

Level 2 Diplomas in Mechanical Manufacturing Engineering (1712)

Qualification handbook for centres



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Level 2 Diplomas in Mechanical Manufacturing Engineering (1712)

Qualification handbook for centres

Qualification title	Number	QAN
City & Guilds Level 2 NVQ Diploma in Mechanical Manufacturing Engineering (QCF) (Machine Operating)	1712-20	501/1802/X
City & Guilds Level 2 NVQ Diploma in Mechanical Manufacturing Engineering (QCF) (CNC Machine Operating)	1712-21	501/1802/X
City & Guilds Level 2 NVQ Diploma in Mechanical Manufacturing Engineering (QCF) (Production Assembly)	1712-22	501/1802/X
City & Guilds Level 2 NVQ Diploma in Mechanical Manufacturing Engineering (QCF) (Composite Manufacture)	1712-23	501/1802/X
City & Guilds Level 2 NVQ Diploma in Mechanical Manufacturing Engineering (QCF) (Optical Engineering)	1712-24	501/1802/X

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1 Introduction to the qualifications

This document contains the information that centres need to offer the following qualifications:

Qualification title and level	City & Guilds qualification number	Qualification accreditation number	Registration and certification
City & Guilds Level 2 NVQ Diploma in Mechanical Manufacturing Engineering (QCF) (Machine Operating)	1712-20	501/1802/X	
City & Guilds Level 2 NVQ Diploma in Mechanical Manufacturing Engineering (QCF) (CNC Machine Operating)	1712-21	501/1802/X	
City & Guilds Level 2 NVQ Diploma in Mechanical Manufacturing Engineering (QCF) (Production Assembly)	1712-22	501/1802/X	Consult the Walled Garden/Online Catalogue for last dates
City & Guilds Level 2 NVQ Diploma in Mechanical Manufacturing Engineering (QCF) (Composite Manufacture)	1712-23	501/1802/X	
City & Guilds Level 2 NVQ Diploma in Mechanical Manufacturing Engineering (QCF) (Optical Engineering)	1712-24	501/1802/X	

See the City & Guilds Walled Garden/On-Line Catalogue for registration and certification end dates.

Area	This qualification
Who is the qualification for?	It meets the needs of candidates who work or want to work as mechanical manufacturing engineers in the engineering sector
What does the qualification cover?	It allows candidates to learn, develop and practise the skills required for employment and/or career progression in the mechanical manufacturing engineering sector.

1.1 Qualification structure

The rules of combination for each of the qualifications are as follow:

To achieve the **Level 2 NVQ Diploma in Mechanical Manufacturing Engineering (QCF) (Machine Operating) (1712-20)**, learners must achieve a minimum of **15** credits from the mandatory units and a minimum of **39** credits from the optional units available.

Unit accreditation number	City & Guilds unit	Unit title	Credit value
Mandatory			
All three mandatory units must be taken			
A/601/5013	201	Complying with statutory regulations and organisational safety requirements	5
Y/601/5102	202	Using and interpreting engineering data and documentation	5
Y/601/5052	203	Working efficiently and effectively in engineering	5
Optional			
Complete one optional unit below for a minimum of 39 credits			
R/600/5409	204	Operating capstan or turret lathes	49
A/600/5419	205	Operating centre lathes	49
R/600/5426	206	Operating single spindle automatic turning machines	39
D/600/5431	207	Operating multi-spindle automatic turning machines	39
T/600/5435	208	Operating milling machines	49
L/600/5442	209	Operating single and multi-spindle drilling machines	49
H/600/5446	210	Operating grinding machines	49
A/600/5453	211	Operating special-purpose machines	49
D/600/5459	212	Operating gear cutting machines	49
K/600/5464	213	Operating electro-discharge machines	49
M/600/5479	214	Operating honing and lapping machines	39
L/600/6008	215	Operating broaching machines	39
R/600/6012	216	Operating shaping, planing or slotting machines	49
D/600/6014	217	Operating gear grinding machines	49
K/600/6016	218	Operating power presses	39

To achieve the **Level 2 NVQ Diploma in Mechanical Manufacturing Engineering (QCF) (CNC Machine Operating) (1712-21)**, learners must achieve a minimum of **15** credits from the mandatory units and a minimum of **39** credits from the optional units available.

Unit accreditation number	City & Guilds unit	Unit title	Credit value
Mandatory		All three mandatory units must be taken	
A/601/5013	201	Complying with statutory regulations and organisational safety requirements	5
Y/601/5102	202	Using and interpreting engineering data and documentation	5
Y/601/5052	203	Working efficiently and effectively in engineering	5
Optional		Complete one optional unit below for a minimum of 39 credits	
M/600/6020	219	Operating CNC turning machines	39
D/600/6031	220	Operating CNC milling machines	39
H/600/6032	221	Operating CNC grinding machines	39
K/600/6033	222	Operating CNC punching machines	39
M/600/6034	223	Operating CNC laser profiling machines	39
F/600/6037	224	Operating CNC electro-discharge machines	39
J/600/6038	225	Operating CNC gear cutting machines	39
L/600/6039	226	Operating CNC machining centres	39

To achieve the **Level 2 NVQ Diploma in Mechanical Manufacturing Engineering (QCF) (Production Assembly) (1712-22)**, learners must achieve a minimum of **15** credits from the mandatory units and a minimum of **49** credits from the optional units available.

Unit accreditation number	City & Guilds unit	Unit title	Credit value
Mandatory		All three mandatory units must be taken	
A/601/5013	201	Complying with statutory regulations and organisational safety requirements	5
Y/601/5102	202	Using and interpreting engineering data and documentation	5
Y/601/5052	203	Working efficiently and effectively in engineering	5
Optional		Complete one optional unit below for a minimum of 49 credits	
F/600/6040	227	Producing mechanical sub-assemblies/assemblies	49
L/600/6042	228	Assembling fluid power components to mechanical equipment	49
R/600/6043	229	Assembling electrical or electronic components to mechanical equipment	49
D/600/6045	230	Assembling pipework components to mechanical equipment	49

To achieve the **Level 2 NVQ Diploma in Mechanical Manufacturing Engineering (QCF) (Composite Manufacture) (1712-23)**, learners must achieve a minimum of **15** credits from the mandatory units and a minimum of **46** credits from the optional units available.

Unit accreditation number	City & Guilds unit	Unit title	Credit value
Mandatory			
All three mandatory units must be taken			
A/601/5013	201	Complying with statutory regulations and organisational safety requirements	5
Y/601/5102	202	Using and interpreting engineering data and documentation	5
Y/601/5052	203	Working efficiently and effectively in engineering	5
Optional			
Complete two optional units below for a minimum of 46 credits			
H/600/6046	231	Producing composite mouldings using wet lay-up techniques	42
M/600/6048	232	Producing composite mouldings using pre-preg laminating techniques	42
K/600/6050	233	Producing components by acrylic moulding	32
M/600/6051	234	Vacuum forming composite materials	32
T/600/6052	235	Trimming composite mouldings using hand tools	32
F/600/6054	236	Identifying defects in composite mouldings	23
J/600/6055	237	Carrying out repairs to composite mouldings	42
L/600/6056	238	Applying surface finishes to composite mouldings	32
Y/600/6058	239	Bonding composite mouldings	23
D/600/6059	240	Producing composite assemblies	42

To achieve the **Level 2 NVQ Diploma in Mechanical Manufacturing Engineering (QCF) (Optical Engineering) (1712-24)**, learners must achieve a minimum of **57** credits from the mandatory units and a minimum of **32** credits from the optional units available.

Unit accreditation number	City & Guilds unit	Unit title	Credit value
Mandatory		All four mandatory units must be taken	
A/601/5013	201	Complying with statutory regulations and organisational safety requirements	5
Y/601/5102	202	Using and interpreting engineering data and documentation	5
Y/601/5052	203	Working efficiently and effectively in engineering	5
R/600/6060	241	Carrying out inspection activities on optical components	42
Optional		Complete one optional unit below for a minimum of 32 credits	
Y/600/6061	242	Operating infra-red/special material lens process machines	42
D/600/6062	243	Operating optical glass lens process machines	42
K/600/6064	244	Operating optical prism and flat process machines	42
A/600/6067	245	Operating CNC aspheric optical and diamond turning machines	32
J/600/6069	246	Operating CNC optical grinding and polishing machines	32
F/600/6071	247	Operating optical cylinder and dome process machines	42
R/600/6074	248	Operating vacuum coating optical process machines	32
Y/600/6075	249	Operating optical plastic process machines	42

1.2 Opportunities for progression

On completion of this these qualifications candidates may progress into employment or to the following City & Guilds qualifications:

- Level 3 NVQ Diploma in Mechanical Manufacturing Engineering
- Level 3 NVQ Extended Diploma in Mechanical Manufacturing Engineering

1.3 Qualification support materials

City & Guilds also provides the following publications and resources specifically for this these qualifications:

Description	How to access
Fast track approval forms/generic fast track approval form	website

2 Centre requirements

This section outlines the approval processes for Centres to offer these qualifications and any resources that Centres will need in place to offer the qualifications including qualification-specific requirements for Centre staff.

Centres already offering City & Guilds qualifications in this subject area

Centres approved to offer the qualification Level 2 NVQ in Mechanical Manufacturing Engineering (1682) may apply for approval for the new Level 2 NVQ Diploma in Mechanical Manufacturing Engineering (1712-20/21/22/23/24) using the **fast track approval form**, available from the City & Guilds website.

Centres may apply to offer the new qualifications using the fast track form

- providing there have been no changes to the way the qualifications are delivered, and
- if they meet all of the approval criteria specified in the fast track form guidance notes.

Fast track approval is available for 12 months from the launch of the qualification. After this time, the qualification is subject to the **standard** Qualification Approval Process. It is the centre's responsibility to check that fast track approval is still current at the time of application.

2.1 Resource requirements

Centre staffing

Staff delivering these qualifications must be able to demonstrate that they meet the following occupational expertise requirements. They should:

- have recent relevant experience in the specific area they will be assessing
- be occupationally knowledgeable in the area for which they are delivering training and/or have experience of providing training. This knowledge must be at least to the same level as the training being delivered
- have credible experience of providing training.

Centre staff may undertake more than one role, eg tutor and assessor or internal verifier, but must never internally verify their own assessments.

Assessors and internal verifiers

Assessor requirements to demonstrate effective assessment practice

Assessment must be carried out by competent Assessors that as a minimum must hold the QCF Level 3 Award in Assessing Competence in the Work Environment. Current and operational Assessors that hold units D32 and/or D33 or A1 and/or A2 as appropriate to the assessment being carried out will not be required to achieve the QCF Level 3 Award as they are still appropriate for the assessment requirements set out in this Unit 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 National Occupational Standards (NOS).

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 QCF unit learning outcomes and associated assessment criteria. 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 learner(s) in the units being assessed.

Assessors must also be:

- Fully conversant with the City & Guilds assessment recording documentation used for the QCF NVQ units against which the assessments and verification are to be carried out, 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 QCF Level 4 Award in the Internal Quality Assurance of Assessment Processes and Practices. Current and operational Internal Verifiers that hold internal verification units V1 or D34 will not be required to achieve the QCF Level 4 Award as they are still appropriate for the verification requirements set out in this Unit Assessment Strategy. Verifiers must be familiar with, and preferably hold, either the nationally recognised Assessor units D32 and/or D33 or A1 and/or A2 or the QCF Level 3 Award in Assessing Competence in the Work Environment.

External quality assurance (**external verification**) must be carried out by competent External Verifiers that as a minimum must hold the QCF Level 4 Award in the External Quality Assurance of Assessment Processes and Practices. Current and operational External Verifiers that hold external verification units V2 or D35 will not be required to achieve the QCF Level 4 Award as they are still appropriate for the verification requirements set out in this Unit Assessment Strategy.

Verifiers must be familiar with, and preferably hold, either the nationally recognised Assessor units D32 and/or D33 or A1 and/or A2 or the QCF Level 3 Award in Assessing Competence in the Work Environment.

External and Internal Verifiers will be expected to regularly review their skills, knowledge and understanding and where applicable undertake continuing professional development to ensure that they are carrying out workplace Quality Assurance (verification) of Assessment Processes and Practices to the most up to date National Occupational Standards (NOS).

Verifiers, both Internal and External, will also be expected to be fully conversant with the terminology used in the QCF NVQ units against which the assessments and verification are to be carried out, the City & Guilds systems and procedures and the relevant City & Guilds documentation, systems and procedures within which the assessment and verification is taking place.

Continuing professional development (CPD)

Centres are expected to support their staff in ensuring that their knowledge remains current of the occupational area and of best practice in delivery, mentoring, training, assessment and verification, and that it takes account of any national or legislative developments.

2.2 Candidate entry requirements

Candidates should not be entered for a qualification of the same type, content and level as that of a qualification they already hold. There are no formal entry requirements for candidates undertaking these qualifications. However, centres must ensure that candidates have the potential and opportunity to gain the qualification successfully.

The SEMTA Engineering Manufacture apprenticeship framework suggests that:

- Employers would be interested in candidates that:
 - Are keen and motivated to work in an engineering environment
 - Are willing to undertake a course of training both on-the-job and off-the-job and apply this learning in the workplace
 - Have previous work experience or employment in the sector
 - Have completed a 14 to 19 Diploma in Engineering or Manufacturing
 - Have completed a Young Apprenticeship in Engineering or other related area
 - Have GCSEs in English, Maths and Science
 - Have completed tests in basic numeracy, literacy and communication skills and have spatial awareness.

As a guide, the Engineering Manufacturing framework is suitable for applicants who have five GCSEs grades D to E in English, Maths and Science. The selection process on behalf of employers may include initial assessment where applicants will be asked if they have any qualifications or experience that can be accredited against the requirements of the apprenticeship. They may also be required to take tests in basic numeracy and literacy, communications skills and spatial awareness. There may also be an interview to ensure applicants have selected the right occupational sector and are motivated to become an apprentice, as undertaking an apprenticeship is a major commitment for both the individual and the employer.

Assessment environment (extract from SEMTA QCF Unit Assessment Strategy 1 January 2011)

The evidence put forward for this qualification can only be regarded valid, reliable, sufficient and authentic if achieved and obtained in the working environment and be clearly attributable to the learner. However, in certain circumstances, simulation/replication of work activities may be acceptable.

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 centres City & Guilds external verifier/qualification consultant 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 learners 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 learners 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 learner to use the communication media that would be expected at the workplace

- for health and safety reason simulations need not involve the use of genuine substances/materials. Any simulations which require the learner to handle or otherwise deal with materials/substances should ensure that the substitute takes the same form as in the workplace.

