problems associated with the vehicle
P4 Assist in the investigation and help establish the most likely causes of the faults
P5 Assist in the selection and use of appropriate diagnostic techniques, tools and aids to locate the fault
P6 Assist in determining which components or units need adjusting or replacing
P7 Where appropriate, ensure that any stored energy or substances are released safely and correctly
P8 Remove, replace or refit the required components, using approved tools and techniques, within the limits of their personal authority and without causing damage to components or surrounding areas
P9 Deal with any difficulties during the fault location, rectification and testing activities
P10 Report any instances where the removal and replacement activities cannot be fully met, or where there are identified defects outside the planned activities
P11 Complete the relevant documentation, in accordance with organisational requirements
P12 Clean the work area and dispose of waste materials and defective components, in accordance with safe working practices and approved procedures

Skills Requirements
The apprentice must be able to:

S1. Carry out **all** of the following during the fault diagnostic activities:

1.1 carry out all preparatory work (such as removal of bodywork, fairings and covers, removing excessive dust, grease and dirt)
1.2 check for obvious signs of damage (such as impact damage, broken parts)
1.3 check for excessive wear or play (such as on shafts, bearings, spherical joints and drive shafts)
1.4 check for leaks on seals, gaskets, bushes, controls and pipe fittings
1.5 check the condition and security of suspension and drive components
1.6 check the condition of tyres (such as damage, wear, pressures, security)
1.7 check for metallic particles in lubricants

S2. Assist in diagnosing faults on **one** of the following types of motor sport vehicle:

2.1 single seater
2.2 rallying
2.3 sports cars
2.4 karts
2.5 Historic
2.6 motorcycles (such as circuit and off road)
2.7 other specific approved competition vehicle

S3. Assist in locating faults that have resulted in **two** of the following breakdown categories:

3.1 intermittent problem
3.2 partial failure (where the vehicle is able to return to the 'pit' area under power)
3.3 complete breakdown (where the vehicle is unable to return to the 'pit' area under power)

S4. Assist in the collection of evidence regarding the fault, from **three** of the following sources:

4.1 system diagrams
4.2 vehicle/equipment manuals
4.3 data logging
4.4 test instruments
4.5 equipment self-diagnostics
4.6 maintenance/history records
4.7 discussion with user/team member
4.8 monitoring equipment (such as gauges recording devices)
4.9 fault analysis charts (such as flow charts)
4.10 troubleshooting guides

S5. Assist in carrying out **three** of the following fault diagnostic techniques:

5.1 function testing
5.2 unit substitution
5.3 input/output
5.4 taking measurements and readings
5.5 half-split
5.6 six point technique
5.7 sensory input (such as sight, sound, smell, touch)

S6. Rectify faults in **four** of the following motorsport vehicle major assemblies or systems:

6.1 Engine
6.2 Transmission
6.3 Chassis
6.4 wheel braking
6.5 suspension
6.6 steering
6.7 fuel
6.8 lubrication
6.9 cooling
6.10 electrical

S7. Use a variety of fault rectification activities, to include **six** of the following:

7.1 removing and replacing electrical connections (such as plugs, sockets, earth straps)
7.2 removing and replacing mechanical fasteners (such as nuts, bolts, circlips, quick-release fasteners, rivets)
7.3 removing and replacing hoses and pipes
7.4 replacing faulty and or worn components with new or reconditioned components
7.5 adjusting components (such as travel, working clearance, torque, electrical values)
7.6 realignment of components
7.7 repairing components (such as brackets, mountings, panels)
7.8 refitting loose/dislodged components
7.9 making temporary repairs to an acceptable standard

S8. Assist in carrying out **four** of the following monitoring or testing procedures, to help diagnose and check that the fault has been rectified:

