

Pearson BTEC Level 2 Diploma in Advanced Manufacturing Engineering (Foundation Competence)

Specification

New Apprenticeship Standards – Competence
Qualification (England only)

First registration September 2015

Issue 4

About Pearson

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This specification is Issue 4. Key changes are summarised on the next page. We will inform centres of any changes to this issue. The latest issue can be found on our website.

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ISBN 978 1 446 95322 8

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Summary of changes to Pearson BTEC Level 2 Diploma in Advanced Manufacturing Engineering (Foundation Competence) specification Issue 4

Summary of changes made between previous issue and this issue	Page number
Units 34, 35, 36 and 37 have been added to the qualification structure	Page 11
The following optional units have been added to the specification:	
Unit 34: Carrying out Aircraft Detail Fitting Activities	Page 271
Unit 35: Installing Aircraft Mechanical Fasteners	Page 279
Unit 36: Producing Composite Mouldings using Pre-Preg Techniques	Page 285
Unit 37: Carrying out Repairs on Composite Mouldings	Page 294

Earlier issues show previous changes.

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

Contents

1	Introducing the New Apprenticeships in England	1
	Background	1
2	Apprenticeship overview	2
	The Mechatronics Maintenance Technician Apprenticeship	2
	The Product Design and Development Technician Apprenticeship	3
	Qualification size	5
3	Qualification key information	6
4	Qualification purpose	7
	Qualification objective	7
	Progression opportunities	7
	Industry support and recognition	8
5	Qualification structure	9
	Pearson BTEC Level 2 Diploma in Advanced Manufacturing Engineering (Foundation Competence)	9
6	Programme delivery	13
	Elements of good practice	13
7	Centre resource requirements	15
	General resource requirements	15
8	Access and recruitment	16
	Prior knowledge, skills and understanding	16
	Access to qualifications for learners with disabilities or specific needs	16
9	Assessment	17
	Language of assessment	17
	Internal assessment	17
	Assessment Strategy	18
	Types of evidence	18
	Assessment of knowledge and understanding requirements	19
	Appeals	19
	Dealing with malpractice	19
	Reasonable adjustments to assessment	21
	Special consideration	22

10 Centre recognition and approval	23
Centre recognition	23
Approvals agreement	23
11 Quality assurance	24
12 Unit format	25
Unit title	25
Level	25
Guided learning hours	25
Unit overview	25
Specific unit requirements	25
Assessment requirements	25
Additional information	25
Performance requirements	25
Skills	26
Knowledge and understanding	26
Unit 1: Complying with Statutory Regulations and Organisational Safety Requirements	27
Unit 2: Working Efficiently and Effectively in an Engineering Environment	33
Unit 3: Using and Communicating Technical Information	40
Unit 4: Conducting Business Improvement Activities	46
Unit 5: Producing Components using Hand Fitting Techniques	52
Unit 6: Maintaining Mechanical Devices and Equipment	60
Unit 7: Assembling and Testing Fluid Power Systems	67
Unit 8: Maintaining Fluid Power Equipment	74
Unit 9: Maintaining Electrical Equipment/Systems	82
Unit 10: Wiring and Testing Electrical Equipment and Circuits	89
Unit 11: Wiring and Testing Programmable Controller Based Systems	98
Unit 12: Producing Mechanical Assemblies	106
Unit 13: Preparing and using Lathes for Turning Operations	113
Unit 14: Preparing and using Milling Machines	121
Unit 15: Preparing and using Semi-Automatic MIG, MAG and Flux Cored Arc Welding Equipment	128
Unit 16: Assembling and Testing Electronic Circuits	136
Unit 17: Maintaining Electronic Equipment/Systems	145
Unit 18: Preparing and using Industrial Robots	154
Unit 19: General Turning, Milling and Welding Applications	161

Unit 20:	Forming and Assembling Pipework Systems	171
Unit 21:	Preparing and Proving CNC Machine Tool Programs	179
Unit 22:	Producing Sheet Metal Components and Assemblies	186
Unit 23:	Maintaining and Testing Process Instrumentation and Control Devices	194
Unit 24:	Producing Components by Rapid Prototyping Techniques	201
Unit 25:	Wiring and Testing Vehicle Electrical Equipment and Circuits	207
Unit 26:	Maintaining Vehicle Electrical Equipment/Systems	215
Unit 27:	Diagnosing and Rectifying Faults on Vehicle Systems	221
Unit 28:	Stripping and Rebuilding Vehicle Engines	228
Unit 29:	Using Computer Software Packages to Assist with Engineering Activities	235
Unit 30:	Producing CAD Models (Drawings) using a CAD System	241
Unit 31:	Producing Electrical or Electronic Engineering Drawings using a CAD System	248
Unit 32:	Producing Engineering Project Plans	256
Unit 33:	Carrying Out Heat Treatment of Engineering Materials	263
Unit 34:	Carrying out Aircraft Detail Fitting Activities	271
Unit 35:	Installing Aircraft Mechanical Fasteners	279
Unit 36:	Producing Composite Mouldings using Pre-Preg Techniques	285
Unit 37:	Carrying out Repairs on Composite Mouldings	294
13	Further information and useful publications	301
14	Professional development and training	302
15	Contact us	303
	Annexe A: Assessment Strategy	305

1 Introducing the New Apprenticeships in England

Background

The government has produced an implementation plan¹ for the future of Apprenticeships in England, following the Richard Review (2012)². The implementation plan includes changes that move the design of Apprenticeships into the hands of employers to make Apprenticeships more rigorous and responsive to employers' needs. Employers will undertake the design of an Apprenticeship for each occupation where they identify the need for apprentices.

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

All new employer-designed Apprenticeships will:

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

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

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

2 Apprenticeship overview

The qualification in this specification relates to two Apprenticeship Standards in the automotive sector: Mechatronics Maintenance Technician and Product Design and Development Technician.

The Mechatronics Maintenance Technician Apprenticeship

This Apprenticeship is designed for those intending to work in the Mechatronics Maintenance Technician role. People in this role ensure that plant and equipment perform to the required standard to facilitate production targets in terms of safety, quality, delivery and cost in high value manufacturing environments. This requires the application of a complex blend of skills, knowledge and occupational behaviours across the electrical, electronic, mechanical, fluid power and control systems disciplines.

The Apprenticeship Standard requires people working in this role to:

- carry out installation, testing, fault finding and on-going planned maintenance of complex automated equipment, including mechanical, fluid and pneumatic power, process control and electric and electronic
- comply with statutory regulations and organisational safety requirements
- use and interpret a range of engineering data sources and supporting documentation
- utilise lean techniques to improve efficiency and effectiveness
- carry out complex fault diagnosis and repair on high-technology engineered systems
- minimise machinery downtime by carrying out preventative planned maintenance
- carry out confirmation testing and subsequent smooth hand over of equipment and plant.

This Apprenticeship is supported by the Institution of Mechanical Engineering (IMechE) .

The Product Design and Development Technician Apprenticeship

This Apprenticeship is designed for those intending to work in the Product Design and Development Technician role. Product Design and Development Technicians work primarily on all stages of product creation and modification. They support activities ranging from early concept feasibility, design and development stages right through to final preparation for launch and customers. This includes working in concept studios, rapid prototyping, assembly, testing, validating and analysing performance.

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

- comply with statutory regulations and organisational safety requirements
- use and interpret a range of engineering data sources and supporting documentation
- organise work efficiently and effectively in engineering resources when completing tasks
- prepare and use lathes, milling, and other general or specialist high technology
- produce assemblies and rigs using a range of materials and techniques and components and prototypes using a wide range of hand fitting techniques
- apply and test mechanical, electrical and electronic devices and equipment
- engineering project planning within the prototyping context and business improvement planning
- apply:
 - mechanical principles and joining techniques to, products, devices and equipment
 - electrical and electronic principles to products devices and equipment
 - latest advanced manufacturing technologies in product creation (such as 3D printing)
- maintain and test instrumentation within product devices
- identify, diagnose and rectify design problems through the whole creation process, including design studio, workshops, test environments and under laboratory conditions.

This Apprenticeship is supported by the Institution of Mechanical Engineering (IMechE).

Both Apprenticeship programmes are structured in two phases; Phase 1 being the Foundation Phase, equivalent to Level 2, and Phase 2 the Development Phase, equivalent to Level 3.

In line with the relevant Apprenticeship assessment plans, knowledge and competence qualifications have been developed at Levels 2 and 3 to meet the requirements of these two phases.

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

Phase	Type of qualification	Qualification title	Contribution % to the Apprenticeship
Foundation Phase	Competence (pass only)	Pearson BTEC Level 2 Diploma in Advanced Manufacturing Engineering (Foundation Competence)	5%
Development Phase	Competence (pass only)	Pearson BTEC Level 3 Diploma in Manufacturing Engineering (Development Competence)	10%
Foundation Phase	Technical knowledge (pass/merit/distinction)	Pearson Level 3 Certificate in Advanced Manufacturing Engineering	10%
Development Phase		Pearson Level 3 Diploma/Extended Diploma in Advanced Manufacturing Engineering	

In addition, other requirements of both Apprenticeship programmes include:

- assessment of behaviours – these are based on a newly-developed behavioural framework. Behaviours do not contribute to the overall standard at Level 2 but contribute 5% at Level 3
- Foundation Phase End Test – this is a scenario-based competency assessment likely to be completed over three days. It acts as a gateway from the Foundation to Development Phase. It contributes 5% to the overall standard
- end-point employer endorsement and sign off – this happens at the end of the Development Phase. It involves an end-point interview, to test the apprentice's full competence. It contributes 65% to the overall standard.

These Apprenticeships will be typically between 36 – 48 months in duration.

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

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

The published Mechatronics Maintenance Technician Apprenticeship Standard and Assessment Plan can be found at:

<https://www.gov.uk/government/publications/apprenticeship-standard-mechatronics-maintenance-technician>

The published Product Design and Development Technician Apprenticeship Standard and Assessment Plan can be found at:

<https://www.gov.uk/government/publications/apprenticeship-standard-product-design-and-development-technician>

Qualification size

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

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

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

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

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

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

3 Qualification key information

Qualification title	Pearson BTEC Level 2 Diploma in Advanced Manufacturing Engineering (Foundation Competence)
Qualification Number (QN)	601/7389/0
Regulation start date	24/08/2015
Operational start date	01/09/2015
Approved age ranges	16–18 19+ Please note that sector-specific requirements or regulations may prevent learners of a particular age from embarking on this qualification. Please refer to the Apprenticeship Assessment Plan and Assessment Strategy
Assessment	Portfolio of Evidence (internal assessment)
Guided learning hours	830
Total Qualification Time	830
Grading information	The qualification and units are graded pass/fail
Entry requirements	There are no entry requirements required for this qualification other than any legal requirements of the process or the environment in which the learner is working. Assessment is open to any learner who has the potential to reach the assessment requirements set out in the relevant units Centres must also follow the Pearson Access and Recruitment policy (see <i>Section 8 Access and recruitment</i>)
Funding	The Trailblazer Apprenticeship funding rules can be found on the Skills Funding Agency's website at: www.gov.uk/government/collections/sfa-funding-rules

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

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

4 Qualification purpose

Qualification objective

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

The qualification is for learners employed as an apprentice in either the role of Mechatronics Maintenance Technician or Product Design and Development Technician.

It gives learners the opportunity to:

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

The units in the qualification are based on the *Employer Units of Competence* (EUCs) that set out the skills, technical knowledge and understanding, and the behaviours needed in employment in either the role of Mechatronics Maintenance Technician or Product Design and Development Technician in the automotive sector.

Progression opportunities

Learners who achieve the Pearson BTEC Level 2 Diploma in Advanced Manufacturing Engineering (Foundation Competence) will have achieved 5% of the overarching Mechatronics Maintenance Technician or Product Design and Development Support Technician Apprenticeship requirements. On completion of the other Foundation Phase requirements, learners can progress to the Level 3 Development Phase and achieve the full Apprenticeship certification, which confirms competency in the stated job roles and enables career progression over time within the engineering industry.

Also on completing their Apprenticeship, learners can apply for EngTech certification. Learners who have achieved the qualification and not completed the full Apprenticeship could progress to Engineering Operative or Semi-skilled Fitter job roles within the engineering industry or to other qualifications such as the Pearson Edexcel Level 3 NVQ Diploma in Engineering Maintenance and the Pearson BTEC Level 3 Foundation Diploma in Engineering.

Industry support and recognition

This qualification is supported by:

- the Automotive Apprenticeship Employer Group, which includes: BMW Group UK, EEF, Ford, GTA England, Jaguar Land Rover, Siemens, Toyota Manufacturing UK, Vauxhall Motors
- Professional Engineering Institutions: the Institution of Mechanical Engineering (IMechE)
- SEMTA, the Skills Council for the engineering sector
- the National Forum of Engineering Centres (NFEC).

5 Qualification structure

Pearson BTEC Level 2 Diploma in Advanced Manufacturing Engineering (Foundation Competence)

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

Minimum number of GLH that must be achieved	830
Number of mandatory units that must be achieved	4
Minimum number of optional units that must be achieved	6

Unit No.	Mandatory units	Level	Guided learning hours
Learners must complete all four mandatory units in this group.			
1	Complying with Statutory Regulations and Organisational Safety Requirements	2	50
2	Working Efficiently and Effectively in an Engineering Environment	2	50
3	Using and Communicating Technical Information	2	40
4	Conducting Business Improvement Activities	2	80

Unit No.	Optional units	Level	Guided learning hours
Learners must complete a minimum of six units in this group.			
5	Producing Components using Hand Fitting Techniques	2	140
6	Maintaining Mechanical Devices and Equipment	2	140
7	Assembling and Testing Fluid Power Systems	2	140
8	Maintaining Fluid Power Equipment	2	140
9	Maintaining Electrical Equipment/Systems	2	150
10	Wiring and Testing Electrical Equipment and Circuits	2	140
11	Wiring and Testing Programmable Controller Based Systems	2	150
12	Producing Mechanical Assemblies	2	150
13	Preparing and Using Lathes for Turning Operations – <i>cannot be taken with Unit 19</i>	2	150
14	Preparing and using Milling Machines – cannot be taken with Unit 19	2	150
15	Preparing and using Semi-Automatic MIG, MAG and Flux Cored Arc Welding Equipment – cannot be taken with Unit 19	2	150
16	Assembling and Testing Electronic Circuits	2	140
17	Maintaining Electronic Equipment/Systems	2	150
18	Preparing and using Industrial Robots	2	140
19	General Turning, Milling and Welding Applications – cannot be taken with Units 13, 14 or 15	2	180
20	Forming and Assembling Pipework Systems	2	140
21	Preparing and Proving CNC Machine Tool Programs	2	140
22	Producing Sheet Metal Components and Assemblies	2	140
23	Maintaining and Testing Process Instrumentation and Control Devices	2	150
24	Producing Components by Rapid Prototyping Techniques	2	110
25	Wiring and Testing Vehicle Electrical Equipment and Circuits	2	140
26	Maintaining Vehicle Electrical Equipment/Systems	2	150
27	Diagnosing and Rectifying Faults on Vehicle Systems	2	150
28	Stripping and Rebuilding Vehicle Engines	2	140
29	Using Computer Software Packages to Assist with Engineering Activities	2	80

Unit No.	Optional units	Level	Guided learning hours
30	Producing CAD Models (Drawings) using a CAD System – cannot be taken with Unit 31	2	110
31	Producing Electrical or Electronic Engineering Drawings using a CAD System – cannot be taken with Unit 30	2	110
32	Producing Engineering Project Plans	2	80
33	Carrying Out Heat Treatment of Engineering Materials	2	90
34	Carrying out Aircraft Detail Fitting Activities	2	175
35	Installing Aircraft Mechanical Fasteners	2	105
36	Producing Composite Mouldings using Pre-Preg Techniques	2	140
37	Carrying out Repairs on Composite Mouldings	2	105

Employer requirements

The optional units are a minimum requirement. Employers may require learners to achieve more units in order to meet their specific business needs.

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

Employer-recommended unit options and combinations

Please read the employer-recommended unit options and combinations for each of the Apprenticeship Standards and the unit-barring rules set out in the structure table.

This qualification is flexible to allow it to be used for different Apprenticeship Standards in the sector. Recommendations from employers for the different standards are given below.

Mechatronics Maintenance Technician Apprenticeship Standard

Learners should complete **all** the following units:

Unit 5: Producing Components using Hand Fitting Techniques

Unit 6: Maintaining Mechanical Devices and Equipment

Unit 8: Maintaining Fluid Power Equipment

Unit 9: Maintaining Electrical Equipment/Systems

Unit 10: Wiring and Testing Electrical Equipment and Circuits

Unit 11: Wiring and Testing Programmable Controller Based Systems

Plus a minimum of **two** units from the following:

Unit 7: Assembling and Testing Fluid Power Systems

Unit 12: Producing Mechanical Assemblies

Unit 13: Preparing and using Lathes for Turning Operations

Unit 14: Preparing and using Milling Machines

Unit 15: Preparing and using Semi-Automatic MIG, MAG and Flux Cored Arc Welding Equipment

Unit 16: Assembling and Testing Electronic Circuits

Unit 17: Maintaining Electronic Equipment/Systems

Unit 18: Preparing and using Industrial Robots

Unit 19: General Turning, Milling and Welding Applications

Unit 20: Forming and Assembling Pipework Systems

Product Design and Development Technician Apprenticeship Standard

Learners should complete **all** the following units:

Unit 5: Producing Components using Hand Fitting Techniques

Unit 6: Maintaining Mechanical Devices and Equipment

Unit 19: General Turning, Milling and Welding Applications

Unit 32: Producing Engineering Project Plans

6 Programme delivery

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

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

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

Elements of good practice

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

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

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

For further information on the delivery and assessment of the New Apprenticeships please refer to *The Trailblazer Apprenticeship Funding Rules* at: www.gov.uk/government/collections/sfa-funding-rules

7 Centre resource requirements

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

General resource requirements

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

8 Access and recruitment

Our policy on access to our qualifications is that:

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

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

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

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

Prior knowledge, skills and understanding

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

Access to qualifications for learners with disabilities or specific needs

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

We are committed to making sure that:

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

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

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

9 Assessment

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

Language of assessment

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

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

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

Internal assessment

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

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

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

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

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

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

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

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

Assessment Strategy

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

Types of evidence

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

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

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

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

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

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

Assessment of knowledge and understanding requirements

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

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

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

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

Appeals

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

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

Dealing with malpractice

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

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

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

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

Internal assessment

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

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

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

External assessment

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

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

Learner malpractice

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

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

Teacher/centre malpractice

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

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

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

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

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

Sanctions and appeals

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

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

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

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

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

The centre will be notified if any of these apply.

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

Reasonable adjustments to assessment

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

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

Both documents are on our website.

Special consideration

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

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

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

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

Both of the documents mentioned above are on our website.

10 Centre recognition and approval

Centre recognition

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

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

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

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

Approvals agreement

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

11 Quality assurance

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

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

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

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

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

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

12 Unit format

Each unit has the following sections.

Unit title

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

Level

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

Guided learning hours

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

Unit overview

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

Specific unit requirements

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

Assessment requirements

Outlines the assessment requirements for each unit.

Additional information

Gives any additional information on the unit.

Performance requirements

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

Skills

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

Knowledge and understanding

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

Unit 1: **Complying with Statutory Regulations and Organisational Safety Requirements**

Level: 2

Guided learning hours: 18

Unit overview

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

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

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

Their responsibilities will require them to comply with organisational policy and procedures for the statutory regulations and organisational safety activities undertaken, and to report any problems with the safety activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. 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.

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety and 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

The learner must be able to:

1. Demonstrate their duties and obligations to health and safety by carrying out **all** of the following:
 - 1.1 applying, in principle, their duties and responsibilities as an individual under the Health and Safety at Work Act and other relevant current legislation
 - 1.2 identifying, within their working environment, appropriate sources of information and guidance on health and safety issues, to include eye protection and personal protective equipment (PPE), COSHH regulations and risk assessments
 - 1.3 identifying the warning signs and labels of the main groups of hazardous or dangerous substances
 - 1.4 complying with the appropriate statutory regulations at all times and specified regulations to their work
2. Comply with **all** emergency requirements, to include:
 - 2.1 identifying the appropriate qualified first aiders or appointed person and the location of first aid facilities
 - 2.2 identifying the procedures to be followed in the event of injury to themselves or others
 - 2.3 following organisational procedures in the event of fire/fire drills and the evacuation of premises/work area
 - 2.4 identifying the procedures to be followed in the event of dangerous occurrences or hazardous malfunctions of equipment, processes or machinery

Skills

The learner must be able to:

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

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

Plus **one** from:

 - 4.2 with assistance of others
 - 4.3 with mechanical assistance

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

Knowledge and understanding

The learner must:

- K1 Describe the roles and responsibilities of themselves and others under the Health and Safety at Work Act 1974 and other current legislation (e.g. The Management of Health and Safety at Work Regulations; Workplace Health and Safety and Welfare Regulations; Personal Protection at Work Regulations; Manual Handling Operations Regulations; Provision and Use of Work Equipment Regulations; Display Screen at Work Regulations)
- K2 Describe the specific regulations, environmental requirements, safe working practices and procedures that apply to their work activities
- K3 Explain the importance of applying the appropriate behaviours in the workplace and the implications for both the learner and the business if these are not adhered to

Knowledge and understanding

The learner must:

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

Knowledge and understanding

The learner must:

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

Unit 2: Working Efficiently and Effectively in an Engineering Environment

Level: 2

Guided learning hours: 18

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to carry out all necessary preparations within the scope of their responsibility prior to undertaking the engineering activity. This will include preparing the work area and ensuring that it is in a safe condition to carry out the intended activities, 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.

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

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

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

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

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety and environmental legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives/values
- P3 Plan the engineering activities before they start them
- P4 Prepare the work area for carrying out the engineering activity
- P5 Obtain all necessary tools and equipment and check that they are in a safe and usable condition
- P6 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
- P7 Maintain effective working relationships with colleagues and supervisors
- P8 Review personal training and development, as appropriate to the job role
- P9 Clean, tidy up and restore the work area on completion of the engineering activity

Skills

The learner must be able to:

1. Ensure that they apply all of the following checks and practices at **all** times during the engineering activities:
 - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
 - 1.2 wear the appropriate personal protective equipment for the work area and specific activity being carried out
 - 1.3 use all tools and equipment safely and correctly, and only for their intended purpose including adherence to the Control of Vibration at Work Regulations (Hand and Arm)
 - 1.4 ensure that the work area is maintained and left in a safe and tidy condition
2. Create and maintain effective working relationships and behaviours, to include carrying out and demonstrating **all** of the following:
 - 2.1 maintains a consistently good record of punctuality and attendance in accordance with company policy
 - 2.2 always suitably dressed for the activities to be undertaken
 - 2.3 follows both verbal and written instructions provided, seeking additional information, clarification or assistance where necessary in a courteous and polite manner
 - 2.4 able to take advice from others in a positive way

Skills

The learner must be able to:

- 2.5 makes a positive contribution to any discussions
 - 2.6 flexible in their approach to work, responding positively to any agreed amendments or changes
 - 2.7 communicates with others using clear, accurate and appropriate language
 - 2.8 demonstrates an open and honest approach, showing respect for the views, rights and property of others including the values of diversity and equality
 - 2.9 demonstrates a willingness to help others when working towards a common team objective
 - 2.10 able to work to targets and deadlines
3. Prepare for the specific engineering activity, by producing work plans which includes **all** of the following as applicable to the processes being undertaken:
- 3.1 documentation required (such as drawings and diagrams, technical/reference/maintenance documents, imperial to metric conversion books, component specifications, maintenance standard operating procedures)
 - 3.2 materials required (such as stock material, components, part-machined components, cables/wire, welding consumables)
 - 3.3 equipment required (such as machine tools to be used, lifting and handling equipment, anti-static equipment, test equipment)
 - 3.4 workholding methods and equipment (such as machine or bench vice, clamps, special workholding arrangements), where appropriate
 - 3.5 tools required (such as hand tools, portable power tools, cutting tools)
 - 3.6 measuring/test equipment required (such as mechanical, electrical, pressure, flow, level, speed, sound)
 - 3.7 the operating sequence to be followed
 - 3.8 timescale required to complete the engineering operations
4. Prepare to carry out the engineering activity, ensuring **all** of the following, as applicable to the work to be undertaken:
- 4.1 the work area is free from hazards and is suitably prepared for the activities to be undertaken
 - 4.2 any required safety procedures are implemented
 - 4.3 any necessary personal protection equipment is obtained, and is in a usable condition
 - 4.4 all necessary drawings, specifications and associated documents are obtained
 - 4.5 job instructions are obtained and understood

Skills

The learner must be able to:

- 4.6 the correct materials or components are obtained
- 4.7 appropriate authorisation to carry out the work is obtained
5. Complete the work activities, to include **all** of the following:
 - 5.1 returning tools and equipment to the designated location
 - 5.2 returning drawings and work instructions
 - 5.3 disposing of waste materials, in line with organisational and environmental requirements
 - 5.4 completing all necessary documentation accurately and legibly
 - 5.5 identifying, where appropriate, any damaged or unusable tools or equipment
6. Recognise and deal with problems affecting the engineering activity, to include **four** of the following:
 - 6.1 materials
 - 6.2 job specification
 - 6.3 timescales
 - 6.4 tools and equipment
 - 6.5 quality
 - 6.6 safety
 - 6.7 drawings
 - 6.8 people
 - 6.9 work activities or procedures
7. Contribute to developing their own engineering competence, to include **all** of the following:
 - 7.1 describing the levels of skill, knowledge and understanding needed for competence in the areas of work expected of them
 - 7.2 describing their development objectives/program, and how these were identified
 - 7.3 providing information on their expectations and progress towards their identified objectives
 - 7.4 using feedback and advice to improve their personal performance

Knowledge and understanding

The learner must:

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

Knowledge and understanding

The learner must:

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

Unit 3: Using and Communicating Technical Information

Level: 2

Guided learning hours: 18

Unit overview

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

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

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

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

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

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

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Use the approved source to obtain the required data, documentation or specifications
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 Extract and interpret information from engineering drawings and other related documentation
- P4 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

The learner must be able to:

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

Skills

The learner must be able to:

- 2.7 modification drawings
 - 2.8 operational diagrams
 - 2.9 fluid power drawings
 - 2.10 sub-assembly drawings
 - 2.11 physical layouts
 - 2.12 wiring/circuit diagrams
 - 2.13 schematic diagrams
 - 2.14 manufacturers' manuals/drawings
 - 2.15 installation drawings
 - 2.16 fabrication drawings
 - 2.17 photographic representations
 - 2.18 approved sketches
3. Use information extracted from related documentation, to include **four** from the following:
- 3.1 Standard Operating Procedures (SOPs)
 - 3.2 job instructions
 - 3.3 material specifications
 - 3.4 planning documentation
 - 3.5 drawing instructions
 - 3.6 finishing specifications
 - 3.7 quality control documents
 - 3.8 test schedules
 - 3.9 reference tables/charts
 - 3.10 operation sheets
 - 3.11 manufacturers' instructions
 - 3.12 national, international and organisational standards
 - 3.13 process specifications
 - 3.14 welding procedure specifications
 - 3.15 performance parameters
4. Extract information that includes **eight** of the following:
- 4.1 materials or components required
 - 4.2 surface finish required
 - 4.3 dimensions

Skills

The learner must be able to:

- 4.4 location/orientation of parts
 - 4.5 weld type and size
 - 4.6 tolerances
 - 4.7 process or treatments required
 - 4.8 operations required
 - 4.9 build quality
 - 4.10 assembly sequence
 - 4.11 shape or profiles
 - 4.12 installation requirements
 - 4.13 inspection requirements
 - 4.14 test points to be used
 - 4.15 connections to be made
 - 4.16 part numbers for replacement parts
 - 4.17 circuit characteristics (such as pressure, flow, current, voltage, speed)
 - 4.18 maintenance requirements
5. Produce, record and communicate technical information, using the following method:
- 5.1 producing fully detailed drawings or sketches of work/circuits completed or required to the relevant standard (such as BS888)
- Plus **two** more from the following:
- 5.2 preparing work planning documentation
 - 5.3 recording data from testing activities
 - 5.4 producing technical reports on activities they have completed
 - 5.5 completing material and tool requisition documentation
 - 5.6 producing a list of replacement parts required for a maintenance activity
 - 5.7 completing training records or portfolio references

Knowledge and understanding

The learner must:

- K1 State the information sources used for the data and documentation that they use in their work activities (such as verbal, written, electronic)
- K2 Describe why technical information is presented in different forms (such as drawings, data sheets, and national and international standards)

Knowledge and understanding

The learner must:

- K3 Describe 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
- K4 Compare 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)
- K5 Describe 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)
- K6 Identify 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)
- K7 Describe the procedures for reporting discrepancies in the data or documents, and for reporting lost or damaged drawings and documents
- K8 State 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
- K9 Describe 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
- K10 Describe the need to ensure that sketches are of a suitable size, use appropriate drawing conventions, are in proportion and are legible to others
- K11 State why it is important to use a fixed common reference point for dimensioning of drawings and sketches
- K12 Describe why they should always seek clarification if they are in any doubt as to the validity or suitability of the information they have gathered
- K13 Identify to whom they should report in the event of problems that they cannot resolve

Unit 4: Conducting Business Improvement Activities

Level: 2

Guided learning hours: 70

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to conduct a business improvement activity using a systematic Plan, Do, Check, Act (PDCA) 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.