Age restrictions

These qualifications are not approved for use by candidates under the age of 16, and City & Guilds cannot accept any registrations for candidates in this age group.

3 Course design and delivery

3.1 Initial assessment and induction

Centres will need to make an initial assessment of each candidate prior to the start of their programme to ensure they are entered for an appropriate type and level of qualification.

The initial assessment should identify:

- any specific training needs the candidate has, and the support and guidance they may require when working towards their qualifications. This is sometimes referred to as diagnostic testing.
- any units the candidate has already completed, or credit they have accumulated which is relevant to the qualifications they are about to begin.

City & Guilds recommends that centres provide an induction programme to ensure the candidate fully understands the requirements of the qualifications they will work towards, their responsibilities as a candidate, and the responsibilities of the centre. It may be helpful to record the information on a learning contract.

3.2 Recommended delivery strategies

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

Centres may design course programmes of study in any way which:

- best meets the needs and capabilities of their candidates
- satisfies the requirements of the qualifications.

When designing and delivering the course programme, centres might wish to incorporate other teaching and learning that is not assessed as part of the qualifications. This might include the following:

- literacy, language and/or numeracy
- personal learning and thinking
- personal and social development
- employability

Where applicable, this could involve enabling the candidate to access relevant qualifications covering these skills.

4 Assessment

4.1 Summary of assessment methods

For these qualifications, candidates will be required to complete the following assessments:

- a portfolio of evidence for **each** unit.

Time constraints

The following time constraints must be applied to the assessment of these qualifications:

- All assignments must be completed and assessed within the candidate's period of registration. Centres should advise candidates of any internal timescales for the completion and marking of individual assignments.

4.2 Evidence requirements

Carrying out assessment

The NVQ units were specifically developed to cover a wide range of activities. The evidence produced for the units will, therefore, depend on the learners choice of "bulleted items" listed in the unit assessment criteria.

Where the assessment criteria gives a choice of bulleted items (for example 'any three from five'), assessors should note that learners do not need to provide evidence of the other items to complete the unit (in this example, two) items, particularly where these additional items may relate to other activities or methods that are not part of the learners normal workplace activity or area of expertise.

Minimum performance evidence requirements

Performance evidence must be the main form of evidence gathered. In order to demonstrate consistent, competent performance for a unit, a minimum of 3 different examples of performance must be provided, and must be sufficient to show that the assessment criteria have been achieved to the prescribed standards. It is possible that some of the bulleted items in the assessment criteria may be covered more than once. The assessor and learner need to devise an assessment plan to ensure that performance evidence is sufficient to cover all the specified assessment criteria and which maximises the opportunities to gather evidence. Where applicable, performance evidence may be used for more than one unit.

The most effective way of assessing competence, is through direct observation of the learner.

Assessors must make sure that the evidence provided reflects the learner's competence and not just the achievement of a training programme.

Evidence that has been produced from team activities, for example, maintenance or installation activities is only valid when it clearly relates to the learners specific and individual contribution to the activity, and not to the general outcome(s).

Each example of performance evidence will often contain features that apply to more than one unit, and can be used as evidence in any unit where appropriate.

Performance evidence must be a combination of:

- outputs of the learner's work, such as items that have been manufactured, installed, maintained, designed, planned or quality assured, and documents produced as part of a work activity together with:
- evidence of the way the learner carried out the activities such as witness testimonies, assessor observations or authenticated learner reports, records or photographs of the work/activity carried out, etc.

Competent performance is more than just carrying out a series of individual set tasks. Many of the units contain statements that require the learner to provide evidence that proves they are capable of combining the various features and techniques. Where this is the case, separate fragments of evidence would not provide this combination of features and techniques and will not, therefore, be acceptable as demonstrating competent performance.

If there is any doubt as to what constitutes valid, authentic and reliable evidence, the internal and/or external verifier should be consulted.

Assessing knowledge and understanding

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 (and the handling of contingency situations) 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. Semta expects oral questioning and practical demonstrations to be used, as these are considered the most appropriate for these units. Assessors should ask enough questions to make sure that the learner has an appropriate level of knowledge and understanding, as required by the unit.

Evidence of knowledge and understanding will **not** be required for those bulleted items in the assessment criteria that have not been selected by the learner.

The achievement of the specific knowledge and understanding requirements of the units cannot simply be inferred by the results of tests or assignments from other units, qualifications or 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 learner, and meets the full knowledge and understanding requirements of the unit.

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

Witness testimony

Where observation is used to obtain performance evidence, this must be carried out against the unit assessment criteria. Best practice would require that such observation is carried out by a qualified Assessor. If this is not practicable, then alternative sources of evidence may be used. For example, the observation may be carried out against the assessment criteria by someone else that is in close contact with the learner. This could be a team leader, supervisor, mentor or line manager who may be regarded as a suitable witness to the learner's competency. However, the witness must be technically competent in the process or skills that they are providing testimony for, to at least the same level of expertise as that required of the learner. It will be the responsibility of the assessor to make sure that any witness testimonies accepted as evidence of the learner's competency are reliable, auditable and technically valid.

4.3 Recognition of prior learning

Recognition of prior learning means using a person's previous experience or qualifications which have already been achieved to contribute to a new qualification. RPL is allowed and is also sector specific.

4.4 Recording forms

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

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

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

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

5 Units

Availability of units

The units for these qualifications follow. The learning outcomes and assessment criteria are also viewable on the Register: <http://register.ofqual.gov.uk/>

Structure of units

The units in these qualifications are written in a standard format and comprise the following:

- City & Guilds reference number
- unit accreditation number (UAN)
- title
- level
- credit value
- unit aim
- guided learning hours
- relationship to NOS, other qualifications and frameworks
- endorsement by a sector or other appropriate body
- learning outcomes which are comprised of a number of assessment criteria.

Summary of units

City & Guilds unit	Unit title	QCF unit number (UAN)	Credit value
201	Complying with statutory regulations and organisational safety requirements	A/601/5013	5
202	Using and interpreting engineering data and documentation	Y/601/5102	5
203	Working efficiently and effectively in engineering	Y/601/5052	5
204	Operating capstan or turret lathes	R/600/5409	49
205	Operating centre lathes	A/600/5419	49
206	Operating single spindle automatic turning machines	R/600/5426	39
207	Operating multi-spindle automatic turning machines	D/600/5431	39
208	Operating milling machines	T/600/5435	49
209	Operating single and multi-spindle drilling machines	L/600/5442	49
210	Operating grinding machines	H/600/5446	49
211	Operating special-purpose machines	A/600/5453	49
212	Operating gear cutting machines	D/600/5459	49
213	Operating electro-discharge machines	K/600/5464	49

City & Guilds unit	Unit title	QCF unit number (UAN)	Credit value
214	Operating honing and lapping machines	M/600/5479	39
215	Operating broaching machines	L/600/6008	39
216	Operating shaping, planing or slotting machines	R/600/6012	49
217	Operating gear grinding machines	D/600/6014	49
218	Operating power presses	K/600/6016	39
219	Operating CNC turning machines	M/600/6020	39
220	Operating CNC milling machines	D/600/6031	39
221	Operating CNC grinding machines	H/600/6032	39
222	Operating CNC punching machines	K/600/6033	39
223	Operating CNC laser profiling machines	M/600/6034	39
224	Operating CNC electro-discharge machines	F/600/6037	39
225	Operating CNC gear cutting machines	J/600/6038	39
226	Operating CNC machining centres	L/600/6039	39
227	Producing mechanical sub-assemblies/assemblies	F/600/6040	49
228	Assembling fluid power components to mechanical equipment	L/600/6042	49
229	Assembling electrical or electronic components to mechanical equipment	R/600/6043	49
230	Assembling pipework components to mechanical equipment	D/600/6045	49
231	Producing composite mouldings using wet lay-up techniques	H/600/6046	42
232	Producing composite mouldings using pre-preg laminating techniques	M/600/6048	42
233	Producing components by acrylic moulding	K/600/6050	32
234	Vacuum forming composite materials	M/600/6051	32
235	Trimming composite mouldings using hand tools	T/600/6052	32
236	Identifying defects in composite mouldings	F/600/6054	23
237	Carrying out repairs to composite mouldings	J/600/6055	42
238	Applying surface finishes to composite mouldings	L/600/6056	32
239	Bonding composite mouldings	Y/600/6058	23
240	Producing composite assemblies	D/600/6059	42
241	Carrying out inspection activities on optical components	R/600/6060	42
242	Operating infra-red/special material lens process machines	Y/600/6061	42
243	Operating optical glass lens process machines	D/600/6062	42
244	Operating optical prism and flat process machines	K/600/6064	42

City & Guilds unit	Unit title	QCF unit number (UAN)	Credit value
245	Operating CNC aspheric optical and diamond turning machines	A/600/6067	32
246	Operating CNC optical grinding and polishing machines	J/600/6069	32
247	Operating optical cylinder and dome process machines	F/600/6071	42
248	Operating vacuum coating optical process machines	R/600/6074	32
249	Operating optical plastic process machines	Y/600/6075	42

Unit 201

Complying with statutory regulations and organisational safety requirements

Level: 2
Credit value: 5
UAN: A/601/5013

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to deal with statutory regulations and organisational safety requirements. It does not deal with specific safety regulations or detailed requirements, it does, however, cover the more general health and safety requirements that apply to working in an industrial environment.

The learner will be expected 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. The learner will need to be able to identify the relevant qualified first aiders and know the location of the first aid facilities. The learner will have a knowledge and 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. The learner will also need to be fully conversant with their organisation's procedures for fire alerts and the evacuation of premises.

The learner will also 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, the materials and substances that they use, any working practices that do not follow laid-down procedures, and manual lifting and carrying techniques.

The learner's responsibilities will require them to comply with all relevant statutory and organisational policy and procedures for health and safety in the workplace. The learner must act in a responsible and safe manner at all times, and present themselves in the workplace suitably prepared for the activities to be undertaken. The learner will be expected to report any problems with health and safety issues, to the relevant authority.

The learner's knowledge will provide a good understanding of the relevant statutory regulations and organisational requirements associated with their work, and will provide an informed approach to the procedures used. The learner will need to understand their organisation's health and safety requirements and their application, in adequate depth to provide a sound basis for carrying out their activities in a safe and competent manner.

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to comply with statutory regulations and organisational safety requirements
- 2 Know how to comply with statutory regulations and organisational safety requirements

Guided learning hours

It is recommended that **35** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta national occupational standard: Complying with statutory regulations and organisational safety requirements (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the QCF NVQ Unit Assessment Strategies, which can also be downloaded from the **Semta** website.

Unit 201

Complying with statutory regulations and organisational safety requirements

Outcome 1

Be able to comply with statutory regulations and organisational safety requirements

Assessment criteria

Practical skills

The learner can:

- 1 comply with their duties and obligations as defined in the Health and Safety at Work Act
- 2 demonstrate their understanding of their duties and obligations to health and safety by:
 - applying in principle their duties and responsibilities as an individual under the Health and Safety at Work Act
 - identifying, within their organisation, appropriate sources of information and guidance on health and safety issues, such as:
 - eye protection and personal protective equipment (PPE)
 - COSHH regulations
 - risk assessments
 - identifying the warning signs and labels of the main groups of hazardous or dangerous substances
 - complying with the appropriate statutory regulations at all times
- 3 present themselves in the workplace suitably prepared for the activities to be undertaken
- 4 follow organisational accident and emergency procedures
- 5 comply with emergency requirements, to include:
 - identifying the appropriate qualified first aiders and the location of first aid facilities
 - identifying the procedures to be followed in the event of injury to themselves or others
 - following organisational procedures in the event of fire and the evacuation of premises
 - identifying the procedures to be followed in the event of dangerous occurrences or hazardous malfunctions of equipment
- 6 recognise and control hazards in the workplace
- 7 identify the hazards and risks that are associated with the following:
 - their working environment
 - the equipment that they use
 - materials and substances (where appropriate) that they use
 - working practices that do not follow laid-down procedures
- 8 use correct manual lifting and carrying techniques
- 9 demonstrate one of the following methods of manual lifting and carrying:
 - lifting alone
 - with assistance of others
 - with mechanical assistance
- 10 apply safe working practices and procedures to include:
 - maintaining a tidy workplace, with exits and gangways free from obstruction
 - using equipment safely and only for the purpose intended
 - observing organisational safety rules, signs and hazard warnings
 - taking measures to protect others from any harm resulting from the work that they are carrying out.

Unit 201

Complying with statutory regulations and organisational safety requirements

Outcome 2

Know how to comply with statutory regulations and organisational safety requirements

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the roles and responsibilities of themselves and others under the Health and Safety at Work Act, and other current legislation (such as The Management of Health and Safety at Work Regulations, Workplace Health and Safety and Welfare Regulations, Personal Protective Equipment at Work Regulations, Manual Handling Operations Regulations, Provision and Use of Work Equipment Regulations, Display Screen at Work Regulations, Reporting of Injuries, Diseases and Dangerous Occurrences Regulations)
- 2 describe the specific regulations and safe working practices and procedures that apply to their work activities
- 3 describe the warning signs for the seven main groups of hazardous substances defined by Classification, Packaging and Labelling of Dangerous Substances Regulations
- 4 explain how to locate relevant health and safety information for their tasks, and the sources of expert assistance when help is needed
- 5 explain what constitutes a hazard in the workplace (such as moving parts of machinery, electricity, slippery and uneven surfaces, poorly placed equipment, dust and fumes, handling and transporting, contaminants and irritants, material ejection, fire, working at height, environment, pressure/stored energy systems, volatile, flammable or toxic materials, unshielded processes, working in confined spaces)
- 6 describe their responsibilities for identifying and dealing with hazards and reducing risks in the workplace
- 7 describe the risks associated with their working environment (such as the tools, materials and equipment that they use, spillages of oil, chemicals and other substances, not reporting accidental breakages of tools or equipment and not following laid-down working practices and procedures)
- 8 describe the processes and procedures that are used to identify and rate the level of risk (such as safety inspections, the use of hazard checklists, carrying out risk assessments, COSHH assessments)
- 9 describe 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
- 10 explain what constitutes dangerous occurrences and hazardous malfunctions, and why these must be reported even if no-one is injured
- 11 describe 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
- 12 describe the organisational policy with regard to fire fighting procedures; the common causes of fire and what they can do to help prevent them
- 13 describe the protective clothing and equipment that is available for their areas of activity
- 14 explain how to safely lift and carry loads, and the manual and mechanical aids available
- 15 explain how to prepare and maintain safe working areas; the standards and procedures to ensure good housekeeping
- 16 describe the importance of safe storage of tools, equipment, materials and products
- 17 describe the extent of their own authority, and to whom they should report in the event of problems that they cannot resolve.