8.1 pressure testing (such as cylinder pressure, hydraulic or pneumatic pressures)
8.2 electrical checks (such as voltage, current, continuity checks)
8.3 noise intensity
8.4 exhaust analysis
8.5 thermal checks (such as bearings, friction surfaces)
8.6 movement checks (such as travel, clearance, operation of levers and links, torque)
8.7 vibration analysis
8.8 functional testing
8.9 functional testing

S9. Complete the relevant paperwork, to include **one** from the following, and pass it to the appropriate people:

9.1 body sheets
9.2 computer records
9.3 vehicle log/report
9.4 corrective action report

Knowledge and understanding
The apprentice must know and understand:

K1. Describe the health and safety requirements of the area in which they are carrying out the fault diagnostic activities, and the responsibility these requirements place on them

K2. Describe the specific safety precautions to be taken when carrying out fault diagnosis on motorsport vehicles

K3. Describe the importance of wearing protective clothing and other appropriate safety equipment during the fault diagnosis and rectification activities, and of good personal presentation to ensure quality representation of the team or organisation

K4. 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

K5. Describe the hazards associated with diagnosing and rectifying motorsport vehicle faults, and with the tools and equipment used (such as moving vehicles in a race environment; the safe support of the vehicle at the correct working height and position; hot vehicle components; the safe release of fuel and other liquids; stored pressure/force; handling and using release agents, sealants and adhesives; misuse of tools), and how they can be minimised

K6. Explain how to extract and use information from the relevant areas to assist in the diagnosis and rectification of the fault on the motorsport vehicles (such as from the driver, rider or team member, telemetry data, engineer's records, set-up sheets and inspection reports)

K7. Describe the techniques used to diagnose the faults (such as sensory information (sight, sound, smell, touch); half-split, six point technique, checking inputs and outputs, component substitution, aural, visual, functional, taking measurements and use of equipment self diagnostics)

K8. Explain how to use a range of fault diagnostic equipment to investigate the problem (such as multimeters, pressure gauges, thermal measuring equipment, Verniers, micrometers and other specialised tools)

K9. Explain how to evaluate the likely risk of running the vehicle with the known fault, and the effects that the fault could have on health and safety, and on the overall vehicle performance

K10. Explain how to remove components from vehicle systems without damage to the components or surrounding structure (such as release of spring pressures/force, draining of fluids, proof marking, extraction of components, and the need to protect the circuit integrity by fitting blanking plugs to exposed pipes)

K11. Explain how to use a range of hand tools (such as spanners, sockets, screwdrivers, pliers, cutters, punches) to remove a range of components, and how to use release agents to help free joined parts where seizure or crash damage may have occurred

K12. Describe the various mechanical fasteners to be removed and replaced, and their method of removal and replacement (such as threaded fasteners and special securing devices)

K13. Explain why securing devices need to be tightened to the correct torque and locked, and the different methods used

K14. Explain why they need to be methodical and lay the removed components out in a logical sequence to aid re-assembly, and methods that can be used to keep component parts together in the order they were removed

K15. Describe the methods of inspecting removed components, and the awareness of what to look for with regard to damage and wear

K16. Describe the equipment used in the rectification operations (such as alignment tools, torque wrenches, presses)

K17. Explain how to rectify the fault using methods such as component replacement, adjustments, repair and refitting techniques
K18. Explain how to select and carry out visual, aural, functional and measurement tests to ensure the correct operation of the component or system
K19. Describe the expected outcomes of the tests being conducted
K20. Describe the importance of working to the critical timescales relevant to the motorsport industry
K21. Explain how to deal with problems (such as what to do when components do not come apart as readily as expected, when to act on their own initiative)
K22. Explain when to act on their own initiative and when to seek help and advice from others
K23. Describe the importance of leaving the work area and vehicle in a safe and clean condition on completion of the activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Unit 091 Diagnosing and Rectifying Faults on Motorsport Vehicle Systems during Competition

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	September 2018
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail

Unit 092 Carrying Out Maintenance Activities on Motorsport Vehicle Electrical Equipment