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

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

Skills

The learner must be able to:

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

Skills

The learner must be able to:

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

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

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

Plus **one** more of the following:

 - 4.3 parts per operator hour (PPOH)
 - 4.4 overall equipment effectiveness (OEE)
 - 4.5 value added per person (VAPP)
 - 4.6 stock turns

Skills

The learner must be able to:

- 4.7 cost breakdown in term of labour, material and overhead
 - 4.8 floor space utilization (FSU)
 - 5. Record and present the records from business improvement activities to the appropriate people using:
 - 5.1 verbal report using visual aids such as flipcharts and Whiteboards
- Plus **one** more method from the following:
- 5.2 written or typed report
 - 5.3 computer-based presentation
 - 5.4 specific company documentation

Knowledge and understanding

The learner must:

- K1 Describe the health and safety requirements of the area in which they are carrying out the business improvement activities
- K2 Explain the importance of following a systematic Plan, Do, Check, Act (PDCA) approach to problem-solving and business improvement
- K3 Outline the implications of not taking account of legislation, regulations, standards and guidelines when conducting business improvement activities
- K4 Explain the importance of applying the appropriate behaviours in the workplace and the implications for both the learner and the business if these are not adhered to
- K5 Describe what is meant by business improvement, and how continuous improvement activities can benefit a company
- K6 Outline the application of the seven key measures of competitiveness (delivered right first time, delivery schedule achievement, people productivity, stock turns, overall equipment effectiveness, value added per person, floor space utilisation)
- K7 Describe how to obtain and interpret information on the engineering/manufacturing operation or process requirements (e.g. customer specifications and instructions, quality control requirements, product drawings/specification, methods and techniques to be used)
- K8 Explain the eight wastes (overproduction, inventory, transport, over-processing, waiting time, operator motion, bad quality, failure to exploit human potential) and how to eliminate these forms of waste in a process or operation
- K9 Explain the steps in a 5S/5C audit and a 'red tag' exercise and describe how to carry them out
- K10 Explain how to score and audit the 5S/5C exercise
- K11 Explain the importance of arranging and labelling the necessary equipment for rapid identification and access

Knowledge and understanding

The learner must:

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

Unit 5: Producing Components using Hand Fitting Techniques

Level: 2

Guided learning hours: 175

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to prepare 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 unit requirements

In order to prove their ability to combine different fitting operations, at least one of the components produced must be of a significant nature, and must have a minimum of **five** of the features listed in paragraph 6 of the *Skills* section.

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

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

Skills

The learner must be able to:

1. Carry out **all** of the following during the hand fitting activities:
 - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
 - 1.2 follow job instructions, assembly drawings and procedures
 - 1.3 ensure that all power tool cables, extension leads or air supply hoses are in a serviceable condition
 - 1.4 check that all measuring equipment is within calibration date
 - 1.5 ensure that the components used are free from foreign objects, dirt or other contamination
 - 1.6 return all tools and equipment to the correct location on completion of the fitting activities
2. Mark out a range of material forms, to include **two** of the following:
 - 2.1 square/rectangular (such as bar stock, sheet material, machined components)
 - 2.2 circular/cylindrical (such as bar stock, tubes, turned components, flat discs)
 - 2.3 sections (such as angles, channel, tee section, joists, extrusions)
 - 2.4 irregular shapes (such as castings, forgings, odd shaped components)

Skills

The learner must be able to:

3. Use a range of marking out equipment/methods, to include **all** of the following:
 - 3.1 rules
 - 3.2 scribes
 - 3.3 dividers/trammels
 - 3.4 centre punches
 - 3.5 squares
 - 3.6 vernier instruments (such as height gauges)Plus **one** from the following:
 - 3.7 templates
 - 3.8 protractor

4. Mark out workpieces which include **all** of the following features:
 - 4.1 datum/centre lines
 - 4.2 circles
 - 4.3 linear hole positions
 - 4.4 square/rectangular profiles
 - 4.5 radial profiles
 - 4.6 angles/angular profiles
 - 4.7 radial hole positions

5. Use **all** of the following hand fitting activities:
 - 5.1 filing
 - 5.2 hand sawing
 - 5.3 power sawing
 - 5.4 off-hand grinding (must include grinding drills)

6. Produce components which combine different operations and have features that cover **all** of the following:
 - 6.1 flat datum faces
 - 6.2 drilled through holes
 - 6.3 internal threads
 - 6.4 faces which are square to each other
 - 6.5 reamed holes
 - 6.6 external threads
 - 6.7 curved profiles

Skills

The learner must be able to:

- 6.8 faces that are parallel to each other
 - 6.9 chamfers and radii
 - 6.10 faces angled to each other
 - 6.11 counterbore, countersink, or spot face
 - 6.12 holes drilled to a depth
 - 6.13 sliding or mating parts (if appropriate)
7. Cut and shape **all** of the following materials:
- 7.1 ferrous
 - 7.2 non-ferrous
 - 7.3 non-metallic
8. Carry out the necessary checks for accuracy, to include **all** of the following:
- 8.1 linear dimensions
 - 8.2 hole position
 - 8.3 flatness
 - 8.4 hole size/fit
 - 8.5 squareness
 - 8.6 depths
 - 8.7 angles
 - 8.8 thread size and fit
 - 8.9 profiles
 - 8.10 surface finish
9. 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

Skills

The learner must be able to:

- 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)
10. Produce components to **all** of the following standards, as applicable to the process:
- 10.1 components to be free from false tool cuts, burrs and sharp edges
 - 10.2 general dimensional tolerance $\pm 0.25\text{mm}$ or $\pm 0.010''$
 - 10.3 there must be one or more specific dimensional tolerances within $\pm 0.1\text{mm}$ or $\pm 0.004''$
 - 10.4 flatness and squareness 0.05mm per 25mm or $0.002''$ per inch
 - 10.5 angles within ± 1 degree
 - 10.6 screw threads to BS Medium fit
 - 10.7 reamed within H8
 - 10.8 surface finish $63 \mu\text{in}$ or $1.6 \mu\text{m}$

Knowledge and understanding

The learner must:

- K1 Describe the health and safety requirements and safe working practices and procedures required for the hand fitting activities undertaken
- K2 Identify 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
- K3 Describe how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken
- K4 Describe how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
- K5 Describe how to convert metric systems of measurement to imperial and vice versa

Knowledge and understanding

The learner must:

- K6 Describe 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 Describe 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 Identify 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)
- K9 Describe 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)
- K10 Identify ways of laying out the marking out shapes or patterns to maximise use of materials
- K11 Describe the need for clear and dimensional accuracy in marking out to specification and drawing requirements
- K12 Identify setting and adjusting tools (such as squares, protractors and verniers)
- K13 Describe 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
- K14 Identify the cutting and shaping methods to be used, and the sequence in which the operations are to be carried out
- K15 Describe the methods and techniques to hand grind drills for different applications
- K16 Identify the various types of file that are available, and the cut of files for different applications
- K17 Describe the importance of ensuring that file handles are secure and free from embedded foreign bodies or splits
- K18 Describe how to prepare the components for the filing operations (cleaning, de-burring, marking out)
- K19 Describe the use of vice jaw plates to protect the workpiece from damage
- K20 Describe 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)
- K21 Identify how to select saw blades for different materials, and how to set the saw blades for different operations (such as cutting externally and internally)
- K22 Describe how to cut external threads using hand dies, and the method of fixing and adjusting the dies to give the correct thread fit
- K23 Describe how to determine the drill size for tapped holes, and the importance of using the taps in the correct sequence

Knowledge and understanding

The learner must:

- K24 Describe 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)
- K25 Describe 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
- K26 State how to produce a sliding or mating fit using by filing
- K27 Describe 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)
- K28 Describe 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 6: Maintaining Mechanical Devices and Equipment

Level: 2

Guided learning hours: 175

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to prepare 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 'lived' items, setting, aligning and adjusting components, tightening fasteners to the required torque and making 'off-load' checks of the maintained equipment.

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

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

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

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

Specific unit requirements

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

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

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

Skills

The learner must be able to:

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

Skills

The learner must be able to:

- 2.4 pumps
 - 2.5 compressors
 - 2.6 processing plant
 - 2.7 transfer equipment
 - 2.8 workholding devices
 - 2.9 process control valves
 - 2.10 mechanical structures
 - 2.11 lifting and handling equipment
 - 2.12 company-specific equipment
3. Use **six** of the following maintenance diagnostic techniques, tools and aids:
- 3.1 fault finding techniques (such as half-split, input/output, unit substitution)
 - 3.2 diagnostic aids (such as manuals, flow charts, troubleshooting guides, maintenance records)
 - 3.3 information gathered from fault reports
 - 3.4 visual checks (such as signs of leakage, damage, missing parts, wear/deterioration)
 - 3.5 alignment checks
 - 3.6 movement checks (such as excessive movement or clearance, loose fittings and connections)
 - 3.7 force/pressure checks (such as spring pressure, belt or chain tension)
 - 3.8 overheating checks (such as bearings, friction surfaces)
 - 3.9 sensory input (such as sight, sound, smell, touch)
 - 3.10 information from monitoring equipment or gauges
 - 3.11 operating (such as manual operation, timing and sequencing)
 - 3.12 test instrumentation measurement (such as pressure, flow, timing, sequence, movement)
 - 3.13 measuring instruments (such as dial test indicators, torque measuring devices, feeler gauges)
4. Carry out **all** of the following maintenance activities:
- 4.1 dismantling equipment to unit/sub-assembly level
 - 4.2 setting, aligning and adjusting replaced components
 - 4.3 dismantling units to component level
 - 4.4 proof marking/labelling of components
 - 4.5 tightening fastenings to the required torque

Skills

The learner must be able to:

- 4.6 checking components for serviceability
- 4.7 making 'off-load' checks before starting up
- 4.8 replacing all 'lived' items (such as seals, bearings, gaskets)
- 4.9 replenishing oils and greases
- 4.10 replacing damaged/defective components
- 5. Remove and refit/replace a range of mechanical components, to include **twelve** of the following:
 - 5.1 shafts
 - 5.2 bearing
 - 5.3 seals
 - 5.4 slides
 - 5.5 couplings
 - 5.6 fitting keys
 - 5.7 rollers
 - 5.8 gears
 - 5.9 springs
 - 5.10 housings
 - 5.11 clutches
 - 5.12 diaphragms
 - 5.13 actuating mechanisms
 - 5.14 valves and seats
 - 5.15 cams and followers
 - 5.16 structural components
 - 5.17 pistons
 - 5.18 chains and sprockets
 - 5.19 locking and retaining devices (such as circlips, pins)
 - 5.20 brakes
 - 5.21 pulleys and belts
 - 5.22 splines
 - 5.23 levers and links
 - 5.24 other specific components
- 6. Carry out checks on the maintained equipment, to include **seven** of the following:
 - 6.1 freedom from damage and foreign objects
 - 6.2 correct operation of moving parts

Skills

The learner must be able to:

- 6.3 alignment
 - 6.4 correct working clearance of parts
 - 6.5 backlash in gears
 - 6.6 belt/chain tension
 - 6.7 bearing loading
 - 6.8 torque loading of fasteners
 - 6.9 completeness
 - 6.10 operational performance
 - 6.11 functionally test the system
7. Maintain mechanical equipment in compliance with **two** of the following:
- 7.1 organisational guidelines and codes of practice
 - 7.2 equipment manufacturers' operation range
 - 7.3 BS and/or ISO standards

Knowledge and understanding

The learner must:

- K1 Describe the health and safety requirements, and safe working practices and procedures required for the mechanical maintenance activities undertaken
- K2 Identify 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
- K3 Identify the system isolation procedures or permit-to-work procedure that applies
- K4 Describe how to obtain and interpret drawings, specifications, manufacturers' manuals and other documents needed in the maintenance process
- K5 Describe the procedure for obtaining drawings, job instructions, related specifications, replacement parts, materials and other consumables necessary for the maintenance activities
- K6 Describe 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
- K7 Describe the various maintenance diagnostic techniques and aids that can be used (such as fault reports, visual checks, measuring, movement and alignment checks, testing)

Knowledge and understanding

The learner must:

- K8 Identify 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 Describe how to evaluate sensory information (sight, sound, smell, touch)
- K10 Describe the sequence to be adopted for the dismantling/reassembly of various types of assemblies
- K11 Describe the methods and techniques used to dismantle/assemble mechanical equipment (such as release of pressures/force, proof marking, extraction, pressing, alignment)
- K12 Describe methods of checking that components are fit for purpose, and how to identify defects and wear characteristics
- K13 Describe the identification, application, fitting and removal of different types of bearings (such as roller, ring, thrust)
- K14 Identify methods and techniques of fitting keys and splines
- K15 Describe identification, application, fitting and removal of different types of gears
- K16 Describe how to correctly tension belts and chains
- K17 Describe the identification and application of different types of locking device
- K18 Compare methods of checking that removed components are fit for purpose, and the need to replace 'lified' items (such as seals and gaskets)
- K19 Describe the uses of measuring equipment (such as micrometers, verniers, run-out devices and other measuring devices)
- K20 Describe how to check that tools and equipment are free from damage or defect, are in a safe and usable condition, are within calibration, and are configured correctly for the intended purpose
- K21 Describe how to make adjustments to components/assemblies to ensure that they function correctly (such as setting working clearance, setting travel, setting backlash in gears, preloading bearings)
- K22 State the importance of making 'off-load' checks before running the equipment under power
- K23 State the importance of completing maintenance documentation and/or reports following the maintenance activity
- K24 Describe the problems associated with the mechanical maintenance activity, and how they can be overcome

Unit 7: Assembling and Testing Fluid Power Systems

Level: 2

Guided learning hours: 105

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to prepare for the assembly activities by obtaining all necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required assembly activities and the sequence of operations they intend to use. They will be required to select the appropriate equipment to use, based on the assembly operations to be carried out and the type of fluid power equipment being assembled, which will include hydraulic, pneumatic or vacuum systems.

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

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

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

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

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

Specific unit requirements

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

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 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

The learner must be able to:

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

Skills

The learner must be able to:

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

3. Produce fluid power assemblies that contain a range of components, including **all** of the following:
 - 3.1 hoses
 - 3.2 valves (such as mechanical, electrical or logic)
 - 3.3 cylinders/actuators

Plus **eight** more from the following:

 - 3.4 rigid pipework
 - 3.5 pumps (such as gear and vane)
 - 3.6 lubricators
 - 3.7 switches
 - 3.8 compressors
 - 3.9 pressure intensifiers
 - 3.10 sensors
 - 3.11 cables and wires
 - 3.12 accumulators
 - 3.13 regulators
 - 3.14 receivers
 - 3.15 gaskets and seals
 - 3.16 reservoirs/storage devices
 - 3.17 gauges/indicators
 - 3.18 filters
 - 3.19 motors
 - 3.20 coolers
 - 3.21 timers (electrical, pneumatic and mechanical)
 - 3.22 other specific components

4. Apply fluid power assembly methods and techniques to include all of the following:
 - 4.1 checking components for serviceability
 - 4.2 applying screw fastener locking devices
 - 4.3 positioning equipment/components

Skills

The learner must be able to:

- 4.4 tightening fastenings to the required torque
 - 4.5 aligning pipework and connections
 - 4.6 applying hose/cable clips and fasteners
 - 4.7 dressing and securing pipes and hoses
 - 4.8 making de-energised checks before filling and/or pressurising the system
 - 4.9 setting, aligning and adjusting system components
 - 4.10 securing by using mechanical fixings
5. Carry out quality checks, to include **all** of the following, using appropriate equipment:
- 5.1 the system is complete, as per specification
 - 5.2 connections to components are tightened to the required torque
 - 5.3 dimensions are within specification requirements
 - 5.4 components are correctly positioned
 - 5.5 pipework is free from ripple and creases
 - 5.6 components are correctly aligned
 - 5.7 electrical connections are correctly made (where applicable)
 - 5.8 direction and flow indicators on components are correct
 - 5.9 components are securely held in place
6. Carry out tests and adjustments on the assembled system, to include:
- 6.1 leak test
 - 6.2 operational performance
- Plus **two** more from the following:
- 6.3 pressure line pressure tests
 - 6.4 speed
 - 6.5 return line pressure test
 - 6.6 sequence
 - 6.7 flow
 - 6.8 contamination
7. Carry out **all** of the following checks to ensure the accuracy and quality of the tests carried out:
- 7.1 the test equipment is correctly calibrated
 - 7.2 the test equipment used is appropriate for the tests being carried out

Skills

The learner must be able to:

- 7.3 test procedures used are as recommended in the appropriate specifications
- 7.4 test readings are taken at the appropriate points, and where appropriate components are adjusted to give the required readings
- 7.5 test equipment is operated within its specification range
- 8. Produce fluid power assemblies which meet **all** of the following:
 - 8.1 all components are correctly assembled and aligned, in accordance with the specification
 - 8.2 moving parts are correctly adjusted and have appropriate clearances
 - 8.3 the system functions in line with the specification requirements (including that the system is working within the specified and safe operating pressures)
 - 8.4 the system is leak free

Knowledge and understanding

The learner must:

- K1 Explain the importance of keeping the work area safe and tidy
- K2 Describe the 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
- K3 Describe how to obtain and interpret drawings, charts, circuit and physical layouts, specifications, manufacturers' manuals, symbols used in fluid power, and other documents needed in the assembly activities
- K4 Explain the importance of applying the appropriate behaviours in the workplace and the implications for both the learner and the business if these are not adhered to
- K5 Describe 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 Outline the procedure for obtaining, components, materials and other consumables necessary for the assembly activities
- K7 State 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
- K8 Describe the different types of pipework/hoses, fittings and manifolds, and their application
- K9 Outline the identification and application of different types of valve (such as poppet, spool, piston, disc)
- K10 Outline the identification and application of different types of sensors and actuators (such as rotary, linear, mechanical, electrical)

Knowledge and understanding

The learner must:

- K11 Outline the identification and application of different types of cylinder (such as single acting, double acting)
- K12 Outline the identification and application of different types of pump (such as positive and non-positive displacement)
- K13 Outline the identification and application of different types compressors (such as screw, piston, rotary vane)
- K14 Outline the applications of static and dynamic seals
- K15 Describe 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)
- K16 Explain, where applicable, the need to ensure that pipework is supported at appropriate intervals, and the need to eliminate stress on the pipework connections
- K17 Explain the need to ensure cleanliness of the fluid power system, and the ways of purging pipework before connection to components and pressure sources
- K18 Outline the recognition of contaminants and the problems they can create, and the effects and likely symptoms of contamination in the system
- K19 Describe methods of testing the fluid power system, the types of test equipment to be used, and their selection for particular tests
- K20 Explain how to make safety checks of the system before carrying out tests, to ensure that all pipes and components are secure and that moving parts are chocked or parked
- K21 Explain how to connect suitably calibrated test equipment into the circuit, and how to connect the circuit to a suitable pressure source containing appropriate ancillary equipment
- K22 Explain 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)
- K23 Explain how to determine pressure settings, and their effect on the system
- K24 Explain how to display/record test results, and the documentation used
- K25 Explain how to interpret the test readings obtained, and the significance of the readings gained
- K26 Explain the importance of ensuring that test equipment is used only for its intended purpose and within its specified range and limits
- K27 Describe 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)
- K28 Outline when to act on their own initiative and when to seek help and advice from others
- K29 Explain the importance of leaving the work area in a safe and clean condition on completion of the assembly activities (such as, cleaning the work area, and removing and disposing of waste)

Unit 8: Maintaining Fluid Power Equipment

Level: 2

Guided learning hours: 105

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to prepare 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 'lived' items, setting and adjusting components, tightening fasteners to the required torque and making 'off-load' checks, before starting up and testing the maintained equipment, using appropriate techniques and procedures.

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

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

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

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

Specific unit requirements

In order to prove their ability to combine different maintenance operations, at least one of the fluid power maintenance activities must be of a significant nature, and must involve the removal and replacement/refitting of a minimum of **five** of the components listed in paragraph 6 of the *Skills* section.

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

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

Skills

The learner must be able to:

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

Skills

The learner must be able to:

3. Use **five** of the following maintenance diagnostic techniques, tools and aids:
 - 3.1 fault finding techniques (such as six point, half-split, input/output, unit substitution, emergent sequence)
 - 3.2 diagnostic aids (such as manuals, flow charts, troubleshooting guides, maintenance records)
 - 3.3 information gathered from fault reports
 - 3.4 inspecting (such as checking for damage, wear/deterioration, leaks, loose fittings and connections)
 - 3.5 sensory input (such as sight, sound, smell, touch)
 - 3.6 monitoring equipment or gauges
 - 3.7 operating the equipment (such as manual operation, timing and sequencing)
 - 3.8 test instrumentation measurement (such as pressure, flow, timing, sequence, movement)

4. Use **two** of the following types of fluid power test instruments:
 - 4.1 measuring devices
 - 4.2 flow indicators
 - 4.3 self-diagnostic equipment
 - 4.4 pressure indicators
 - 4.5 test rigs

5. Carry out **all** of the following maintenance activities:
 - 5.1 chocking/supporting cylinders/rams/components
 - 5.2 draining and removing fluids (as applicable)
 - 5.3 releasing stored energy
 - 5.4 disconnecting/removing hoses and pipes
 - 5.5 removing and replacing units/components (such as pumps, cylinders, valves, actuators)
 - 5.6 proof marking/labelling of removed components
 - 5.7 checking components for serviceability
 - 5.8 replacing damaged/defective components
 - 5.9 replacing all 'lifer' items (such as seals, filters, gaskets)
 - 5.10 tightening fastenings to the required torque
 - 5.11 setting, aligning and adjusting replaced components
 - 5.12 prime, bleed and recharge the system (as applicable)
 - 5.13 making de-energised checks before re-pressurising the system

Skills

The learner must be able to:

6. Remove and replace/refit a range of fluid power components, to include **all** of the following:
 - 6.1 pipework/hoses
 - 6.2 valves
 - 6.3 cylinders/actuatorsPlus **eight** of the following:
 - 6.4 reservoirs/storage devices
 - 6.5 pumps
 - 6.6 switches
 - 6.7 accumulators
 - 6.8 motors
 - 6.9 sensors
 - 6.10 pressure intensifiers
 - 6.11 gaskets and seals
 - 6.12 lubricators
 - 6.13 compressors
 - 6.14 pistons
 - 6.15 filters
 - 6.16 receivers
 - 6.17 spools
 - 6.18 cables and wires
 - 6.19 regulators
 - 6.20 gauges/indicators
 - 6.21 timers
 - 6.22 coolers
 - 6.23 other specific components

7. Carry out tests on the maintained equipment, to include **both** of the following:
 - 7.1 leak test
 - 7.2 operational performancePlus **two** from the following:
 - 7.3 pressure line pressure tests
 - 7.4 speed
 - 7.5 return line pressure test
 - 7.6 sequence

Skills

The learner must be able to:

- 7.7 flow
- 7.8 fluid contamination test
- 8. Carry out **all** of the following checks to ensure the accuracy and quality of the tests carried out:
 - 8.1 the test equipment is correctly calibrated
 - 8.2 the test equipment used is appropriate for the tests being carried out
 - 8.3 test procedures used are as recommended in the appropriate specifications
 - 8.4 test readings are taken at the appropriate points, and where appropriate components are adjusted to give the required readings
 - 8.5 test equipment is operated within its specification range
- 9. Maintain fluid power equipment in compliance with **two** of the following:
 - 9.1 organisational guidelines and codes of practice
 - 9.2 equipment manufacturers' operation range
 - 9.3 BS and/or ISO standards

Knowledge and understanding

The learner must:

- K1 Explain the importance keeping the work area safe and tidy
- K2 Describe the 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
- K3 Explain the system isolation procedures or permit-to-work procedure that applies
- K4 Explain the importance of applying the appropriate behaviours in the workplace and the implications for both the learner and the business if these are not adhered to
- K5 Describe 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
- K6 Outline the procedure for obtaining, replacement parts, materials and other consumables necessary for the maintenance activities
- 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 State 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

Knowledge and understanding

The learner must:

- K9 Describe the different types of pipework/hoses, fittings and manifolds, and their application
- K10 Outline the identification and application of different types of valve (such as poppet, spool, piston, disc)
- K11 Outline the identification and application of different types of sensors and actuators (such as rotary, linear, mechanical, electrical)
- K12 Outline the identification and application of different types of cylinder (such as single acting, double acting)
- K13 Outline the identification and application of different types of pump (such as positive and non-positive displacement)
- K14 Outline the identification and application of different types compressors (such as screw, piston, rotary vane)
- K15 Outline the applications of static and dynamic seals
- K16 Describe the techniques used to dismantle/assemble fluid power equipment (such as release of energy/force, proof marking, extraction)
- K17 Explain how to make adjustments to components/assemblies to ensure that they function correctly
- K18 Describe how to determine pressure settings, and their effect on the system
- K19 Outline the selection of fluids for the system
- K20 Outline the recognition of contaminants and the problems they can create, and the effects and likely symptoms of contamination in the system
- K21 Describe the various maintenance diagnostic techniques and aids that can be used (such as fault reports, visual checks, measuring, movement and alignment checks, testing)
- K22 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)
- K23 Explain how to evaluate sensory information (sight, sound, smell, touch)
- K24 Explain how to use a range of fault diagnostic equipment to investigate the problem
- K25 Describe the care, handling and application of mechanical measuring/test equipment (such as measuring instruments, pressure and flow indicators and self-diagnostic equipment)
- K26 Describe types of test equipment to be used, and their selection for particular tests
- K27 Explain how the test equipment is connected into the circuit, and the methods of doing this
- K28 Describe the techniques, methods and procedures to be used during the tests
- K29 Explain how to display/record test results, and the documentation used
- K30 Explain how to interpret the test readings obtained, and the significance of the readings gained

Knowledge and understanding

The learner must:

- K31 Explain the importance of ensuring that test equipment is used only for its intended purpose and within its specified range and limits
- K32 Describe the problems associated with maintaining fluid power equipment, and how they can be overcome (such as leaks, pressure fluctuation or pressure loss)
- K33 Outline when to act on their own initiative and when to seek help and advice from others
- K34 Explain the importance of leaving the work area in a safe and clean condition on completion of the maintenance activities (such, cleaning the work area, and removing and disposing of waste)

Unit 9: Maintaining Electrical Equipment/Systems

Level: 2

Guided learning hours: 175

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to prepare for the electrical maintenance activities by obtaining all necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required maintenance activities and the sequence of operations they intend to use.

They will be required to select the appropriate equipment to use, based on the maintenance operations to be carried out and the type of electrical equipment/systems being maintained. This will include electrical equipment that uses single, three-phase or direct current power supplies, and includes equipment such as control systems, motors and starters, switchgear and distribution panels, electrical plant, pumps, fans, alternators, generators, transformers, wiring enclosures and luminaires, portable appliances and other specific electrical equipment. They will be expected to use a variety of maintenance diagnostic techniques and procedures, such as gathering information from fault reports, using recognised fault finding techniques and diagnostic aids, measuring, inspecting and operating the equipment.

They will be expected to cover a range of maintenance activities, such as isolating and locking off, disconnecting, removing and reconnecting electrical components, wires and cables, attaching cable identification markers, replacing damaged or defective components, cables and wires, setting and adjusting components, and making 'off-load' checks before testing the equipment, using appropriate techniques and procedures.

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

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

They will understand the safety precautions required when carrying out the maintenance activities (especially those for ensuring that the equipment is correctly isolated), and when using maintenance tools and equipment. They will be required to demonstrate safe working practices throughout, and will understand their responsibility for taking the necessary safeguards to protect themselves and others in the workplace.