Unit 202

Using and interpreting engineering data and documentation

Level: 2
Credit value: 5
UAN: Y/601/5102

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to make effective use of text, numeric and graphical information, by interpreting and using technical information extracted from documents such as engineering drawings, technical manuals, reference tables, specifications, technical sales/marketing documentation, charts or electronic displays, in accordance with approved procedures. The learner will be required to extract the necessary information from the various documents, in order to establish and carry out the work requirements, and to make valid decisions about the work activities based on the information extracted.

The learner's responsibilities will require them to comply with organisational policy and procedures for obtaining and using the documentation applicable to the activity. They will be expected to report any problems with the use and interpretation of the documents that they cannot personally resolve, or are outside their permitted authority, to the relevant people. They will be expected to work to instructions if necessary, with an appropriate level of supervision or as a member of a team, and take personal responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's underpinning knowledge will provide a good understanding of the types of documentation used, and will provide an informed approach to applying instructions and procedures. They will be able to read and interpret the documentation used and will know about the conventions, symbols and abbreviations, in adequate depth to provide a sound basis for carrying out the activities to the required specification.

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to use and interpret engineering data and documentation
- 2 Know how to use and interpret engineering data and documentation

Guided learning hours

It is recommended that **25** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta national occupational standard: Using and interpreting engineering data and documentation (Suite 2)

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the QCF NVQ Unit Assessment Strategies, which can also be downloaded from the **Semta** website.

Unit 202

Using and interpreting engineering data and documentation

Outcome 1

Be able to use and interpret engineering data and documentation

Assessment criteria

Practical skills

The learner can:

- 1 use the approved source to obtain the required data and documentation
- 2 use the data and documentation and carry out all of the following:
 - check the currency and validity of the data and documentation used
 - exercise care and control over the documents at all times
 - correctly extract all necessary data in order to carry out the required tasks
 - seek out additional information where there are gaps or deficiencies in the information obtained
 - deal with or report any problems found with the data and documentation
 - make valid decisions based on the evaluation of the engineering information extracted from the documents
 - return all documents to the approved location on completion of the work
 - complete all necessary work related documentation such as production documentation, installation documentation, maintenance documentation, planning documentation
- 3 correctly identify, interpret and extract the required information
- 4 extract information that includes three of the following:
 - materials or components required
 - dimensions
 - tolerances
 - build quality
 - installation requirements
 - customer requirements
 - timescales
 - financial information
 - operating parameters
 - surface texture requirements
 - location/orientation of parts
 - process or treatments required
 - dismantling/assembly sequence
 - inspection/testing requirements
 - number/volumes required
 - repair/service methods
 - method of manufacture
 - weld type and size
 - operations required
 - connections to be made
 - surface finish required

- shape or profiles
 - fault finding procedures
 - safety/risk factors
 - environmental controls
 - specific data (such as component data, maintenance data, electrical data, fluid data)
 - resources (such as tools, equipment, personnel)
 - utility supply details (such as electricity, water, gas, air)
 - location of services, including standby and emergency backup systems
 - circuit characteristics (such as pressure, flow, current, voltage, speed)
 - protective arrangements and equipment (such as containment, environmental controls, warning and evacuation systems and equipment)
 - other specific related information
- 5 use the information obtained to ensure that work output meets the specification
- 6 use information extracted from documents to include one from the following:
- drawings (such as component drawings, assembly drawings, modification drawings, repair drawings, welding/fabrication drawings, distribution and installation drawings)
 - diagrams (such as schematic, fluid power diagrams, piping, wiring/circuit diagrams)
 - manufacturers manuals/drawings
 - approved sketches
 - technical illustrations
 - photographic representations
 - visual display screen information
 - technical sales/marketing documentation
 - contractual documentation
 - other specific drawings/documents
- 7 use information extracted from related documentation, to include two from the following:
- instructions (such as job instructions, drawing instructions, manufacturers instructions)
 - specifications (such as material, finish, process, contractual, calibration)
 - reference materials (such as manuals, tables, charts, guides, notes)
 - schedules
 - operation sheets
 - service/test information
 - planning documentation
 - quality control documents
 - company specific technical instructions
 - national, international and organisational standards
 - health and safety standards relating to the activity (such as COSHH)
 - other specific related documentation
- 8 deal promptly and effectively with any problems within their control and report those which cannot be solved
- 9 report any inaccuracies or discrepancies in documentation and specifications.

Unit 202

Using and interpreting engineering data and documentation

Outcome 2

Know how to use and interpret engineering data and documentation

Assessment criteria

Underpinning knowledge

The learner can:

- 1 explain what information sources are used for the data and documentation that they use in their work activities
- 2 explain how documents are obtained, and how to check that they are current and valid
- 3 explain the basic principles of confidentiality (including what information should be available and to whom)
- 4 describe the different ways/formats that data and documentation can be presented (such as such as drawings, job instructions product data sheets, manufacturers' manuals, financial spreadsheets, production schedules, inspection and calibration requirements, customer information)
- 5 explain how to use other sources of information to support the data (such as electronic component pin configuration specifications, reference charts, standards, bend allowances required for material thickness, electrical conditions required for specific welding rods, mixing ratios for bonding and finishing materials, metal specifications and inspection requirements, health and safety documentation)
- 6 describe the importance of differentiating fact from opinion when reviewing data and documentation
- 7 describe the importance of analysing all available data and documentation before decisions are made
- 8 describe the different ways of storing and organising data and documentation to ensure easy access
- 9 describe the procedures for reporting discrepancies in the data or documentation, and for reporting lost or damaged documents
- 10 describe the importance of keeping all data and documentation up to date during the work activity, and the implications of this not being done
- 11 explain the care and control procedures for the documents, and how damage or graffiti on documents can lead to scrapped work
- 12 explain the importance of returning documents to the designated location on completion of the work activities
- 13 explain what basic drawing conventions are used and why there needs to be different types of drawings (such as isometric and orthographic, first and third angle, assembly drawings, circuit and wiring diagrams, block and schematic diagrams)
- 14 explain what types of documentation are used and how they interrelate (such as production drawings, assembly drawings, circuit and wiring diagrams, block and schematic diagrams)
- 15 explain the imperial and metric systems of measurement; tolerancing and fixed reference points
- 16 describe the meaning of the different symbols and abbreviations found on the documents that they use (such as surface finish, electronic components, weld symbols, linear and geometric tolerances, pressure and flow characteristics)
- 17 describe the extent of their own responsibility, when to act on their own initiative to find, clarify and evaluate information, and to whom they should report if they have problems that they cannot resolve.

Level: 2
Credit value: 5
UAN: Y/601/5052

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to work efficiently and effectively in the workplace, in accordance with approved procedures and practices. Prior to undertaking the engineering activity, the learner will be required to carry out all necessary preparations within the scope of their responsibility. This may include preparing the work area and ensuring that it is in a safe condition to carry out the intended activities, ensuring they have the appropriate job specifications and instructions, and ensuring that any tools, equipment, materials and other resources required are available and in a safe and usable condition.

On completion of the engineering activity, the learner will be required to return their immediate work area to an acceptable condition before recommencing further work requirements. This may involve placing completed work in the correct location, returning and/or storing any tools and equipment in the correct area, identifying any waste and/or scrapped materials and arranging for their disposal, and reporting any defects or damage to tools and equipment used.

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

The learner's responsibilities will require them to comply with organisational policy and procedures for the engineering activities undertaken, and to report any problems with the activities or the tools and equipment that are used that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, and to take personal responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will be sufficient to provide a good understanding of their work, and will provide an informed approach to working efficiently and effectively in an engineering environment. The learner 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, how to deal with problems, maintain effective working relationships and agree their development objectives and targets, in adequate depth to provide a sound basis for carrying out the activities safely and correctly.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to work efficiently and effectively in engineering
- 2 Know how to work efficiently and effectively in engineering

Guided learning hours

It is recommended that **25** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta national occupational standard: Working efficiently and effectively in engineering (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the QCF NVQ Unit Assessment Strategies, which can also be downloaded from the **Semta** website.

Unit 203

Working efficiently and effectively in engineering

Outcome 1

Be able to work efficiently and effectively in engineering

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 prepare the work area to carry out the engineering activity
- 3 prepare to carry out the engineering activity, taking into consideration all of the following, as applicable to the work to be undertaken:
 - the work area is free from hazards and suitably prepared for the activities to be undertaken
 - any required safety procedures are implemented
 - any necessary personal protection equipment is obtained and is in a usable condition
 - tools and equipment required are obtained and checked that they are in a safe and useable condition
 - all necessary drawings, specifications and associated documentation is obtained
 - job instructions are obtained and understood
 - the correct materials or components are obtained
 - storage arrangements for work are appropriate
 - appropriate authorisation to carry out the work is obtained
- 4 check that there are sufficient supplies of materials and/or consumables and that they meet work requirements
- 5 ensure completed products or resources are stored in the appropriate location on completion of the activities
- 6 complete work activities, to include all of the following:
 - returning tools and equipment
 - returning drawings and work instructions
 - completing all necessary documentation accurately and legibly
 - identifying, where appropriate, any unusable tools, equipment and components
 - arranging for the safe disposal of waste materials
- 7 tidy up the work area on completion of the engineering activity
- 8 deal promptly and effectively with problems within their control and report those that cannot be resolved
- 9 deal with problems affecting the engineering process, to include two of the following:
 - materials
 - tools and equipment
 - drawings
 - job specification
 - quality
 - people
 - timescales

- safety
 - activities or procedures
- 10 contribute to organisational procedures for identifying opportunities for improvement to one of the following:
- working practices
 - working methods
 - quality
 - safety
 - tools and equipment
 - supplier relationships
 - internal communication
 - customer service
 - training and development
 - teamwork
 - other
- 11 maintain effective working relationships with colleagues to include two of the following:
- colleagues within their own working group
 - people outside their normal working group
 - line management
 - external contacts
- 12 review personal training and development as appropriate to the job role
- 13 review personal development objectives and targets to include one of the following:
- dual or multi-skilling
 - training on new equipment/technology
 - increased responsibility
 - understanding of company working practices, procedures, plans and policies
 - other specific requirements.

Unit 203

Working efficiently and effectively in engineering

Outcome 2

Know how to work efficiently and effectively in engineering

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed whilst preparing and tidying up their work environment
- 2 describe the correct use of any equipment to protect the health and safety of themselves and their colleagues
- 3 describe the procedure for ensuring that all documentation relating to the work being carried out is available and current, prior to starting the activity
- 4 describe the action that should be taken if documentation received is incomplete and/or incorrect
- 5 describe the procedure for ensuring that all tools and equipment are available prior to undertaking the activity
- 6 describe the checks to be carried out to ensure that tools and equipment are in full working order, prior to undertaking the activity
- 7 describe the action that should be taken if tools and equipment are not in full working order
- 8 describe the checks to be carried out to ensure that all required materials are correct and complete, prior to undertaking the activity
- 9 describe the action that should be taken if materials do not meet the requirements of the activity
- 10 explain whom to inform when the work activity has been completed
- 11 describe the information and/or documentation that others will require to confirm that the activity has been completed
- 12 explain what materials, equipment and tools can be re-used
- 13 explain how any waste materials and/or products are transferred, stored and disposed of
- 14 explain where tools and equipment should be stored and located
- 15 describe the importance of maintaining effective working relationships within the workplace
- 16 describe the procedures for dealing with and reporting any problems that can affect working relationships
- 17 describe the importance of making a contribution to improving working practices
- 18 describe the procedure and format for making suggestions for improvements
- 19 describe the benefits for the work area if improvements can be identified
- 20 describe the difficulties that can occur in working relationships
- 21 describe the regulations that affect how they should be treated at work (such as Equal Opportunities Act, Race and Sex Discrimination, Working Time Directive)
- 22 describe the benefits of continuous personal development
- 23 describe the training opportunities that are available in the workplace
- 24 describe the importance of reviewing their training and development
- 25 explain with whom to discuss training and development issues
- 26 describe the extent of their own authority and to whom they should report if they have any problems that they cannot resolve.

Level: 2
Credit value: 49
UAN: R/600/5409

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out turning operations on a capstan or turret lathe, in accordance with approved procedures. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. The learner will be expected to produce a range of components that combine a number of different features, such as parallel, stepped and tapered diameters, drilled, bored and reamed holes, internal and external threads.

The learner will be required to operate the machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, to make minor adjustments or seek the help of the setter to make the required adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying machining procedures. The learner will have an understanding of the capstan or turret lathe turning process, and its application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate capstan or turret lathes
- 2 Know how to operate capstan or turret lathes

Guided learning hours

It is recommended that **151** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 4: Operating Capstan or Turret Lathes (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 204

Outcome 1

Operating capstan or turret lathes

Be able to operate capstan or turret lathes

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the machine is set up and ready for the machining activities to be carried out
- 3 manipulate the machine tool controls safely and correctly in line with operational procedures
- 4 produce components to the required quality and within the specified dimensional accuracy
- 5 apply all of the following during the machining activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without distortion
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 6 produce machined components which combine different operations and cover six of the following:
 - flat faces
 - parallel diameters
 - stepped diameters
 - tapered diameters
 - drilled holes
 - bored holes
 - reamed holes
 - profile forms
 - internal threads
 - external threads
 - eccentric features
 - parting off
 - chamfers and radii
 - knurls/special finishes

- grooves/undercuts
 - counterbores
- 7 machine components made from one of the following types of material:
- ferrous
 - non-ferrous
 - non-metallic
- 8 produce components with dimensional accuracy, form and surface texture within all of the following quality and accuracy standards, as is applicable to the operations performed:
- components to be free from false tool cuts, burrs and sharp edges
 - dimensional tolerance equivalent to BS 4500 or BS 1916 Grade 9
 - surface finish $63\mu\text{in}$ or $1.6\mu\text{m}$
 - reamed or bored holes within H8
 - screw threads BS medium fit
 - angles within ± 1 degree
- 9 carry out quality sampling checks at suitable intervals
- 10 use appropriate gauges or instruments to carry out the necessary checks, during production, for accuracy of four of the following:
- diameters
 - hole size/fit
 - angle
 - surface finish
 - lengths
 - depths
 - thread fit
 - grooves/undercuts
- 11 deal promptly and effectively with problems within their control and report those that cannot be solved.