Level:	Level 2
GLH:	150
Relationship to NOS:	EUCL2F-092
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 skills and knowledge needed to prove the competences required to carry out maintenance activities on motorsport vehicle electrical systems, in accordance with approved procedures. It will prepare them for entry into the motorsport sector, 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 involve dismantling, removing and replacing or repairing faulty components, in line with company procedures on electrical equipment that uses battery, alternating current generators, or direct current power supplies. This includes equipment such as control systems, switches and solenoids, starter motors, wiring harnesses and instrumentation panel, wiring enclosures and warning lights, vehicle lighting systems, data acquisition systems and other specific electrical equipment. They will be expected to apply a range of maintenance techniques and procedures, such as selection of raw materials, attaching connectors, shielding, testing, isolating, disconnecting, removing and reconnecting electrical components and looms, attaching cable identification markers, replacing damaged or defective electrical components and looms, setting and adjusting components, and making continuity checks before testing and starting up the equipment. Their responsibilities will require them to comply with organisational policy and procedures for the maintenance

	activities undertaken, to take account of any potential difficulties or problems that may arise, and to seek appropriate help and advice in determining and implementing a suitable solution. They will be expected to work with either a high level of supervision or as a member of a team. Where team working is involved, they must demonstrate a significant personal contribution during the team activities in order to satisfy the requirements of the standard, and competence in all the areas required by the standard must be demonstrated. On completion of the activities, they must show that they can competently clean the work area that they are responsible for, including tidying up bays or garages to a standard that will reflect the professional image of the team. They must show that they can use and maintain the tools and equipment needed for the maintenance activities, and return them to their recognised storage area ready for further use. Their knowledge will be sufficient to provide a broad understanding of their work, and will enable them to apply the appropriate electrical maintenance procedures. They will know how the motorsport electrical equipment functions, the common faults that can occur, the purpose of the individual components and associated defects, in adequate depth to carry out the maintenance, repair or adjustment activities, and to ensure that the equipment functions to the required specification. In addition, they will have sufficient knowledge of these components to ensure that they are fit for purpose and meet the specifications. They will understand the safety precautions required when carrying out the maintenance activities, especially those for isolating the 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.

Performance Requirements
The apprentice must be able to:

P1 Work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines
P2 Demonstrate the required behaviours in line with the job role and company objectives
P3 Obtain all the information they need for the motorsport vehicle electrical maintenance activities to be carried out
P4 Follow the relevant maintenance procedures to carry out the required work
P5 Carry out the maintenance activities, within the limits of their personal authority
P6 Carry out the maintenance activities in the specified sequence, and in an agreed timescale
P7 Report any instances where the maintenance activities cannot be fully met, or where there are identified defects outside the planned schedule
P8 Use the evidence they have gained to during maintenance activities to improve future reliability and performance of the motorsport vehicle
P9 Dispose of waste materials, in accordance with safe working practices and approved procedures
P10 Tidy up on completion of the electrical maintenance activities

Skills Requirements
The apprentice must be able to:

S1. Carry out **all** of the following during the electrical maintenance activities:

1.1 plan the maintenance activities, in conjunction with others involved, so as to minimise disruption to motorsport vehicle preparation
1.2 use the correct issue of drawings, job instructions and procedures
1.3 adhere to risk assessment, COSHH and other relevant safety standards
1.4 ensure the safe isolation of equipment (such as mechanical, electricity, fuel, air or fluids)
1.5 ensure that safe working arrangements have been provided for the maintenance area (such as pit lane/service point)
1.6 re-connect and return the equipment to service on completion of activities
1.7 dispose of waste items in a safe and environmentally acceptable manner, and leave the work area in a safe condition

S2. Carry out maintenance of electrical equipment on **one** of the following types of motorsport vehicle:

2.1 single seater
2.2 rallying
2.3 sports cars
2.4 karts
2.5 historic
2.6 motorcycles (such as circuit and off-road)
2.7 other specific approved competition vehicle