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

Specific unit requirements

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

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 Plan the maintenance activities before they start them
- P4 Obtain all the information they need for the safe removal and replacement of the equipment/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

The learner must be able to:

1. Carry out **all** of the following during the electrical maintenance activities:
 - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) 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
2. Carry out maintenance/repair activities on **four** of the following types of electrical equipment:
 - 2.1 electrical plant
 - 2.2 motors and starters
 - 2.3 transformers

Skills

The learner must be able to:

- 2.4 wiring enclosures
 - 2.5 heaters
 - 2.6 pumps
 - 2.7 portable appliances
 - 2.8 luminaires
 - 2.9 fans/blowers
 - 2.10 generators
 - 2.11 switchgear
 - 2.12 distribution panels
 - 2.13 other specific electrical equipment
3. Carry out maintenance/repair activities on **three** of the following electrical systems:
- 3.1 lighting circuits
 - 3.2 air conditioning control circuits
 - 3.3 power circuits
 - 3.4 refrigeration control circuits
 - 3.5 motor start and control circuits
 - 3.6 heating/boiler control circuits
 - 3.7 power generation and control circuits
 - 3.8 instrumentation and control circuits
 - 3.9 emergency lighting systems
 - 3.10 alarm systems (such as fire, intruder, process control)
 - 3.11 communication systems
 - 3.12 electro-pneumatic or electro-hydraulic control circuits
 - 3.13 computer systems
 - 3.14 other control circuits (such as pumps, fans, blowers, extractors)
 - 3.15 other specific electrical circuits
4. Use **both** of the following maintenance diagnostic techniques:
- 4.1 fault finding techniques (such as six point, half-split, input/output, unit substitution)
 - 4.2 test instrumentation measurement (such as voltage, resistance, current)
- Plus **three** from the following:
- 4.3 diagnostic aids (such as manuals, flow charts, troubleshooting guides, maintenance records)

Skills

The learner must be able to:

- 4.4 information gathered from fault reports
 - 4.5 visual checks (such as signs of damage, overheating, missing parts, wear/deterioration)
 - 4.6 movement checks (such as loose fittings and connections)
 - 4.7 monitoring equipment or gauges
5. Carry out **all** of the following maintenance activities:
- 5.1 removing excessive dirt and grime
 - 5.2 making mechanical/screwed/clamped connections
 - 5.3 dismantling/disconnecting equipment to the required level
 - 5.4 soldering and de-soldering
 - 5.5 crimping (such as tags and pins)
 - 5.6 disconnecting and reconnecting wires and cables
 - 5.7 replacing damaged/defective components
 - 5.8 stripping cable insulation/protection
 - 5.9 removing and replacing damaged wires and cables
 - 5.10 attaching suitable cable identification markers
 - 5.11 setting and adjusting replaced components
 - 5.12 removing electrical units/components
 - 5.13 making de-energised checks before reconnecting power supply
 - 5.14 removing/replacing cable end fittings
 - 5.15 checking components for serviceability
6. Replace/refit a range of electrical components, to include **six** of the following:
- 6.1 cables and connectors
 - 6.2 capacitors
 - 6.3 batteries
 - 6.4 locking and retaining devices
 - 6.5 circuit boards
 - 6.6 transformers
 - 6.7 overload protection devices
 - 6.8 luminaires
 - 6.9 solenoids
 - 6.10 inverter and servo controllers
 - 6.11 switches or sensors

Skills

The learner must be able to:

- 6.12 thermistors or thermocouples
 - 6.13 relay components
 - 6.14 contactors
 - 6.15 encoders or resolvers
 - 6.16 rectifiers
 - 6.17 other specific components
7. Carry out **all** of the following checks and tests on the maintained equipment, to include:
- 7.1 making visual checks (such as completeness, signs of damage, incorrect termination)
 - 7.2 movement checks (such as loose fittings and connections)
 - 7.3 testing that the equipment operates to the circuit specification
 - 7.4 check/test load current
- Plus **five** from the following:
- 7.5 carrying out fault finding techniques (such as half-split, input/output, unit substitution)
 - 7.6 protective conductor impedance
 - 7.7 power rating
 - 7.8 insulation resistance values
 - 7.9 polarity
 - 7.10 frequency values
 - 7.11 continuity
 - 7.12 resistance
 - 7.13 inductance
 - 7.14 voltage levels
 - 7.15 capacitance
 - 7.16 RCD disconnection time
 - 7.17 specialised tests (such as speed, sound, light, temperature)
8. Maintain electrical equipment, in accordance with **two** of the following quality and accuracy standards:
- 8.1 BS 7671/IET wiring regulations
 - 8.2 other BS and/or ISO standards
 - 8.3 company standards and procedures
 - 8.4 equipment manufacturer's requirement

Knowledge and understanding

The learner must:

- K1 Describe the isolation and lock-off procedure or permit-to-work procedure that applies to electrical maintenance activities (to include electrical isolation, locking off switchgear, removal of fuses, placing of maintenance warning notices, proving that isolation has been achieved and secured)
- K2 Describe the 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
- K3 Describe 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)
- K4 Explain the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy
- K5 Describe the procedure for obtaining drawings, job instructions, related specifications, replacement parts, materials and other consumables necessary for the maintenance activities
- K6 Describe the general principles of how the equipment they have maintained functions, and the working purpose of individual units/components and how they interact
- K7 Describe the different types of cabling used in the maintenance activities, and their methods of termination
- K8 Describe the different earthing systems and their applications such as TN-S, TN-C-S, TT and IT
- K9 Explain why electrical bonding/earthing is critical, and why it must be both mechanically and electrically secure
- K10 Describe the tools and equipment used in the maintenance activities (such as the use of cable stripping tools, crimping tools, soldering irons and torches, gland connecting tools)
- K11 Explain the importance of completing documentation and/or reports following the maintenance activity
- K12 Explain the importance of making 'off-load' checks before proving the equipment with the electrical supply on
- K13 Outline how to use appropriate lifting and handling equipment in the maintenance activity
- K14 Describe the problems that can occur during the electrical maintenance activity, and how they can be overcome
- K15 Describe 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 its designated location, cleaning the work area, and removing and disposing of waste)

Unit 10: Wiring and Testing Electrical Equipment and Circuits

Level: 2

Guided learning hours: 140

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to 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 their own actions and for the quality and accuracy of the work that they carry out.

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate electrical wiring and testing procedures and techniques safely. They will understand the wiring and testing methods and procedures used, and their application, and will know about the various cables and components used to produce the circuits, to the required depth to provide a sound basis for carrying out the activities to the required specification.

They will understand the safety precautions required when carrying out the wiring and testing activities, especially those for ensuring the safe isolation of the equipment and circuits produced. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

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

Specific unit requirements

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

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations 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

The learner must be able to:

1. Carry out **all** of the following activities during the wiring and testing activities:
 - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations 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

Skills

The learner must be able to:

2. Wire circuits using **all** of the following types of cables:
 - 2.1 single core
 - 2.2 multicore
 - 2.3 PVC twin and earth
 - 2.4 armouredPlus **two** more from the following:
 - 2.5 flexible (such as cotton covered, rubber or thermosetting)
 - 2.6 data/communication
 - 2.7 ribbon cables
 - 2.8 fibre-optics
 - 2.9 screened
 - 2.10 coaxial
 - 2.11 wiring loom/harness

3. Connect **all** of the following electrical modules/components to produce circuits:
 - 3.1 isolators
 - 3.2 protective devices (must include fuses such as HBC and HRC and circuit breakers)
 - 3.3 contactors
 - 3.4 motor starters
 - 3.5 motors
 - 3.6 transformers
 - 3.7 residual current device (RCD)Plus **eight** of the following:
 - 3.8 overloads
 - 3.9 blowers
 - 3.10 cable connectors
 - 3.11 switches
 - 3.12 lamp holders
 - 3.13 sockets
 - 3.14 panel lamps
 - 3.15 luminaires
 - 3.16 sensors
 - 3.17 ballast chokes
 - 3.18 actuators

Skills

The learner must be able to:

- 3.19 solenoids
 - 3.20 consumer units
 - 3.21 junction boxes
 - 3.22 relays
 - 3.23 terminal blocks
 - 3.24 alarm devices
 - 3.25 instruments
 - 3.26 electronic modules/units
 - 3.27 control devices
 - 3.28 pumps
 - 3.29 panels or sub-assemblies
 - 3.30 heaters
 - 3.31 other electrical components
4. Apply wiring methods and techniques to include **all** of the following:
- 4.1 positioning and securing of equipment and components
 - 4.2 levelling and alignment of components
 - 4.3 determining and calculating current rating and lengths of cables required
 - 4.4 securing by using mechanical fixings (such as screws, nuts and bolts)
 - 4.5 laying in cables without twisting or plaiting
 - 4.6 feeding cables into conduit without twisting or plaiting
 - 4.7 leaving sufficient slack for termination and movement
5. Carry out **eight** of the following cable termination activities:
- 5.1 stripping cable sheaths without damage to conductor insulation
 - 5.2 terminating mineral insulated cables
 - 5.3 removing cable insulation
 - 5.4 sealing/protecting cable connections
 - 5.5 connecting accessories (such as plugs, sockets multi-way connectors)
 - 5.6 attaching suitable cable identification
 - 5.7 making mechanical/screwed/clamped connections
 - 5.8 crimping (such as spade end, loops, tags and pins)
 - 5.9 soldering and de-soldering
 - 5.10 securing wires and cables (such as clips, plastic strapping, lacing, harnessing)

Skills

The learner must be able to:

- 5.11 terminating armoured cables
 - 5.12 heat shrinking (devices and boots)
 - 5.13 earth bonding
 - 5.14 cable glands and grips
6. Wire up **three** of the following electrical systems:
- 6.1 lighting circuits
 - 6.2 air conditioning control circuits
 - 6.3 power circuits
 - 6.4 refrigeration control circuits
 - 6.5 motor start and control
 - 6.6 heating/boiler control circuits
 - 6.7 power generation and control circuits
 - 6.8 instrumentation and control circuits
 - 6.9 emergency lighting systems
 - 6.10 alarm systems (such as fire, intruder, process control)
 - 6.11 communication systems
 - 6.12 electro-pneumatic or electro-hydraulic control circuits
 - 6.13 computer systems
 - 6.14 other control circuits (such as pumps, fans, blowers, extractors)
 - 6.15 other specific electrical circuits
7. Use **all** the following test instruments during the wiring and testing activities:
- 7.1 multimeter
 - 7.2 insulation resistance tester
 - 7.3 earth-loop impedance tester
 - 7.4 polarity tester/indicator
 - 7.5 RCD tester
 - 7.6 voltmeter/indicator
 - 7.7 other specific test/proving equipment (where applicable)

Skills

The learner must be able to:

8. Carry out checks and adjustments, appropriate to the equipment and circuits being wired, to include **all** of the following:
 - 8.1 making visual checks (such as completeness, signs of damage, incorrect termination)
 - 8.2 movement checks (such as loose fittings and connections)
 - 8.3 testing that the equipment operates to the circuit specification
 - 8.4 check/test load currentPlus **six** more checks/tests from the following:
 - 8.5 carrying out fault finding techniques (such as half-split, input/output, unit substitution)
 - 8.6 protective conductor impedance
 - 8.7 power rating
 - 8.8 insulation resistance values
 - 8.9 polarity
 - 8.10 frequency values
 - 8.11 continuity
 - 8.12 resistance
 - 8.13 inductance
 - 8.14 voltage levels
 - 8.15 capacitance
 - 8.16 RCD disconnection time
 - 8.17 specialised tests (such as speed, sound, light, temperature)

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

Knowledge and understanding

The learner must:

- K1 Describe the hazards associated with wiring and testing electrical equipment, and with the tools and equipment used, such as using sharp instruments for stripping cable insulation, and how they can be minimised
- K2 Explain the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy
- K3 Explain what constitutes a hazardous voltage and how to recognise victims of electric shock
- K4 Explain 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
- K5 Describe the different types of cabling and their application (such as multicore cables, single core cables, solid and multi-stranded cables, steel wire armoured (SWA), mineral insulated (MI), screened cables, data/communications cables, fibre-optics)
- K6 Describe the application and use of a range of electrical components (such as plugs, switches, sockets, lighting and fittings, junction boxes, consumer units, relays, solenoids, transformers, sensors and actuators)
- K7 Describe the application and use of circuit protection equipment (such as fuses and other overload protection devices, trips, residual current device (RCD))
- K8 Describe the different earthing systems and their applications such as TN-S, TN-C-S, TT and IT
- K9 Explain why electrical bonding/earthing is critical, and why it must be both mechanically and electrically secure
- K10 Describe the methods of mounting and securing electrical equipment/components to various surfaces (such as the use of nuts and bolts, screws and masonry fixing devices)
- K11 Explain why airflow is an important factor to consider when installing cables and wires and how this is calculated
- K12 Explain the use of BS7671/IET wiring regulations when selecting wires and cables and when carrying out tests on systems
- K13 Outline the tools and equipment used in the wiring and testing activities (including the use of cable stripping tools, crimping tools, soldering irons and torches, gland connecting tools)
- K14 Explain why equipment is checked so that it is electrically safe (such as PAT testing), and the implications if this is not undertaken
- K15 Explain the importance of conducting inspections and checks before connecting to the supply (such as visual examination for loose or exposed conductors, excessive solder or solder spikes which may allow short circuits to occur, strain on terminations, insufficient slack cable at terminations, continuity and polarity checks, insulation checks)

Knowledge and understanding

The learner must:

- K16 Describe the care, handling and application of electrical test and measuring instruments (such as multimeter, insulation resistance tester, loop impedance test instruments)
- K17 Explain how to identify suitable test points within the circuit, and how to position the test instruments into the circuit whilst ensuring the correct polarity and without damaging the circuit components and the test equipment
- K18 Explain how to set the instrument's zero readings; obtaining instrument readings and comparing them with circuit parameters
- K19 Describe the problems that can occur with the wiring and testing operations, and how these can be overcome
- K20 Describe 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 its designated location, cleaning the work area, and removing and disposing of waste)

Unit 11: Wiring and Testing Programmable Controller Based Systems

Level: 2

Guided learning hours: 140

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to prepare for the programmable controller wiring and testing activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they 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 unit 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 of the *Skills* section.

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations 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

The learner must be able to:

1. 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

Skills

The learner must be able to:

2. Connect and test equipment for **one** of the following types of programmable controller systems:
 - 2.1 monitoring system
 - 2.2 combination system
 - 2.3 process/product control system
 - 2.4 diagnostic system
 - 2.5 other specific system

3. Connect up and test **one** of the following types of programmable controller equipment/components:
 - 3.1 rack mounted controller units
 - 3.2 modular controller units

Plus **eight** from the following:

 - 3.3 sensors (such as inductive, proximity, temperature, colour, optical)
 - 3.4 actuators (such as pneumatic or hydraulic)
 - 3.5 printers panels and sub-assemblies
 - 3.6 switches (such as emergency stop, limit, pressure)
 - 3.7 valves (such as pneumatic or hydraulic)
 - 3.8 electrical wires and cable connections
 - 3.9 safety interlocks
 - 3.10 signal transmission components/cables
 - 3.11 motor starters
 - 3.12 overload protection devices
 - 3.13 barcode scanners
 - 3.14 PC peripheral devices
 - 3.15 analogue to digital modules
 - 3.16 PID (proportional, integral, derivative) controller
 - 3.17 other devices

4. Apply wiring and connection methods and techniques, to include **all** of the following:
 - 4.1 locating and securing equipment in the correct positions
 - 4.2 attaching suitable cable identification
 - 4.3 making mechanical/screwed/clamped connections
 - 4.4 routing and securing wires and cables
 - 4.5 stripping cable insulation/protection

Skills

The learner must be able to:

- 4.6 crimping (such as tags and pins)
 - 4.7 connecting all input and output devices
 - 4.8 soldering and de-soldering connections (where applicable)
 - 4.9 using heat shrinking devices or boots (where applicable)
 - 4.10 sealing and protecting cable connections (where applicable)
5. Develop programs which use **one** of the following, applicable to the type of controller and programming software:
- 5.1 ladder and logic diagrams
 - 5.2 function block diagrams
 - 5.3 statement/instruction lists
 - 5.4 state logic
 - 5.5 structured text
 - 5.6 sequential function charts
 - 5.7 other specific programming language
6. Prove and edit the programmable logic controller program, using **both** the following:
- 6.1 edit facilities
 - 6.2 program full run
- Plus **five** from the following:
- 6.3 single block/sub routine run
 - 6.4 program save/store facilities
 - 6.5 data input facilities
 - 6.6 search facilities
 - 6.7 program override controls
 - 6.8 graphic displays
 - 6.9 taking test measurements
 - 6.10 using monitoring mode
 - 6.11 using process simulation techniques (forcing contacts on/off)
 - 6.12 counter and timer settings

Skills

The learner must be able to:

7. Use **three** of the following test instruments during the wiring and testing activities:
 - 7.1 multimeter
 - 7.2 voltmeter/indicator
 - 7.3 programming devices (such as loader terminal, handheld programmer, personal computer)
 - 7.4 network testing equipment
 - 7.5 other specific test equipment

8. Carry out **all** of the following on completion of the programming activity:
 - 8.1 check and review program content
 - 8.2 edit programs using the correct procedure (where appropriate)
 - 8.3 check that the program is correctly titled and referenced
 - 8.4 ensure that programs are stored safely and correctly in the correct format
 - 8.5 create a separate backup copy of the program in case of file corruption

9. Use **all** of the following diagnostic techniques, tools and aids:
 - 9.1 visual checks (such as signs of damage, missing parts, wear/deterioration)
 - 9.2 movement checks (such as loose fittings and connections)
 - 9.3 fault finding techniques (such as input/output, half-split, unit substitution)
 - 9.4 diagnostic aids (such as manuals, flow charts, logic diagrams, troubleshooting guides)
 - 9.5 test instrumentation measurement (such as continuity, voltage, resistance, current)
 - 9.6 controller error warning lights/displays

10. 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 learner must:

- K1 Describe 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
- K2 Explain the importance of wearing appropriate protective clothing and equipment (PPE), and of keeping the work area safe and tidy
- K3 Describe the methods and procedures used to minimise the chances of infecting a computer with a virus
- K4 Explain the implications if the computer they are using does become infected with a virus and who to contact if it does occur
- K5 Explain what constitutes a hazardous voltage and how to recognise victims of electric shock
- K6 Explain 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)
- K7 Describe 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
- K8 Explain the use of BS 7671/IET wiring, and other regulations, when selecting wires and cables, and when carrying out tests on systems
- K9 Explain 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)
- K10 Describe 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
- K11 Describe the programming languages commonly used with programmable controller based systems (such as ladder, statement lists, logic function blocks, Boolean algebra)
- K12 Describe the common programmable controller numbering systems (such as binary, octal, decimal, hexadecimal, binary coded decimal (BCD))
- K13 Describe the different programming codes used to identify factors such as sensor inputs, actuator and other outputs, process management and auxiliary functions
- K14 Describe 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

Knowledge and understanding

The learner must:

- K15 Describe 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
- K16 Describe 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)
- K17 Explain 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
- K18 Explain 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
- K19 Explain how to back up completed or edited programs, and the implications if this is not carried out effectively
- K20 Describe the problems that can occur with the wiring and testing operations, and how these can be overcome
- K21 Describe 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 its designated location, cleaning the work area, and removing and disposing of waste)

Unit 12: Producing Mechanical Assemblies

Level: 2

Guided learning hours: 140

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to prepare for the assembly activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required assembly activities and the sequence of operations they intend to use. They will be required to select the appropriate equipment to use, based on the operations to be carried out and the type of components to be assembled.

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

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

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

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

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

Specific unit requirements

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

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

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

Skills

The learner must be able to:

1. Carry out **all** of the following during the assembly activities:
 - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
 - 1.2 follow job instructions, assembly drawings and procedures
 - 1.3 ensure that all power tool cables, extension leads or air supply hoses are in a safe and serviceable condition
 - 1.4 check that tools and measuring instruments to be used are within calibration date
 - 1.5 use lifting and slinging equipment in accordance with health and safety guidelines and procedures (where appropriate)
 - 1.6 ensure that the components used are free from foreign objects, dirt or other contamination
 - 1.7 return all tools and equipment to the correct locations on completion of the assembly activities
2. Produce assemblies using **eight** of the following methods and techniques:
 - 2.1 assembling of components by expansion/contraction
 - 2.2 applying sealants/adhesives
 - 2.3 fitting (such as filing, scraping, lapping or polishing)
 - 2.4 electrical bonding of components

Skills

The learner must be able to:

- 2.5 securing by using mechanical fasteners/threaded devices
 - 2.6 assembling of products by pressure
 - 2.7 setting and adjusting
 - 2.8 applying bolt locking methods
 - 2.9 aligning components
 - 2.10 drilling
 - 2.11 shimming and packing
 - 2.12 riveting
 - 2.13 pinning
 - 2.14 reaming
 - 2.15 blue-bedding of components
 - 2.16 torque setting
 - 2.17 balancing components
3. Assemble products to meet the required specification, using **twelve** of the following types of component:
- 3.1 assembly structure (framework, support, casings, panels)
 - 3.2 pre-machined components
 - 3.3 shafts
 - 3.4 levers/linkages
 - 3.5 springs
 - 3.6 fabricated components
 - 3.7 chains
 - 3.8 keys
 - 3.9 belts
 - 3.10 bearings
 - 3.11 couplings
 - 3.12 pulleys
 - 3.13 gaskets
 - 3.14 seals
 - 3.15 sprockets
 - 3.16 gears
 - 3.17 pipework/hoses
 - 3.18 bushes
 - 3.19 cams and followers
 - 3.20 other specific component

Skills

The learner must be able to:

4. Secure the components using **both** of the following categories of fastening devices:
 - 4.1 threaded fasteners (such as nuts, bolts, machine screws, cap screws)
 - 4.2 locking and retaining devices (such as tab washers, locking nuts, wire locks, special purpose types)

Plus **two** more from the following:

 - 4.3 pins (such as parallel/dowels, hollow/roll, tapered, split)
 - 4.4 spring clips (such as external circlips, internal circlips, special clips)
 - 4.5 rivets (such as countersunk, roundhead, blind, special purpose types)

5. Assemble products using **two** of the following assembly aids and equipment:
 - 5.1 workholding devices
 - 5.2 shims and packing
 - 5.3 lifting and moving equipment
 - 5.4 rollers or wedges
 - 5.5 specialised assembly tools/equipment
 - 5.6 supporting equipment
 - 5.7 jigs and fixtures

6. Carry out the required quality checks, to include **eight** from the following, using appropriate equipment:
 - 6.1 positional accuracy
 - 6.2 alignment
 - 6.3 freedom of movement
 - 6.4 function
 - 6.5 component security
 - 6.6 bearing/shaft end float
 - 6.7 completeness
 - 6.8 operating/working clearances
 - 6.9 dimensions
 - 6.10 freedom from damage or foreign objects
 - 6.11 orientation
 - 6.12 torque settings

Skills

The learner must be able to:

7. Produce mechanical assemblies which comply with **all** of the following:
 - 7.1 all components are correctly assembled and aligned in accordance with the specification
 - 7.2 moving parts are correctly adjusted and have appropriate clearances
 - 7.3 where appropriate, assemblies meet required geometric tolerances (such as square, straight, angles free from twists)
 - 7.4 all fastenings have appropriate washers and are tightened to the required torque
 - 7.5 where appropriate, bolt locking methods are applied

Knowledge and understanding

The learner must:

- K1 Describe the health and safety requirements, and safe working practices and procedures required for the assembly activities undertaken
- K2 Identify 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
- K3 Describe how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken
- K4 Describe how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
- K5 Describe 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)
- K6 Describe 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)
- K7 Identify the assembly/joining methods, techniques and procedures to be used, and the importance of adhering to these procedures
- K8 Describe how the components are to be aligned, adjusted and positioned prior to securing, and the tools and equipment to be used for this
- K9 Identify the various mechanical fastening devices that are used (such as nuts, bolts, machine screws, cap screws, clips, pins, locking and retaining devices)
- K10 Describe the importance of using the specified components and joining devices for the assembly, and why they must not use substitutes
- K11 Describe where appropriate, the application of sealants and adhesives within the assembly activities, and the precautions that must be taken when working with them

Knowledge and understanding

The learner must:

- K12 Describe 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)
- K13 Describe how to detect assembly defects, and what to do to rectify them (such as ineffective joining techniques, foreign objects, component damage)
- K14 State the methods and equipment used to transport, lift and handle components and assemblies
- K15 Describe how to check that the tools and equipment to be used are correctly calibrated and are in a safe and serviceable condition
- K16 Describe the importance of ensuring that all tools are used correctly and within their permitted operating range
- K17 Describe 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
- K18 Describe problems that could occur with the assembly operations, and the importance of informing appropriate people of non-conformances

Unit 13: Preparing and using Lathes for Turning Operations

Level: 2

Guided learning hours: 140

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to carry out 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 unit requirements

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

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 Plan the machining activities before they start them
- P4 Obtain and prepare the appropriate materials, tools and equipment
- P5 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

Skills

The learner must be able to:

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

Skills

The learner must be able to:

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

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

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

Skills

The learner must be able to:

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

Skills

The learner must be able to:

Plus **four** more of the following:

- 7.5 rules
- 7.6 bore/hole gauges
- 7.7 internal micrometers
- 7.8 thread gauges (such as ring, plug, profile)
- 7.9 depth micrometers
- 7.10 plug gauges
- 7.11 depth verniers
- 7.12 radius/profile gauges
- 7.13 slip gauges
- 7.14 protractors
- 7.15 coordinate measuring machine (CMM)

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

- 8.1 components to be free from false tool cuts, burrs and sharp edges
- 8.2 general dimensional tolerance $\pm 0.25\text{mm}$ or $\pm 0.010''$
- 8.3 there must be one or more specific dimensional tolerances within $\pm 0.1\text{mm}$ or $\pm 0.004''$
- 8.4 surface finish $63\ \mu\text{in}$ or $1.6\ \mu\text{m}$
- 8.5 reamed holes within H8
- 8.6 screw threads BS medium fit
- 8.7 angles within ± 0.5 degree

Knowledge and understanding

The learner must:

- K1 Describe the hazards associated with the turning operations (e.g. revolving/moving parts of machinery, airborne and hot metal particles, sharp cutting tools and burrs and sharp edges on component), and how they can be minimised
- K2 Define the safety mechanisms on the machine (such as emergency stop buttons, emergency treadle brakes), and the procedure for checking that they function correctly
- K3 Explain the correct operation of the machine controls in both hand and power modes and describe how to stop the machine in both normal and emergency situations and describe the procedure for restarting after an emergency

Knowledge and understanding

The learner must:

- K4 Describe the process for planning and preparing to carry out the machining operations (e.g. obtaining the component drawing, determining the machines required, selecting materials, selecting workholding methods and devices, selecting cutting tools, determining a suitable sequence of operations, determining quality checks to be made and equipment to be used)
- K5 Define the main features of the lathe and the accessories that can be used (e.g. saddle, capstan/turret head, compound slide, tailstock, taper turning attachments, profile attachments, fixed and travelling steadies)
- K6 Explain the importance of positioning and securing workholding devices to the machine spindle, and the checks to be made (e.g. ensuring that all seating/location faces are clean and undamaged, that (where appropriate) the workholding device location marks are lined up with those on the machine spindle, and checking that all bolts, cam locks or other securing devices are tightened securely)
- K7 Describe the effects of clamping the workpiece in a chuck/workholding device, and how this can cause damage or distortion in the finished components
- K8 Define the various turning operations that can be performed, and the shapes and types of tooling that can be used (such as solid high-speed tooling, brazed tip tooling, interchangeable tipped tooling)
- K9 Describe different methods of mounting and securing the cutting tools in the tool holding devices (e.g. front or rear tools posts; mounting drills in chucks or by the use of morse taper sockets) and explain the importance of ensuring that the tool is at the correct centre height and that tool overhang is kept to a minimum
- K10 Describe the process for checking that cutting tools are in a safe and usable condition and how to handle and store tools safely/correctly
- K11 Describe the methods and techniques to hand grind lathe tools and drills for different applications
- K12 Define the effects of backlash in machine slides and screws, and how this can be overcome
- K13 Describe the techniques of taking trial cuts and checking dimensional accuracy; the application of roughing and finishing cuts, and the effect on tool life, surface finish and dimensional accuracy
- K14 Define factors that affect the selection of cutting feeds and speeds, and the depth of cut that can be taken (e.g. type of material, type of tool used, size of material, operations being performed, workholding method/security of workpiece, condition of machine, finish and tolerance required)
- K15 Explain the importance of the application of cutting fluids and compounds with regard to a range of different materials, and why some materials do not require cutting fluids to be used
- K16 Define the checks to be carried out on the components before removing them from the machine, and the equipment that will need to be used (including micrometers, verniers and surface texture comparison methods)

Knowledge and understanding

The learner must:

- K17 Describe the process for checking that the measuring equipment is within current calibration dates and that the instruments are correctly zeroed; measuring internal and external dimensions (e.g. lengths, diameters, depths, slots, hole positions, angles, profiles); measuring geometric features (e.g. flatness, squareness, parallelism, concentricity, ovality); how to check surface finish (e.g. by using comparison blocks or instruments)
- K18 Describe the problems that can occur with the turning activities (e.g. defects caused by incorrectly ground tools, inappropriate feeds/speeds, damage by workholding devices), and how these can be overcome

Unit 14: Preparing and using Milling Machines

Level: 2

Guided learning hours: 140

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to carry out 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 unit requirements