Unit 204

Outcome 2

Operating capstan or turret lathes

Know how to operate capstan or turret lathes

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed whilst operating capstan or turret lathes
- 2 describe the safety mechanisms on the machine and the procedure for checking that they function correctly
- 3 describe the operation of the machine controls in both hand and power modes, including rapid power of the turret head
- 4 explain how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
- 5 describe the personal protective equipment to be worn, and where this can be obtained
- 6 describe the hazards associated with operating capstan lathes and carrying out the turning operations, and how to minimise them and reduce any risks
- 7 describe the importance of keeping the work area clean and tidy
- 8 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 9 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards in relation to work undertaken)
- 10 explain how to use imperial and metric systems of measurement
- 11 describe the main features of the capstan or turret lathe, and the accessories that can be used
- 12 describe the various turning operations that can be performed, and the methods and equipment used
- 13 describe the effects of backlash in machine slides and screws, and how this can be overcome
- 14 describe the application of roughing and finishing cuts and the effect on tool life, surface finish and dimensional accuracy
- 15 describe the application of cutting fluids with regard to a range of different materials
- 16 describe the effects of clamping the workpiece in a chuck/workholding device, and how this can cause distortion in the finished components
- 17 explain how to recognise machining faults, and how to identify when tools need re-sharpening
- 18 describe the quality control procedures used and inspection checks to be carried out, and the equipment that will need to be used for these checks
- 19 describe the problems that can occur with the turning activities, and how they can be overcome
- 20 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Level: 2
Credit value: 49
UAN: A/600/5419

Unit aim

This unit covers the skills and knowledge needed to prove the competences required for carrying out turning operations on a centre lathe, in accordance with approved procedures. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components, materials and consumables are available. The learner will be expected to produce a range of components that combine a number of different features, such as parallel, stepped and tapered diameters, drilled, bored and reamed holes, internal and external threads.

The learner will be required to operate the machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the setter to make the adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying centre lathe machining procedures. The learner will have an understanding of the centre lathe turning process, and its application, and will know about the equipment, materials and consumables, in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate centre lathes
- 2 Know how to operate centre lathes

Guided learning hours

It is recommended that **151** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 5: Operating Centre Lathes (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 205

Operating centre lathes

Outcome 1

Be able to operate centre lathes

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the machine is set up and ready for the machining activities to be carried out
- 3 manipulate the machine tool controls safely and correctly in line with operational procedures
- 4 produce components to the required quality and within the specified dimensional accuracy
- 5 apply all of the following during the machining activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without distortion
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 6 produce machined components which combine different operations and cover six of the following:
 - flat faces
 - parallel diameters
 - stepped diameters
 - tapered diameters
 - drilled holes
 - bored holes
 - reamed holes
 - profile forms
 - internal threads
 - external threads
 - eccentric features
 - parting off
 - chamfers
 - knurls or special finishes

- grooves
 - undercuts
- 7 machine components made from one of the following types of material:
- ferrous
 - non-ferrous
 - non-metallic
- 8 produce components with dimensional accuracy, form and surface texture within all of the following quality and accuracy standards, as is applicable to the operations performed:
- components to be free from false tool cuts, burrs and sharp edges
 - dimensional tolerance equivalent to BS 4500 or BS 1916 Grade 7
 - surface finish 63 μin or 1.6 μm
 - reamed or bored holes within H8
 - screw threads BS medium fit
 - angles within +/- 1 degree
- 9 carry out quality sampling checks at suitable intervals
- 10 use appropriate gauges or instruments to carry out the necessary checks, during production, for accuracy of four of the following:
- diameters
 - hole size/fit
 - surface finish
 - angle/taper
 - thread fit
 - lengths
 - depths
 - grooves/undercut
- 11 deal promptly and effectively with problems within their control and report those that cannot be solved
- 12 shut down the equipment to a safe condition on conclusion of the machining activities.

Unit 205

Outcome 2

Operating centre lathes

Know how to operate centre lathes

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed whilst operating centre lathes
- 2 describe the safety mechanisms on the machine, and the procedure for checking that they function correctly
- 3 describe the operation of the machine controls in both hand and power modes
- 4 explain how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
- 5 describe the personal protective equipment to be worn, and where this can be obtained
- 6 describe the hazards associated with operating centre lathes and carrying out the turning operations, and how to minimise them and reduce any risks
- 7 describe the importance of keeping the work area clean and tidy
- 8 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 9 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards in relation to work undertaken)
- 10 explain how to use imperial and metric systems of measurement
- 11 describe the main features of the centre lathes and the accessories that can be used (such as saddle, compound slide, tailstock, taper turning attachments, profile attachments, fixed and travelling steadies)
- 12 describe the various turning operations that can be performed, and the methods and equipment used
- 13 describe the effects of backlash in machine slides and screws, and how this can be overcome
- 14 describe the application of roughing and finishing cuts, and the effect on tool life, surface finish and dimensional accuracy
- 15 describe the application of cutting fluids with regard to a range of different materials
- 16 describe the effects of clamping the workpiece in a chuck/workholding device, and how this can cause distortion in the finished components
- 17 explain how to recognise machining faults and how to identify when tools need re-sharpening
- 18 describe the quality control procedures used, inspection checks to be carried out, and the equipment that will need to be used
- 19 describe the problems that can occur with the turning activities, and how these can be overcome
- 20 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Unit 206

Operating single spindle automatic turning machines

Level: 2
Credit value: 39
UAN: R/600/5426

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out turning operations on a single spindle automatic turning machine, in accordance with approved procedures. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. The learner will be expected to produce a range of 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 profiles.

The learner will be required to operate the machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the setter to make the required adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying procedures for automatic turning machines. The learner will have an understanding of the single spindle automatic turning machine process, and its application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate single spindle automatic turning machines
- 2 Know how to operate single spindle automatic turning machines

Guided learning hours

It is recommended that **130** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 6: Operating Single Spindle Automatic Turning Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 206

Operating single spindle automatic turning machines

Outcome 1

Be able to operate single spindle automatic turning machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the machine is set up and ready for the machining activities to be carried out
- 3 manipulate the machine tool controls safely and correctly in line with operational procedures
- 4 produce components to the required quality and within the specified dimensional accuracy
- 5 apply all of the following during the machining activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without distortion
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 6 produce machined components which combine different operations and cover six of the following:
 - flat faces
 - parallel diameters
 - stepped diameters
 - tapered diameters
 - drilled holes
 - bored holes
 - reamed holes
 - profile forms
 - internal threads
 - external threads
 - eccentric features

- parting off
 - chamfers and radii
 - knurls/special finishes
 - grooves/undercuts
 - counterbores
- 7 machine components made from one of the following types of material:
- ferrous
 - non-ferrous
 - non-metallic
- 8 produce components with dimensional accuracy, form and surface texture within all of the following quality and accuracy standards, as is applicable to the operations performed:
- components to be free from false tool cuts, burrs and sharp edges
 - dimensional tolerance equivalent to BS 4500 or BS 1916 Grade 9
 - surface finish $63\mu\text{in}$ or $1.6\mu\text{m}$
 - reamed or bored holes within H8
 - screw threads BS medium fit
 - angles within ± 1 degree
- 9 carry out quality sampling checks at suitable intervals
- 10 use appropriate gauges or instruments to carry out the necessary checks, during production, for accuracy of four of the following:
- diameters
 - hole size/fit
 - angle/taper
 - surface finish
 - lengths
 - depths
 - thread fit
 - grooves/undercuts
- 11 deal promptly and effectively with problems within their control and report those that cannot be solved
- 12 shut down the equipment to a safe condition on conclusion of the machining activities.

Unit 206

Operating single spindle automatic turning machines

Outcome 2

Know how to operate single spindle automatic turning machines

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed whilst operating single spindle automatic turning machines
- 2 describe the safety mechanisms on the machine, and the procedure for checking that they function correctly
- 3 describe the operation of the machine controls in both hand and power modes
- 4 describe how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
- 5 describe the personal protective equipment to be worn, and where this can be obtained
- 6 describe the hazards associated with operating single spindle automatic turning operations and carrying out the turning operations, and how to minimise them and reduce any risks
- 7 describe the importance of keeping the work area clean and tidy
- 8 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 9 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards in relation to work undertaken)
- 10 explain how to use imperial and metric systems of measurement
- 11 describe the main features of the single spindle automatic turning machines, and the accessories that can be used
- 12 describe the various turning operations that can be performed, and the methods and equipment used
- 13 describe the application of roughing and finishing cuts, and the effect on tool life, surface finish and dimensional accuracy
- 14 describe the application of cutting fluids with regard to a range of different materials
- 15 describe the effects of clamping the workpiece in a chuck/workholding device, and how this can cause distortion in the finished components
- 16 explain how to recognise machining faults, and how to identify when tools need re-sharpening
- 17 describe the quality control procedures used, inspection checks to be carried out and the equipment that will need to be used
- 18 describe the problems that can occur with the turning activities, and how these can be overcome
- 19 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Unit 207

Operating multi-spindle automatic turning machines

Level: 2
Credit value: 39
UAN: D/600/5431

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out turning operations on a multi-spindle automatic turning machine, in accordance with approved procedures. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. The learner will be expected to produce a range of components that combine a number of different features, such as parallel, stepped and tapered diameters, drilled and reamed holes, internal and external threads, and special profiles or forms.

The learner will be required to operate the machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the setter to make the required adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying procedures for automatic turning machines. The learner will have an understanding of the multi-spindle automatic turning machine process, and its application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate multi-spindle automatic turning machines
- 2 Know how to operate multi-spindle automatic turning machines

Guided learning hours

It is recommended that **130** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 7: Operating Multi-Spindle Automatic Turning Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 207

Operating multi-spindle automatic turning machines

Outcome 1

Be able to operate multi-spindle automatic turning machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the machine is set up and ready for the machining activities to be carried out
- 3 manipulate the machine tool controls safely and correctly in line with operational procedures
- 4 produce components to the required quality and within the specified dimensional accuracy
- 5 apply all of the following during the machining activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without distortion
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 6 produce machined components which combine different operations and cover six of the following:
 - flat faces
 - parallel diameters
 - stepped diameters
 - tapered diameters
 - drilled holes
 - bored holes
 - reamed holes
 - profile forms
 - internal threads
 - external threads
 - eccentric features

- parting off
 - chamfers and radii
 - knurls/special finishes
 - grooves/undercuts
 - counterbores
- 7 machine components made from one of the following types of material:
- ferrous
 - non-ferrous
 - non-metallic
- 8 produce components with dimensional accuracy, form and surface texture within all of the following quality and accuracy standards, as is applicable to the operations performed:
- components to be free from false tool cuts, burrs and sharp edges
 - dimensional tolerance equivalent to BS 4500 or BS 1916 Grade 9
 - surface finish $63\mu\text{in}$ or $1.6\mu\text{m}$
 - reamed holes within H8
 - screw threads BS medium fit
 - angles within ± 1 degree
- 9 carry out quality sampling checks at suitable intervals
- 10 use appropriate gauges or instruments to carry out the necessary checks, during production, for accuracy of four of the following:
- diameters
 - hole size/fit
 - angle
 - surface finish
 - lengths
 - depths
 - thread fit
 - grooves/recesses
- 11 deal promptly and effectively with problems within their control and report those that cannot be solved
- 12 shut down the equipment to a safe condition on conclusion of the machining activities.

Unit 207

Operating multi-spindle automatic turning machines

Outcome 2

Know how to operate multi-spindle automatic turning machines

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed whilst operating multi-spindle automatic turning machines
- 2 describe the safety mechanisms on the machine, and the procedure for checking that they function correctly
- 3 describe the operation of the machine controls in both hand and power modes
- 4 explain how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
- 5 describe the personal protective equipment to be worn, and where this can be obtained
- 6 describe the hazards associated with operating multi-spindle turning machines, and carrying out the turning operations and how to minimise them and reduce any risks
- 7 describe the importance of keeping the work area clean and tidy
- 8 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 9 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards in relation to work undertaken)
- 10 explain how to use imperial and metric systems of measurement
- 11 describe the main features of the multi-spindle automatic turning machines, and the accessories that can be used
- 12 describe the various turning operations that can be performed, and the methods and equipment used
- 13 describe the application of roughing and finishing cuts, and the effect on tool life, surface finish and dimensional accuracy
- 14 describe the application of cutting fluids with regard to a range of different materials
- 15 describe the effects of clamping the workpiece in a chuck/workholding device, and how this can cause distortion in the finished components
- 16 explain how to recognise machining faults, and how to identify when tools need re-sharpening
- 17 describe the quality control procedures used, inspection checks to be carried out, and the equipment that will need to be used
- 18 describe the problems that can occur with the turning activities, and how these can be overcome
- 19 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Level: 2
Credit value: 49
UAN: T/600/5435

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out milling operations on a milling machine, in accordance with approved procedures. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. The learner will be expected to produce a range of components that combine a number of different features, such as flat faces, parallel faces, faces that are flat and square to each other, angular faces, steps, slots and special forms.

The learner will be required to operate the machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the setter to make the required adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying procedures for milling machining. The learner will have an understanding of the milling machine process, and its application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate milling machines
- 2 Know how to operate multi-spindle automatic turning machines

Guided learning hours

It is recommended that **151** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 8: Operating Milling Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 208

Outcome 1

Operating milling machines

Be able to operate milling machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the machine is set up and ready for the machining activities to be carried out
- 3 manipulate the machine tool controls safely and correctly in line with operational procedures
- 4 produce components to the required quality and within the specified dimensional accuracy
- 5 apply all of the following during the machining activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without distortion
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 6 operate one type of milling machine from the following:
 - horizontal milling machine
 - vertical milling machine
 - universal milling machine
- 7 produce machined components which combine different operations and cover six of the following:
 - flat faces
 - square faces
 - parallel faces
 - angular faces
 - steps/shoulders
 - open ended slots
 - enclosed slots
 - recesses
 - tee slots
 - drilled holes

- bored holes
 - profile forms (such as vee, concave, convex, gear forms)
 - serrations
 - indexed or rotated forms
 - special forms
- 8 machine components made from one of the following types of material:
- ferrous
 - non-ferrous
 - non-metallic
- 9 produce components with dimensional accuracy, form and surface texture within all the following quality and accuracy standards, as is applicable to the operations performed:
- components to be free from false tool cuts, burrs and sharp edges
 - dimensional tolerance equivalent to BS 4500 or BS 1916 Grade 9
 - flatness and squareness within 0.005" per inch or 0.125mm per 25mm
 - surface finish 63 μ m or 1.6 μ m
 - angles within +/- 1 degree
- 10 carry out quality sampling checks at suitable intervals
- 11 use appropriate gauges or instruments to carry out the necessary checks, during production, for accuracy of four of the following:
- dimensions
 - squareness
 - hole size/fit
 - angles
 - flatness
 - surface finish
 - slots
 - recesses
- 12 deal promptly and effectively with problems within their control and report those that cannot be solved
- 13 shut down the equipment to a safe condition on conclusion of the machining activities.