S3. Carry out maintenance activities on **five** of the following types of motorsport vehicle sub-systems:

3.1 charging systems
3.2 data acquisition system
3.3 direct current power supply system
3.4 auxiliary motorsport vehicle power supply system
3.5 lighting systems
3.6 instrumentation, indication and warning systems
3.7 electrical control system
3.8 safety and emergency systems

S4. Maintain motorsport vehicle electrical equipment, in compliance with **one** or more of the following standards:

4.1 Race Associations (such as FIA, MSA)
4.2 BS or ISO standards and procedures
4.3 vehicle manufacturer's specification
4.4 customer standards and requirements
4.5 team/company standards and procedures
4.6 specific system requirements

S5. Carry out **all** of the following maintenance activities:

5.1 isolating the equipment
5.2 disconnecting and reconnecting wires and looms
5.3 attaching suitable cable identification markers
5.4 removing electrical units/components
5.5 checking components for serviceability
5.6 replacing damaged/defective components
5.7 removing and replacing damaged wires and looms
5.8 setting and adjusting replaced components
5.9 making 'continuity' checks before powering up
5.10 functionally testing the maintained equipment
5.11 examining wiring looms for chafing, dislodging, correct routeing, protection in hazardous areas

S6. Replace and/or repair a range of motorsport vehicle electrical components, to include **ten** of the following:

6.1 looms and connectors
6.2 locking and retaining devices
6.3 overload protection devices
6.4 pickup sensor
6.5 relay components
6.6 potentiometers
6.7 capacitors
6.8 circuit boards
6.9 lighting components
6.10 electrical switches or sensors
6.11 manual switches
6.12 transmitter beacons
6.13 batteries
6.14 solenoids
6.15 thermistors or thermocouples
6.16 starter motors

6.17 other specific motorsport related components

S7. Complete the relevant maintenance records accurately, to include **one** of the following, and pass them on to the appropriate person:

7.1 job cards
7.2 computer records
7.3 company specific documentation
7.4 formal risk assessment
7.5 vehicle maintenance logs or reports

Knowledge and understanding
The apprentice must know and understand:

K1. Describe the specific safety practices and procedures that they need to observe when carrying out electrical maintenance activities on motorsport vehicles (including lifting and handling techniques; safe working practices with regard to removing components from motorsport vehicles; procedures which satisfy current regulations - such as HASAWA, COSHH, PUWER and other related legislation and guidelines)

K2. Describe the hazards associated with removing and replacing motorsport vehicle electrical components, and with the tools and equipment used (such as ensuring the safe support of the vehicle at the correct working height and position, ensuring the safe isolation of the circuits/equipment, removal of fuses, misuse of tools), and how they can be minimised

K3. Describe the protective equipment that they need to use for both personal protection and protection of the vehicle

K4. 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

K5. Describe the importance of good housekeeping within the working area (such as leaving the work area free of debris and used materials, cleaning and maintaining tools and equipment, returning equipment to designated storage area, leaving the work area in a safe and tidy condition), and of good personal presentation to ensure quality representation of the team or organisation

K6. Explain how to use and extract information from motorsport vehicle documentation (such as vehicle manuals, system diagrams, telemetry data, engineer's records, set-up sheets, inspection reports)

K7. Describe the importance of ensuring that they use the correct and up-to-date documentation

K8. Describe the basic principles of how the motorsport vehicle electrical equipment functions, its operating sequence, the working purpose of individual units/components and how they interact

K9. Describe the different types of cabling and their application (such as multicore cables, single core cables, screened cables) as used on motorsport vehicles

K10. Describe the care, handling and application of electrical measuring instruments

K11. Describe the techniques used to dismantle/assemble electrical equipment (such as unplugging, desoldering, removal of screwed, clamped and crimped connections)

K12. Describe the various types of electrical connectors that are used, methods of unlocking, orientation indicators and locating and locking in of the connections

K13. Describe the methods of removing and replacing cables, wires and looms without causing damage to existing cabling or other vehicle component.