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

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 Plan the machining activities before they start them
- P4 Obtain and prepare the appropriate materials, tools and equipment
- P5 Mount and set the required workholding devices, workpiece and cutting tools
- P6 Set and adjust the machine tool speeds and feeds to achieve the component specification
- P7 Use the machine tool controls safely and correctly, in line with operational procedures
- P8 Measure and check that all dimensional and geometrical aspects of the component are to the specification
- P9 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
- P10 Shut down the equipment to a safe condition on completion of the machining activities

Skills

The learner must be able to:

1. Ensure that they apply **all** of the following checks and practices at all times during the machining activities:
 - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
 - 1.2 machine guards are in place and correctly adjusted
 - 1.3 components are held securely (without damage or distortion)
 - 1.4 cutting tools are maintained in a suitable/safe condition
 - 1.5 make sure the work area is maintained and left in a safe and tidy condition
2. Machine components made from **two** of the following types of material:
 - 2.1 low carbon/mild steel
 - 2.2 cast iron
 - 2.3 plastic/nylon/composite
 - 2.4 high carbon steel
 - 2.5 brass/brass alloys
 - 2.6 aluminium/aluminium alloys
 - 2.7 other specific material

Skills

The learner must be able to:

3. Mount, secure and machine components, using **two** of the following workholding devices:
 - 3.1 fixed vice (must include setting/clocking up to ensure it is square)
 - 3.2 direct clamping to machine table
 - 3.3 magnetic or pneumatic devices
 - 3.4 swivel or universal vice
 - 3.5 angle plates
 - 3.6 chucks
 - 3.7 fixtures
 - 3.8 vee block and clamps
 - 3.9 indexing device

4. Mount and use **four** of the following types of milling cutters/tools:
 - 4.1 face mills
 - 4.2 slot cutters
 - 4.3 twist/core drills
 - 4.4 slab/cylindrical cutters
 - 4.5 slitting saws
 - 4.6 reamers
 - 4.7 end mills
 - 4.8 vee cutters
 - 4.9 boring bars
 - 4.10 slot drills
 - 4.11 taps
 - 4.12 side and face cutters
 - 4.13 other form cutters

5. Produce machined components that combine different operations and have features that cover **all** of the following:
 - 5.1 flat faces
 - 5.2 parallel faces
 - 5.3 open ended slots
 - 5.4 square faces
 - 5.5 steps/shoulders
 - 5.6 enclosed slots

Skills

The learner must be able to:

Plus **two** more of the following:

- 5.7 angular faces
- 5.8 drilled holes
- 5.9 bored holes
- 5.10 indexed or rotated forms
- 5.11 recesses
- 5.12 tee slots
- 5.13 profile forms (such as vee, concave, convex, gear forms, serrations, special forms)

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

- 6.1 linear dimensions
- 6.2 surface finish
- 6.3 depths
- 6.4 slots (such as position, width, depth)
- 6.5 flatness
- 6.6 angles (where appropriate)
- 6.7 squareness
- 6.8 hole size/fit (where appropriate)

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

- 7.1 external micrometers
- 7.2 dial test indicators (DTI)
- 7.3 vernier/digital/dial callipers
- 7.4 surface finish equipment (such as comparison plates, machines)

Plus **four** more of the following:

- 7.5 rules
- 7.6 feeler gauges
- 7.7 squares
- 7.8 bore/hole gauges
- 7.9 internal micrometers
- 7.10 slip gauges
- 7.11 depth micrometers
- 7.12 radius/profile gauges
- 7.13 depth verniers

Skills

The learner must be able to:

- 7.14 protractors
- 7.15 coordinate measuring machine (CMM)
- 8. Produce components to **all** of the following quality and accuracy standards, as applicable to the operation:
 - 8.1 components to be free from false tool cuts, burrs and sharp edges
 - 8.2 general dimensional tolerance $\pm 0.25\text{mm}$ or $\pm 0.010''$
 - 8.3 there must be one or more specific dimensional tolerances within $\pm 0.1\text{mm}$ or $\pm 0.004''$
 - 8.4 flatness and squareness within 0.125mm per 25mm or $0.005''$ per inch
 - 8.5 reamed holes within H8
 - 8.6 surface finish $63\ \mu\text{in}$ or $1.6\ \mu\text{m}$
 - 8.7 angles within ± 1 degree

Knowledge and understanding

The learner must:

- K1 Describe the hazards associated with the milling operations (e.g. revolving/moving parts of machinery, airborne and hot metal particles, sharp cutting tools and burrs and sharp edges on component), and how they can be minimised
- K2 Define the safety mechanisms on the machine (e.g. emergency stop buttons, emergency brakes), and the procedure for checking that they function correctly
- K3 Explain the correct operation of the machine controls in both hand and power modes, how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
- K4 Describe the process for planning and preparing to carry out the machining operations (e.g. obtaining the component drawing, determining the machines required, selecting materials, selecting workholding methods and devices, selecting cutting tools, determining a suitable sequence of operations, determining quality checks to be made and equipment to be used)
- K5 Define the main features of the milling machine, and the accessories that can be used (e.g. vertical heads, indexing devices)
- K6 Explain the importance of positioning and securing workholding devices to the machine table, and the checks to be made (e.g. ensuring all seating/location faces are clean and undamaged, ensuring that the device is suitably aligned using instruments or tenons, as appropriate, and checking that all bolts or other securing devices are tightened securely)
- K7 Describe the effects of clamping the workpiece in a vice or other workholding device, and how this can cause damage or distortion in the finished components

Knowledge and understanding

The learner must:

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

Unit 15: Preparing and using Semi-Automatic MIG, MAG and Flux Cored Arc Welding Equipment

Level: 2

Guided learning hours: 140

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to prepare the welding equipment and to ensure that all leads/cables, shielding gas system, hoses and wire feed mechanisms are securely connected and free from damage. They will also need to obtain and check that all the workholding equipment is in a safe and usable condition.

In preparing to weld, they will need to set and adjust the welding conditions, in line with instructions and/or the welding procedure specification. They must operate the equipment safely and correctly, and make any necessary adjustments to settings in line with their permitted authority, in order to produce the welded joints to the required specification.

On completion of the welding operations, they will be expected to check the quality of the welds using measuring equipment, visual examination and destructive testing techniques, as appropriate to the aspects being checked. They will need to be able to recognise welding defects, to take appropriate action to limit any faults that occur and to ensure that the finished workpiece is within the specification requirements. On completion of the welding activities, they will be expected to return all tools, equipment and workholding devices to their designated location, and to leave the welding equipment and work area in a safe and tidy condition.

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

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate semi-automatic MIG, MAG or flux cored wire welding techniques safely. They will understand the welding process, and its application, and will know about the equipment, materials and consumables to the required depth to provide a sound basis for carrying out the activities to the required specification. They will understand the safety precautions required when working with the MIG, MAG or flux cored wire welding equipment, and with the associated tools and equipment. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

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

Specific unit requirements

Welded joints must be at least 150mm long, using single- or multi-run welds (as appropriate), with at least one stop and start included.

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 Plan the welding activities before they start them
- P4 Obtain and prepare the appropriate welding equipment and welding consumables
- P5 Prepare and support the joint, using the appropriate methods
- P6 Tack weld the joint at appropriate intervals, and check the joint for accuracy before final welding
- P7 Weld the joint to the specified quality, dimensions and profile
- P8 Use appropriate methods and equipment to check the quality, and that all dimensional and geometrical aspects of the weld are to the specification
- P9 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
- P10 Shut down and make safe the welding equipment on completion of the welding activities

Skills

The learner must be able to:

1. Prepare for the MIG, MAG or flux cored-wire arc welding process by carrying out **all** of the following:
 - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
 - 1.2 check the condition of, and correctly connect, welding leads/cables, hoses, shielding gas supply and wire feed mechanisms
 - 1.3 set and adjust the welding conditions/parameters, in accordance with the welding procedure specification
 - 1.4 prepare the work area for the welding activities (such as positioning welding screens and fume extraction)
 - 1.5 prepare the materials and joint in readiness for welding (such as cleaning of joint faces, grinding weld preparations, setting up the joint, supporting the joint)
 - 1.6 make sure the work area is maintained and left in a safe and tidy condition

Skills

The learner must be able to:

2. Use manual/semi-automatic welding and related equipment to include **one** of the following:
 - 2.1 MIG
 - 2.2 MAG
 - 2.3 Flux cored wire welding equipment

3. Use consumables appropriate to the material and application, to include: **one** of the following wire types:
 - 3.1 solid wire
 - 3.2 cored wirePlus **one** of the following types of shielding gas:
 - 3.3 inert
 - 3.4 active

4. Produce **three** of the following welded joints of at least 150mm long, by single or multi-run (as appropriate), with at least one stop and start included:
 - 4.1 fillet lap joints
 - 4.2 corner joints
 - 4.3 tee fillet joints
 - 4.4 butt joints

5. Produce joints as follows: **one** type of material from the following:
 - 5.1 carbon steel
 - 5.2 stainless steel
 - 5.3 aluminiumand **two** forms of material from the following:
 - 5.4 plate
 - 5.5 sheet (less than 3mm)
 - 5.6 pipe/tube
 - 5.7 section
 - 5.8 other forms

6. Weld joints in good access situations in **two** of the following BS EN ISO 6947 positions:
 - 6.1 Flat (PA)
 - 6.2 Vertical upwards (PF)
 - 6.3 Horizontal vertical (PB)

Skills

The learner must be able to:

- 6.4 Vertical downwards (PG)
- 6.5 Horizontal (PC)

- 7. Check that the welded joint conforms to the specification, by checking **all** of the following:
 - 7.1 dimensional accuracy
 - 7.2 size and profile of weld
 - 7.3 number of runs
 - 7.4 alignment/squareness

- 8. Carry out non-destructive testing of the welds, using **one** of the following:
 - 8.1 dye penetrant
 - 8.2 fluorescent penetrant
 - 8.3 magnetic particle

- 9. Carry out destructive tests on weld specimens using **one** of the following:
 - 9.1 macroscopic examination
 - 9.2 nick break test
 - 9.3 bend tests (such as face, root or side, as appropriate)

- 10. Identify **all** of the following weld defects:
 - 10.1 lack of continuity of the weld
 - 10.2 uneven and irregular ripple formation
 - 10.3 incorrect weld size or profilePlus **four** more of the following:
 - 10.4 undercutting
 - 10.5 internal cracks
 - 10.6 overlap
 - 10.7 surface cracks
 - 10.8 inclusions
 - 10.9 lack of fusion
 - 10.10 porosity
 - 10.11 lack of penetration

Skills

The learner must be able to:

11. Produce welded joints which meet **all** of the following (with reference to BS 4872 Part 1 Weld test requirements):
 - 11.1 welds meet the required dimensional accuracy
 - 11.2 fillet welds are equal in leg length and slightly convex in profile, with the size of the fillet equivalent to the thickness of the material welded
 - 11.3 the weld contour is linear, of uniform profile, free from excessive undulations, with regular and even ripple
 - 11.4 the welds are adequately fused, and there is minimal undercut, overlap and surface inclusions
 - 11.5 joins at stop/start positions merge smoothly, with no pronounced hump or crater in the weld surface
 - 11.6 tack welds are blended in to form part of the finished weld, without excessive hump
 - 11.7 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
 - 11.8 the weld surface is free from cracks, and substantially free from porosity, shrinkage cavities and trapped slag
 - 11.9 the weld surface and adjacent parent metal is substantially free from arcing or chipping marks

Knowledge and understanding

The learner must:

- K1 State the hazards associated with MIG, MAG or flux cored wire arc welding (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
- K2 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)
- K3 Explain the importance of applying the appropriate behaviours in the workplace and the implications for both the learner and the business if these are not adhered to
- K4 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
- K5 Outline 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)

Knowledge and understanding

The learner must:

- K6 Describe the types, selection and application of electrode wires (such as solid and cored)
- K7 Explain the reasons for using shielding gases, and the types and application of the various gases
- K8 Outline gas pressures and flow rates (in relation to the type of material being welded)
- K9 Describe the types of welded joints to be produced (such as lap joints, corner joints, tee joints and butt welds)
- K10 State the terminology used for the appropriate welding positions
- K11 Describe 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)
- K12 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)
- K13 Outline tack welding size and spacing (in relation to material thickness)
- K14 Describe the checks to be made prior to welding (such as confirming the correct set-up of the joint; the condition of electrical connections, welding return and earthing arrangements; wire feed mechanisms; gas supply; operating parameters)
- K15 Describe 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)
- K16 Outline methods/modes of metal transfer and their uses (such as dip, globular, free flight, spray and pulsed)
- K17 Explain how to close down the welding equipment safely and correctly
- K18 Explain how to control distortion (such as welding sequence; deposition technique)
- K19 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
- K20 Outline 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)
- K21 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)

Knowledge and understanding

The learner must:

- K22 Describe how to check the welded joints for uniformity, alignment, position, weld size and profile
- K23 Outline the various procedures for visual examination of the welds for cracks, porosity and slag inclusions (such as dye penetrant, fluorescent penetrant; magnetic particle testing)
- K24 Outline the various procedures for carrying out destructive tests on the welds (such as macroscopic examination, bend tests, nick break tests)
- K25 Describe methods of removing a specimen of weld from a suitable position in the joint (such as a stop/start position), using a non-thermal process (such as hand saws, power saws, abrasive discs)
- K26 Explain how to examine the welds after the tests, and how to check for such defects as the degree of penetration and fusion, inclusions, porosity, cracks, undercut and overlap, uneven and irregular ripple formation
- K27 Outline when to act on your own initiative and when to seek help and advice from others

Unit 16: Assembling and Testing Electronic Circuits

Level: 2

Guided learning hours: 140

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to carry out the assembly of a range of electronic components such as resistors (fixed and variable), capacitors (fixed and variable), diodes, transistors and other semiconductor devices, integrated circuits (analogue and digital), miniature transformers, switches, indicators, wire links and a range of connectors, spacers and brackets to form various types of circuits. This will involve using a range of tools and equipment along with soldering techniques and anti-static protection techniques.

The assembly activities will include making all necessary checks and adjustments to the circuits, including continuity checks, voltage, current and resistance values, waveform and ensuring that the circuit functions to the specification.

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

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate electronic assembly, wiring and testing procedures and techniques safely. They will understand the assembly methods and procedures used, and their application, and will know about the various components used to produce the circuits, to the required depth to provide a sound basis for carrying out the activities to the required specification.

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

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

Specific unit requirements

In order to prove their ability to combine different electronic assembly and testing activities, at least one of the electronic assemblies produced must be of a significant nature, and must contain a minimum of **ten** of the components listed in paragraph 5 of the *Skills* section.

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 Plan the 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 they cannot resolve
- P11 Leave the work area in a safe and tidy condition on completion of the electronic assembly and testing activities

Skills

The learner must be able to:

1. Carry out **all** of the following during the electronic assembly and testing activities:
 - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
 - 1.2 follow job instructions, assembly drawings and test procedures at all times
 - 1.3 ensure that the components are free from damage, dirt or other contamination
 - 1.4 prepare the electronic components for the assembly operations (such as pre-forming and cleaning pins)
 - 1.5 use safe and approved techniques to mount the electronic components on the circuit boards
 - 1.6 check that the tools and test instruments are within calibration date and are in a safe, tested and usable condition

Skills

The learner must be able to:

- 1.7 where appropriate, apply procedures and precautions to eliminate electrostatic discharge (ESD) hazards (such as the use of grounded wrist straps and mats)
 - 1.8 follow clean work area protocols, where appropriate
 - 1.9 return all tools and equipment to the correct location on completion of the assembly activities
2. Assemble **one** of the following circuit types:
- 2.1 single-sided circuit
 - 2.2 thick film circuit
 - 2.3 thin film circuit
 - 2.4 flexible circuit
 - 2.5 double-sided circuit
 - 2.6 hybrid circuit
3. Assemble electronic components using **two** of the following:
- 3.1 manual soldering techniques
 - 3.2 surface mount techniques
 - 3.3 mechanical fixing methods
4. Assemble circuits using **four** of the following tools:
- 4.1 heat shunts/tweezers
 - 4.2 component forming devices
 - 4.3 mechanical fasteners (screwdriver, spanners)
 - 4.4 snipe or long nosed pliers
 - 4.5 wire strippers
 - 4.6 anti-static packaging, mats and straps
 - 4.7 sleeving pliers
 - 4.8 side or end cutters
 - 4.9 specialised assembly tools/equipment

Skills

The learner must be able to:

5. Assemble circuits to the required specification, to include using fifteen of the following types of component:
 - 5.1 fixed resistors
 - 5.2 variable resistors
 - 5.3 potentiometers
 - 5.4 encoders or resolvers
 - 5.5 transistors
 - 5.6 inverters or servo controllers
 - 5.7 thyristors
 - 5.8 edge connectors
 - 5.9 thermistors
 - 5.10 light dependant resistors (LDR)
 - 5.11 analogue or digital integrated circuits
 - 5.12 wiring pins/tags/wire links
 - 5.13 fixing spacers
 - 5.14 fixed capacitors
 - 5.15 variable capacitors
 - 5.16 insulators
 - 5.17 surface mount packages
 - 5.18 rectifiers
 - 5.19 small heat sinks
 - 5.20 electrolytic capacitors
 - 5.21 switches
 - 5.22 cables
 - 5.23 diodes
 - 5.24 Zener diodes
 - 5.25 light emitting diodes (LEDs)
 - 5.26 mini transformers
 - 5.27 decoders
 - 5.28 protection devices
 - 5.29 cable connectors
 - 5.30 regulators
 - 5.31 relays
 - 5.32 inductors
 - 5.33 other specific electronic components

Skills

The learner must be able to:

6. Assemble electronic components to produce **five** of the following types of circuit:
 - 6.1 audio amplifiers
 - 6.2 filters
 - 6.3 regulated power supplies
 - 6.4 signal converters
 - 6.5 microprocessor based applications (such as PIC chips)
 - 6.6 logic function controls
 - 6.7 signal generators
 - 6.8 comparators
 - 6.9 display circuits
 - 6.10 counter/timers
 - 6.11 power amplifiers
 - 6.12 ADC and DAC hybrid circuits
 - 6.13 oscillators
 - 6.14 motor control
 - 6.15 sensor/actuator circuit (such as linear, rotational, temperature, photo-optic, flow, level, pressure)
 - 6.16 digital circuit (such as process control, microprocessor, logic devices, display devices)
 - 6.17 signal processing circuit (such as frequency modulating/ demodulating, amplifiers, filters)
 - 6.18 alarms and protection circuits
 - 6.19 other specific circuit

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

Skills

The learner must be able to:

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

9. Carry out checks, adjustments and fault rectification where appropriate to the circuits being assembled, to include **six** of the following:
 - 9.1 logic states
 - 9.2 pulse width/rise time
 - 9.3 inductance
 - 9.4 DC voltage/current levels
 - 9.5 open/short circuit
 - 9.6 frequency modulation/demodulation
 - 9.7 AC voltage/current levels
 - 9.8 resistance
 - 9.9 amplification
 - 9.10 clock/timer switching
 - 9.11 capacitance
 - 9.12 signal noise/interference levels
 - 9.13 oscillations
 - 9.14 waveform analysis
 - 9.15 attenuation

Skills

The learner must be able to:

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

Knowledge and understanding

The learner must:

- K1 Describe the hazards associated with assembling and testing electronic circuits (such as heat, toxic fumes, spilled/splashed chemicals/solder, static electricity, using sharp instruments for stripping cable insulation, connecting clips/probes into circuits), and how they can be minimised
- K2 Describe what constitutes a hazardous voltage and how to recognise victims of electric shock
- K3 Explain how to reduce the risks of a phase to earth shock (such as insulated tools, rubber matting and isolating transformers)
- K4 Explain the importance of applying the appropriate behaviours in the workplace and the implications for both the learner and the business if these are not adhered to
- K5 Describe 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
- K6 Describe the various types of circuit boards used (such as printed circuit boards, thin film, thick film and flexible film circuitry)
- K7 Explain how to recognise, read the values and identify polarity and any other orientation requirements for all electronic components being used in the assemblies (such as capacitors, diodes, transistors, integrated circuit chips, and other discrete through-hole or surface-mounted components)
- K8 Explain how to check that components meet the required specification/operating conditions (such as values, tolerance, current carrying capacity, voltage rating, power rating, working temperature range)
- K9 State 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
- K10 Outline the application and use of circuit protection equipment (such as fuses and other overload protection devices)
- K11 Outline the preparation requirements for components to be used in the assembly (such as pre-forming component pins/legs)
- K12 Describe methods of mounting and securing electronic components to various surfaces (such as the use of manual soldering techniques, surface mount technologies and mechanical fixing devices, use of heat sinks/shunts)

Knowledge and understanding

The learner must:

- K13 Describe methods of attaching markers/labels to components or cables to assist with identification (such as colour coding conductors, using coded tabs)
- K14 Outline the use of calculations, and regulations, when selecting wires and cables and when carrying out tests on electronic circuits
- K15 Explain the importance of making visual checks of the completed assembly (such as examination for excessive solder or solder spikes which may allow short circuits to occur, correct orientation of components for pin configuration or polarity, obvious signs of damage (such as heat damage) or strain on terminations)
- K16 Describe the tools and equipment used in the electronic assembly activities (including the use of cable stripping tools, crimping tools, soldering irons, specialist assembly tools)
- K17 Explain the importance of ensuring that all tools are in a safe and serviceable condition, are used correctly and are returned to their correct location on completion of the assembly activities
- K18 Describe the care, handling and application of electronic test and measuring instruments (such as multimeter, oscilloscope, signal generators, stabilised power supplies, logic probes/analysers, measuring bridges)
- K19 Explain how to check that test equipment is safe to use (such as condition of power cables, using suitably fused test probes, clips and leads); 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
- K20 Explain how to connect to an approved power supply and, where appropriate, signal source; identifying correct test points in the circuit; how to position test instruments into circuits without damaging circuit components (such as using test probes, ensuring correct polarity, taking anti-static precautions); setting instrument zero readings; obtaining instrument readings and comparing them with expected results
- K21 Explain how to make adjustments to circuit components; making decisions on circuit performance and faulty components; removal and replacement of faulty components
- K22 Describe the fault-finding techniques to be used when the equipment fails to operate correctly (such as half split, unit substitution and input/output)
- K23 Describe the problems that can occur with the assembling and testing operations, and how these can be overcome
- K24 Outline when to act on their own initiative and when to seek help and advice from others

Unit 17: Maintaining Electronic Equipment/Systems

Level: 2

Guided learning hours: 140

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to prepare for the electronic maintenance activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required maintenance activities and the sequence of operations they intend to use.

They will be required to select the appropriate equipment to use, based on the maintenance operations to be carried out and the type of electronic equipment or systems being maintained. This will include power supplies, motor control systems, alarm and protection circuits, sensors and actuator circuits, digital circuits and systems, analogue circuits and systems, and hybrid circuits and systems. They will be expected to use a variety of maintenance diagnostic techniques and procedures, such as gathering information from fault reports, using recognised fault finding techniques and diagnostic aids, measuring, inspecting and operating the equipment.

They will be expected to apply a range of dismantling and reassembly methods and techniques at circuit board and component level, such as soldering, de-soldering, crimping, harnessing, securing cables and components, replacing damaged or defective components, cables and wires, setting and adjusting components, and making de-energised checks before testing the equipment, using appropriate techniques and procedures. They will be expected to take care that they do not cause further damage to the equipment/circuit during the repair activities and, therefore, the application of electrostatic discharge (ESD) procedures will be a critical part of their role.

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

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

They will understand the safety precautions required when carrying out the repair activities, especially those for isolating the equipment, and for taking the necessary safeguards to protect themselves, and others, against direct and indirect electric shock. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

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

Specific unit requirements

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

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 Plan the maintenance activities before they start them
- P4 Obtain all the information they need for the safe removal and replacement of the equipment/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

The learner must be able to:

1. Carry out **all** of the following during the maintenance activities:
 - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
 - 1.2 ensure the safe isolation of equipment (where appropriate)
 - 1.3 follow job instructions, maintenance drawings and procedures
 - 1.4 take electrostatic discharge (ESD) precautions when handling sensitive components and circuit boards
 - 1.5 check that the tools and test instruments are within calibration date and are in a safe, PAT-tested and usable condition
 - 1.6 ensure that the system is kept free from foreign objects, dirt or other contamination
 - 1.7 return all tools and equipment to the correct location on completion of the maintenance activities
 - 1.8 leave the work area in a safe and tidy condition

Skills

The learner must be able to:

2. Carry out maintenance/repair activities on **three** of the following types of electronic equipment:
 - 2.1 power supplies (such as switched mode, series regulation, shunt regulation)
 - 2.2 motor control systems (such as closed loop servo/proportional control, inverter control)
 - 2.3 sensor/actuator circuit (such as linear, rotational, temperature, photo-optic, flow, level, pressure)
 - 2.4 digital circuit (such as process control, microprocessor, logic devices, display devices)
 - 2.5 signal processing circuit (such as frequency modulating/demodulating, amplifiers, filters)
 - 2.6 alarms and protection circuits
 - 2.7 ADC and DAC hybrid circuits

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

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

Skills

The learner must be able to:

- 4.8 removing and replacing electronic components
 - 4.9 making adjustments to components and/or connections
 - 4.10 re-assembling of units or sub-assemblies
5. Replace/refit a range of electronic components, to include **twelve** of the following:
- 5.1 cables and connectors
 - 5.2 rectifiers
 - 5.3 surface mount packages
 - 5.4 printed circuit boards
 - 5.5 encoders or resolvers
 - 5.6 integrated circuits
 - 5.7 fixed resistors
 - 5.8 variable resistors
 - 5.9 potentiometers
 - 5.10 thyristors
 - 5.11 transistors
 - 5.12 regulators
 - 5.13 decoders
 - 5.14 light dependant resistor (LDR)
 - 5.15 thermistors
 - 5.16 diodes
 - 5.17 Zener diodes
 - 5.18 opto-electronics/optical fibre components
 - 5.19 light emitting diodes (LEDs)
 - 5.20 analogue or digital integrated circuits
 - 5.21 fixed capacitors
 - 5.22 electrolytic capacitors
 - 5.23 variable capacitors
 - 5.24 sensors
 - 5.25 switches
 - 5.26 edge connectors
 - 5.27 heat sinks
 - 5.28 wiring pins/tags/wire links
 - 5.29 mini transformers

Skills

The learner must be able to:

- 5.30 protection devices
 - 5.31 inverters or servo controllers
 - 5.32 relays
 - 5.33 inductors
6. Use the correct joining/connecting techniques to deal with **three** of the following types of connection:
- 6.1 push-fit connectors
 - 6.2 crimped connections
 - 6.3 soldering or de-soldering
 - 6.4 zero insertion force (zif) connectors
 - 6.5 clip assemblies
 - 6.6 adhesive joints/assemblies
 - 6.7 threaded connections
 - 6.8 edge connectors
7. Use **five** of the following types of test equipment:
- 7.1 multimeter
 - 7.2 signal generator
 - 7.3 oscilloscope
 - 7.4 signal tracer
 - 7.5 logic probe/clip
 - 7.6 stabilised power supplies
 - 7.7 logic analyser
 - 7.8 measuring bridges
 - 7.9 pulse sequencing analyser
 - 7.10 software diagnostic programs
 - 7.11 counter-timers
 - 7.12 data communications test set
 - 7.13 signature analysers
 - 7.14 bus exerciser/analyser
 - 7.15 protocol analyser

Skills

The learner must be able to:

8. Carry out checks and tests on the maintained equipment, to include **both** of the following:
 - 8.1 visual checks (such as for solder bridges, dry joints, incorrect value components, signs of damage, missing components)
 - 8.2 movement checks (such as loose wires and connections, incorrectly seated devices/packages)

Plus **three** more from the following:

 - 8.3 logic states
 - 8.4 pulse width/rise time
 - 8.5 inductance
 - 8.6 DC voltage/current levels
 - 8.7 open/short circuit
 - 8.8 frequency modulation/demodulation
 - 8.9 AC voltage/current levels
 - 8.10 resistance
 - 8.11 amplification
 - 8.12 clock/timer switching
 - 8.13 capacitance
 - 8.14 signal noise/interference levels
 - 8.15 oscillations
 - 8.16 wave form analysis
 - 8.17 attenuation

9. Carry out maintenance activities on electronic equipment, in accordance with **one** or more of the following:
 - 9.1 organisational guidelines and codes of practice
 - 9.2 equipment manufacturer's operation range
 - 9.3 BS and ISO standards

Knowledge and understanding

The learner must:

- K1 Describe the isolation and lock-off procedure or permit-to-work procedure that applies to the electronic repair activities and the electronic equipment or circuits being worked on (such as electrical isolation, locking off switchgear, removal of fuses, placing maintenance warning notices, proving that isolation has been achieved and secured)
- K2 Describe the hazards associated with maintaining electronic equipment, and with the tools and equipment that are used (such as live electrical components, capacitor discharge, misuse of tools, using damaged or badly maintained tools and equipment, not following laid-down maintenance procedures), and how these can be minimised
- K3 Describe 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)
- K4 Explain the importance of 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 learner and the business if these are not adhered to
- K6 Describe the procedure for obtaining drawings, job instructions, related specifications, replacement parts, materials and other consumables necessary for the maintenance activities
- K7 Describe 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)
- K8 Outline the procedures and precautions to be adopted to eliminate electrostatic discharge (ESD) hazards
- K9 State 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
- K10 Describe the various maintenance diagnostic techniques and aids that can be used (such as fault reports, visual checks, measuring, movement and alignment checks, testing; fault location using techniques such as half-split, input-to-output, function testing, unit substitution, and equipment self-diagnostics)
- K11 Describe the care, handling and application of electronic measuring instruments/fault diagnostic equipment to investigate the problem (such as multimeter, oscilloscope, signal generators, logic probes/analysers, measuring bridges)
- K12 Explain how to check that test equipment is safe to use (such as condition of power cables, using suitably fused test probes, clips and leads); 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

Knowledge and understanding

The learner must:

- K13 Explain how to connect to an approved power supply and, where appropriate, signal source; identifying correct test points in the circuit; how to position test instruments into circuits without damaging circuit components (such as using test probes, ensuring correct polarity, taking antistatic precautions); setting instrument zero readings; obtaining instrument readings and comparing them with expected results
- K14 Outline the application of Ohm's law and relevant calculations (including units of electronic measurement and their multiples and sub-multiples)
- K15 Describe the use of calculations and regulations, when selecting wires and cables and when carrying out tests on electronic circuits
- K16 Explain how to make adjustments to circuit components; making decisions on circuit performance and faulty components; removal and replacement of faulty components
- K17 Explain how to check that the replacement components meet the required specification/operating conditions (such as values, tolerance, current-carrying capacity, ambient temperatures, connection orientation)
- K18 Describe methods of removing and replacing the faulty components from the equipment (such as unplugging, de-soldering, removal of screwed, clamped, edge connected, zero insertion force, and crimped connections) without causing damage to other components, wiring, circuit boards or the surrounding structure
- K19 Describe the tools and equipment used in the repair activities (including the use of wire-stripping tools, crimping tools, soldering irons, insertion devices and connecting tools); how to check that they are in a safe and usable condition
- K20 Explain 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)
- K21 Explain the importance of making de-energised checks before proving the equipment with the electrical supply on
- K22 Explain how to make adjustments to components/assemblies to ensure that they function correctly
- K23 Describe 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
- K24 Describe problems that can occur with the electronic equipment maintenance activity, and how they can be overcome
- K25 Outline when to act on their own initiative and when to seek help and advice from others

Unit 18: Preparing and using Industrial Robots

Level: 2

Guided learning hours: 140

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to produce, 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 unit 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 of the *Skills* section.