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed whilst operating milling machines
- 2 describe the safety mechanisms on the machine, and the procedure for checking that they function correctly
- 3 describe the operation of the machine controls in both hand and power modes, and how to stop the machine in an emergency
- 4 describe the personal protective equipment to be worn, and where this can be obtained
- 5 describe the hazards associated with operating milling machines and carrying out the milling operations, and how to minimise them and reduce any risks
- 6 describe the importance of keeping the work area clean and tidy
- 7 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 8 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards in relation to work undertaken)
- 9 explain how to use imperial and metric systems of measurement
- 10 describe the main features of the milling machine, and the accessories that can be used
- 11 describe the various milling operations that can be performed, and the methods and equipment used
- 12 describe the effects of backlash in machine slides and screws, and how this can be overcome
- 13 explain how to handle and store cutting tools safely and correctly
- 14 describe the application of roughing and finishing cuts, and the effect on tool life, surface finish and dimensional accuracy
- 15 describe the application of cutting fluids with regard to a range of different materials
- 16 describe the effects of clamping the workpiece, and how this can cause distortion in the finished components
- 17 explain how to recognise machining faults, and how to identify when cutters need re-sharpening
- 18 describe the quality control procedures that are used, inspection checks to be carried out, and the equipment that will need to be used
- 19 describe the problems that can occur with the milling activities, and how these can be overcome
- 20 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Unit 209

Operating single and multi-spindle drilling machines

Level: 2
Credit value: 49
UAN: L/600/5442

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out drilling operations on single or multi-spindle drilling machines, such as bench drilling machines, pedestal machines, radial arm machines or special-purpose drilling machines, in accordance with approved procedures. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. The learner will be expected to produce a range of components that combine a number of different features, such as drilled and reamed holes, counterbores, countersinks and internal threads.

The learner will be required to operate the machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the setter to make the required adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying drilling procedures. The learner will have an understanding of the single and multi-spindle drilling processes, and their application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate single and multi-spindle drilling machines
- 2 Know how to operate single and multi-spindle drilling machines

Guided learning hours

It is recommended that **151** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 9: Operating Single and Multi-Spindle Drilling Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 209

Operating single and multi-spindle drilling machines

Outcome 1

Be able to operate single and multi-spindle drilling machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the machine is set up and ready for the machining activities to be carried out
- 3 manipulate the machine tool controls safely and correctly in line with operational procedures
- 4 produce components to the required quality and within the specified dimensional accuracy
- 5 apply all of the following during the machining activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without distortion
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 6 operate two of the following types of drilling machine:
 - single spindle pedestal drill
 - multi-spindle pedestal drill
 - special-purpose drilling machines
 - radial arm drill
 - bench drill
- 7 produce drilled components which combine different operations and cover five of the following:
 - drilling to depth
 - drilling through the work piece
 - drilling flat bottomed
 - counterboring
 - countersinking

- spot facing
 - reaming
 - tapping
- 8 drill components made from one of the following types of material:
- ferrous
 - non-ferrous
 - non-metallic
- 9 produce components with dimensional accuracy, form and surface texture within all of the following quality and accuracy standards, as is applicable to the operations performed:
- components to be free from false tool cuts, burrs and sharp edges
 - dimensional tolerance equivalent to BS 4500 or BS 1916 Grade 9
 - surface finish $63\mu\text{in}$ or $1.6\mu\text{m}$
 - reamed holes within H8
 - screw threads BS medium fit
- 10 carry out quality sampling checks at suitable intervals
- 11 use appropriate gauges or instruments to carry out the necessary checks, during production, for accuracy of all of the following:
- hole size/fit
 - hole depths
 - thread fits
- 12 deal promptly and effectively with problems within their control and report those that cannot be solved
- 13 shut down the equipment to a safe condition on conclusion of the machining activities.

Unit 209

Operating single and multi-spindle drilling machines

Outcome 2

Know how to operate single and multi-spindle drilling machines

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed whilst operating single or multi-spindle drilling machines
- 2 describe the safety mechanisms on the machine, and the procedure for checking that they function correctly
- 3 describe the operation of the machine controls in both hand and power modes
- 4 explain how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
- 5 describe the personal protective equipment to be worn, and where this can be obtained
- 6 describe the hazards associated with operating multi-spindle drilling machines and carrying out the drilling operations, and how to minimise them and reduce any risks
- 7 describe the importance of keeping the work area clean and tidy
- 8 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 9 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards in relation to work undertaken)
- 10 explain how to use imperial and metric systems of measurement
- 11 describe the main features of the single or multi-spindle drilling machine, and the accessories that can be used
- 12 describe the various drilling operations that can be performed, and the methods and equipment used
- 13 explain how to handle and store drills and tools safely and correctly
- 14 describe the application of cutting fluids with regard to a range of different materials
- 15 describe the effects of clamping the workpiece in a jig/workholding device, and how this can cause distortion in the finished components
- 16 explain how to recognise machining faults, and how to identify when drills and tools need re-sharpening
- 17 describe the quality control procedures that are used, inspection checks to be carried out, and the equipment that will need to be used
- 18 describe the problems that can occur with the drilling activities, and how these can be overcome
- 19 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Level: 2
Credit value: 49
UAN: H/600/5446

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out grinding operations, using machines such as horizontal or vertical surface grinding, external cylindrical, internal cylindrical, centreless, profile or thread grinding machines, in accordance with approved procedures. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. The learner will be expected to grind a range of components that combine a number of different features, such as parallel faces, flat faces, vertical faces, parallel, diameters, stepped diameters, tapered diameters, shoulders and faces, bores and counterbores, different thread forms and profiles.

The learner will be required to operate the machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the setter to make the required adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying grinding procedures. The learner will have an understanding of the grinding machine used, the grinding process and its application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate grinding machines
- 2 Know how to operate grinding machines

Guided learning hours

It is recommended that **151** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 10: Operating Grinding Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 210

Outcome 1

Operating grinding machines

Be able to operate grinding machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the machine is set up and ready for the machining activities to be carried out
- 3 manipulate the machine tool controls safely and correctly in line with operational procedures
- 4 produce components to the required quality and within the specified dimensional accuracy
- 5 apply all of the following during the machining activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without distortion
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that grinding wheels are maintained correctly dressed/formed and are in a usable condition
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 6 operate one of the following types of grinding machine:
 - horizontal surface
 - vertical surface
 - external cylindrical
 - internal cylindrical
 - universal
 - centreless
 - thread grinding
 - profile grinding

- 7 produce ground components which include three of the following features, as applicable to the type of machine used:
 - flat faces
 - vertical faces
 - parallel faces
 - faces square to each other
 - shoulders and faces
 - slots
 - parallel diameters
 - tapered diameters
 - counterbores
 - tapered bores
 - parallel bores
 - profile forms
 - other thread forms
 - vee-form threads
 - left hand threads
 - right hand threads
 - single start threads
 - multi-start threads
 - internal threads
 - external threads
 - angular faces
- 8 produce components with dimensional accuracy, form and surface texture within all the following standards as is applicable to the operations performed:
 - tolerance to BS 4500 or BS 1916 Grade 5
 - surface texture $8 \mu\text{in}$ or $0.2\mu\text{m}$
 - angles within ± 0.5 degree
 - components to be free from false grinding cuts, burrs and sharp edges
- 9 grind components made from one of the following types of material:
 - ferrous
 - non-ferrous
 - non-metallic
- 10 carry out quality sampling checks at suitable intervals
- 11 use appropriate gauges or instruments to carry out the necessary checks, during production, for accuracy of three of the following:
 - dimensions
 - parallelism
 - squareness
 - profile
 - concentricity
 - thread form
 - surface texture
 - angle/taper
 - ovality/lobing
- 12 deal promptly and effectively with problems within their control and report those that cannot be solved
- 13 shut down the equipment to a safe condition on conclusion of the machining activities.

Unit 210

Outcome 2

Operating grinding machines

Know how to operate grinding machines

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed whilst operating grinding machines
- 2 describe the safety mechanisms on the machine, and the procedure for checking that they function correctly
- 3 describe the operation of the machine controls in both hand and power modes
- 4 explain how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
- 5 describe the personal protective equipment to be worn, and where this can be obtained
- 6 describe the hazards associated with operating grinding machines and carrying out the grinding operations (such as moving machine parts, sparks/airborne particles, bursting grinding wheels, insecure workpiece), and how to minimise them and reduce any risks
- 7 describe the importance of keeping the work area clean and tidy
- 8 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 9 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 10 explain how to use imperial and metric systems of measurement
- 11 describe the main features of the grinding machine, and the accessories that can be used
- 12 describe the various grinding operations that can be performed, and the methods and equipment used
- 13 describe the effects of backlash in machine slides and screws, and how this can be overcome
- 14 describe the application of roughing and finishing cuts, and the effect on wheel life, surface finish and dimensional accuracy
- 15 explain how to dress and reshape grinding wheels, and the equipment to be used
- 16 describe the application of cutting fluids with regard to a range of different materials
- 17 describe the effects of clamping the workpiece in/on a chuck/workholding device, and how this can cause distortion in the finished components
- 18 explain how to recognise machining faults and identify when wheels need dressing
- 19 describe the quality control procedures used, inspection checks to be carried out, and the equipment that will need to be used
- 20 describe the problems that can occur with the grinding activities, and how these can be overcome
- 21 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Level: 2
Credit value: 49
UAN: A/600/5453

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out machining operations on special-purpose machines, in accordance with approved procedures. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. The learner will be expected to produce components relevant to the special-purpose machine's capabilities and to the required specifications.

The learner will be required to operate the machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the setter to make the required adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying machining procedures. The learner will have an understanding of the special-purpose machining process, and its application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate special-purpose machines
- 2 Know how to operate special-purpose machines

Guided learning hours

It is recommended that **151** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 11: Operating Special-Purpose Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 211

Outcome 1

Operating special-purpose machines

Be able to operate special-purpose machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the machine is set up and ready for the machining activities to be carried out
- 3 manipulate the machine tool controls safely and correctly in line with operational procedures
- 4 produce components to the required quality and within the specified dimensional accuracy
- 5 apply all of the following during the machining activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without distortion
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 6 produce machined components covering two of the following operations:
 - turning
 - drilling
 - milling
 - grinding
 - erosion
 - other special operations
- 7 produce components which combine different operations and cover six of the following:
 - flat faces
 - parallel faces
 - square faces
 - angular faces
 - slots
 - parallel diameters
 - tapered diameters

- stepped diameters
 - bores
 - counterbores
 - drilled holes
 - tapped holes
 - reamed holes
 - profiles
 - special finishes
- 8 machine components made from one of the following types of material:
- ferrous
 - non-ferrous
 - non-metallic
- 9 produce components with dimensional accuracy, form and surface texture within all of the following quality and accuracy standards, as is applicable to the operations performed:
- components to be free from false tool cuts, burrs and sharp edges
 - dimensional tolerance equivalent to BS 4500 or BS 1916 Grade 9
 - surface finish 63 μ m or 1.6 μ m
 - bored or reamed holes within H8
 - screw threads BS medium fit
 - angles within +/- 1 degree
- 10 carry out quality sampling checks at suitable intervals
- 11 use appropriate gauges or instruments to carry out the necessary checks, during production, for accuracy of three of the following:
- diameters
 - lengths
 - depths
 - hole size/fit
 - thread fit
 - angles
 - surface finish
 - profile
- 12 deal promptly and effectively with problems within their control and report those that cannot be solved
- 13 shut down the equipment to a safe condition on conclusion of the machining activities.

Unit 211

Outcome 2

Operating special-purpose machines

Know how to operate special-purpose machines

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed whilst operating special-purpose machines
- 2 describe the safety mechanisms on the machine, and the procedure for checking that they function correctly
- 3 describe the operation of the machine controls in both hand and power modes (including rapid power, where appropriate)
- 4 explain how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
- 5 describe the personal protective equipment to be worn, and where this can be obtained
- 6 describe the hazards associated with operating special-purpose machinery and carrying out the machining operations, and how to minimise them and reduce any risks
- 7 describe the importance of keeping the work area clean and tidy
- 8 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 9 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards in relation to work undertaken)
- 10 explain how to use imperial and metric systems of measurement
- 11 describe the main features of the special-purpose machine, and the accessories that are to be used
- 12 describe the various operations that can be performed on the machine, and the methods and equipment used
- 13 describe the application of roughing and finishing cuts, and the effect on tool life, surface finish and dimensional accuracy
- 14 describe the application of cutting fluids with regard to a range of different materials
- 15 describe the effects of clamping the workpiece in a chuck/workholding device, and how this can cause distortion in the finished components
- 16 explain how to recognise machining faults, and how to identify when tools need re-sharpening
- 17 describe the quality control procedures used, inspection checks to be carried out, and the equipment that will need to be used
- 18 describe the problems that can occur with special-purpose machining activities, and how these can be overcome
- 19 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Unit 212

Operating gear cutting machines

Level: 2
Credit value: 49
UAN: D/600/5459

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out gear cutting operations, in accordance with approved procedures, using machines such as gear hobbing, gear shaping, gear shaving, gear planing, bevel gear cutting. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. The learner will be expected to produce a range of components that combine a number of different features, such as spur gears, helical and double helical gears, bevel gears, chain sprockets, external splines and serrations.