K14. Describe the use of BS/ISO wiring and other regulations when selecting wires and cables, and when carrying out tests on systems

K15. Describe the methods of attaching identification markers/labels to removed components or cables to assist with re-assembly

K16. Describe the tools and equipment used in the maintenance activities (such as cable stripping tools, crimping tools, soldering irons and torches, gland connecting tools)

K17. Describe the methods of checking that components are fit for purpose, and the need to replace 'lifed' items (such as seals and gaskets, overload protection devices)

K18. Explain how to make adjustments to components/assemblies to ensure that they function correctly

K19. Explain how to check that tools and equipment are free from damage or defects, are in a safe and usable condition, and are set up correctly for the intended purpose

K20. Describe the importance of making 'off-load' checks before proving the equipment with the electrical supply on

K21. Describe the equipment operating and control procedures to be applied during the maintenance activity

K22. Explain how to use appropriate lifting and handling equipment techniques in the maintenance activity

K23. Describe the problems that can occur during the maintenance activity, and how they can be overcome

K24. Describe the recording documentation to be completed for the activities undertaken and, where appropriate, the importance of marking and identifying specific pieces of work in relation to the documentation

K25. Explain when to act on their own initiative and when to seek help and advice from others

K26. Describe the importance of leaving the work area and vehicle in a safe and clean condition on completion of the maintenance activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Unit 092 Carrying Out Maintenance Activities on Motorsport Vehicle Electrical EquipmentCarrying Out Maintenance Activities on Motorsport Vehicle Electrical Equipment

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	September 2018
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@Enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification Assessment Strategy and specifying the title of the relevant Trailblazer Standard
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Grading System	Pass/Fail

Unit 093 Stripping and Rebuilding Motorsport Engines Pre-Competition

Level:	Level 2
GLH:	140
Relationship to NOS:	EUCL2F-093
Endorsement by a sector or regulatory body:	SEMTA (now Enginuity)
Aim:	This Employer Unit of Competence (EUC) has been developed by employers in the Advanced Manufacturing and Engineering 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 skills and knowledge needed to prove the competences required to re-build a motorsport engine in a recognised sequence and to a high standard, prior to a competition. It will prepare them for entry into the motorsport sector, 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 involve the dismantling and removal of components, inspection and checking for faults, excessive wear and potential problems, replacement of components, and rebuilding the engine using hand tools, specialist tools and test equipment, in accordance with approved procedures. It covers motorsport engines fitted into motorsport vehicles such as single seater, rally cars, sports cars, karts, historic vehicles, motorcycles and other specific approved competition vehicles. The stripping and re-building activities will include carrying out all necessary safety activities, to lift and support the engine and its ancillary components. They will need to lift and remove the engine from any transportation containers and place it onto an approved holding device, ready for removing all ancillary components and the stripping and rebuilding of the engine. They will need to ensure that all removed components are stored safely, prior to inspection and re-building. They will also be expected to use recognised methods for crack testing ferrous and non-ferrous materials/components, and to be able to inspect a motorsport engine within the team's or organisation's guidelines.

	Their responsibilities will require them to comply with recognised procedures for the stripping and rebuilding activities undertaken, to take account of any potential difficulties or problems that may arise, and to seek appropriate help and advice in determining and implementing a suitable solution. They will be expected to work with either a high level of supervision or as a member of a team. Where team working is involved, they must demonstrate a significant personal contribution during the team activities in order to satisfy the requirements of the standard, and competence in all the areas required by the standard must be demonstrated. On completion of the activities, they must show that they can competently clean the work area that they are responsible for, including tidying up bays or garages to a standard that will reflect the professional image of the team. They must show that they can use and maintain the tools and equipment needed for the stripping and rebuilding activities, and return them to their recognised storage area ready for further use. Their knowledge will be sufficient to provide a broad understanding of their work, and will enable them to apply the appropriate stripping, inspection and rebuilding procedures. They will know how the equipment functions, the common faults that can occur, the purpose of the individual components and associated defects, in adequate depth to carry out the stripping and rebuilding activities, correct faults and to ensure that the equipment is replaced to the required standard. They will also have sufficient knowledge of these components to ensure that they are fit for purpose and meet the specifications. They will understand the safety precautions required when carrying out the stripping and rebuilding activities, especially those for lifting and supporting the 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.