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 Plan the programming activities before they start them
- P4 Determine an operational sequence that avoids wasted 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

The learner must be able to:

1. 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

Skills

The learner must be able to:

2. Prepare and use **one** of the following types of industrial robot:
 - 2.1 Cartesian (gantry)
 - 2.2 SCARA
 - 2.3 articulated
 - 2.4 parallel
 - 2.5 other specific type

3. Prepare, load and prove programs using **one** of the following types of robot programming methods:
 - 3.1 positional commands (x, y, z)
 - 3.2 teach pendant
 - 3.3 off-line programming
 - 3.4 other specific method

4. Produce robot programs for **one** of the following engineering applications:
 - 4.1 welding
 - 4.2 logistics movement/control
 - 4.3 surface coating
 - 4.4 packaging
 - 4.5 gluing/sealing
 - 4.6 stud welding
 - 4.7 machine loading/unloading
 - 4.8 assembly
 - 4.9 other specific activity

5. Select and set up **one** of the following types of robot end effectors for the engineering application of:
 - 5.1 welding guns
 - 5.2 spot welders
 - 5.3 spray guns
 - 5.4 glue/sealing gun
 - 5.5 grippers
 - 5.6 drills
 - 5.7 vacuum devices
 - 5.8 other specific tooling

Skills

The learner must be able to:

6. Develop programs that contain **all** of the following:
 - 6.1 safe start and stop positions
 - 6.2 all necessary positional information
 - 6.3 type of motion (such as joint interpolated, linear, circular)
 - 6.4 preparatory commands and process management/auxiliary functions
 - 6.5 repetitive programs (such as sub-routines, canned cycles, labels, function blocks)
 - 6.6 speed/acceleration parameters
 - 6.7 sensor information
 - 6.8 programs downloaded from the appropriate and approved source

7. Prove the robot program using **four** of the following:
 - 7.1 single block run
 - 7.2 full dry run
 - 7.3 search facilities
 - 7.4 edit facilities
 - 7.5 program override controls
 - 7.6 data input facilities
 - 7.7 all modes (such as auto, T1, T2 and remote)

8. Carry out operations for **one** of the applications identified in section 4, to include **all** of the following:
 - 8.1 checking that all safety mechanisms are in place and that the equipment is set correctly for the required operations
 - 8.2 positioning work in relation to the robot parameters (such as securing in the workholding device)
 - 8.3 running the operating program in accordance with operating procedures
 - 8.4 checking that all operations are carried out safely and correctly
 - 8.5 editing programs using the correct procedure (where appropriate)
 - 8.6 examining the completed work visually and/or using suitable test/measuring instruments, gauges or checking fixtures, as appropriate to the operations performed (where applicable)
 - 8.7 determining if the completed set-up completes the operations to the required specification, including repeatability and accuracy

Knowledge and understanding

The learner must:

- K1 Describe the hazards associated with using industrial robots (e.g. automatic/sudden movements of arm, power operated accessories), and how they can be minimised
- K2 Define the safety mechanisms on the robot and operating envelope (e.g. emergency stop buttons, movement/hazard sensors), and the procedure for checking that they function correctly
- K3 Explain how to stop the robot in both normal and emergency situations, and the procedure for restarting after an emergency
- K4 Explain the correct operation of all available modes (e.g. automatic operation, teach pendant, program operating and control buttons)
- K5 Explain how to drive the robot in each type of coordinate frame (e.g. tool, global, joint, user)
- K6 Explain how to drive the robot at different speeds, including jog mode
- K7 Outline 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
- K8 Describe the information and data required in order to produce complete and accurate robot programs
- K9 Describe 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)
- K10 Describe how to produce effective and efficient programs to avoid unnecessary operations (e.g. using function blocks and canned cycles, to reduce program size)
- K11 Describe the methods and procedures used to check that the completed program will perform safely, accurately and efficiently (e.g. conducting trial runs, using single block run, dry run and speed override controls)
- K12 Explain the importance of saving the completed programs in the appropriate format
- K13 Explain how to back up completed or edited programs, and the implications if this is not carried out effectively
- K14 Describe the methods and procedures used to minimise the chances of infecting a computer with a virus
- K15 Describe the implications if the computer they are using does become infected with a virus and who to contact if it does occur
- K16 Outline the problems that can occur with the downloading and running of the robot program, and how these can be overcome
- K17 Identify the various workholding devices that are used for robot applications, and describe the methods of positioning and setting them in relation to the robot's operating parameters (e.g. jigs and fixtures)
- K18 Outline the various tools and end effector equipment that are used for the particular robot operations (e.g. mechanical grippers, welding torches, stud guns, spray guns, drilling attachments)

Knowledge and understanding

The learner must:

- K19 Explain the importance of ensuring that tools are positioned correctly in relationship to the robot's reference points and tool centre points
- K20 Explain the importance of checking that the tool change positions (where appropriate) are clear of the workpiece and can be safely and quickly achieved
- K21 Explain the importance of ensuring that all guards are in place and that the interlock systems are in correct working order
- K22 Outline how to check that the finished operations meet the work specification
- K23 Describe typical problems that can occur with the programming, loading and editing activities, and what to do if they occur

Unit 19: General Turning, Milling and Welding Applications

Level: 2

Guided learning hours: 140

Unit overview

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

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

They will be expected to carry out a range of practical skills tasks in order to gain an understanding of how these machining and welding activities are undertaken, the types of equipment used, the manufacturing techniques, and the operating and safety procedures that are required.

In carrying out the activities, they will use appropriate tools, equipment, methods and techniques appropriate to the operations being performed. These activities will include turning, milling and welding operations.

During, and on completion of, the operations, they will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and the tolerances to be achieved. They will need to be able to recognise when the activities/outputs are not meeting the required specification, and to discuss/determine what action needs to be taken to remedy any faults that occur, in order to ensure that the finished workpiece is within the specification requirements. On completion of the activities, they will be expected to return all tools and equipment that they have used to the correct location, and to leave the work area in a safe and tidy condition.

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

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

They will understand the safety precautions required when carrying out the various turning, milling and welding techniques, and when using any hand tools and machinery. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

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

Specific unit requirements

Turning

In order to prove their ability to combine different turning operations, at least one of the machined components produced must be of a significant nature, and must have a minimum of **nine** of the features listed in paragraph 4 of the *Skills* section.

Milling

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

Welding

Welded joints must be at least 150mm long, using single- or multi-run welds (as appropriate).

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

Turning and Milling

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 Plan the machining activities before they start them
- P4 Obtain and prepare the appropriate materials, tools and equipment
- P5 Grind lathe tools and drills to meet the required component specification
- P6 Mount and set the required workholding devices, workpiece and cutting tools
- P7 Set and adjust the machine tool speeds and feeds to achieve the component specification
- P8 Use the machine tool controls safely and correctly, in line with operational procedures
- P9 Measure and check that all dimensional and geometrical aspects of the component are to the specification
- P10 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
- P11 Shut down the equipment to a safe condition on completion of the machining activities

Welding

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 Plan the welding activities before they start them
- P4 Obtain and prepare the appropriate welding equipment and welding consumables
- P5 Prepare and support the joint, using the appropriate methods
- P6 Tack weld the joint at appropriate intervals, and check the joint for accuracy before final welding
- P7 Weld the joint to the specified quality, dimensions and profile
- P8 Use appropriate methods and equipment to check the quality, and that all dimensional and geometrical aspects of the weld are to the specification
- P9 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
- P10 Shut down and make safe the welding equipment on completion of the welding activities

Skills (machining)

The learner must be able to:

1. Carry out **all** of the following during the machining, fitting and assembly activities:
 - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
 - 1.2 ensure that all hand tools and equipment used are in a safe and serviceable condition (such as cables to hand tools and extension leads, file handles, hammer striking faces)
 - 1.3 ensure that all machine tools are correctly guarded at all times
 - 1.4 check that all measuring equipment is within calibration date
 - 1.5 return all tools and equipment to the correct location on completion of the fitting activities
2. Machine **two** different types of material from the following:
 - 2.1 ferrous
 - 2.2 non-ferrous
 - 2.3 non-metallic
3. Use **four** of the following workholding methods and techniques:
 - 3.1 three-jaw chuck
 - 3.2 collet chuck
 - 3.3 four-jaw chuck
 - 3.4 machine vice
 - 3.5 clamping direct to milling machine table
 - 3.6 indexing device
 - 3.7 other workholding/supporting methods (such as vee blocks, parallels, drive plate and centres)
4. Carry out turning operations to include **all** of the following:
 - 4.1 mounting the workpiece in an appropriate workholding device
 - 4.2 mounting cutting tools in tool holders to give the correct centre height
 - 4.3 selecting and setting appropriate feeds and speeds
 - 4.4 facing off
 - 4.5 producing chamfers
 - 4.6 producing tapered diameters
 - 4.7 producing parallel diameters
 - 4.8 centre drilling and drilling a hole
 - 4.9 producing stepped diameters

Skills (machining)

The learner must be able to:

- 4.10 reaming or boring a hole
 - 4.11 producing and/or maintaining internal and external threads
 - 4.12 producing grooves/undercuts
 - 4.13 producing radii
 - 4.14 parting off
 - 4.15 knurling
5. Carry out milling operations, to include **all** of the following:
- 5.1 mounting the workpiece in an appropriate workholding device
 - 5.2 mounting cutting tools on appropriate arbors or direct to the machine spindle
 - 5.3 selecting and setting appropriate feeds and speeds
 - 5.4 producing flat and square faces
 - 5.5 producing an enclosed slot (such as a key way)
 - 5.6 producing parallel faces
 - 5.7 producing an open ended slot
 - 5.8 producing angular faces
 - 5.9 centre drilling and drilling a hole
 - 5.10 reaming a hole
 - 5.11 producing a tapped hole
6. Carry out the necessary checks for accuracy, to include **all** of the following:
- 6.1 linear dimensions (such as length, depth and width)
 - 6.2 external and internal diameters
 - 6.3 hole size and position
 - 6.4 thread size and fit
 - 6.5 squareness
 - 6.6 angles
 - 6.7 position
 - 6.8 parallelism
 - 6.9 surface finish

Skills (machining)

The learner must be able to:

- 7.8 squares
 - 7.9 slip gauges
 - 7.10 radius/profile gauges
 - 7.11 depth micrometers
 - 7.12 thread gauges
 - 7.13 depth verniers
 - 7.14 feeler gauges
 - 7.15 surface finish equipment (such as comparison plates, machines)
 - 7.16 coordinate measuring machine (CMM)
8. Produce components within **all** of the following standards, as applicable to the process:
- 8.1 components to be free from false tool cuts, burrs and sharp edges
 - 8.2 general dimensional tolerance +/- 0.25mm or +/- 0.010"
 - 8.3 there must be one or more specific dimensional tolerances within +/- 0.1mm or +/- 0.004"
 - 8.4 flatness and squareness 0.05mm per 25mm or 0.002" per inch
 - 8.5 angles within +/- 0.5 degree
 - 8.6 screw threads to BS Medium fit
 - 8.7 reamed holes within H8
 - 8.8 surface finish 63 µin or 1.6 µm
9. Carry out **all** of the following during the welding activities:
- 9.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
 - 9.2 ensure that all hand tools and equipment used are in a safe and serviceable condition and electrically safe condition, such as PAT tested (such as extension leads, powered hand tools and welding equipment cables, welding plant hoses and hammers)
 - 9.3 return all tools and equipment to the correct location on completion of the fabrication activities

Skills (welding)

The learner must be able to:

10. Use **one** materials from the following:
 - 10.1 carbon steel
 - 10.2 stainless steel
 - 10.3 aluminium
 - 10.4 plate
 - 10.6 pipe/tube
 - 10.7 section
 - 10.8 other forms

11. Use manual welding and related equipment, to include **one** of the following welding processes:
 - 11.1 MMA
 - 11.2 MIG
 - 11.3 MAG
 - 11.4 TIG
 - 11.5 flux cored wire welding
 - 11.6 manual oxy/fuel gas welding

12. Produce **two** of the following welded joints of at least 150mm long, with at least one stop and start included:
 - 12.1 fillet lap joints
 - 12.2 corner joints
 - 12.3 tee fillet joints
 - 12.4 butt joints

13. Weld joints in good access situations in **two** of the following BS EN ISO 6947 positions:
 - 13.1 Flat (PA)
 - 13.2 Vertical upwards (PF)
 - 13.3 Horizontal vertical (PB)
 - 13.4 Vertical downwards (PG)
 - 13.5 Horizontal (PC)

Skills (welding)

The learner must be able to:

14. Check that the welded joint conforms to the specification, by checking **all** of the following:
 - 14.1 dimensional accuracy
 - 14.2 size and profile of weld
 - 14.3 alignment/squareness

15. Carry out testing of the welds, using **one** of the following:
 - 15.1 dye or fluorescent penetrant
 - 15.2 nick break test
 - 15.3 bend tests (such as face, root or side, as appropriate)

16. Produce welded joints which meet **all** of the following (with reference to BS 4872 Part 1 Weld test requirements) **as applicable** to the weld being produced:
 - 16.1 welds meet the required dimensional accuracy
 - 16.2 fillet welds are equal in leg length and slightly convex in profile, with the size of the fillet equivalent to the thickness of the material welded
 - 16.3 the weld contour is linear, of uniform profile, free from excessive undulations, with regular and even ripple
 - 16.4 the welds are adequately fused, and there is minimal undercut, overlap and surface inclusions
 - 16.5 joins at stop/start positions merge smoothly, with no pronounced hump or crater in the weld surface
 - 16.6 tack welds are blended in to form part of the finished weld, without excessive hump
 - 16.7 the weld surface is free from cracks, and substantially free from porosity, shrinkage cavities and trapped slag
 - 16.8 the weld surface and adjacent parent metal is substantially free from arcing or chipping marks

Knowledge and understanding

The learner must:

General

- K1 Describe the 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
- K2 Explain the importance of applying the appropriate behaviours in the workplace and the implications for both the learner and the business if these are not adhered to
- K3 Describe 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 Describe how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
- K5 Outline when to act on your own initiative and when to seek help and advice from others
- K6 Explain 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

- K7 Explain 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)
- K8 Describe the techniques of taking trial cuts and checking dimensional accuracy; the application of roughing and finishing cuts, and the effect on tool life, surface finish and dimensional accuracy
- K9 Describe the 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)
- K10 Describe the application of cutting fluids and compounds with regard to a range of different materials, and why some materials do not require cutting fluids to be used
- K11 Explain how to check the workpiece and the measuring equipment that is used (such as rules, micrometers, verniers, gauges and surface finish comparison equipment)
- K12 Explain the need to check that the measuring equipment is within current calibration dates, and that the instruments are correctly zeroed; measuring internal and external dimensions (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)

Knowledge and understanding

The learner must:

K13 Describe 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

K14 Describe, 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)

K15 Describe the general principles of the type of welding process being undertaken, power sources requirements, the major parts of the welding equipment, their function and equipment set up requirements)

K16 Describe the types, selection and application of electrode/wires and other consumables

K17 Describe the types of welded joints to be produced (such as lap joints, corner joints, tee joints and butt welds)

K18 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)

K19 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)

K20 Outline the appropriate tack welding size and spacing (in relation to material thickness)

K21 Describe the checks to be made prior to welding (such as confirming the correct set-up of the joint; the condition of electrical connections, welding return and earthing arrangements; wire feed mechanisms; gas supply; operating parameters)

K22 Describe the techniques of operating the welding equipment to produce a range of joints in the various joint positions (such as adjustment of parameters; correct manipulation of the welding gun; blending in stops/starts and tack welds)

K23 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

K24 Explain how to safely prepare the welds for examination (such as removing surface irregularities; cleaning the weld, polishing and making saw cuts on welds to be break tested)

K25 Explain how to check the welded joints for uniformity, alignment, position, weld size and profile

K26 Explain how to identify and check for defects such as lack of continuity of weld, uneven or irregular ripple formation, incorrect weld size or profile, undercutting, internal cracks, overlap, surface cracks, inclusions, lack of fusion, porosity, lack of penetration

Unit 20: Forming and Assembling Pipework Systems

Level: 2

Guided learning hours: 140

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to 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.

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

Specific unit requirements

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

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

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

Skills

The learner must be able to:

1. Carry out **all** of the following during the pipe bending, forming and fitting activities:
 - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
 - 1.2 follow job instructions, assembly drawings and procedures
 - 1.3 check that the bending and forming equipment is in a safe and usable condition
 - 1.4 return all tools and equipment to the correct location on completion of the pipe fitting activities
 - 1.5 apply safe working practices at all times
2. Produce pipework assemblies using **two** of the following types of pipe:
 - 2.1 carbon steel
 - 2.2 copper
 - 2.3 aluminium
 - 2.4 stainless steel

Skills

The learner must be able to:

- 2.5 brass
- 2.6 plastic
- 3. Mark out pipework, using the following method:
 - 3.1 direct marking using tapes and markersPlus **one** more from the following:
 - 3.2 set-outs of pipework using templates
 - 3.3 producing set wires
 - 3.4 set-outs of pipework onto floor
- 4. Cut and prepare the pipes for forming and assembly, to include carrying out **all** of the following:
 - 4.1 cutting pipes to length with appropriate allowance for fittings
 - 4.2 removing all external and internal burrs
 - 4.3 cleaning pipe ends for soldering or cementing (where appropriate)
 - 4.4 cutting threads on pipe ends to the appropriate length (where appropriate)
 - 4.5 checking that prepared pipes are the correct length
- 5. Cut and prepare pipework using the following:
 - 5.1 saws (hand or power)Plus **two** more from the following:
 - 5.2 pipe/tube cutter
 - 5.3 de-burring reamers
 - 5.4 abrasive cloth
 - 5.5 wire pipe cleaners
- 6. Bend and form pipe using the following method:
 - 6.1 hand-operated pipe benderPlus **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

Skills

The learner must be able to:

7. Produce pipework bends/forms that include **both** of the following:
 - 7.1 angular bends
 - 7.2 offsetsPlus **one** more from the following:
 - 7.3 bridge sets
 - 7.4 radii
 - 7.5 internal swaged ends
 - 7.6 expansion loops
 - 7.7 external swaged ends

8. Assemble pipes using **three** of the following methods:
 - 8.1 compression fittings
 - 8.2 soldered fittings
 - 8.3 cemented fittings
 - 8.4 snap-on/push fittings
 - 8.5 brazed fittings
 - 8.6 welded joints
 - 8.7 screwed connections

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

Skills

The learner must be able to:

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

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

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

Knowledge and understanding

The learner must:

- K1 Describe the health and safety requirements, and safe working practices and procedures required for the pipe fitting activities undertaken
- K2 Identify 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
- K3 Describe how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken
- K4 Describe how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
- K5 Describe the principles and methods of marking out pipework, and the type of equipment used (such as direct marking, use of templates, use of set wires)

Knowledge and understanding

The learner must:

- K6 Describe how to prepare the pipes in readiness for the marking out activities (visually checking for defects, cleaning the materials, removing burrs and sharp edges)
- K7 Describe how to determine the overall length of the pipework required, taking into account allowances for pipe fittings and (where appropriate) screwed connections
- K8 Identify the tools and equipment used in the cutting and preparing the pipes (such as saws, pipe and tube cutters)
- K9 Describe 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
- K10 Describe the methods used to hand bend and form the pipe (including the use of bending springs, hand bending machines, fillers, heating methods)
- K11 Describe how to produce the various bends required (such as angled bends, dog-leg sets, bridge sets and expansion loops)
- K12 Explain the reasons for incorporating expansion loops in a system, and where they should be positioned
- K13 Describe 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)
- K14 Describe the methods used to seal screwed joints (such as tapes and sealing compounds)
- K15 Describe the use of flanges to connect pipes; use of gaskets; and torque loading of flange bolts
- K16 Describe 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
- K17 Describe the various types of soldered connectors available (such as solder ring types and capillary fittings)
- K18 Describe the methods used to solder the joints, and how to recognise when the fitting is correctly soldered
- K19 Describe the precautions to be taken when using gas torches to form the joint, and the effect of overheating the joint
- K20 Describe 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
- K21 Describe the methods used to cement the joints, and how to recognise when the fitting is correctly secured
- K22 Describe the various adhesives and sealing compounds that are used on non-metallic pipework
- K23 Describe 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)

Knowledge and understanding

The learner must:

- K24 Describe the use of compression fittings; how the pipes are sealed; and the effects of over tightening the fittings
- K25 Describe the use of push-fit connectors, and their advantages and disadvantages
- K26 Explain how to identify the correct orientation of fittings with regard to flow, and the consequences of incorrect orientation
- K27 Describe the supporting methods that are used when assembling pipework, and the type of fittings that are used
- K28 Describe the methods of testing pipework systems for leaks (using air, water or hydraulic testing methods)
- K29 Describe 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 designated location, cleaning the work area and removing and disposing of waste)

Unit 21: Preparing and Proving CNC Machine Tool Programs

Level: 2

Guided learning hours: 140

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to 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 unit requirements

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

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 Plan the programming activities before they start them
- P4 Determine an operational sequence that avoids wasted tool/cutter movements and tool changes
- P5 Develop component programs using appropriate programming codes and techniques
- P6 Specify positional information and machine axes that are consistent with the requirements of each stage/operation
- P7 Load/input the program to the machine controller, and check/prove the program for errors using approved procedures
- P8 Save and store the program in line with organisational procedures
- P9 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
- P10 Shut down the equipment to a safe condition on completion of the programming activities

Skills

The learner must be able to:

1. Ensure that they apply **all** of the following checks and practices at all times during the programming activities:
 - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
 - 1.2 the correct component drawings are obtained and checked for currency and validity
 - 1.3 the appropriate reference manuals and programming codes are used to suit the machine controller
 - 1.4 the machine controller is prepared ready to accept the operating program
 - 1.5 the prepared program is input/loaded into the controller safely and correctly
 - 1.6 programs are stored safely and correctly in the appropriate format
 - 1.7 program media is stored safely and correctly, away from contaminants and corruption

Skills

The learner must be able to:

2. Prepare and prove programs for **one** of the following types of CNC machine tool:
 - 2.1 two axis machine
 - 2.2 multiple axis machines (5 or more)
 - 2.3 three axis machine
 - 2.4 machining centres
3. Produce CNC programs using **one** of the following methods:
 - 3.1 entered directly into the machine controller
 - 3.2 using computer software
4. Develop part programs which contain **all** of the following, as applicable to the machine type:
 - 4.1 all necessary positional information
 - 4.2 appropriate codes
 - 4.3 machine management commands (preparatory/auxiliary functions)
 - 4.4 repetitions within programs (using features such as sub-routines, canned cycles, labels)
 - 4.5 absolute or incremental co-ordinates
 - 4.6 tool/cutter change positions
 - 4.7 tool information (such as lengths, offsets, radius compensation)
5. Develop programs to produce components which cover eight of **the** following features:
 - 5.1 parallel diameters
 - 5.2 angular faces
 - 5.3 enclosed slots/recesses
 - 5.4 stepped diameters
 - 5.5 internal profiles
 - 5.6 open ended slots
 - 5.7 tapered diameters
 - 5.8 external profiles
 - 5.9 eccentric diameters
 - 5.10 flat faces
 - 5.11 reamed holes
 - 5.12 external screw threads

Skills

The learner must be able to:

- 5.13 internal undercuts
 - 5.14 tapped holes
 - 5.15 internal screw threads
 - 5.16 external undercuts
 - 5.17 drilled holes
 - 5.18 chamfers and radii
 - 5.19 steps/shoulders
 - 5.20 holes on pitched circles
 - 5.21 bored holes
 - 5.22 parallel faces
 - 5.23 holes linearly pitched
 - 5.24 special forms (such as concave, convex)
 - 5.25 faces that are square to each other
 - 5.26 parting-off
6. Develop part programs to machine components made from **two** of the following types of material:
- 6.1 low carbon/mild steel
 - 6.2 cast iron
 - 6.3 plastic/nylon/composite
 - 6.4 high carbon steel
 - 6.5 brass/brass alloys
 - 6.6 aluminium/aluminium alloys
 - 6.7 other specific material
7. Prove the part program using **six** of the following:
- 7.1 single block mode
 - 7.2 graphic displays/modelling
 - 7.3 data input facilities
 - 7.4 full dry run (in air)
 - 7.5 search facilities
 - 7.6 edit facilities
 - 7.7 program override controls (spindle speed, feed rate, tool data)
 - 7.8 program save/store facilities

Skills

The learner must be able to:

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

Knowledge and understanding

The learner must:

- K1 Describe the hazards associated with using CNC machine tools (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
- K2 State the safety mechanisms on the machine (such as emergency stop buttons, emergency brakes), and the procedure for checking that they function correctly
- K3 Describe the correct operation of the various hand and automatic modes of machine control (such as program operating and control buttons)
- K4 Describe how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
- K5 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
- K6 State the computer coding language used in CNC programs (with regard to machine axes, positional information, machine management and auxiliary functions)
- K7 Describe how to prepare part programs (using operational sequences and machining techniques that avoid unnecessary tool/cutter movements or tool changes)
- K8 Describe the use of features that enable reductions in program size and input time (such as canned cycles, sub-routines and labels)
- K9 Outline the function keys and operating system of the machine computer control system being operated
- K10 Describe how to set machine datums for each of the machine axes being used

Knowledge and understanding

The learner must:

- K11 Describe how to set the machine control system in the programming and editing mode, download (input) and upload (output) modes
- K12 Describe how to deal with error messages and faults on the program or equipment
- K13 Describe how to access the program edit facility, in order to enter tooling data (such as tool datums, positions, lengths, offsets and radius compensation)
- K14 Describe the use of tool posts, magazines, carousels and turrets, and how to identify the tools in relationship to the operating program
- K15 Describe how to conduct trial runs (using single block run, dry run and feed and spindle speed override controls)
- K16 Describe the 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)
- K17 State the checks to be made before allowing the CNC machine to operate in full program run mode
- K18 Describe 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
- K19 Describe the typical problems that can occur with the programming, loading and editing activities, and what to do if they occur
- K20 Describe the methods and procedures used to minimise the chances of infecting a computer with a virus
- K21 Describe the implications if the computer they are using does become infected with a virus and who to contact if it does occur

Unit 22: Producing Sheet Metal Components and Assemblies

Level: 2

Guided learning hours: 140

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to cover a broad range of basic sheet (up to and including 3mm) 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.