The learner will be required to operate the machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the setter to make the required adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying procedures for gear machining. The learner will have an understanding of the gear cutting machine used, the gear cutting process and its application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate gear cutting machines
- 2 Know how to operate gear cutting machines

Guided learning hours

It is recommended that **151** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 12: Operating Gear Cutting Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 212

Operating gear cutting machines

Outcome 1

Be able to operate gear cutting machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the machine is set up and ready for the machining activities to be carried out
- 3 manipulate the machine tool controls safely and correctly in line with operational procedures
- 4 produce components to the required quality and within the specified dimensional accuracy
- 5 apply all of the following during the machining activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without distortion
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 6 operate one type of gear cutting machine from the following:
 - gear hobbing
 - gear shaping
 - bevel gear cutting
 - gear planing
 - gear shaving
- 7 produce one of the following types of machined gears:
 - external spur gear
 - internal spur gear
 - single helical gear
 - double helical gear
 - chain sprockets
 - serrations
 - splines
 - straight bevel gears

- 8 machine gears made from one of the following types of material:
 - ferrous
 - non-ferrous
 - non-metallic
- 9 produce components with dimensional accuracy, form and surface texture within all of the following quality and accuracy standards, as is applicable to the operations performed:
 - components to be free from false tool cuts, burrs and sharp edges
 - straight splines and serrations to BS 2059 or BS1953 Class 1
 - spur and helical gears to BS 436 Pt 1 or BS1967
 - involute splines to BS 3550 1963 Class 1
 - tolerance to BS 4500 or BS1916 Grade 9
 - surface texture 63 μin or 1.6 μm
- 10 carry out quality sampling checks at suitable intervals
- 11 use appropriate gauges or instruments to carry out the necessary checks, during production, for accuracy of three of the following:
 - gear blanks
 - lead and helix angle
 - gear tooth thickness
 - involute form
 - composite error rolling test
 - surface texture
 - concentricity
- 12 deal promptly and effectively with problems within their control and report those that cannot be solved
- 13 shut down the equipment to a safe condition on conclusion of the machining activities.

Unit 212

Operating gear cutting machines

Outcome 2

Know how to operate gear cutting machines

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed whilst operating gear cutting machines
- 2 describe the safety mechanisms on the machine, and the procedure for checking that they function correctly
- 3 describe the operation of the machine controls in both hand and power modes (including rapid power, where appropriate)
- 4 explain how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
- 5 describe the personal protective equipment to be worn, and where this can be obtained
- 6 describe the hazards associated with operating gear cutting machines and carrying out the gear cutting operations, and how to minimise them and reduce any risks
- 7 describe the importance of keeping the work area clean and tidy
- 8 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 9 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 10 explain how to use imperial and metric systems of measurement
- 11 describe the main features of the gear cutting machine, and the accessories that can be used
- 12 describe the various gear cutting operations that can be performed, and the methods and equipment used
- 13 describe the effects of backlash in machine slides and screws, and how this can be overcome
- 14 explain how to handle and store tools safely and correctly
- 15 describe the application of roughing and finishing cuts, and the effect on tool life, surface finish and dimensional accuracy
- 16 describe the application of cutting fluids with regard to a range of different materials
- 17 describe the effects of clamping the workpiece on a workholding device, and how this can cause distortion in the finished components
- 18 explain how to recognise machining faults, and how to identify when wheels need dressing
- 19 describe the quality control procedures used, inspection checks to be carried out, and the equipment that will need to be used
- 20 describe the problems that can occur with the gear cutting activities, and how these can be overcome
- 21 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Level: 2
Credit value: 49
UAN: K/600/5464

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out machining operations on an electro-discharge machine, in accordance with approved procedures. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. The learner will be expected to produce a range of component shapes, such as internal and external profiles that have flat, square, parallel and tapered faces, square /rectangular forms, concave and convex forms, holes, slots, radii/arcs, cavities and special forms.

The learner will be required to operate the machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the setter to make the required adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying procedures for electro-discharge machining. The learner will have an understanding of the electro-discharge process and its application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate electro-discharge machines
- 2 Know how to operate electro-discharge machines

Guided learning hours

It is recommended that **151** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 13: Operating Electro-Discharge Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 213

Outcome 1

Operating electro-discharge machines

Be able to operate electro-discharge machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the machine is set up and ready for the machining activities to be carried out
- 3 manipulate the machine tool controls safely and correctly in line with operational procedures
- 4 produce components to the required quality and within the specified dimensional accuracy
- 5 apply all of the following during the machining activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without distortion
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 6 operate one of the following types of electro-discharge machine:
 - spark erosion
 - wire erosion
- 7 produce machined components which include four of the following features:
 - flat faces
 - square faces
 - parallel faces
 - threads
 - concave forms
 - convex forms
 - holes
 - engraving
 - profile forms
 - cavities
 - radii/arcs

- slots
 - square/rectangular forms
 - angular faces
 - other special features
- 8 produce components with dimensional accuracy, form and surface texture within all the relevant quality and accuracy standards as is applicable to the operations performed:
- components to be free from false starts and sharp edges
 - tolerance to BS 4500 or BS 1916 Grade 9
 - surface texture 32 μin or 0.8 μm or 18VDI
- 9 machine components made from one of the following types of material:
- ferrous
 - non-ferrous
- 10 carry out quality sampling checks at suitable intervals
- 11 use appropriate gauges or instruments to carry out the necessary checks, during production, for accuracy of three of the following:
- dimensions
 - parallelism
 - angle/taper
 - squareness
 - surface texture
 - profile
- 12 deal promptly and effectively with problems within their control and report those that cannot be solved
- 13 shut down the equipment to a safe condition on conclusion of the machining activities.

Unit 213

Outcome 2

Operating electro-discharge machines

Know how to operate electro-discharge machines

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed whilst operating electro-discharge machines
- 2 describe the hazards associated with the operating electro-discharge machines and carrying out the machining operations (such as moving machine parts, electrical components, handling dielectrics, fumes), and how to minimise them and reduce any risks
- 3 describe the safety mechanisms on the machine, and the procedure for checking that they function correctly
- 4 describe the operation of the machine controls in both hand and power modes (including rapid power, where appropriate)
- 5 explain how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
- 6 describe the personal protective equipment to be worn, and where this can be obtained
- 7 describe the importance of keeping the work area clean and tidy
- 8 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 9 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 10 explain how to use imperial and metric systems of measurement
- 11 describe the main features of the electro-discharge machine being used, and the accessories that can be used
- 12 describe the various erosion operations that can be performed, and the methods and equipment used
- 13 describe the effects of backlash in machine slides and screws, and how this can be overcome
- 14 explain how to handle and store electrodes and wires safely and correctly
- 15 describe the application of roughing and finishing cuts, and the effect on electrode life, surface finish and dimensional accuracy
- 16 describe the application of dielectric fluid with regard to a range of different materials
- 17 describe the effects of clamping the workpiece in a chuck/workholding device, and how this can cause distortion in the finished components
- 18 explain how to recognise machining faults, and how to identify when electrodes need changing
- 19 describe the quality control procedures used, inspection checks to be carried out, and the equipment that will need to be used
- 20 describe the problems that can occur with the electro-discharge machining activities, and how these can be overcome
- 21 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Level: 2
Credit value: 39
UAN: M/600/5479

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out machining operations on a honing or lapping machine, in accordance with approved procedures. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. The learner will be expected to hone/lap a range of components, which will include through holes, blind holes and flat surfaces.

The learner will be required to operate the machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the setter to make the required adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying honing and lapping procedures. The learner will have an understanding of the honing and lapping process, and its application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate honing and lapping machines
- 2 Know how to operate honing and lapping machines

Guided learning hours

It is recommended that **130** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 14: Operating Honing and Lapping Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 214

Outcome 1

Operating honing and lapping machines

Be able to operate honing and lapping machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the machine is set up and ready for the machining activities to be carried out
- 3 manipulate the machine tool controls safely and correctly in line with operational procedures
- 4 produce components to the required quality and within the specified dimensional accuracy
- 5 apply all of the following during the machining activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without distortion
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 6 operate one of the following types of honing or lapping machine:
 - horizontal honing
 - vertical honing
 - rotary disc lapping
 - reciprocating machines
- 7 **either**
 - rough, finish and polish components which includes two of the following for honing machines:
 - through holes
 - blind holes
 - tapered holes
 - or**
 - rough, finish and polish components which includes two of the following for lapping machines:
 - flat faces
 - parallel faces
 - angular faces

- 8 produce components with dimensional accuracy, form and surface texture within all of the following standards:
- tolerance to BS 4500 or BS 1916 Grade 5
 - surface texture 8 μin or 0.2 μm
 - components to be free from stone/disc marks, burrs and sharp edges
- 9 hone and lap components made from one of the following types of material:
- ferrous
 - non-ferrous
- 10 carry out quality sampling checks at suitable intervals
- 11 **either**
- carry out all of the following checks, during production, for accuracy when using honing machines:
 - dimensions
 - parallelism
 - surface texture
 - ovality/lobbing
- or**
- carry out all of the following checks, during production, for accuracy when using lapping machines:
 - dimensions
 - parallelism
 - surface texture
 - flatness
- 12 deal promptly and effectively with problems within their control and report those that cannot be solved
- 13 shut down the equipment to a safe condition on conclusion of the machining activities.

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed whilst operating honing and lapping machines
- 2 describe the hazards associated with the operating honing and lapping machines and carrying out the honing and lapping operations (such as moving machine parts, airborne particles, insecure workpiece), and how to minimise them and reduce any risks
- 3 describe the safety mechanisms on the machine and the procedure for checking that they function correctly
- 4 describe the operation of the machine controls in both hand and power modes (including rapid power, where appropriate)
- 5 explain how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
- 6 describe the personal protective equipment to be worn, and where this can be obtained
- 7 describe the importance of keeping the work area clean and tidy
- 8 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 9 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 10 explain how to use imperial and metric systems of measurement
- 11 describe the main features of the honing and lapping machine used, and the accessories that can be used
- 12 describe the various honing or lapping operations that can be performed, and the methods and equipment used
- 13 describe the effects of backlash in machine slides and screws, and how this can be overcome
- 14 explain how to handle and store honing and lapping stones and equipment safely and correctly
- 15 describe the application of roughing and finishing cuts, and the effect on stone life, surface finish and dimensional accuracy
- 16 explain how to adjust the equipment, to correct taper in bores and achieve workpiece tolerances
- 17 describe the application of cutting fluids with regard to a range of different materials
- 18 describe the effects of clamping the workpiece, and how this can cause distortion in the finished components
- 19 explain how to recognise honing and lapping faults, and how to identify when the stones need replacing
- 20 describe the quality control procedures used, inspection checks to be carried out, and the equipment that will need to be used
- 21 describe the problems that can occur with the honing and lapping activities, and how these can be overcome
- 22 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Unit 215

Operating broaching machines

Level: 2
Credit value: 39
UAN: L/600/6008

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out machining operations on a broaching machine, in accordance with approved procedures. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. The learner will be expected to produce a range of components that cover a number of different features, such as keyways, square holes, hexagonal and octagonal holes, holes with a single flat side, splines, serrations and special forms.

The learner will be required to operate the machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the setter to make the required adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying broaching procedures. The learner will have an understanding of the broaching process and its application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate broaching machines
- 2 Know how to operate broaching machines

Guided learning hours

It is recommended that **130** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 15: Operating Broaching Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 215

Operating broaching machines

Outcome 1

Be able to operate broaching machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the machine is set up and ready for the machining activities to be carried out
- 3 manipulate the machine tool controls safely and correctly in line with operational procedures
- 4 produce components to the required quality and within the specified dimensional accuracy
- 5 apply all of the following during the machining activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without distortion
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 6 operate one type of broaching machine from the following:
 - horizontal broaching machine
 - vertical broaching machine
- 7 produce machined components which cover three of the following:
 - keyways
 - flat sided holes
 - square holes
 - hexagonal holes
 - octagonal holes
 - splines
 - serrations
 - other/special forms
- 8 machine components made from one type of material from the following:
 - ferrous
 - non-ferrous

- non-metallic
- 9 produce components with dimensional accuracy, form and surface texture within all of the following quality and accuracy standards:
 - dimensional tolerance equivalent to BS 4500 or BS 1916 grade 9
 - surface finish 63 μin or 1.6 μm
 - components to be free from false tool cuts, burrs and sharp edges
 - 10 carry out quality sampling checks at suitable intervals
 - 11 use appropriate gauges or instruments to carry out the necessary checks, during production, for accuracy of three of the following:
 - dimensions
 - squareness
 - spline/serration fit
 - surface finish
 - keyway width
 - keyway position
 - 12 deal promptly and effectively with problems within their control and report those that cannot be solved
 - 13 shut down the equipment to a safe condition on conclusion of the machining activities.

Unit 215

Outcome 2

Operating broaching machines

Know how to operate broaching machines

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed whilst operating broaching machines
- 2 describe the safety mechanisms on the machine, and the procedure for checking that they function correctly
- 3 describe the operation of the machine controls in both hand and power modes, and how to stop the machine in an emergency
- 4 describe the personal protective equipment to be worn, and where this can be obtained
- 5 describe the hazards associated with the broaching operations (such as moving parts of machines, handling broaches, handling cutting oils, insecure components, breakages of broaches), and how to minimise them and reduce any risk
- 6 describe the importance of keeping the work area clean and tidy
- 7 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 8 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN Standards) in relation to work undertaken
- 9 explain how to use imperial and metric systems of measurement
- 10 describe the various broaching techniques that can be used to produce the required shapes, and the types of broaches used (roughing and finishing broaches, high speed steel and tipped broaches)
- 11 explain how to handle and store broaches safely and correctly
- 12 describe the application of cutting fluids with regard to a range of different materials
- 13 describe the effects of clamping the workpiece, and how this can cause distortion in the finished components
- 14 explain how to recognise broaching faults, and how to identify when tools need re-sharpening
- 15 describe the quality control procedures used, inspection checks to be carried out, and the equipment that will need to be used
- 16 describe the problems that can occur with the broaching activities, and how these can be overcome
- 17 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Unit 216

Operating shaping, planing or slotting machines

Level: 2
Credit value: 49
UAN: R/600/6012

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out machining operations on a shaping, planing or slotting machine, in accordance with approved procedures. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. The learner will be expected to produce a range of components that cover a number of different features, such as parallel faces, flat faces, faces that are square to each other, angular faces, steps, slots, keyways, flat sided holes, splines and serrations, as applicable to the machine used.