Performance Requirements
The apprentice must be able to:

P1 Work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines
P2 Demonstrate the required behaviours in line with the job role and company objectives
P3 Obtain all the information they need for the motorsport engine stripping and re-building activities to be carried out
P4 Establish and, where appropriate, mark component orientation for re-assembly
P5 Ensure that the motorsport engine is correctly mounted in the correct work area
P6 Carry out the engine stripping and re-building activities, within the limits of their personal authority
P7 Remove and replace the required components, using approved tools and techniques
P8 Take suitable precautions to prevent damage to components and surrounding systems
P9 Report any instances where the engine stripping and re-building activities cannot be fully met, or where there are identified defects outside the planned activities
P10 Complete the relevant documentation, in accordance with organisational requirements
P11 Label and store (in an appropriate location) components that require repair or overhaul
P12 Dispose of waste materials and scrap components, in accordance with safe working practices and approved procedures

Skills Requirements

S1. Carry out **all** of the following in preparation for the stripping and rebuilding of the motorsport engine:

1.1 undertake the maintenance activities to cause minimal disruption to normal working
1.2 visual check for damage and wear to engine externals
1.3 mount the engine on the correct mounting stand
1.4 drain all coolants and lubricants from the engine
1.5 obtain all stripping and re-building documentation, prior to disassembly
1.6 obtain suitable storage bins for the removed components

S2. Rebuild engines for **one** of the following types of motorsport vehicle:

2.1 single seater
2.2 rallying
2.3 sports cars
2.4 karts
2.5 historic
2.6 motorcycles (such as circuit and off-road)
2.7 other specific approved competition vehicle

S3. Use **three** of the following to aid the stripping and rebuilding of the motorsport engine:

3.1 system diagrams
3.2 lifting records
3.3 engine strip check sheets
3.4 engineer's records
3.5 engineering drawings
3.6 engine re-build sheets

S4. Remove and refit motorsport engine components from three of the following areas:

4.1 engine ancillary components (such as exhaust primaries and silencers, airboxes, engine mounts, filters)
4.2 clutch (such as clutch covers, driven plates, thrust bearings)
4.3 cam timing (such as pulleys, belts, gears, adjusters)
4.4 electrical (such as generation, ignition, engine management, data control boxes, ECUs, wiring looms)
4.5 system components (such as sensors, regulators, safety devices, gauges) Plus assist in the stripping and re-building of motorsport engine components from **three** of the following areas:
4.6 cylinder head (such as valves, valve springs, valve spring heights, rockers, valve stem seals, spark plugs)
4.7 engine block (such as crankshafts, connecting rods, pistons, rings, main bearings, big end bearings)
4.8 lubrication system (such as oil pumps, oil filters, scavenge pumps, oil tanks, pressure relief valves)
4.9 fuel system (such as carburettors, fuel pumps, fuel filters, metering units, fuel rails, pressure relief valves)

S5. Carry out **eleven** of the following stripping and rebuilding activities:

5.1 removing covers and cowlings
5.2 disconnecting electrical connections
5.3 disconnecting and removing hoses and pipes
5.4 proof marking/labelling of components to aid reassembly
5.5 separation of components by means of removing mechanical fasteners (such as nuts, bolts, circlips, quick-release fasteners, rivets)
5.6 inspecting components for damage and wear, and identifying all components and fasteners that require replacement.
5.7 arranging and storing components in a manner that makes re-assembly as straightforward as possible
5.8 labelling (and storing in the correct location) components that require repair or overhaul
5.9 replacing damaged/defective and 'lifed' components
5.10 reassembly of components, using mechanical fastening devices (such as nuts, bolts, quick-release fasteners, circlips, rivets)
5.11 checking of bearing clearances (such as using engineer's blue or compressible strip)
5.12 lapping in valves and valve seats
5.13 torque setting cylinder-head bolts, in the correct sequence
5.14 replacement of sealing devices (such as 'O' rings, seals, gaskets, sealing compounds)
5.15 positioning, aligning, setting, and adjusting replaced components (such as valve spring heights, cam timing, ring gaps, torque angles)
5.16 tightening fastenings to the required torque, and applying bolt locking methods (such as split pins, wire locking, lock nuts, engineering adhesives)

S6. Carry out **three** of the following inspection and testing techniques:

6.1 ferrous metal crack detection
6.2 non-ferrous crack detection
6.3 mechanical measurements
6.4 sensory testing (such as sight, sound, smell or touch)
6.5 connecting and setting engine to dynamometer installation

Plus **two** more of the following test procedures:

6.6 compression testing
6.7 leak down cylinder leakage testing
6.8 carburettor vacuum testing
6.9 ignition timing
6.10 electrical charging tests
6.11 other specific tests

S7. Strip and re-build motorsport engine equipment and components, in compliance with **one** or more of the following standards:

7.1 BS or ISO standards and procedures
7.2 vehicle manufacturer's specification
7.3 customer standards and requirements
7.4 team/company standards and procedures
7.5 specific engine system requirements

S8. Complete the relevant paperwork, to include **one** from the following, and pass it to the appropriate people:

8.1 post-competition stripdown sheets
8.2 engineer's/team's records
8.3 engine re-build sheet
8.4 formal risk assessment

Knowledge and understanding
The apprentice must know and understand:

K1. Describe the specific safety practices and procedures that they need to observe when stripping and rebuilding motorsport engines and when using lubricants and fluids (including lifting and handling techniques; safe working practices with regard to dismantling motorsport vehicles; procedures which satisfy current regulations - such as HASAWA, COSHH, PUWER and other related legislation and guidelines)

K2. Describe the hazards associated with stripping and re-building motorsport engine components, and with the tools and equipment used (such as the safe support of the engine at the correct working height and position, the safe release of fuel and other liquids, misuse of tools), and how they can be minimised

K3. Describe the protective equipment that they need to use for both personal protection and protection of the engine

K4. 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

K5. Describe the importance of good housekeeping within the working area (such as leaving the work area free of debris and used materials, cleaning and maintaining tools and equipment, returning equipment to designated storage area, leaving the work area in a safe and tidy condition), and of good personal presentation to ensure quality representation of the team or organisation

K6. Describe the preparations to be carried out on the engine (such as removing transportation containers, cleaning away dirt, dust, oil or track debris; making visual checks of the systems and components for obvious signs of damage or excessive wear - such as leaking coolant or oil, chafing, cracks, excessive clearances; ensuring suitable storage space is readied once the systems have been removed from the engine and providing suitable containers for the storage of fasteners and other small components)

K7. Explain how to use and extract information from motorsport engine building documentation (such as engine manuals, system diagrams, engineering drawings, engineer's records)

K8. Describe the importance of ensuring that they use the correct and up-to-date documentation

K9. Describe the techniques used to remove components from motorsport engines without damage to the components or surrounding systems (such as release of spring pressures/force, draining of fluids, proof marking, extraction of components and the need to protect the system integrity by fitting blanking plugs to exposed pipes)

K10. Explain how to use a range of hand tools (such as spanners, sockets, screwdrivers, punches, drifts) to remove a range of components (such as studs, pins, circlips, seals and gaskets, bearings, gears), and how to use release agents to help free joined parts where seizure or damage may have occurred