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

Specific unit requirements

In order to prove their ability to combine different sheet metal cutting and forming operations, at least one of the jobs produced must be of a significant nature, and must contain a minimum of three of the features listed in paragraph 7 plus **three** of the features listed in paragraph 9 of the *Skills* section.

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 Plan the sheet metalworking activities before they start them
- P4 Obtain the appropriate tools and equipment for the sheet metalworking operations, and check that they are in a safe and usable condition
- P5 Mark out the components for the required operations, using appropriate tools and techniques
- P6 Cut and shape the materials to the required specification, using appropriate tools and techniques
- P7 Use the appropriate methods and techniques to assemble and secure the components in their correct positions
- P8 Measure and check that all dimensional and geometrical aspects of the component are to the specification
- P9 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
- P10 Leave the work area in a safe and tidy condition on completion of the fitting activities

Skills

The learner must be able to:

1. Carry out **all** of the following during the sheet metalworking activities:
 - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
 - 1.2 ensure that all power tool cables, extension leads or air supply hoses are in a tested and serviceable condition
 - 1.3 return all tools and equipment to the correct location on completion of the sheet metalworking activities
 - 1.4 check that all measuring equipment is within calibration date
2. Use marking out methods and techniques, including:
 - 2.1 direct marking using instruments

Plus **one** more from the following:

 - 2.2 use of templates
 - 2.3 tracing/transfer methods

Skills

The learner must be able to:

3. Use a range of marking out equipment, to include **all** of the following:
 - 3.1 scriber
 - 3.2 rule or tape
 - 3.3 square
 - 3.4 dividers or trammels
 - 3.5 punch
 - 3.6 straight edge
 - 3.7 protractor
 - 3.8 chalk, blueing or paint

4. Mark out material, to include **all** of the following features:
 - 4.1 datum and centre lines
 - 4.2 curved profiles
 - 4.3 square/rectangular profiles
 - 4.4 cutting and bending detail (including allowances)
 - 4.5 angles
 - 4.6 hole centring and outlining (such as circular or linear)
 - 4.7 circles

5. Cut and finish material to the marked out shape, using **both** of the following hand tools:
 - 5.1 tin snips
 - 5.2 bench shears

Plus **two** more from the following:

 - 5.3 hacksaw
 - 5.4 files
 - 5.5 hand power tools (such as drill, nibbling, saw)
 - 5.6 pneumatic tools
 - 5.7 trepanning
 - 5.8 thermal device
 - 5.9 other specific tool

Skills

The learner must be able to:

6. Cut and finish material to the marked out shape, using the following machine tool:
 - 6.1 guillotinePlus **two** more of the following:
 - 6.2 pillar drill
 - 6.3 punch/cropping machine
 - 6.4 trepanning machine
 - 6.5 bench saw
 - 6.6 nibbling machine
 - 6.7 band saw

7. Perform cutting operations to produce components with all **three** of the following shapes:
 - 7.1 square or rectangular profiles
 - 7.2 angled profiles
 - 7.3 external curved profilesPlus **two** more from the following:
 - 7.4 notches
 - 7.5 internal curved contours
 - 7.6 round holes
 - 7.7 square holes

8. Use **both** of the following types of forming equipment/techniques:
 - 8.1 bending machine (hand or powered)
 - 8.2 rolling machine (hand or powered)Plus **two** more from the following:
 - 8.3 hammers/panel beating equipment
 - 8.4 wheeling machine
 - 8.5 stakes and formers
 - 8.6 swaging machine
 - 8.7 presses
 - 8.8 shrinking techniques
 - 8.9 jenny/wiring machine
 - 8.10 stretching techniques

Skills

The learner must be able to:

9. Carry out forming operations which produce components having **all** of the following shapes:
 - 9.1 bends/upstands
 - 9.2 tray/box sections
 - 9.3 folds/safe edges
 - 9.4 cylindrical sectionsPlus **one** more from the following:
 - 9.5 wired edges
 - 9.6 cowlings and rounded covers
 - 9.7 swages
 - 9.8 square to round trunking
 - 9.9 curved panels
 - 9.10 lobster-back trunking
 - 9.11 ribbed components
 - 9.12 concertina ducting or trunking

10. Assemble sheet metal components, using **two** of the following methods:
 - 10.1 temporary tack welding
 - 10.2 adhesive bonding
 - 10.3 soldering or brazing
 - 10.4 flanged and mechanically fastened (such as bolts, screws)
 - 10.5 resistance spot welding
 - 10.6 self-securing joints (such as knocked up, paned down, swaged, joggled)
 - 10.7 riveting (such as hollow or solid)

11. Use sheet metal (up to and including 3mm) in **two** different materials from the following:
 - 11.1 hot rolled mild steel
 - 11.2 cold rolled mild steel
 - 11.3 coated mild steel (such as primed, tinned, galvanised)
 - 11.4 copper
 - 11.5 brass
 - 11.6 lead
 - 11.7 stainless steel
 - 11.8 titanium
 - 11.9 aluminium

Skills

The learner must be able to:

12. Produce sheet metal components which meet **all** of the following:
 - 12.1 all dimensions are within +/- 2.0mm or +/- 0.079"
 - 12.2 finished components meet the required shape/geometry (square, straight, angles free from twists)
 - 12.3 completed components are free from excessive tooling marks, deformation, cracking, sharp edges, slivers or burrs
 - 12.4 all components are correctly assembled and have secure and firm joints

Knowledge and understanding

The learner must:

- K1 Describe the correct methods of moving or lifting sheet materials
- K2 Describe the safe working practices and procedures to be observed when using manual and power operated tools
- K3 Describe the hazards associated with carrying out sheet metalworking activities (such as handling sheet materials, using dangerous or badly maintained tools and equipment, operating guillotines and bending machines, and when using hand and bench shears), and how they can be minimised
- K4 Describe the procedure for obtaining the required drawings, job instructions and other related specifications
- K5 Describe how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
- K6 Describe 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 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
- K8 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)
- K9 Describe ways of laying out the marking-out shapes or patterns to maximise use of materials
- K10 Identify the tools and techniques available for cutting and shaping sheet metal (such as tin snips, bench shears, guillotines, portable power tools, bench drills, saws)
- K11 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 sharp, undamaged, plugs and cables secure and free from damage, PAT tested, machine guards or safety devices operating correctly)

Knowledge and understanding

The learner must:

- K12 Identify the 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
- K13 Describe the various machine tool forming equipment that can be used to produce a range of shapes (such as bends, box sections, cylinders and curved sections, wired edges and swages)
- K14 Describe the methods of stretching and shrinking materials, and the tools, equipment and techniques used for this
- K15 Describe 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)
- K16 Describe the ways of limiting distortion, marking, creases, flats (in curved sections)
- K17 Describe the characteristics of the various materials used (with regard to the bending and forming process)
- K18 Explain how the materials are to be prepared for the forming operations, and why some materials may require a heating process prior to forming
- K19 Describe 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
- K20 Describe the various methods of securing the assembled components, and the range of mechanical fastening devices that are used (such as nuts and bolts, rivets, screws, special fasteners), resistance and tack welding methods and techniques, adhesive bonding of components and self-secured joints (such as knocked up, paned down, swaged and joggled)
- K21 Describe the preparations to be carried out on the components prior to assembling them
- K22 Explain how to set up and align the various components, and the tools and equipment that are used for this
- K23 Describe the methods of temporarily holding the joints together to aid the assembly activities (such as clamps, rivet clamps)
- K24 Describe the inspection techniques that can be applied to check that shape (including straightness) and dimensional accuracy are to specification and within acceptable limits
- K25 Describe the problems that can occur with the sheet metalworking activities (such as defects caused by incorrectly set or blunt shearing blades), and how these can be overcome

Unit 23: Maintaining and Testing Process Instrumentation and Control Devices

Level: 2

Guided learning hours: 175

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to carry out 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.

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 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 paragraph 4 of the *Skills* section.

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 Plan the maintenance activities before they start them
- P4 Obtain all the information they need for the safe removal and replacement of the 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

The learner must be able to:

1. 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
2. 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

Skills

The learner must be able to:

- 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
3. 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)
4. Carry out **all** of the following instrumentation maintenance activities:
- 4.1 removing excessive dirt and grime
 - 4.2 replacing all 'lived' 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

Skills

The learner must be able to:

- 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
5. 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)
6. 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

Skills

The learner must be able to:

- 6.15 insulation testers
- 6.16 special-purpose test equipment
- 7. 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 and understanding

The learner must:

- K1 Describe 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
- K2 Describe the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy
- K3 Describe the 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
- K4 Describe 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 Describe the procedures and precautions to be adopted to eliminate electrostatic discharge (ESD)
- K6 Describe the basic principles of operation of the instrumentation being maintained (to include pressure, temperature, level and flow instrument sensors)
- K7 Explain how to identify the various instrument sensors (including how to identify their markings, calibration information, component values, operating parameters and working range)
- K8 Explain 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
- K9 Describe 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)
- K10 Explain how to carry out visual checks of the instruments (such as security of joints and physical damage)

Knowledge and understanding

The learner must:

- K11 Describe 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
- K12 Outline the types and application of standard test equipment (such as pressure sources, deadweight tester, temperature baths, signal sources and comparators)
- K13 Describe 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
- K14 Describe the generation of maintenance documentation and/or reports following the maintenance activity
- K15 Describe the problems that can occur during the maintenance of the instrumentation and control system, and how they can be overcome
- K16 Describe the organisational procedure to be adopted for the safe disposal of waste of all types of materials
- K17 Describe 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 its designated location, cleaning the work area, and removing and disposing of waste)

Unit 24: Producing Components by Rapid Prototyping Techniques

Level: 2

Guided learning hours: 105

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to 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.

Assessment requirements

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

Additional information

Although all of the content and assessment requirements must be met in full employers can tailor the training outcomes to ensure that the content of the programme is specific to their requirements in terms of products, processes, procedures, tools, equipment, materials, documentation and information systems. This will allow each organisation to develop their own specific and tailored training programme whilst meeting their own business requirements whilst at the same time ensuring that the overall generic content is to a high standard in terms of depth and breadth to enable progression and/or transferability to other employers.

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 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

The learner must be able to:

1. 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
2. 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

Skills

The learner must be able to:

3. 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

4. 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

5. 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)

6. 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 and understanding

The learner must:

- K1 Describe how to start and stop the machine in normal and emergency situations, and how to close the machine down on completion of activities
- K2 Outline 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
- K3 Describe the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy
- K4 Explain the importance of ensuring that the machine is isolated from the power supply before working with the equipment
- K5 Describe the methods and procedures used to minimise the chances of infecting a computer with a virus
- K6 Describe the implications if the computer they are using does become infected with a virus and who to contact if it does occur
- K7 Describe the basic principles of rapid prototyping relevant to the machine being used
- K8 Describe the benefits and limitations of the different types of rapid prototyping equipment
- K9 Describe the rapid prototyping techniques used, and how to differentiate between the different processes (including the advantages and disadvantages)
- K10 Describe the finishing techniques that are required, and how they are applied to the different rapid prototyping processes
- K11 Describe how to import appropriate files (STL) from a data system into the rapid prototyping software
- K12 Describe setting up the rapid prototyping equipment to achieve the component specification (such as electrical and optical conditions; focal distance; forming speed)
- K13 Explain 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
- K14 Describe 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
- K15 Describe the reasons why certain materials are suitable for producing components by the rapid prototyping process
- K16 Describe the importance of knowing when components can be unloaded from the machine in relation to the different rapid prototyping processes
- K17 Describe the importance of handling and storing materials correctly and linking to the correct documentation
- K18 Describe the 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

Knowledge and understanding

The learner must:

K19 Describe 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 25: **Wiring and Testing Vehicle Electrical Equipment and Circuits**

Level: 2

Guided learning hours: 140

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to 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 starter motors, control devices, lighting systems, relays and instruments.

They will be required to select the appropriate tools, materials and equipment to use, based on the operations to be performed and the components to be connected. They will be expected to use appropriate tools and techniques for the wiring of the various electrical components and connectors that make up the electrical system/circuit. In addition, they will be expected to make all necessary electrical connections to the switches, relays, sensors/actuators and other devices, as appropriate to the equipment and circuit being produced. The wiring and testing activities will include making all necessary checks and adjustments to the circuit, including continuity, polarity, insulation resistance values, and ensuring that the equipment functions to the specification.

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

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate electrical wiring and testing procedures and techniques safely. They will understand the wiring and testing methods and procedures used, and their application, and will know about the various cables and components used to produce the circuits, to the required depth to provide a sound basis for carrying out the activities to the required specification.

They will understand the safety precautions required when carrying out the wiring and testing activities, especially those for ensuring the safe isolation of the equipment and circuits produced. They will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

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

Specific unit requirements

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

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 Plan the 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 components safely and correctly, to meet specification requirements
- P7 Install and terminate the cables to the appropriate connections on the components
- P8 Use appropriate test methods and equipment to check that the completed circuit is safe and meets all aspects of the specification
- P9 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
- P10 Leave the work area in a safe and tidy condition on completion of the wiring and testing activities

Skills

The learner must be able to:

1. Carry out **all** of the following activities during the wiring and testing activities:
 - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
 - 1.2 ensure the safe isolation of services during the wiring and testing activities
 - 1.3 follow job instructions, circuit drawings and test procedures at all times
 - 1.4 check that tools and test instruments to be used are within calibration date, and are in a safe and usable condition
 - 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

Skills

The learner must be able to:

2. Wire circuits using **six** of the following types of cables:
 - 2.1 single core
 - 2.2 multicore
 - 2.3 PVC twin and earth
 - 2.4 armoured
 - 2.5 flexible (such as cotton or rubber covered)
 - 2.6 data/communication
 - 2.7 ribbon cables
 - 2.8 fibre-optics
 - 2.9 screened
 - 2.10 coaxial
 - 2.11 wiring loom/harness

3. Connect **eighteen** of the following electrical modules/components to produce circuits:
 - 3.1 isolators (such as hybrid)
 - 3.2 fuses
 - 3.3 starter motors
 - 3.4 motors
 - 3.5 transformers
 - 3.6 circuit breakers
 - 3.7 overloads
 - 3.8 cable connectors
 - 3.9 switches
 - 3.10 lamp holders
 - 3.11 sockets
 - 3.12 panel lamps
 - 3.13 lighting
 - 3.14 sensors
 - 3.15 actuators
 - 3.16 solenoids
 - 3.17 relays
 - 3.18 terminal blocks
 - 3.19 alarm devices
 - 3.20 instruments

Skills

The learner must be able to:

- 3.21 electronic modules/units
 - 3.22 control devices
 - 3.23 pumps
 - 3.24 heaters
 - 3.25 other electrical components
4. Apply wiring methods and techniques to include **all** of the following:
- 4.1 positioning and securing of equipment and components
 - 4.2 levelling and alignment of components
 - 4.3 determining and calculating current rating and lengths of cables required
 - 4.4 securing by using mechanical fixings (such as screws, nuts and bolts)
 - 4.5 laying in cables without twisting or plaiting
 - 4.6 feeding cables into conduit without twisting or plaiting
 - 4.7 leaving sufficient slack for termination and movement
5. Carry out **nine** of the following cable termination activities:
- 5.1 stripping cable sheaths without damage to conductor insulation
 - 5.2 terminating cables
 - 5.3 removing cable insulation
 - 5.4 sealing/protecting cable connections
 - 5.5 connecting accessories (such as plugs, sockets multi-way connectors)
 - 5.6 attaching suitable cable identification
 - 5.7 making mechanical/screwed/clamped connections
 - 5.8 crimping (such as spade end, loops, tags and pins)
 - 5.9 soldering and de-soldering
 - 5.10 securing wires and cables (such as clips, plastic strapping, lacing, harnessing)
 - 5.11 terminating armoured cables
 - 5.12 heat shrinking (devices and boots)
 - 5.13 earth bonding
6. Wire up **six** of the following electrical systems:
- 6.1 vehicle lighting circuits
 - 6.2 vehicle air conditioning control circuits

Skills

The learner must be able to:

- 6.3 vehicle heating or ventilating
 - 6.4 power generation and control circuits
 - 6.5 vehicle starting and ignition systems
 - 6.6 instrumentation and control circuits
 - 6.7 communication systems
 - 6.8 electro-pneumatic or electro-hydraulic control circuits (such as suspension systems)
 - 6.9 computer systems (such as ECU)
 - 6.10 other vehicle control circuits (such as pumps, fans, blowers)
 - 6.11 other specific electrical circuits
7. Use **both** of the following test instruments during the wiring and testing activities:
- 7.1 multimeter
 - 7.2 other specific test/proving equipment
8. Carry out checks and adjustments, appropriate to the equipment and circuits being wired, to include **all** of the following:
- 8.1 making visual checks (such as completeness, signs of damage, incorrect termination)
 - 8.2 movement checks (such as loose fittings and connections)
 - 8.3 testing that the equipment operates to the circuit specification
 - 8.4 carrying out fault finding techniques (such as half split, input/output, unit substitution)
- Plus **six** more checks/tests from the following:
- 8.5 power rating
 - 8.6 load current
 - 8.7 insulation resistance values
 - 8.8 polarity
 - 8.9 frequency values
 - 8.10 continuity
 - 8.11 resistance
 - 8.12 inductance
 - 8.13 voltage levels
 - 8.14 capacitance
 - 8.15 specialised tests (such as speed, sound, light, temperature)

Skills

The learner must be able to:

9. Produce electrical circuits in accordance with **both** of the following standards:
 - 9.1 other BS and/or ISO standards
 - 9.2 company standards and procedures

Knowledge and understanding

The learner must:

- K1 Describe the hazards associated with wiring and testing electrical equipment, and with the tools and equipment used, (such as using sharp instruments for stripping cable insulation), and how they can be minimised
- K2 Explain the importance of wearing appropriate protective clothing and equipment (PPE), and keeping the work area safe and tidy
- K3 Explain what constitutes a hazardous voltage and how to recognise victims of electric shock
- K4 Explain 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
- K5 Describe the different types of cabling and their application (such as multicore cables, single core cables, solid and multi- stranded cables, steel wire armoured (SWA), screened cables, data/communications cables, fibre-optics)
- K6 Describe the application and use of a range of electrical components (such as plugs, switches, sockets, lighting and fittings, relays, solenoids, transformers, sensors and actuators)
- K7 Describe the application and use of circuit protection equipment (such as fuses and other overload protection devices/trips)
- K8 Explain why electrical bonding/earthing is critical, and why it must be both mechanically and electrically secure
- K9 Describe the methods of mounting and securing electrical equipment/components to various surfaces (such as the use of nuts, bolts, screws and fixing devices)
- K10 Explain the use of wiring regulations when selecting wires and cables and when carrying out tests on systems
- K11 Outline the tools and equipment used in the wiring and testing activities (including the use of cable stripping tools, crimping tools, soldering irons and torches)
- K12 Explain why equipment is checked so that it is electrically safe and the implications if this is not undertaken
- K13 Explain the importance of conducting inspections and checks before connecting to the supply (such as visual examination for loose or exposed conductors, excessive solder or solder spikes which may allow short circuits to occur, strain on terminations, insufficient slack cable at terminations, continuity and polarity checks, insulation checks)

Knowledge and understanding

The learner must:

- K14 Describe the care, handling and application of electrical test and measuring instruments (such as multimeter, insulation resistance tester)
- K15 Explain how to identify suitable test points within the circuit, and how to position the test instruments into the circuit whilst ensuring the correct polarity and without damaging the circuit components and the test equipment
- K16 Explain how to set the instrument's zero readings; obtaining instrument readings and comparing them with circuit parameters
- K17 Describe the problems that can occur with the wiring and testing operations, and how these can be overcome
- K18 Describe 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 its designated location, cleaning the work area, and removing and disposing of waste)

Unit 26: Maintaining Vehicle Electrical Equipment/Systems

Level: 2

Guided learning hours: 175

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to carry out maintenance activities on vehicle electrical systems, in accordance with approved procedures.

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 underpinning 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 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.

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

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 Obtain all the information they need for the 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 vehicle
- P9 Complete the relevant maintenance records accurately, and pass them on to the appropriate person
- P10 Dispose of waste materials, in accordance with safe working practices and approved procedures
- P11 Tidy up on completion of the electrical maintenance activities

Skills

The learner must be able to:

1. 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 the 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
 - 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

Skills

The learner must be able to:

2. Carry out maintenance of electrical equipment on **two** of the following types of vehicle:
 - 2.1 front wheel drive
 - 2.2 rear wheel drive
 - 2.3 four wheel drive
 - 2.4 hybrid
 - 2.5 other specific approved vehicle

3. Carry out maintenance activities on **six** of the following types of vehicle sub-systems:
 - 3.1 charging systems
 - 3.2 lighting systems
 - 3.3 data acquisition system
 - 3.4 instrumentation, indication and warning systems
 - 3.5 direct current power supply system
 - 3.6 electrical control system
 - 3.7 auxiliary motorsport vehicle power supply system
 - 3.8 safety and emergency systems
 - 3.9 air conditioning
 - 3.10 ABS braking systems

4. Carry out **all** of the following maintenance activities:
 - 4.1 isolating the equipment
 - 4.2 disconnecting and reconnecting wires and looms
 - 4.3 attaching suitable cable identification markers
 - 4.4 removing electrical units/components
 - 4.5 checking components for serviceability
 - 4.6 replacing damaged/defective components
 - 4.7 removing and replacing damaged wires and looms
 - 4.8 setting and adjusting replaced components
 - 4.9 making 'continuity' checks before powering up
 - 4.10 functionally testing the maintained equipment
 - 4.11 examining wiring looms for chafing, dislodging, correct routeing, protection in hazardous areas

Skills

The learner must be able to:

5. Replace and/or repair a range of vehicle electrical components, to include **fourteen** of the following:
 - 5.1 looms and connectors
 - 5.2 capacitors
 - 5.3 batteries
 - 5.4 locking and retaining devices
 - 5.5 circuit boards
 - 5.6 solenoids
 - 5.7 overload protection devices
 - 5.8 lighting components
 - 5.9 thermistors or thermocouples
 - 5.10 pickup sensor
 - 5.11 electrical switches or sensors
 - 5.12 starter motors
 - 5.13 relay components
 - 5.14 manual switches
 - 5.15 transmitter beacons
 - 5.16 potentiometers
 - 5.17 other specific vehicle related components

6. Maintain vehicle electrical equipment, in compliance with **three** or more of the following standards:
 - 6.1 BS or ISO standards and procedures
 - 6.2 vehicle manufacturer's specification
 - 6.3 company standards and procedures
 - 6.4 specific system requirements

7. Complete **three** of the following maintenance records and pass them 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 learner must:

- K1 Describe the hazards associated with removing and replacing 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
- K2 Explain 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)
- K3 Explain the importance of ensuring that they use the correct and up-to-date documentation
- K4 Explain the basic principles of how the vehicle electrical equipment functions, its operating sequence, the working purpose of individual units/components and how they interact
- K5 Describe the different types of cabling and their application (such as multicore cables, single core cables, screened cables) as used on vehicles
- K6 Describe the care, handling and application of electrical measuring instruments
- K7 Describe the various types of electrical connectors that are used, methods of unlocking, orientation indicators and locating and locking in of the connections
- K8 Explain the use of BS/ISO wiring and other regulations when selecting wires and cables, and when carrying out tests on systems
- K9 Describe the tools and equipment used in the maintenance activities (such as cable stripping tools, crimping tools, soldering irons and torches, gland connecting tools)
- K10 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
- K11 Explain the importance of making 'off-load' checks before proving the equipment with the electrical supply on
- K12 Outline how to use appropriate lifting and handling equipment techniques in the maintenance activity
- K13 Describe the problems that can occur during the maintenance activity, and how they can be overcome
- K14 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 27: Diagnosing and Rectifying Faults on Vehicle Systems

Level: 2

Guided learning hours: 140

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to diagnose and rectify faults on vehicle systems.

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 the requirements of the standard.

Their underpinning 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.

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

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 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

The learner must be able to:

1. 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

Skills

The learner must be able to:

2. Assist in diagnosing faults on **two** of the following types of vehicle:
 - 2.1 front wheel drive
 - 2.2 rear wheel drive
 - 2.3 four wheel drive
 - 2.4 hybrid
 - 2.5 other specific approved vehicle

3. Assist in locating faults that have resulted in **two** of the following breakdown categories:
 - 3.1 intermittent problem
 - 3.2 partial failure
 - 3.3 complete breakdown

4. Assist in the collection of evidence regarding the fault, from **six** of the following sources:
 - 4.1 system diagrams
 - 4.2 maintenance/history records
 - 4.3 vehicle/equipment manuals
 - 4.4 discussion with user/team member
 - 4.5 data logging
 - 4.6 monitoring equipment (such as gauges recording devices)
 - 4.7 test instruments
 - 4.8 fault analysis charts (such as flow charts)
 - 4.9 equipment self-diagnostics
 - 4.10 troubleshooting guides

5. Assist in carrying out **six** of the following fault diagnostic techniques:
 - 5.1 function testing
 - 5.2 half-split
 - 5.3 unit substitution
 - 5.4 six point technique
 - 5.5 input/output
 - 5.6 sensory input (such as sight, sound, smell, touch)
 - 5.7 taking measurements and readings

Skills

The learner must be able to:

6. Rectify faults in **all** of the following vehicle systems:
 - 6.1 engine
 - 6.2 steering
 - 6.3 transmission
 - 6.4 fuel
 - 6.5 chassis
 - 6.6 lubrication
 - 6.7 wheel braking
 - 6.8 cooling
 - 6.9 suspension
 - 6.10 electrical

7. Use a variety of fault rectification activities, to include **seven** 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

8. Assist in carrying out **all** 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)

Skills

The learner must be able to:

- 8.7 vibration analysis
- 8.8 functional testing
- 8.9 visual examination to the required standard
- 9. Complete the relevant paperwork, to include **three** 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 learner must:

- K1 Explain the importance of wearing protective clothing and other appropriate safety equipment during the fault diagnosis and rectification activities
- K2 Describe the hazards associated with diagnosing and rectifying vehicle faults, and with the tools and equipment used (such as moving vehicles; 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
- K3 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)
- K4 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
- K5 Describe 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)
- K6 Describe 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
- K7 Explain why securing devices need to be tightened to the correct torque and locked, and the different methods used
- K8 Outline 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
- K9 Describe methods of inspecting removed components, and the awareness of what to look for with regard to damage and wear

Knowledge and understanding

The learner must:

- K10 Outline the equipment used in the rectification operations (such as alignment tools, torque wrenches, presses)
- K11 Describe the expected outcomes of the tests being conducted
- K12 Explain the importance of working to the critical timescales relevant to the industry
- K13 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 28: Stripping and Rebuilding Vehicle Engines

Level: 2

Guided learning hours: 140

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to rebuild an engine in a recognised sequence and to a high standard.

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.

The stripping and rebuilding 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 rebuilding. They will also be expected to use recognised methods for crack testing ferrous and non-ferrous materials/components, and to be able to inspect an engine within the 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 underpinning 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.