The learner will be required to operate the machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the setter to make the required adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying shaping, planing or slotting procedures. The learner will have an understanding of the shaping, planing, or slotting process and its application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate shaping, planing or slotting machines
- 2 Know how to operate shaping, planing or slotting machines

Guided learning hours

It is recommended that **151** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 16: Operating Shaping, Planing or Slotting Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 216

Operating shaping, planing or slotting machines

Outcome 1

Be able to operate shaping, planing or slotting machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the machine is set up and ready for the machining activities to be carried out
- 3 manipulate the machine tool controls safely and correctly in line with operational procedures
- 4 produce components to the required quality and within the specified dimensional accuracy
- 5 apply all of the following during the machining activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without distortion
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 6 operate one type of machine from the following:
 - shaping
 - planing
 - slotting
 - milling machine with slotting attachment
- 7 produce machined components which combine different operations and cover four of the following:
 - flat faces
 - faces that are square to each other
 - parallel faces
 - steps/shoulders
 - angular faces
 - slots/grooves

- special forms
 - keyways
 - flat sided holes (such as square, hexagonal)
 - splines
 - serrations
- 8 machine components made from one type of material from the following:
- ferrous
 - non-ferrous
 - non-metallic
- 9 produce components with dimensional accuracy, form and surface within all the relevant quality and accuracy standards as is applicable to the operations performed:
- components to be free from false tool cuts, burrs and sharp edges
 - dimensional tolerance equivalent to BS 4500 or BS 1916 Grade 9
 - flatness and squareness within 0.005" per inch or 0.125mm per 25mm
 - surface finish 63 μin or 1.6 μm
 - angles within +/- 1 degree
- 10 carry out quality sampling checks at suitable intervals
- 11 use appropriate gauges or instruments to carry out the necessary checks, during production, for accuracy of three of the following:
- dimensions
 - squareness
 - angles
 - flatness
 - spline or serration fit
 - surface finish
 - slot or recess width and position
 - keyway position
- 12 deal promptly and effectively with problems within their control and report those that cannot be solved
- 13 shut down the equipment to a safe condition on conclusion of the machining activities.

Unit 216

Operating shaping, planing or slotting machines

Outcome 2

Know how to operate shaping, planing or slotting machines

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed whilst operating shaping, planing or slotting machines
- 2 describe the safety mechanisms on the machine, and the procedure for checking that they function correctly
- 3 describe the operation of the machine controls in both hand and power modes (including rapid power, where appropriate)
- 4 explain how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
- 5 describe the personal protective equipment to be worn, and where this can be obtained
- 6 describe the hazards associated with operating shaping, planing or slotting machines and with the operations carried out, and how to minimise them and reduce any risks
- 7 describe the importance of keeping the work area clean and tidy
- 8 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 9 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 10 explain how to use imperial and metric systems of measurement
- 11 describe the main features of the shaping, planing or slotting machine used, and the accessories that can be used
- 12 describe the various operations that can be performed on the machine, and the methods and equipment used
- 13 describe the effects of backlash in machine slides and screws, and how this can be overcome
- 14 explain how to handle and store tools safely and correctly
- 15 describe the application of roughing and finishing cuts, and the effect on tool life, surface finish and dimensional accuracy
- 16 describe the application of cutting fluids with regard to a range of different materials
- 17 describe the effects of clamping the workpiece in a chuck/workholding device, and how this can cause distortion in the finished components
- 18 explain how to recognise machining faults, and how to identify when tools need re-sharpening
- 19 describe the quality control procedures used, inspection checks to be carried out, and the equipment that will need to be used
- 20 describe the problems that can occur with the machining activities, and how these can be overcome
- 21 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Unit 217

Operating gear grinding machines

Level: 2
Credit value: 49
UAN: D/600/6014

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out gear grinding operations, in accordance with approved procedures. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. The learner will be expected to grind a range of components that cover a number of different features, such as spur gears, helical and double helical gears, bevel gears and splines.

The learner will be required to operate the machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the setter to make the required adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying gear-grinding procedures. The learner will have an understanding of the gear grinding machine, the gear grinding process used and its application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate gear grinding machines
- 2 Know how to operate gear grinding machines

Guided learning hours

It is recommended that **151** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 17: Operating Gear Grinding Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 217

Outcome 1

Operating gear grinding machines

Be able to operate gear grinding machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the machine is set up and ready for the machining activities to be carried out
- 3 manipulate the machine tool controls safely and correctly in line with operational procedures
- 4 produce components to the required quality and within the specified dimensional accuracy
- 5 apply all the following during the machining activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without distortion
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 6 operate one of the following types of gear grinding machine:
 - gear grinding using formed wheels
 - gear grinding by generation
- 7 finish grind two of the following types of gears, as applicable to the machine type:
 - external spur gear
 - internal spur gear
 - single helical gear
 - double helical gear
 - bevel gears
 - straight splines
 - involute splines
 - tip and root relief
- 8 grind gears made from one of the following types of material:
 - ferrous
 - non-ferrous

- non-metallic
- 9 produce components with dimensional accuracy, form and surface texture within all the relevant quality and accuracy standards:
- dimensional tolerance equivalent to BS 4500 Grade 5 or BS1916
 - surface texture 16 μin or 0.4 μm
 - components to be free from false grinding cuts, burrs and sharp edges
- 10 carry out quality sampling checks at suitable intervals
- 11 carry out the necessary checks, during production, for accuracy of three of the following:
- gear tooth profile
 - lead and pitch
 - gear tooth thickness
 - involute form
 - concentricity
 - surface texture
- 12 deal promptly and effectively with problems within their control and report those that cannot be solved
- 13 shut down the equipment to a safe condition on conclusion of the machining activities.

Unit 217

Outcome 2

Operating gear grinding machines

Know how to operate gear grinding machines

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed whilst operating gear grinding machines
- 2 describe the safety mechanisms on the machine, and the procedure for checking that they function correctly
- 3 describe the operation of the machine controls in both hand and power modes (including rapid power, where appropriate)
- 4 explain how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
- 5 describe the personal protective equipment to be worn, and where this can be obtained
- 6 describe the hazards associated with operating gear grinding machines and the gear grinding operations, and how to minimise them and reduce any risks
- 7 describe the importance of keeping the work area clean and tidy
- 8 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 9 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 10 explain how to use imperial and metric systems of measurement
- 11 describe the main features of the gear grinding machines, and the accessories that can be used
- 12 describe the various gear grinding operations that can be performed, and the methods and equipment used
- 13 describe the effects of backlash in machine slides and screws, and how this can be overcome
- 14 describe the application of roughing and finishing cuts, and the effect on wheel life, surface finish and dimensional accuracy
- 15 describe the application of cutting fluids with regard to a range of different materials
- 16 describe the effects of clamping the workpiece in a workholding device, and how this can cause distortion in the finished components
- 17 explain how to recognise machining faults, and how to identify when wheels need dressing
- 18 describe the quality control procedures that are used, inspection checks to be carried out, and the equipment that will need to be used
- 19 describe the problems that can occur with the gear grinding activities, and how these can be overcome
- 20 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Unit 218

Operating power presses

Level: 2
Credit value: 39
UAN: K/600/6016

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out press operations on a power press, in accordance with approved procedures. The learner will confirm with the press setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. The learner will be expected to produce a range of components that cover a number of different features, such as blanking, piercing, cropping, shearing, bending, forming, cupping, rolling, planishing, flattening, coining and notching, as applicable to the power press being used.

The learner will be required to operate the power press in line with safe working practices and approved procedures, to continuously monitor the press operations and, where necessary, make minor adjustments or seek the help of the setter to make the required adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the pressing activities undertaken, and to report any problems with the pressing activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying power press procedures. The learner will have an understanding of the power press operations and their application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate power presses
- 2 Know how to operate power presses

Guided learning hours

It is recommended that **130** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 18: Operating Power Presses (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 218

Outcome 1

Operating power presses

Be able to operate power presses

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the machine is set up and ready for the machining activities to be carried out
- 3 manipulate the machine tool controls safely and correctly in line with operational procedures
- 4 produce components to the required quality and within the specified dimensional accuracy
- 5 apply all of the following during the machining activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the press setter that the press is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the press
 - ensure that the power press guards are in place and are correctly adjusted
 - ensure that materials are correctly located and positioned
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that press settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 6 operate one of the following types of power press:
 - single action
 - multiple action
- 7 produce pressed components which cover four of the following operations:
 - blanking
 - piercing
 - cropping/shearing
 - bending
 - cupping
 - rolling
 - planishing/flattening
 - embossing
 - coining
 - notching
 - forming
 - assembling

- other operations
- 8 produce components made from one type of material from the following:
 - ferrous
 - non-ferrous
 - non-metallic
 - 9 produce components within all the relevant quality and accuracy standards:
 - components meet drawing, specification, template or job requirements
 - components meet customer requirements
 - components have the required dimensional accuracy within specified tolerances
 - components are free from false tool marks, excessive burrs and sharp edges
 - components are free from surface damage and deformity and have an acceptable appearance
 - 10 carry out quality sampling checks at suitable intervals
 - 11 use appropriate gauges or instruments to carry out the necessary checks, during production, for accuracy of two of the following:
 - dimensions
 - squareness
 - flatness
 - form/profile
 - security of assembled parts
 - 12 deal promptly and effectively with problems within their control and report those that cannot be solved
 - 13 shut down the equipment to a safe condition on conclusion of the machining activities.

Unit 218

Operating power presses

Outcome 2

Know how to operate power presses

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed whilst operating power presses
- 2 describe the safety mechanisms on the machine, and the procedure for checking that they function correctly
- 3 describe the operation of the machine controls in both hand and power modes (including rapid power, where appropriate)
- 4 explain how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
- 5 describe the personal protective equipment to be worn, and where this can be obtained
- 6 describe the hazards associated with operating power presses and with the operations carried out, and how to minimise them and reduce any risks
- 7 describe the importance of keeping the work area clean and tidy
- 8 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 9 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 10 explain how to use imperial and metric systems of measurement
- 11 describe the main features of the power presses being used, and the accessories that can be used
- 12 describe the various gear grinding operations that can be performed on the press, and the methods and equipment used
- 13 explain how to handle and store tools safely and correctly
- 14 describe the application of lubricants to assist pressing operations
- 15 describe the effects of clamping the workpiece in a workholding device, and how this can cause distortion in the finished components
- 16 explain how to handle and store components and safely and correctly
- 17 explain how to recognise machining faults, and how to identify when tools need re-sharpening
- 18 describe the quality control procedures that are used, inspection checks to be carried out, and the equipment that will need to be used
- 19 describe the problems that can occur with the power press activities, and how these can be overcome
- 20 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Level: 2
Credit value: 39
UAN: M/600/6020

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out turning operations, in accordance with approved procedures, using Computer Numerical Control (CNC) machines, or CNC machining centres. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. In operating the machine, the learner will be expected to follow the correct procedures for calling up the operating program, dealing with any error messages and executing the program activities safely and correctly.

The learner will be expected to produce a range of components that combine a number of different features, such as parallel, stepped and tapered diameters, drilled and reamed holes, internal and external threads, special forms and profiles. The learner will be required to operate the CNC machine in line with safe working practices and approved procedures, to monitor continuously the machining operations and, where necessary, make minor adjustments or seek the help of the setter to make the required adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying CNC machining procedures. The learner will have an understanding of the CNC turning process and its application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate CNC turning machines
- 2 Know how to operate CNC turning machines

Guided learning hours

It is recommended that **130** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 19: Operating CNC Turning Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 219

Outcome 1

Operating CNC turning machines

Be able to operate CNC turning machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the equipment is set up and ready for operation
- 3 check all of the following to confirm that the machine is ready for operation:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without distortion
 - check that the operating program is at the correct start point and the workpiece is clear of the machine spindle
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 4 follow the defined procedures for starting and running the operating system
- 5 operate one of the following CNC turning machines:
 - CNC lathe
 - CNC machining centre
- 6 produce machined components which combine different operations and cover six of the following features:
 - parallel diameters
 - stepped diameters
 - tapered diameters
 - flat faces
 - internal undercuts
 - external undercuts
 - internal profiles
 - external profiles
 - reamed holes
 - tapped holes

- drilled holes
 - parting-off
 - eccentric diameters
 - external screw threads
 - internal screw threads
 - chamfers and radii
 - bored holes
 - grooves
- 7 machine one of the following types of material:
- ferrous
 - non-ferrous
 - non-metallic
- 8 produce components with dimensional accuracy, form and surface texture within all the relevant quality and accuracy standards, as applicable to the operations performed:
- dimensional tolerance equivalent to BS4500 or BS 1916 Grade 9
 - surface finish $63\mu\text{in}$ or $1.6\mu\text{m}$
 - reamed and bored holes within H 8
 - angles within ± 0.5 degree
 - screw threads BS medium fit
- 9 deal promptly and effectively with error messages or equipment faults that are within their control and report those that cannot be solved
- 10 monitor the computer process and ensure that the production output is to the required specification
- 11 use appropriate gauges or instruments to carry out the necessary checks, during production, for accuracy of three of the following:
- diameters
 - hole size/fit
 - angle/taper
 - lengths/depths
 - surface finish
 - thread fit
- 12 shut down the equipment to a safe condition on conclusion of the activities.

Unit 219

Outcome 2

Operating CNC turning machines

Know how to operate CNC turning machines

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed whilst operating CNC lathes
- 2 describe the safety mechanisms on the CNC turning machine, and the procedure for checking that they function correctly
- 3 describe the hazards associated with working on CNC lathes (such as use of power operated chucks, moving machinery, automatic machine operation, handling cutting tools, lifting and handling workholding devices, hot and airborne metal particles), and how to minimise them and reduce any risks
- 4 describe the personal protective equipment to be worn, and where this can be obtained
- 5 describe the importance of keeping the work area clean and tidy
- 6 describe the main features of the CNC turning machine, and the accessories that can be used
- 7 describe the various CNC turning operations that can be performed, and the methods and equipment used
- 8 describe the operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons)
- 9 explain how to stop the CNC lathe in both normal and emergency situations, and the procedure for restarting after an emergency
- 10 explain how to use the visual display and understand the various messages displayed
- 11 describe the function of error messages, and what to do when an error message is displayed
- 12 explain how to find the correct restart point in the program when the machine has been stopped before completion of the program
- 13 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 14 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 15 explain how to use imperial and metric systems of measurement
- 16 describe the application of roughing and finishing cuts, and the effect on tool life, surface finish and dimensional accuracy
- 17 describe the application of cutting fluids with regard to a range of different materials
- 18 describe the effects of clamping the workpiece in a chuck/workholding device, and how this can cause distortion in the finished components
- 19 explain how to recognise CNC turning faults, and how to identify when tools need re-sharpening/replacing
- 20 describe the quality control procedures that are used, inspection checks to be carried out, and the equipment that will need to be used
- 21 describe the problems that can occur with the CNC turning activities, and how these can be overcome
- 22 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Level: 2
Credit value: 39
UAN: D/600/6031

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to operate Computer Numerical Control (CNC) three-axis or multi-axis machines, or CNC machining centres, in accordance with approved procedures. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. In operating the machine, the learner will be expected to follow the correct procedures for calling up the operating program, dealing with any error messages and executing the program activities safely and correctly.