K11. Describe the various mechanical fasteners to be removed and replaced, and their method of removal and replacement (such as threaded fasteners, special securing devices)

K12. Describe the various types of electrical connectors that are used, methods of unlocking, orientation indicators and locating and locking-in of connections

K13. Describe the methods of lifting, handling and supporting the components/equipment during the stripping and re-building activities

K14. Describe the methods of checking the components for damage or wear (using visual methods, measurements, and crack detection techniques)

K15. Describe the need to use new components where checks during stripping revealed such needs; fitting together new or prototype components where a degree of initial

fitting may be needed (such as filing, fettling, reaming, tapping, shimming, polishing and adjusting to achieve the required assembly specification); sealing and securing components (such as using nuts, bolts and **associated** fasteners, rivets, circlips, sealants and locking compounds); checking for correctness of fit and accuracy at critical stages during the rebuild and on completion of the assembly

K16. Explain how to make adjustments to components/assemblies to ensure that they function correctly (such as travel and working clearance, timing and sequence)

K17. Explain why securing devices need to be tightened to the correct torque and locked, and the different methods used

K18. Describe the tools and equipment used in the engine stripping and re-building activities, and their calibration/care and control procedures, and the need to control and account for all tools and equipment used during the stripping and re-building activities

K19. Explain how to deal with problems (such as what to do when components are damaged or worn in some way, the correct equipment or parts not available, components do not come apart as readily as expected)

K20. Describe the recording documentation to be completed for the activities undertaken and, where appropriate, the importance of marking and identifying specific pieces of work in relation to the documentation

K21. Describe the procedure for the safe disposal of waste materials, scrap components, contaminated oil and fuel

K22. Explain when to act on their own initiative and when to seek help and advice from others

K23. Describe the importance of leaving the work area and equipment in a safe and clean condition on completion of the stripping and rebuilding activities (such as returning tools and equipment to the designated location, cleaning the work area, and removing and disposing of waste)

Unit 093 Stripping and Rebuilding Motorsport Engines Pre-Competition

Supporting Information

Developed by	Advanced Manufacturing and Engineering Trailblazer Group
Version number	Version 1.0
Date approved	September 2018
Assessment Requirements	Assessment requirements have been developed by employers for the occupational competency units and qualifications for Advanced Manufacturing and Engineering Sector. These assessment requirements are set down in the relevant Qualification Assessment Strategies available from Semta (now Enginuity). Please contact **Customer.Services@enginuity.org** quoting Advanced Manufacturing and Engineering Trailblazer Qualification
Additional Information	Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems This will allow each organisation to develop their own specific and tailored apprentice training programme that meets 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
Grading System	Pass/Fail

Appendix 1 Relationships to other qualifications

Links to other qualifications

This qualification is the mandatory on programme competence qualification for the Level 2 Engineering Operative Apprenticeship.

The qualification has connections to the:

- Level 2 Certificate in Engineering Operations (Knowledge)

Appendix 2 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 Assessment: 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.

City & Guilds

For almost 150 years, we have worked with people, organisations and economies to help them identify and develop the skills they need to thrive. We understand the life-changing link between skills development, social mobility, prosperity and success. Everything we do is focused on developing and delivering high-quality training, qualifications, assessments and credentials that lead to jobs and meet the changing needs of industry.

We partner with our customers to deliver work-based learning programmes that build competency to support better prospects for people, organisations and wider society. We create flexible learning pathways that support lifelong employability because we believe that people deserve the opportunity to (re)train and (re)learn again and again – gaining new skills at every stage of life, regardless of where they start.

The City & Guilds community of brands includes Gen2, ILM, Intertrain, Kineo and The Oxford Group.

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This Qualification Handbook however may contain references to historic information, such as former organisations, obsolete frameworks, codes or standards, or retired units and qualifications. This information is included for reference purposes only.

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