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

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 Obtain all the information they need for the engine stripping and rebuilding activities to be carried out
- P4 Establish and, where appropriate, mark component orientation for re-assembly
- P5 Ensure that the engine is correctly mounted in the correct work area
- P6 Carry out the engine stripping and rebuilding 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 rebuilding 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

The learner must be able to:

1. Carry out **all** of the following in preparation for the stripping and rebuilding of the engine:
 - 1.1 remove engine from its transportation container, and remove dirt, and oil from engine externals
 - 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 rebuilding documentation, prior to disassembly
 - 1.6 obtain any tooling including any specialist tooling
 - 1.7 obtain suitable storage bins for the removed components

Skills

The learner must be able to:

2. Use **all** of the following to aid the stripping and rebuilding of the engine:
 - 2.1 system diagrams
 - 2.2 engine build book
 - 2.3 engineering drawings
 - 2.4 lifting records
 - 2.5 engineer's records
 - 2.6 engine rebuild sheets

3. Rebuild engines for **both** of the following types of vehicle:
 - 3.1 petrol
 - 3.2 diesel

4. Carry out **fourteen** of the following stripping and rebuilding activities:
 - 4.1 removing covers and cowlings
 - 4.2 disconnecting and removing hoses and pipes
 - 4.3 disconnecting electrical connections
 - 4.4 proof marking/labelling of components to aid reassembly
 - 4.5 separation of components by means of removing mechanical fasteners (such as nuts, bolts, circlips, quick-release fasteners, rivets)
 - 4.6 inspecting components for damage and wear, and identifying all components and fasteners that require replacement
 - 4.7 arranging and storing components in a manner that makes re-assembly as straightforward as possible
 - 4.8 labelling (and storing in the correct location) components that require repair or overhaul
 - 4.9 replacing damaged/defective and 'lifer' components
 - 4.10 reassembly of components, using mechanical fastening devices (such as nuts, bolts, quick-release fasteners, circlips, rivets)
 - 4.11 checking of bearing clearances (such as using engineer's blue or compressible strip)
 - 4.12 lapping in valves and valve seats
 - 4.13 torque setting cylinder-head bolts, in the correct sequence
 - 4.14 replacement of sealing devices (such as 'O' rings, seals, gaskets, sealing compounds)
 - 4.15 positioning, aligning, setting, and adjusting replaced components (such as valve spring heights, cam timing, ring gaps, torque angles)
 - 4.16 tightening fastenings to the required torque, and applying bolt locking methods (such as split pins, wire locking, lock nuts, engineering adhesives)

Skills

The learner must be able to:

5. Remove and refit engine components from **four** of the following areas:
 - 5.1 engine ancillary components (such as exhaust primaries and silencers, airboxes, engine mounts, filters)
 - 5.2 clutch (such as clutch covers, driven plates, thrust bearings)
 - 5.3 cam timing (such as pulleys, belts, gears, adjusters)
 - 5.4 electrical (such as generation, ignition, engine management, data control boxes, ECUs, wiring looms)
 - 5.5 system components (such as sensors, regulators, safety devices, gauges)

Plus assist in the stripping and rebuilding of engine components from **three** of the following areas:

 - 5.6 cylinder head (such as valves, valve springs, valve spring heights, rockers, valve stem seals, spark plugs)
 - 5.7 engine block (such as crankshafts, connecting rods, pistons, rings, main bearings, big end bearings)
 - 5.8 lubrication system (such as oil pumps, oil filters, scavenge pumps, oil tanks, pressure relief valves)
 - 5.9 fuel system (such as carburettors, fuel pumps, fuel filters, metering units, fuel rails, pressure relief valves)
6. Carry out **three** of the following inspection and testing techniques:
 - 6.1 ferrous metal crack detection
 - 6.2 sensory testing (such as sight, sound, smell or touch)
 - 6.3 non-ferrous crack detection
 - 6.4 connecting and setting engine to dynamometer installation
 - 6.5 mechanical measurements

Plus **three** more of the following test procedures:

 - 6.6 compression testing
 - 6.7 ignition timing
 - 6.8 leak down cylinder leakage testing
 - 6.9 electrical charging tests
 - 6.10 other specific tests

Skills

The learner must be able to:

7. Strip and rebuild engine equipment and components, in compliance with **two** 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 company standards and procedures
 - 7.5 specific engine system requirements

8. Complete the relevant paperwork, to include **one** from the following, and pass it to the appropriate people:
 - 8.1 engineer's/team's records
 - 8.2 engine rebuild sheet
 - 8.3 formal risk assessment

Knowledge and understanding

The learner must:

- K1 Describe the hazards associated with stripping and rebuilding 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
- K2 Explain 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)
- K3 Explain the importance of ensuring that they use the correct and up-to-date documentation
- K4 Describe 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
- K5 Describe the various types of electrical connectors that are used, methods of unlocking, orientation indicators and locating and locking-in of connections
- K6 Outline methods of lifting, handling and supporting the components/equipment during the stripping and rebuilding activities

Knowledge and understanding

The learner must:

- K7 Explain 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
- K8 Describe how to make adjustments to components/assemblies to ensure that they function correctly (such as travel and working clearance, timing and sequence)
- K9 Explain why securing devices need to be tightened to the correct torque and locked, and the different methods used
- K10 Outline the tools and equipment used in the engine stripping and rebuilding activities and explain their calibration/care and control procedures
- K11 Explain the need to control and account for all tools and equipment used during the stripping and rebuilding activities
- K12 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 29: Using Computer Software Packages to Assist with Engineering Activities

Level: 2

Guided learning hours: 70

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to 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 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.

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 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

The learner must be able to:

1. 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
2. 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

Skills

The learner must be able to:

- 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 email system
- 2.29 mobile text messaging
- 2.30 internet email
- 2.31 web camera chat/conferencing

Skills

The learner must be able to:

3. 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)
4. 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

Skills

The learner must be able to:

5. 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

Knowledge and understanding

The learner must:

- K1 Describe the 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)
- K2 Describe the correct start-up and shutdown procedures to be used for the computer systems
- K3 Describe the methods and procedures used to minimise the chances of infecting a computer with a virus
- K4 Describe the implications if the computer they are using does become infected with a virus and who to contact if it does occur
- K5 Describe the use of software manuals or help facilities and related documents to aid efficient operation of the relevant software system
- K6 Explain how to deal with system problems (such as error messages received, peripherals which do not respond as expected, obvious faults with the equipment or connecting leads)
- K7 Describe the use of personal access codes, and logging on/off procedures that are required
- K8 Describe the various standard document formats that are used (such as letters, memoranda, facsimile, technical reports)
- K9 Describe 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 30: Producing CAD Models (Drawings) using a CAD System

Level: 2

Guided learning hours: 140

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to 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 unit 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 paragraph 7 of the Skills, and must include a minimum of **seven** of the features listed in paragraph 8 of the *Skills* section.

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 Plan the 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

The learner must be able to:

1. Prepare the CAD system for operation, by carrying out **all** of the following:
 - 1.1 check that all the equipment is correctly connected and in a safe and usable working condition (such as cables undamaged, correctly connected, safely routed and PAT tested)
 - 1.2 power up the equipment and activate the appropriate modelling software
 - 1.3 set up the modelling environment and select a suitable template/folder
 - 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 create a modelling template to the required standards, which includes all necessary detail (such as title, file/drawing number, material, date)

Skills

The learner must be able to:

2. Use **three** 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

3. Take into account **three** 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

Skills

The learner must be able to:

4. 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)

5. Use one of the following modelling tools:
 - 5.1 surface modelling
 - 5.2 solid modelling
 - 5.3 wire frame modelling

6. Use **all** of the following CAD operations to highlight design areas in the modelling environment:
 - 6.1 pan
 - 6.2 isometric
 - 6.3 zoom

7. Produce models which include the use of **eight** of 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

Skills

The learner must be able to:

8. Modify parts in the assembly environment using the following feature:
 - 8.1 constrained parts and assembliesPlus **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
9. 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
10. 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)

Skills

The learner must be able to:

11. 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 learner must:

- K1 Describe the 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)
- K2 Describe the correct start-up and shutdown procedures to be used for the computer systems
- K3 Describe 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
- K4 Explain how to deal with system problems (such as error messages received, peripherals which do not respond as expected, obvious faults with the equipment or connecting leads)
- K5 Describe the documentation required for particular applications (such as design briefs, specification sheets, request for change orders)
- K6 Describe types of drawings that may be produced by the modelling software
- K7 Describe 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)
- K8 Describe the application and use of modelling tools (such as for straight lines, curves and circles; how to add dimensions and text to drawings)
- K9 Describe how to access, recognise and use a wide range of standard components and symbol libraries from the CAD equipment
- K10 Describe the applications of different 3D modelling programmes (such as surface, solid and wire frame)
- K11 Describe how to produce models with sufficient information to allow them to be successfully exported to the manufacturing system used
- K12 Explain the need for document control (such as ensuring that completed models are approved, labelled and stored on a suitable storage medium)
- K13 Explain why it is necessary to be able to recall previous issues of modified models
- K14 Describe 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 31: Producing Electrical or Electronic Engineering Drawings using a CAD System

Level: 2

Guided learning hours: 140

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able 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, 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 unit requirements

In order to prove their ability to combine different electrical/electronic drawing features, at least one of the drawings produced must be of a significant nature, and must have a minimum of **seven** of the features listed in paragraph 6 of the *Skills* section.

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

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 Plan the drawing activities before they start them
- P4 Use appropriate sources to obtain the required information for the drawing to be created
- P5 Access and use the correct drawing software
- P6 Use appropriate techniques to create drawings, in the required formats, that are sufficiently and clearly detailed
- P7 Use codes and other references that follow the required conventions
- P8 Make sure that 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

The learner must be able to:

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

Skills

The learner must be able to:

2. Use **three** of the following to obtain the necessary data to produce the required drawings:
 - 2.1 drawing brief/request
 - 2.2 specifications
 - 2.3 drawing change or modification request
 - 2.4 electrical regulations
 - 2.5 manuals
 - 2.6 previous drawings/designs
 - 2.7 calculations (such as Ohm's law)
 - 2.8 standards
 - 2.9 sketches
 - 2.10 standard reference documents (such as current carrying capacity of cables, electrical or electronic component catalogues)
 - 2.11 notes from meetings/discussions
 - 2.12 other available data

3. Take into account **four** of the following design features, as appropriate to the drawing being produced:
 - 3.1 function
 - 3.2 operating voltages
 - 3.3 ergonomics
 - 3.4 operating environment
 - 3.5 cost
 - 3.6 lifetime of the product
 - 3.7 tolerances
 - 3.8 interfaces
 - 3.9 aesthetics
 - 3.10 physical space/dimensions of circuit
 - 3.11 power supplies
 - 3.12 safety
 - 3.13 component orientation
 - 3.14 connectors/test point access
 - 3.15 types of components available/to be used
 - 3.16 method of installation (such as conduit, trunking, traywork)
 - 3.17 position of circuit elements/components

Skills

The learner must be able to:

- 3.18 type of cables (such as PVC, mineral insulated)
 - 3.19 connections between components
 - 3.20 uses an appropriate type of circuit (such as digital, analogue, hybrid)
 - 3.21 uses appropriate technology of circuit design (such as single sided, double sided, multi-layer, flexi-rigid)
 - 3.22 meets signal integrity parameters (such as capacitance, inductance, resistance, insulation voltages)
 - 3.23 meets specified operating conditions (such as temperature, humidity, shock and vibration)
 - 3.24 any assembly/manufacturing schedule constraints (such as high profile components mounted after low profile SMT ones)
4. Carry out **all** of the following before producing the engineering drawing:
 - 4.1 ensure that data and information are complete and accurate
 - 4.2 review the data and information to identify the drawing requirements
 - 4.3 recognise and deal with problems (such as information based, technical)
5. Produce **three** of the following types of electrical or electronic engineering drawings:
 - 5.1 circuit diagrams
 - 5.2 general assembly drawings
 - 5.3 installation/commissioning
 - 5.4 wiring diagrams
 - 5.5 panel assembly
 - 5.6 manufacture of cable looms
 - 5.7 block diagrams
 - 5.8 cable and routing
 - 5.9 fault diagnostics (such as flow diagrams)
 - 5.10 schematics
 - 5.11 circuit board assembly
 - 5.12 system drawings
 - 5.13 circuit board layout
 - 5.14 modifications to equipment/systems (such as cable looms, cable routing and clipping, panels/sub-assemblies, installation of electrical systems)

Skills

The learner must be able to:

6. Produce electrical or electronic drawings which include **ten** of the following:
 - 6.1 straight lines
 - 6.2 curved/contour lines
 - 6.3 dimensions
 - 6.4 circles or ellipses
 - 6.5 angled lines
 - 6.6 hidden detail
 - 6.7 text
 - 6.8 parts lists
 - 6.9 insertion of standard electrical or electronic components
 - 6.10 test points
 - 6.11 type and size of cables
 - 6.12 colour/component coding
 - 6.13 connection/termination details
 - 6.14 parts lists
 - 6.15 electrical/electronic symbols and abbreviations
 - 6.16 fault diagnosis (such as flow diagrams)
 - 6.17 other specific electrical or electronic detail

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

Skills

The learner must be able to:

8. Produce drawings which comply with the following:
 - 8.1 BS and ISO standards and proceduresPlus **one** more from the following:
 - 8.2 organisational guidelines
 - 8.3 statutory regulations and codes of practice
 - 8.4 CAD software standards
 - 8.5 other international standards

Knowledge and understanding

The learner must:

- K1 Describe the specific safety precautions to be taken when working with computer systems (to include safety guidance relating to the use of visual display unit (VDU) equipment and work station environment (such as lighting, seating, positioning of equipment), repetitive strain injury (RSI); the dangers of trailing leads and cables; how to spot faulty or dangerous electrical leads, plugs and connections)
- K2 Describe the 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 Describe the methods and procedures used to minimise the chances of infecting a computer with a virus
- K4 Describe the implications if the computer they are using does become infected with a virus and who to contact if it does occur
- K5 Describe the functionality of the circuit being drawn, and its interrelationship with other circuits and assemblies
- K6 Describe the correct start-up and shutdown procedures to be used for the computer systems
- K7 Describe the use of software manuals and related documents to aid efficient operation of the relevant drawing system
- K8 Explain how to deal with system problems (such as error messages received, peripherals which do not respond as expected, obvious faults with the equipment or connecting leads)
- K9 Describe the 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)
- K10 Explain how to access, recognise and use a wide range of standard components and symbol libraries from the CAD equipment
- K11 Describe the factors to be taken into account when producing electrical drawings (such as safety requirements, operating parameters of components, position of components in relation to other sources or circuits, possibility of external interference)

Knowledge and understanding

The learner must:

- K12 Outline an understanding of the electrical or electronic equipment and circuits being worked on, and the function of the individual components within the circuits
- K13 Describe the selection of the various components and cables being used (with regard to their operating ranges and current carrying capacity)
- K14 Describe the use of specific regulations and standard reference tables when selecting components and cables
- K15 Explain how power cables might affect/corrupt signal transmission, and the need to consider this in siting and routing cables
- K16 State the basic calculations that may be required to be carried out to verify the acceptability of components and circuits (such as Ohm's law)
- K17 Describe 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 32: Producing Engineering Project Plans

Level: 2

Guided learning hours: 70

Unit overview

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

This unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to 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.

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 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

The learner must be able to:

1. 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
2. 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

Skills

The learner must be able to:

- 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
3. 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)
4. 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
5. 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

Skills

The learner must be able to:

- 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
6. 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
7. 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
8. Record and present the plans to the appropriate people, using the following methods:
 - 8.1 verbal reportPlus **one** more method from the following:
 - 8.2 written or typed report
 - 8.3 specific company documentation
 - 8.4 computer-based presentation

Knowledge and understanding

The learner must:

- K1 Explain 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 Describe the implications of not taking account of legislation, regulations, standards and guidelines when producing the engineering project plans
- K3 Explain 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)
- K4 Explain how to access and use the appropriate information and documentation systems
- K5 Describe 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)
- K6 Describe the materials, formats, codes and conventions that are used in preparing the engineering project plans
- K7 Describe the main project planning methods and techniques in use, and what problems could occur with them
- K8 Describe the factors to be taken into account when preparing the project plans, especially those covering working conditions and safety
- K9 Describe 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)
- K10 Describe the obvious (and hidden) costs of resources/activities
- K11 Describe the normal timescales for carrying out specific engineering activities, and how and why they vary
- K12 Explain how to arrive at an estimate of timescales for the project, and the need to set milestones for achievement
- K13 Explain how to estimate the likely costs of the project (including the cost of raw materials, people and overheads)
- K14 Describe the products (or assets) involved in the activity being planned, and how to determine their availability
- K15 Describe the development of the engineering project plans (to include both master documents and working instructions, along with their purpose, content and status)
- K16 Explain how to write project plans that specify quality, cost and delivery requirements (including allocation of responsibilities and milestone targets)
- K17 Explain how to prepare the plans (to include the structure, style, clarity and compliance with relevant standards)

Knowledge and understanding

The learner must:

- K18 Describe the process used in the organisation to validate the engineering plans produced
- K19 Describe the procedures for changing the plans, and why control procedures are used
- K20 Describe the procedures and process for project plan approval, and why these procedures and processes are used
- K21 Describe the importance of maintaining records, what needs to be recorded and where records are kept
- K22 Explain why contingency plans need to be drawn up
- K23 Describe the different ways of presenting information to different people
- K24 Describe the importance of providing the right information at the right time
- K25 Describe the type of problems that can occur during the implementation of the plan, and how these problems can be rectified

Unit 33: Carrying Out Heat Treatment of Engineering Materials

Level: 2

Guided learning hours: 90

Unit overview

This unit of competence 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 unit of competence identifies the training and development required in order that the learner can demonstrate that they are competent in being able to apply 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.

Assessment requirements

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

Additional information

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

This will allow each organisation to develop their own specific and tailored training programme 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.

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 Plan the 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

The learner must be able to:

1. 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

2. 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

Skills

The learner must be able to:

3. 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)

4. 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

5. 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

Skills

The learner must be able to:

6. 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

7. Carry out the heat treatment activities to include **all** of the following:
 - 7.1 lighting up the furnace/forging 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

8. 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)

9. 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 learner must:

- 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

Knowledge and understanding

The learner must:

- 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 to
- 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 34: Carrying out Aircraft Detail Fitting Activities

Level: 2

Guided learning hours: 175

Unit overview

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

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

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

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

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

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

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

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

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

Specific unit requirements

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

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

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

Skills

The learner must be able to:

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

Skills

The learner must be able to:

- 2.4 irregular shapes (such as castings, forgings, odd shaped components)
- 2.5 detail assemblies
3. Use **both** the following types of material:
 - 3.1 metallic material relevant to the aerospace sector
 - 3.2 composite material relevant to the aerospace sector
4. Use marking out methods and techniques which include the following:
 - 4.1 direct marking using instrumentsPlus **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 positionsPlus **two** more from the following:
 - 6.5 angles/angular profiles
 - 6.6 allowances for bending
 - 6.7 radial hole positions
 - 6.8 simple pattern development

Skills

The learner must be able to:

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

8. Produce components which combine different operations and have features that cover **all** of the following:
 - 8.1 edges/faces that are square to each other
 - 8.2 curved or circular forms
 - 8.3 edges/faces that are parallel
 - 8.4 holes linearly pitchedPlus **two** more of the following:
 - 8.5 edges/faces that are angled
 - 8.6 external profiles
 - 8.7 internal profiles
 - 8.8 holes radially pitched

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

Skills

The learner must be able to:

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

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

Plus **four** more of the following:

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

Skills

The learner must be able to:

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

Knowledge and understanding

The learner must:

- K1 Describe the hazards associated with the aircraft detail fitting activities (e.g. use of power tools, trailing leads or hoses, damaged or badly maintained tools and equipment, use of forming and bending equipment, using hand shears and guillotines), and how they can be minimised
- K2 Explain material selection for different applications (including material identification systems, codes used and grain flow indicators)
- K3 Explain the principles of marking out, and the equipment used in the aerospace industry
- K4 Describe the importance of cleaning and preparing the surfaces to be marked out, ensuring that grain flow is taken into account where appropriate
- K5 Describe the process for calculating bending allowances when marking out
- K6 Describe the importance of ensuring that marking out is undertaken from the selected datums, and the possible effects of working from different datums
- K7 Describe the various methods of pattern development that can be used (e.g. parallel line; radial line; triangulation), and typical applications of each method
- K8 Describe the importance of laying out the marking-out shapes or patterns to maximise use of materials
- K9 Describe the need for clear and dimensional accuracy in marking out to specification and drawing requirements
- K10 Describe the shaping methods and techniques that can be used to produce a range of shapes/profiles on the various section materials (e.g. sawing, shearing, drilling, filing, abrading), and the sequence in which the operations will need to be carried out

Knowledge and understanding

The learner must:

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

Unit 35: Installing Aircraft Mechanical Fasteners

Level: 2

Guided learning hours: 105

Unit overview

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

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

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

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

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

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

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

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

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

Specific unit requirements

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

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 Plan the installation of the mechanical fasteners before they start the activity
- P4 Obtain the appropriate tools and equipment for the installation operations, and check that they are in a safe and usable condition
- P5 Assemble and secure the components, using the correct fastening devices and joining techniques
- P6 Measure and check that all dimensional and geometrical aspects of the component are to the specification
- P7 Check that the installation is complete, and that all components are free from damage
- P8 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
- P9 Leave the work area in a safe and tidy condition on completion of the fitting activities

Skills

The learner must be able to:

1. Carry out **all** of the following activities during the installation of the mechanical fasteners:
 - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
 - 1.2 check that all measuring equipment is within calibration date
 - 1.3 ensure that all power tool cables, extension leads or air supply hoses are in a serviceable condition and PAT tested
 - 1.4 return all tools and equipment to the correct location on completion of the installation activities
2. Install a range of mechanical fasteners, to include **all** of the following:
 - 2.1 hollow rivets
 - 2.2 solid rivets
 - 2.3 threaded fasteners
 - 2.4 quick release fasteners

Plus **two** more from the following:

 - 2.5 collared fasteners

Skills

The learner must be able to:

- 2.6 split pins
 - 2.7 pin clips
 - 2.8 wire locks
 - 2.9 anchor nuts
 - 2.10 Rivnuts
 - 2.11 NAPPY pins
 - 2.12 PIP/PIT pins
 - 2.13 other locking devices
3. Use **both** of the following types of equipment:
- 3.1 riveting guns (appropriate to rivet type)
 - 3.2 gripping pins and location dowels
- Plus **two** more from the following:
- 3.3 gauges (such as for intrusions)
 - 3.4 redline templates
 - 3.5 clamps
 - 3.6 drills and tools with attachments
 - 3.7 jigs
4. Use **all** of the following installation methods and techniques:
- 4.1 countersinking
 - 4.2 solid riveting (single and double handed)
 - 4.3 through-hole
 - 4.4 milling rivets
 - 4.5 wire locking
 - 4.6 blind riveting
5. Make **three** types of connection from:
- 5.1 wet assembly
 - 5.2 panels
 - 5.3 structures
 - 5.4 dry assembly
 - 5.5 skins
 - 5.6 repairs

Skills

The learner must be able to:

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

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

Knowledge and understanding

The learner must:

- K1 Describe the hazards associated with installing aircraft mechanical fasteners, and with the tools and equipment used (e.g. use of power tools, trailing leads or hoses, damaged or badly maintained tools and equipment), and how they can be minimised
- K2 Explain the importance of working to the installation instructions and appropriate specifications
- K3 Explain the implications if the correct and specified fastener is not fitted to the component and the impact this could have on the business

Knowledge and understanding

The learner must:

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

Unit 36: Producing Composite Mouldings using Pre-Preg Techniques

Level: 2

Guided learning hours: 140

Unit overview

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

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

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

They will be expected to prepare the tooling, apply release agents and prepare the composite materials. They will produce composite mouldings, which will incorporate a range of features, using a range of application methods. Mouldings produced will include laminates and sandwich structures, using suitable resin, fibre and core materials. The activities will also include making all necessary visual and dimensional checks, to ensure that the mouldings meet the required specification and have an appropriate cosmetic appearance.

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

Their underpinning knowledge will provide an understanding of their work, and will enable them to apply appropriate composite moulding pre-preg laminating techniques and procedures safely. They will understand the moulding/laminating procedure, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

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

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

Specific unit requirements

In order to prove their ability to combine different pre-preg laminating operations, at least one of the components produced must be of a significant nature, and must have a minimum of **three** of the features listed in paragraph 6 of the *Skills* section.

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 Plan the moulding/laminating activities before they start them
- P4 Prepare the moulds, jigs or formers ready for the manufacturing operations
- P5 Mix and prepare the required materials
- P6 Carry out the moulding/laminating activities, using the correct methods and techniques
- P7 Remove the mouldings from the formers, and trim/finish them to specification
- P8 Check that all the required operations have been completed to specification
- P9 Deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
- P10 Leave the work area in a safe and tidy condition on completion of the moulding activities

Skills

The learner must be able to:

1. Carry out **all** of the following during the moulding activities:
 - 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
 - 1.2 follow job instructions, drawings, process specifications and moulding/laminating procedures
 - 1.3 ensure that all equipment and tools used are in a safe and serviceable condition
 - 1.4 return all tools and equipment to the correct location on completion of the moulding/laminating activities
2. Carry out **all** of the following activities when preparing production tooling:
 - 2.1 check that tooling is correct and complete
 - 2.2 clean tooling and remove resin build-ups
 - 2.3 check for surface defects
 - 2.4 correctly apply sealers/release agents
 - 2.5 clean and store tooling suitably after use

Skills

The learner must be able to:

3. Carry out **all** of the following activities to prepare materials for production:
 - 3.1 obtain correct materials for the activity
 - 3.2 thaw material removed from freezer storage
 - 3.3 identifying defects in pre-preg materials
 - 3.4 check that materials are fit for purpose and in life
 - 3.5 check availability of ancillary materials required
 - 3.6 cut materials to correct shape and orientation
 - 3.7 check materials when provided in kit form
 - 3.8 identify and protect materials in the work area

4. Produce a range of mouldings, using **one** of the following types of production tool:
 - 4.1 pattern
 - 4.2 mandrels
 - 4.3 metal
 - 4.4 tooling block
 - 4.5 glass pre-preg
 - 4.6 carbon pre-preg
 - 4.7 female tooling
 - 4.8 male tooling
 - 4.9 multi-part tools
 - 4.10 matched tooling
 - 4.11 closed tooling

5. Produce a range of mouldings incorporating **two** of the following in the lay-up:
 - 5.1 butt joins
 - 5.2 overlap joins
 - 5.3 staggered joins
 - 5.4 orientated plies
 - 5.5 inverted plies
 - 5.6 balancing plies
 - 5.7 inserts
 - 5.8 fixtures

Skills

The learner must be able to:

6. Produce a range of mouldings incorporating **four** of the following shape features:
 - 6.1 internal corners
 - 6.2 external corners
 - 6.3 horizontal surface
 - 6.4 vertical surface
 - 6.5 double curvature
 - 6.6 concave surface
 - 6.7 convex surfaces
 - 6.8 return surfaces
 - 6.9 joggle details
 - 6.10 nett edges

7. Produce a range of mouldings using **one** type of resin from:
 - 7.1 bio resin
 - 7.2 thermoplastic
 - 7.3 epoxy
 - 7.4 phenolic
 - 7.5 bismaleimide
 - 7.6 cyanate ester
 - 7.7 other (to be specified)

8. Produce a range of mouldings using techniques for **one** type of fibre from:
 - 8.1 natural fibre
 - 8.2 thermoplastic
 - 8.3 glass
 - 8.4 aramid
 - 8.5 carbon
 - 8.6 hybrid
 - 8.7 other (to be specified)

9. Produce a range of mouldings using **one** type of reinforcement from:
 - 9.1 continuous
 - 9.2 uni-directional
 - 9.3 tapes

Skills

The learner must be able to:

- 9.4 tissues/veils
 - 9.5 woven
 - 9.6 braids
 - 9.7 multi-axis
10. Produce a range of mouldings using **one** type of core material (**where applicable to the Sector or process**):
- 10.1 solid timber
 - 10.2 end grain balsa
 - 10.3 thermoplastic core
 - 10.4 rigid foam
 - 10.5 syntactic core
 - 10.6 expanding core
 - 10.7 fibrous honeycomb
 - 10.8 aluminium honeycomb
 - 10.9 other (to be specified)
11. Use **one** of the following methods when using core materials (**where applicable to the Sector or process**):
- 11.1 core templates
 - 11.2 pre-shaping core
 - 11.3 core chamfers
 - 11.4 core splicing
 - 11.5 peel plies
 - 11.6 bonding paste
 - 11.7 edge filling
 - 11.8 adhesive/resin films
 - 11.9 potting/filler compound
 - 11.10 single stage curing
 - 11.11 multi-stage curing
12. Prepare the moulding for temperature curing using **one** of the following methods:
- 12.1 oven
 - 12.2 autoclave
 - 12.3 heated tools/moulds

Skills

The learner must be able to:

- 12.4 heat mats
 - 12.5 heated press
 - 12.6 curing lamps
 - 12.7 infrared heating
 - 12.8 UV curing
 - 12.9 electro-magnetic inductance
 - 12.10 micro-wave
 - 12.11 other (to be specified)
13. Preparing the moulding for pressure consolidation using **one** of the following methods:
- 13.1 vacuum bags
 - 13.2 hot de-bulk
 - 13.3 pressure de-bulk
 - 13.4 pressure bags
 - 13.5 thermal mould expansion
 - 13.6 fibre tensioning
 - 13.7 press
 - 13.8 autoclave
14. Remove composite moulding and carryout **all** of the following:
- 14.1 visually check that the moulding is complete and free from defects
 - 14.2 use appropriate equipment/gauges to check for dimensional accuracy (such as overall dimensions, thickness of material/moulding, geometric features)
 - 14.3 mark out the mouldings for trimming of excess material
 - 14.4 cut/trim the mouldings using appropriate tools and equipment (such as cutting wheels/discs, routers, saws)
 - 14.5 carry out repairs (where appropriate)
 - 14.6 finish the mouldings, using appropriate tools and equipment (such as rubbing blocks, diamond files, disc or belt sanders, pencil grinders)
 - 14.7 polish the mouldings using appropriate tools and equipment (such as wet sanding, cutting compounds)

Skills

The learner must be able to:

15. Produce mouldings which comply with **one** of the following standards:
 - 15.1 components are dimensionally accurate, within specification requirements
 - 15.2 finished components meet the required shape/geometry (such as square, straight, angle, free from twists)
 - 15.3 completed components are free from defects, sharp edges or slivers
 - 15.4 components meet company standards and procedures

Knowledge and understanding

The learner must:

- K1 Describe the hazards associated with carrying out pre-preg laminating techniques, and with the composite materials, consumables, tools and equipment used, and how to minimise these and reduce any risks
- K2 Describe the specific environmental conditions that must be observed when producing composite mouldings (e.g. temperature, humidity, fume/dust extraction systems and equipment)
- K3 Describe the quality procedures used in the workplace to ensure production control (in relation to currency, issue, meeting specification) and the completion of such documents
- K4 Outline the conventions and terminology used for pre-preg laminating techniques (e.g. material orientation, material identification, material templates, ply lay-up, pressure plates, vacuum bagging, cure cycles, exotherm)
- K5 Outline the different types of resins, reinforcement, catalysts, accelerators and additives used, and their applications
- K6 Outline the different types of fibre materials, fabrics, orientations, their combinations and applications
- K7 Explain the building up laminates (including orientation and balance of plies) to minimise spring and distortion in composite mouldings
- K8 Outline the different core, insert and filler materials, and their applications
- K9 Outline the identification of materials by product codes
- K10 Outline the different types of production tooling used for producing composite mouldings, and their applications
- K11 Describe the correct methods of storage, thawing and handling of pre-preg materials (including monitoring temperature, storage life and out-life)
- K12 Describe the methods used in the application of pre-preg materials to tooling surfaces (including methods of tailoring and cutting)
- K13 Outline the correct methods of storage and handling of ancillary and consumable materials

Knowledge and understanding

The learner must:

- K14 Outline the selection and use of ancillary and consumable materials (e.g. release films, breather fabrics, bagging films, tapes) to meet performance requirements (e.g. temperature and compatibility)
- K15 State the tools and equipment used in the pre-preg laminating activities, and their care, preparation and control procedures
- K16 Describe the problems that can occur during the lay-up process (including modifications to the ply lay-up, and defects such as contamination and distortion)
- K17 Outline the cure cycles (including temperature and pressure ramps, dwell times, post curing)
- K18 Explain the need for monitoring the cure cycle (using thermocouples, probes, chart recorders and data logs)
- K19 the care and safe handling of production tooling and composite mouldings throughout the production cycle
- K20 Explain the production controls used in the work area, and actions to be taken for unaccounted items
- K21 Explain how the composite moulding relates to its own quality documents, and the production tooling used

Unit 37: Carrying out Repairs on Composite Mouldings

Level: 2

Guided learning hours: 105

Unit overview

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

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

They will need to repair composite mouldings (such as cured panels, moulds, components and jigs), in accordance with approved procedures. They will be required to use appropriate drawings, specifications and documentation to repair composites materials, using the approved techniques.

They will repair a range of composite mouldings with various defects using a range of methods. Mouldings repaired will include a range of resin and fibre materials.

Their responsibilities will require them to comply with organisational policy and procedures for the repair activities undertaken and to report any problems with the repair activities, equipment or materials that they cannot personally resolve, or are outside their permitted authority, to the relevant people. They will be expected to work to instructions under supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they produce.

Their underpinning knowledge will provide a good understanding of their work and will provide an informed approach to applying composite moulding repair procedures. They will understand the repair techniques used and their application, in adequate depth to provide a sound basis for carrying out the activities to the required specification.

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

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

Assessment requirements

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

Additional information

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

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

Performance requirements

The learner must be able to:

- P1 Work safely at all times, complying with health and safety, environmental and other relevant regulations, directives and guidelines
- P2 Demonstrate the required behaviours in line with the job role and company objectives
- P3 Follow the relevant drawings and documentation for the moulding to be repaired
- P4 Complete any preparation required prior to undertaking the repair
- P5 Carry out the repairs within agreed timescale using approved materials and components and methods and procedures
- P6 Carry out any checks required confirming the repaired moulding meets the specified operating conditions
- P7 Deal promptly and effectively with problems within their control and report those that cannot be solved
- P8 Dispose of waste and excess materials in line with agreed organisational procedures
- P9 Produce accurate and complete records of all repair work carried out using organisational procedures and documentation

Skills

The learner must be able to:

- 1 Carry out **all** of the following during the repair activities:
 - 1.1. use the appropriate documentation (such as job instructions, drawings, material data sheets, specifications, planning and quality control documentation)
 - 1.2. adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment and other relevant safety regulations and procedures to realise a safe system of work
 - 1.3. maintain a safe working environment for the composite repair activities
 - 1.4. check that all tools and equipment to be used are correct for the operation to be carried out and are in a safe and usable condition
 - 1.5. follow safe practice/approved composite repair techniques and procedures at all times
 - 1.6. return all tools and equipment to the correct location on completion of the composite repair activities
 - 1.7. segregate and dispose of waste materials using the correct procedure
 - 1.8. leave the work area in a safe and appropriate condition on completion of the activities
 - 1.9. complete relevant production documentation

Skills

The learner must be able to:

- 2 Carry out **all** of the following activities when preparing for the repair activity:
 - 2.1. confirm what has to be prepared
 - 2.2. confirm the method of repair to be used
 - 2.3. check availability of ancillary materials required
 - 2.4. confirm the tools, materials and equipment selected is suitable for the repair activity
 - 2.5. identify and protect the moulding and repair materials in the work area

- 3 Carry out **three** of the following types of repair:
 - 3.1. non structural
 - 3.2. graft/pre-cured patch
 - 3.3. laminate only
 - 3.4. partial thickness laminate
 - 3.5. type A sandwich panel
 - 3.6. single sided access
 - 3.7. double sided access

- 4 Repair defects in **four** of the following types of composite moulding:
 - 4.1. internal corners
 - 4.2. external corners
 - 4.3. horizontal surface
 - 4.4. vertical surface
 - 4.5. concave surface
 - 4.6. flat surfaces
 - 4.7. webs/ribs

- 5 Repair defects in composite mouldings using **three** of the following methods:
 - 5.1. localised curing
 - 5.2. laminating
 - 5.3. resin injection
 - 5.4. wet-lay patching
 - 5.5. pre-preg patching
 - 5.6. core patching
 - 5.7. insert/core potting

Skills

The learner must be able to:

- 6 Repair defects using techniques/materials applicable to **one** of the following resin types:
 - 6.1. polyester
 - 6.2. epoxy

- 7 Repair defects using techniques/materials applicable to **one** of the following fibre types:
 - 7.1. glass
 - 7.2. carbon

- 8 Repair defects in **one** of the following core materials (**where applicable to the Sector or process**):
 - 8.1. rigid foam
 - 8.2. honeycomb
 - 8.3. aluminium honeycomb
 - 8.4. syntactic core

- 9 Repair **six** of the following types of defect in composite mouldings:
 - 9.1. blisters
 - 9.2. dents or 'dings'
 - 9.3. surface cracks
 - 9.4. broken fibres
 - 9.5. stray fibres
 - 9.6. splintering
 - 9.7. voids
 - 9.8. damaged cores
 - 9.9. dis-bonds
 - 9.10. de-lamination
 - 9.11. impact damage
 - 9.12. puncture
 - 9.13. holes
 - 9.14. abrasion/erosion

Skills

The learner must be able to:

- 10 Where applicable cure bonded repairs using two of the following methods:
 - 10.1. room temperature
 - 10.2. oven
 - 10.3. heated tools/moulds
 - 10.4. heat mats
 - 10.5. hot bonder

- 11 Repair a range of mouldings in compliance with **all** of the following standards:
 - 11.1. OEM approved data
 - 11.2. Regulatory standards

Knowledge and understanding

The learner must:

- K1 Describe the health and safety precautions to be taken and procedures used when working with composite materials, consumables, tools and equipment in the specific work area
- K2 Describe the hazards associated with carrying out composite repair activities and with the composite materials, consumables, tools and equipment used and how to minimise these and reduce any risks
- K3 Describe the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables
- K4 Describe the specific environmental conditions that must be observed when repairing composite mouldings (such as temperature, humidity, fume/dust extraction systems and equipment)
- K5 Explain how to identify and use information from engineering drawings and related documentation, to include symbols and conventions to appropriate BS, ISO or BSEN standards in relation to work undertaken
- K6 Explain the quality procedures used in the workplace to ensure production control (in relation to currency, issue, meeting specification) and the completion of such documents
- K7 Describe the basic conventions and terminology used when repairing composite mouldings (such as dis-bonds, de-lamination, resin injection, resin voids, core potting, repair patches)
- K8 Describe the methods used to repair composite mouldings
- K9 Describe the methods used to cure bonded repairs and their applications
- K10 Explain the importance of carrying out dimensional/tolerance checks on completion of the repair activity

Knowledge and understanding

The learner must:

- K11 Describe why repairs may affect the structural integrity of the composite moulding
- K12 Describe the procedure used to determine if additional testing (such as joint integrity, strength testing) is required following a repair
- K13 Explain the correct methods of storing and handling composite materials
- K14 Describe the tools and equipment used for various activities associated with repairing composite mouldings
- K15 Describe the documentation to be completed during and/or on completion of the repair activity

13 Further information and useful publications

To get in touch with us visit our 'Contact us' pages:

- Edexcel, BTEC and Pearson Work Based Learning contact details: qualifications.pearson.com/en/support/contact-us.html
- books, software and online resources for UK schools and colleges: www.pearsonschoolsandfecolleges.co.uk

Key publications

- *Adjustments for candidates with disabilities and learning difficulties – Access and Arrangements and Reasonable Adjustments, General and Vocational qualifications* (Joint Council for Qualifications (JCQ))
- *Supplementary guidance for reasonable adjustments and special consideration in vocational internally assessed units* (Pearson)
- *Suspected Malpractice in Examination and Assessments: Policies and Procedures* (JCQ)
- *Equality Policy* (Pearson)
- *Recognition of Prior Learning Policy and Process* (Pearson)
- *UK Information Manual* (Pearson)
- *UK Quality Vocational Assurance Handbook* (Pearson).

All of these publications are available on our website: qualifications.pearson.com

Further information and publications on the delivery and quality assurance of NVQ/Competence-based qualifications are available at our website on the Delivering BTEC pages. Our publications catalogue lists all the material available to support our qualifications. To access the catalogue and order publications, please go to the resources page of our website.

14 Professional development and training

Professional development and training

Pearson supports customers with training related to our qualifications. This support is available through a choice of training options offered on our website:

The support we offer focuses on a range of issues, such as:

- planning for the delivery of a new programme
- planning for assessment and grading
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- building your team and teamwork skills
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- building in effective and efficient quality assurance systems.

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Training and support for the lifetime of the qualifications

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Online support: find the answers to your questions in *Knowledge Base*, a searchable database of FAQs and useful videos that we have put together with the help of our subject advisors to support you in your role. Whether you are a teacher, administrator, Assessment Associate or training provider, you will find answers to your questions. If you are unable to find the information you need please send us your query and our qualification or administrative experts will get back to you.

15 Contact us

We have a dedicated Account Support team, across the UK, to give you more personalised support and advice. To contact your Account Specialist:

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Telephone: 0844 576 0045

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We will formally acknowledge your complaint within two working days of receipt and provide a full response within seven working days.

Apprenticeship Standard

**Advanced Manufacturing
Engineering Sector**

Employer Occupational Brief

**Occupational Competence and
Technical Knowledge Qualifications**

Assessment Strategy for

**Employers, Training Providers and
Awarding Organisations**

Version 2

Table of Contents

Introduction	307
Section 1	308
Occupational Competence Qualifications (Foundation and Development Phase)	308
Assessor Requirements to Demonstrate Effective Assessment Practice	308
Assessor Technical Requirements	308
Assessors must also:	308
Verifier Requirements (internal and external)	308
Specific technical requirements for internal and external verifiers	309
Assessment Environment of the Employer Units of Competence in the Foundation Phase of the Apprenticeship	311
Assessment Environment of the Employer Units of Competence in the Development Phase of the Apprenticeship	312
Access to Assessment	313
Carrying Out Assessments of the Occupational Competence Qualifications	313
Performance Evidence Requirements of the Occupational Competence Qualifications	313
Specific Unit Requirements	314
Assessing Knowledge and Understanding requirements in the Occupational Competence Qualifications	314
Witness testimony	315
Maximising opportunities to use assessment evidence	315
Section 2	316
General Requirements	316
Continuing Professional Development (CPD)	316
Assessors/Teachers/Trainers/Lecturers (as applicable):	316
Quality Control of Assessment	316
Notes	317

Introduction

Employers in the Advanced Manufacturing Engineering Sector have produced this Assessment Strategy to:

- support the implementation and delivery of the Apprenticeship Standard
- provide clarity for Awarding Organisations on what constitutes competent performance
- encourage and promote consistent assessment of Competence and Technical Knowledge requirements
- promote cost effective delivery and assessment plans.

This document also provides definitions for:

- the qualifications and experience required for Assessors/Trainers/Teachers and Verifiers
- the assessment environment for the Foundation and Development Phase Occupational Competence Qualifications
- access to assessment.

and requirements relating to:

- carrying out occupational competence assessments
- performance evidence requirements for occupational competence
- assessing knowledge and understanding
- use of witness testimonies
- continuing professional development
- quality control of assessment.

Section 1

Occupational Competence Qualifications (Foundation and Development Phase)

Assessor Requirements to Demonstrate Effective Assessment Practice

Assessment must be carried out by competent Assessors that as a minimum must hold the Level 3 Award in Assessing Competence in the Work Environment. Current and operational Assessors that hold units D32 and/or D33 or A1 and/or A2 as appropriate to the assessment being carried out, will not be required to achieve the Level 3 Award as they are still appropriate for the assessment requirements set out in this Assessment Strategy. However, they will be expected to regularly review their skills, knowledge and understanding and where applicable undertake continuing professional development to ensure that they are carrying out workplace assessment to the most up to date Employer Units of Competence.

Assessor Technical Requirements

Assessors must be able to demonstrate that they have verifiable, relevant and sufficient technical competence to evaluate and judge performance and knowledge evidence requirements as set out in the relevant outcomes in the Employer Units of Competence.

This will be demonstrated either by holding a relevant technical qualification or by proven industrial experience of the technical areas to be assessed. The assessor's competence must, at the very least, be at the same level as that required of the Apprentice in the units being assessed.

Assessors must also:

Be fully conversant with the Awarding Organisation's assessment recording documentation used for the Employer Units of Competence against which the assessments and verification are to be carried out, plus any other relevant documentation and system and procedures to support the QA process.

Verifier Requirements (internal and external)

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

External quality assurance (External Verification) must be carried out by competent External Verifiers that as a minimum must hold the Level 4 Award in the External Quality Assurance of Assessment Processes and Practices. Current and operational External Verifiers that hold external verification units V2 or D35 will not be required to achieve the Level 4 Award as they are still appropriate for the verification requirements set out in this Assessment Strategy. Verifiers must be familiar with, and preferably hold, either the nationally recognised Assessor units D32 and/or D33 or A1 and/or A2 or the Level 3 Award in Assessing Competence in the Work Environment.

External and Internal Verifiers will be expected to regularly review their skills, knowledge and understanding and where applicable undertake continuing professional development to ensure that they are carrying out workplace Quality Assurance (verification) of Assessment Processes and Practices to the most up to date Employer Units of Competence.

Verifiers, both Internal and External, will also be expected to be fully conversant with the terminology used in the Employer Units of Competence against which the assessments and verification are to be carried out, the appropriate Regulatory

Body's systems and procedures and the relevant Awarding Organisation's documentation, systems and procedures within which the assessment and verification is taking place.

Specific technical requirements for internal and external verifiers

Internal and external Verifiers for the Employer Units of Competence must be able to demonstrate that have verifiable, sufficient and relevant industrial experience, and must have a working knowledge of the processes, techniques and procedures that are used in the engineering industry.

The tables below and overleaf show the recommended levels of technical competence for assessors, internal verifiers, and external verifiers.

Technical Requirements for Assessors and Verifiers

Position	Prime activity requirements	Support activity requirements	Technical requirements (see notes)
Assessor	Assessment Skills	IV Systems	Technical <i>competence</i> in the areas covered by the Employer Units of Competence being assessed
Internal Verifier	Verification Skills	Assessment Knowledge	Technical <i>understanding</i> of the areas covered by the Employer Units of Competence being verified
External Verifier	Verification skills	Assessment Understanding	Technical <i>awareness</i> of the areas covered by the Employer Units Competence being verified

Notes

1. Technical competence is defined here as a combination of practical skills, knowledge, and the ability to apply both of these, in familiar and new situations, within a real working environment.
2. Technical understanding is defined here as having a good understanding of the technical activities being assessed, together with knowledge of relevant Health & Safety implications and requirements of the assessments.
3. Technical awareness is defined here as a general overview of the subject area, sufficient to ensure that assessment and evidence are reliable, and that relevant Health and Safety requirements have been complied with.
4. The competence required by the assessor, internal verifier and external verifier, in the occupational area being assessed, is likely to exist at three levels as indicated by the shaded zones in the following table.

Technical Competence	An ability to <i>discuss</i> the general principles of the competences being assessed	An ability to <i>describe</i> the practical aspects of the competence being assessed	An ability to <i>demonstrate</i> the practical competences being assessed
Required by:			
Assessor			
Internal Verifier			
External Verifier			

Assessment Environment of the Employer Units of Competence in the Foundation Phase of the Apprenticeship

The Employer Units of Competence are intended to have a wide application throughout the Advanced Manufacturing Engineering Sector. It is necessary therefore to have a flexible approach to the environment in which the Employer Units of Competence are delivered and assessed during the Foundation Phase of the Apprenticeship.

Therefore, there is much to be gained by acquiring the basic engineering competencies required in the Foundation Phase of the Apprenticeship whilst working in a sheltered but realistic environment such as in a Training Centre or College. This is due to an ongoing emphasis on safety critical work activities and the need to ensure flexibility of assessment opportunities to both maintain and enhance the provision of competent personnel within the Advanced Manufacturing Engineering sector. This assessment method will allow a minimum safe level of skills, knowledge and understanding to be achieved and demonstrated by the Apprentice prior to being exposed to the hazards of the industrial environment, thus minimising the risk of injury to themselves and other employees.

For the above reasons the assessment of the Apprentices competence in a sheltered but realistic environment is acceptable for the Employer Units of Competence included the Foundation Stage of the Apprenticeship, where the environment replicates that expected in industry.

Where applicable, the machinery, tools, materials, equipment and resources used must be representative of industry standards and there must be sufficient equipment/resources available for each Apprentice to demonstrate their competence on an individual basis. Workpieces or work outcomes assessed must be the Apprentices own work and should be actual work examples that combine the skills, techniques required by the Employer Units of Competence so that achievement will properly reflect the Apprentices capabilities.

Assessors must therefore ensure that the competency is fully transferable to the workplace. Other aspects that should be considered could include:

- environmental conditions such as lighting conditions, noise levels and the presence of hazards
- pressure of work such as time constraints and repetitive activities
- producing actual workpieces or work outcomes and the consequence of making mistakes and the effect this has on customer, supplier and departmental relationships.

Assessment Environment of the Employer Units of Competence in the Development Phase of the Apprenticeship

The evidence put forward for the Employer Units of Competence can only be regarded valid, reliable, sufficient and authentic if achieved and obtained in the working environment, where the Apprentice is employed and be clearly attributable to the Apprentice. However, in certain circumstances, simulation/replication of work activities may be acceptable, but must be kept to an absolute minimum.

The use of high quality, realistic simulations/replication, which impose pressures which are consistent with workplace expectations, should only be used in relation to the assessment of the following:

- rare or dangerous occurrences, such as those associated with health, safety and the environment issues, emergency scenarios and rare operations at work;
- the response to faults and problems for which no opportunity has presented for the use of naturally occurring workplace evidence of learners competence;
- aspects of working relationships and communications for which no opportunity has presented for the use of naturally occurring workplace evidence of learners competence.

Simulations/replications will require prior approval from the specific Awarding Organisation and should be designed in relation to the following parameters:

- the environment in which simulations take place must be designed to match the characteristics of the working environment;
- competencies achieved via simulation/replication must be transferable to the working environment;
- simulations which are designed to assess competence in dealing with emergencies, accidents and incidents must be verified as complying with relevant health, safety and environmental legislation by a competent health and safety/environmental control officer before being used;
- simulated activities should place Apprentices under the same pressures of time, access to resources and access to information as would be expected if the activity was real;
- simulated activities should require Apprentices to demonstrate their competence using plant and/or equipment used in the working environment;
- simulated activities which require interaction with colleagues and contacts should require the Apprentice to use the communication media that would be expected at the workplace;
- for health and safety reasons simulations need not involve the use of genuine substances/materials. Any simulations which require the Apprentice to handle or otherwise deal with materials substances/should ensure that the substitute takes the same form as in the workplace.

Access to Assessment

T There are no entry requirements required for the Employer Units of Competence unless this is a legal requirement of the process or the environment in which the Apprentice is working in. Assessment is open to any Apprentice who has the potential to reach the assessment requirements set out in the relevant units.

Aids or appliances, which are designed to alleviate disability, may be used during assessment, providing they do not compromise the standard required.

Carrying Out Assessments of the Occupational Competence Qualifications

The Employer Units of Competence have been specifically developed to cover a wide range of activities. The evidence produced for the units will, therefore, depend on the skills and knowledge required by employer and specified in the Apprentices Training Plan. The Skills section of the Employer Units of Competence makes reference to a number of optional items listed in the Skills section of the units (**for example 'any three from five'**). This is the minimum standard set by employers.

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

Performance Evidence Requirements of the Occupational Competence Qualifications

Performance evidence must be the main form of evidence gathered.

In order to demonstrate consistent competent performance for a unit, a minimum of **two** different examples of performance of the unit activity will be required in the Foundation Phase. For the Development Phase a minimum of three different examples of performance of the unit activity will be required (there will be no gateway assessment at the end of the Development Phase). Items of performance evidence often contain features that apply to more than one unit, and **can be used as evidence in any unit** where they are suitable performance evidence must be:

- products of the Apprentices work, such as items that have been produced or worked on, plans, charts, reports, standard operating procedures, documents produced as part of a work activity, records or photographs of the completed activity

together with:

- evidence of the way the Apprentice carried out the activities, such as witness testimonies, assessor observations or authenticated Apprentice reports of the activity undertaken.

Competent performance is more than just carrying out a series of individual set tasks. Many of the units in the Foundation Phase contain statements that require the Apprentice to provide evidence that proves they are capable of combining various features and techniques. Where this is the case, separate fragments of

evidence would not provide this combination of features and techniques and, therefore, will not be acceptable as demonstrating competent performance.

If there is any doubt as to what constitutes suitable evidence the internal/external verifier should be consulted.

Example:

Foundation Unit 6: Maintaining Mechanical Devices and Equipment Unit specific additional assessment requirements:

Specific Unit Requirements

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

It is a requirement that training providers and assessors develop a written training plan and/or scheme of work that outlines the number of training activities and interventions throughout each planned session. The plan should also outline when assessment is planned to take place, which should be after a number of training activities on the topic have taken place over a sustained period. Competency assessments should not start until the relevant training has been given and the providers/assessors are confident the learner can achieve the assessment requirements.

Assessing Knowledge and Understanding requirements in the Occupational Competence Qualifications

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

Knowledge and understanding can be demonstrated in a number of different ways. It is recommended that oral questioning and practical demonstrations are used perhaps whilst observing the apprentice undertake specific tasks, as these are considered the most appropriate for these units. Assessors should ask enough questions to make sure that the Apprentice has an appropriate level of knowledge and understanding, as required by the unit.

Evidence of knowledge and understanding will **not** be required for those items in the skills section of the Employer Units of Competence that have not been selected by the Employer.

The achievement of the specific knowledge and understanding requirements in the units **may** not simply be inferred by the results of tests, exams or assignments from other units such as in the technical knowledge qualifications or other training programmes. Where evidence is submitted from these sources, the assessor must, as with any assessment, make sure the evidence is valid, reliable, authentic, directly attributable to the Apprentice, and meets the full knowledge and understanding requirements of the unit. Awarding Organisations should be able to provide advice and guidance where evidence from Technical Knowledge qualification

tests and/or assignments can be mapped and used to meeting the requirements of the Occupational Competence unit requirements.

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

Witness testimony

Where 'observation is used to obtain performance evidence, this must be carried out against the unit assessment criteria. Best practice would require that such observation is carried out by a qualified Assessor. If this is not practicable, then alternative sources of evidence may be used.

For example, the observation may be carried out against the assessment criteria by someone else that is in close contact with the Apprentice. This could be a team leader, supervisor, mentor or line manager who may be regarded as a suitable witness to the Apprentices competency. However, the witness must be technically competent in the process or skills that they are providing testimony for, to at least the same level of expertise as that required of the Apprentice. It will be the responsibility of the assessor to make sure that any witness testimonies accepted as evidence of the Apprentices competency are reliable, auditable and technically valid.

Maximising opportunities to use assessment evidence

One of the critical factors required in order to make this Assessment Strategy as efficient and effective as possible and to ease the burden of assessment, is the Assessors ability and expertise to work in partnership with the Apprentice and their employer to provide advice and guidance on how to maximise opportunities to cross reference performance and knowledge evidence to all relevant Employer Units of Competence. For example if a knowledge statement is repeated in a number of separate Employer Units of Competence and the expected evidence/response to that statement is the same including the context, then the same piece of evidence should be cross referenced to the appropriate units. As stated above, evidence from Technical Knowledge qualification test and assignments etc. should be used where this is valid, reliable and can be attributed to the individual Apprentice.

Section 2

General Requirements

Continuing Professional Development (CPD)

Centres must support their staff to ensure that they have current technical knowledge of the occupational area, that delivery, mentoring, training, assessment and verification are in line with best practice, technical advancements and that they will take account of any national or legislative developments.

There must be an auditable individual CPD plan in place for all staff assessing and verifying the qualifications within the relevant foundation and development phases, the plan must meet the relevant provider and Advanced Manufacturing Engineering employer requirements.

Assessors/Teachers/Trainers/Lecturers (as applicable):

- Must understand the Engineering Technician (UK spec) requirements when providing guidance to assessors. They will be required to provide a signed declaration confirming they have read and understood the Engineering Technician (UK spec) and the evidence requirements to meet the Engineering Technician (UK spec) criteria (Currently in development). The Engineering Technician (UK spec) can be found at www.engc.org.uk
- Must understand the requirements of the relevant Apprenticeship Standards – End of Scheme Assessment Recording Document (Currently in development).
- Must understand the requirements of the relevant Apprenticeship Standards – Behavioral Framework and the review and assessment recording documentation (Currently in development).

Quality Control of Assessment

General

There are two major points where an Awarding Organisation interacts with the Centre in relation to the External Quality Control of Assessment and these are:

- approval - when a Centre take on new qualifications/units, the Awarding Organisation, normally through an External Verifier (EV) ensures that the Centre is suitably equipped and prepared to deliver the new units/qualification
- monitoring - throughout the ongoing delivery of the qualification/units the Awarding Organisation, through EV monitoring and other mechanisms must maintain the quality and consistency of assessment of the units/qualification.

Approval

In granting Approval, the Awarding Organisation, normally through its External Verifiers (EV) must ensure that the prospective Centre:

- meets the requirements of the Qualification Regulator
- has sufficient and appropriate physical and staff resources

- meets relevant health and safety and/or equality and access requirements
- has a robust plan for the delivery of the qualification/units.

The Awarding Organisation may visit the Centre to view evidence or may undertake this via other means.

Monitoring

The Awarding Organisation, through EV monitoring and other mechanisms must ensure:

- that a strategy is developed and deployed for the ongoing Awarding Organisation monitoring of the Centre. This strategy must be based on an active risk assessment of the Centre. In particular the strategy must identify the Apprentice, assessors and Internal Verifier sampling strategy to be deployed and the rationale behind this
- that the Centre's internal quality assurance processes are effective in assessment
- that sanctions are applied to a Centre where necessary and that corrective actions are taken by the Centre and monitored by the Awarding Organisation/EV
- that reviews of Awarding Organisation's external auditing arrangements are undertaken.

Notes

- a) It is recognised that each Awarding Organisation (AO) will have its own guidance and procedure on the internal and external quality assurance process applied to these qualifications. See individual AO websites for further information
- b) This Assessment Strategy is "work in progress" and will be amended and re issued as the Competence and Technical Knowledge Qualifications and assessment methodologies are developed and modified
- c) The Advanced Manufacturing Engineering Sector is mindful that its Apprenticeships are and **must** be available across all four Nations in the UK where applicable. Therefore the Sector has ensured that the Employer Occupational Brief (EOB) and the associated Employer Units of Competence are directly aligned to the existing format and content of the Sectors National Occupational Standards (NOS).

November 2024

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