The learner will be expected to produce a range of components that combine a number of different features, such as flat faces, angled faces, internal and external profiles, slots, steps, holes which are linearly or radially pitched, and special profiles such as convex or concave. The learner will be required to operate the CNC machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the setter to make the required adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying CNC milling procedures. The learner will have an understanding of the CNC milling process and its application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate CNC milling machines
- 2 Know how to operate CNC milling machines

Guided learning hours

It is recommended that **130** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 20: Operating CNC Milling Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 220

Outcome 1

Operating CNC milling machines

Be able to operate CNC milling machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the equipment is set up and ready for operation
- 3 confirm that the machine is ready for operation by checking all of the following:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without distortion
 - check that the operating program is at the correct start point and the workpiece is clear of the machine spindle
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 4 follow the defined procedures for starting and running the operating system
- 5 operate one of the following CNC milling machines:
 - CNC three-axis milling machine
 - CNC multi-axis milling machine
 - CNC machining centre
- 6 produce machined components which combine different operations and cover six of the following:
 - flat faces
 - steps/shoulders
 - enclosed slots/recesses
 - internal profiles
 - holes on pitched circles
 - parallel faces
 - angular faces
 - open ended slots
 - external profiles

- holes linearly pitched
 - circular/curved profiles
 - tapped holes
 - special forms (such as concave, convex)
 - faces that are square to each other
- 7 machine components made from one of the following types of material:
- ferrous
 - non-ferrous
 - non-metallic
- 8 produce components with dimensional accuracy, form and surface texture within all the relevant quality and accuracy standards as is applicable to the operations performed:
- dimensional tolerance equivalent to BS4500 or BS 1916 Grade 9
 - surface finish $63\mu\text{in}$ or $1.6\mu\text{m}$
 - reamed and bored holes within H 8
 - flatness and squareness within $0.001''$ per inch or 0.025mm per 25mm
 - angles within ± 0.5 degree
- 9 deal promptly and effectively with error messages or equipment faults that are within their control and report those that cannot be solved
- 10 monitor the computer process and ensure that the production output is to the required specification
- 11 use appropriate gauges or instruments to carry out the necessary checks, during production, for accuracy of three of the following:
- dimensions
 - squareness
 - hole size/fit
 - surface finish
 - angles
 - flatness
 - slots
 - recesses
- 12 shut down the equipment to a safe condition on conclusion of the activities.

Unit 220

Outcome 2

Operating CNC milling machines

Know how to operate CNC milling machines

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the specific safety precautions to be taken when working with CNC milling machines and equipment
- 2 describe the safety mechanisms on the machine, and the procedures for checking that they are operating correctly
- 3 explain how to start and stop the machine in both normal and emergency situations and the procedure for restarting after an emergency
- 4 describe the hazards associated with working on CNC milling machines (such as use of power operated workholding devices, moving machinery, automatic machine operation, handling cutting tools, hot and airborne metal particles), and how to minimise them and reduce any risks
- 5 describe the importance of wearing the appropriate protective clothing and equipment, and of keeping the work area clean and tidy
- 6 describe the personal protective equipment to be worn, and where this can be obtained
- 7 describe the main features of the CNC milling machine, and the accessories that can be used
- 8 describe the various CNC milling operations that can be performed, and the methods and equipment used
- 9 describe the operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons)
- 10 explain how to use the visual display and understand the various messages displayed
- 11 describe the function of error messages, and what to do when an error message is displayed
- 12 explain how to find the correct restart point in the program when the machine has been stopped before completion of the program
- 13 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 14 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 15 explain how to use imperial and metric systems of measurement
- 16 describe the application of roughing and finishing cuts, and the effect on tool life, surface finish and dimensional accuracy
- 17 describe the application of cutting fluids with regard to a range of different materials
- 18 describe the effects of clamping the workpiece in a chuck/workholding device, and how this can cause distortion in the finished components
- 19 explain how to recognise CNC milling faults, and how to identify when tools need re-sharpening/replacing
- 20 describe the quality control procedures used, inspection checks to be carried out, and the equipment that will need to be used
- 21 describe the problems that can occur with the CNC milling activities, and how these can be overcome
- 22 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Unit 221

Operating CNC grinding machines

Level: 2
Credit value: 39
UAN: H/600/6032

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out grinding operations, in accordance with approved procedures, using Computer Numerical Control (CNC) machines, such as universal grinding machines, gear grinding machines, thread grinding machines, ring grinding machines and grinding machining centres. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. In operating the machine, the learner will be expected to follow the correct procedures for calling up the operating program, dealing with any error messages and executing the program activities safely and correctly.

The learner will be expected to produce a range of components that combine a number of different features, such as ground plain diameters, external screw threads, stepped diameters, flat faces and shoulders, chamfers, special forms, internal and external profiles, tapered diameters and faces, grooves/undercuts, parallel and tapered bores.

The learner will be required to operate the CNC machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the setter to make the required adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying machining procedures. The learner will have an understanding of the CNC grinding process used, and its application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate CNC grinding machines
- 2 Know how to operate CNC grinding machines

Guided learning hours

It is recommended that **130** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 21: Operating CNC Grinding Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 221

Operating CNC grinding machines

Outcome 1

Be able to operate CNC grinding machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the equipment is set up and ready for operation
- 3 confirm that the machine is ready for operation by checking all of the following:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without distortion
 - check that the operating program is at the correct start point and the workpiece is clear of the machine spindle
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 4 follow the defined procedures for starting and running the operating system
- 5 operate one of the following CNC grinding machines:
 - CNC universal grinder
 - CNC gear grinder
 - CNC grinding machining centre
 - CNC thread grinder
 - other specific CNC grinding machine
- 6 produce ground components which cover four of the following, as applicable to the machine type used:
 - plain diameters
 - stepped diameters
 - tapered diameters
 - flat faces and shoulders
 - internal and external profiles
 - eccentric diameters
 - external screw threads

- chamfers and radii
 - parallel bores
 - tapered bores
 - involute and helical forms
 - curvic couplings
 - special forms (such as concave, convex)
 - internal/external undercuts/bearing tracks
- 7 machine one type of material from the following:
- ferrous
 - non-ferrous
 - non-metallic
- 8 produce component with dimensional accuracy, form and surface texture within all of the following quality and accuracy standards as is applicable to the operations performed:
- dimensional tolerance equivalent to BS4500 or BS 1916 Grade 7
 - flatness and squareness within 0.0005" per inch or 0.0125mm per 25mm
 - angles within +/- 0.5 degree
 - surface finish 16µin or 0.8µm
 - ground bores/holes within H 8
 - screw threads BS medium fit
- 9 deal promptly and effectively with error messages or equipment faults that are within their control and report those that cannot be solved
- 10 monitor the computer process and ensure that the production output is to the required specification
- 11 use appropriate gauges or instruments to carry out the necessary checks for accuracy, during production, of three of the following:
- dimensions
 - parallelism
 - squareness
 - profile
 - concentricity
 - thread form
 - surface texture
 - angle/taper
 - ovality/lobing
 - hole size
- 12 shut down the equipment to a safe condition on conclusion of the activities.

Unit 221

Operating CNC grinding machines

Outcome 2

Know how to operate CNC grinding machines

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed whilst operating CNC grinding machines
- 2 describe the safety mechanisms on the CNC grinding machine, and the procedure for checking that they function correctly
- 3 explain how to stop the CNC grinding machine in both normal and emergency situations, and the procedure for restarting after an emergency
- 4 describe the hazards associated with working on CNC grinding machines (such as moving machinery, automatic machine operation, sparks/airborne particles, bursting grinding wheels), and how to minimise them and reduce any risk
- 5 describe the personal protective equipment to be worn, and where this can be obtained
- 6 describe the importance of keeping the work area clean and tidy
- 7 describe the operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons)
- 8 explain how to use the visual display and understand the various messages displayed
- 9 describe the function of error messages, and what to do when an error message is displayed
- 10 explain how to find the correct restart point in the program when the machine has been stopped before completion of the program
- 11 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 12 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 13 explain how to use imperial and metric systems of measurement
- 14 describe the main features of the CNC grinding machine, and the accessories that can be used
- 15 describe the various CNC grinding operations that can be performed, and the methods and equipment used
- 16 explain how to handle and store grinding wheels safely and correctly
- 17 describe the application of roughing and finishing cuts, and the effect on wheel life, surface finish and dimensional accuracy
- 18 describe the application of cutting fluids with regard to a range of different materials
- 19 describe the effects of clamping the workpiece in a chuck/workholding device, and how this can cause distortion in the finished components
- 20 explain how to recognise CNC grinding machining faults, and identify when adjustments need to be made
- 21 describe the quality control procedures used, inspection checks to be carried out, and the equipment that will need to be used
- 22 describe the problems that can occur with the CNC grinding activities, and how these can be overcome
- 23 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Level: 2
Credit value: 39
UAN: K/600/6033

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out pressing and punching operations, in accordance with approved procedures, using Computer Numerical Control (CNC) machines. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. In operating the machine, the learner will be expected to follow the correct procedures for calling up the operating program, dealing with any error messages and executing the program activities safely and correctly. The learner will be expected to produce a range of components that cover a number of different features, such as linearly pitched holes, radially pitched holes, internal square/rectangular profiles, curved/circular profiles, swages, louvres, forms and profiles.

The learner will be required to operate the CNC machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the setter to make the required adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying machining procedures. The learner will have an understanding of the CNC pressing/punching process and its application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate CNC punching machines
- 2 Know how to operate CNC punching machines

Guided learning hours

It is recommended that **130** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 22: Operating CNC Punching Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 222

Operating CNC punching machines

Outcome 1

Be able to operate CNC punching machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the equipment is set up and ready for operation
- 3 confirm that the machine is ready for operation by checking all of the following:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without distortion
 - check that the operating program is at the correct start point and the workpiece is clear of the machine spindle
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 4 follow the defined procedures for starting and running the operating system
- 5 operate one of the following CNC punching machines:
 - CNC punching machine
 - CNC fabrication machining centre for punching operations
- 6 produce components which cover four of the following features:
 - holes linearly pitched
 - holes radially pitched
 - square/rectangular profiles
 - curved profiles
 - swages
 - louvres
 - other applications
- 7 machine one of the following types of material:
 - ferrous
 - non-ferrous
 - special alloys

- 8 produce components within all of the following quality and accuracy standards:
 - dimensional tolerance equivalent to BS 4500 or BS 1916 Grade 9
 - components to be free from deformity, burrs and sharp edges
- 9 deal promptly and effectively with error messages or equipment faults that are within their control and report those that cannot be solved
- 10 monitor the computer process and ensure that the production output is to the required specification
- 11 use appropriate gauges or instruments to carry out the necessary checks, during production, for accuracy of three of the following:
 - dimensions of punched features
 - position of features
 - hole positions linearly pitched
 - hole positions radially pitched
 - accuracy of profiles
 - flatness/freedom from excessive distortion
 - accuracy of louvres and swages
- 12 shut down the equipment to a safe condition on conclusion of the activities.

Unit 222

Operating CNC punching machines

Outcome 2

Know how to operate CNC punching machines

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed whilst operating CNC pressing/punching machines
- 2 describe the safety mechanisms on the CNC pressing/punching machine, and the procedure for checking that they function correctly
- 3 describe the hazards associated with working on CNC punching machines (such as moving machinery, automatic machine operation, lifting and handling sheet materials), and how to minimise them and reduce any risks
- 4 explain how to stop the CNC pressing/punching machine in both normal and emergency situations, and the procedure for restarting after an emergency
- 5 describe the personal protective equipment to be worn, and where this can be obtained
- 6 describe the importance of keeping the work area clean and tidy
- 7 describe the operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons)
- 8 explain how to use the visual display and understand the various messages displayed
- 9 describe the function of error messages, and what to do when an error message is displayed
- 10 explain how to find the correct restart point in the program when the machine has been stopped before completion of the program
- 11 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 12 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 13 explain how to use imperial and metric systems of measurement
- 14 describe the main features of the CNC pressing/punching machine, and the accessories that can be used
- 15 describe the various CNC pressing/punching operations that can be performed, and the methods and equipment used
- 16 describe the effects of clamping the workpiece in a workholding device, and how this can cause distortion in the finished components
- 17 explain how to recognise CNC pressing/punching faults, and how to identify when tools need re-sharpening, replacing or adjustments are required
- 18 describe the quality control procedures used, inspection checks to be carried out, and the equipment that will need to be used
- 19 describe the problems that can occur with the CNC pressing/punching activities, and how these can be overcome
- 20 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Level: 2
Credit value: 39
UAN: M/600/6034

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out cutting and profiling operations using Computer Numerical Control (CNC) laser profiling machines, in accordance with approved procedures. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. In operating the machine, the learner will be expected to follow the correct procedures for calling up the machine-operating program, dealing with any error messages and executing the program activities safely and correctly. The learner will be expected to produce a range of components that cover a number of different features, such as square and rectangular profiles, angular profiles, curved profiles, circles, holes linearly positioned, holes radially positioned, slots and grooves.

The learner will be required to operate the CNC laser cutting machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the setter to make the required adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying CNC laser machining procedures. The learner will have an understanding of the CNC laser cutting process and its application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate CNC laser profiling machines
- 2 Know how to operate CNC laser profiling machines

Guided learning hours

It is recommended that **130** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 23: Operating CNC Laser Profiling Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 223

Outcome 1

Operating CNC laser profiling machines

Be able to operate CNC laser profiling machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the equipment is set up and ready for operation
- 3 confirm that the machine is ready for operation by checking all of the following:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without distortion
 - check that the laser lens is clean and in a suitable condition
 - check that the operating program is at the correct start point
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 4 follow the defined procedures for starting and running the operating system
- 5 produce machined components which cover four of the following features:
 - square/rectangular profiles
 - angular profiles
 - curved profiles
 - circles
 - ellipses
 - holes linearly positioned
 - holes radially positioned
 - slots and apertures
 - other features
- 6 machine one of the following types of material:
 - ferrous
 - non-ferrous
 - stainless/alloy steel

- non-metallic
- 7 produce component within all of the following quality and accuracy standards:
 - dimensional tolerance equivalent to BS4500 or BS 1916 Grade 7
 - angles within +/- 0.5 degree
 - surface texture within 63µin or 1.6µm
 - 8 deal promptly and effectively with error messages or equipment faults that are within their control and report those that cannot be solved
 - 9 monitor the computer process and ensure that the production output is to the required specification
 - 10 use appropriate gauges or instruments to carry out the necessary checks, during production, for accuracy of three of the following:
 - dimensions
 - position of features
 - holes positioned linearly
 - holes positioned radially
 - angles
 - profiles
 - flatness/freedom from distortion
 - 11 shut down the equipment to a safe condition on conclusion of the activities.

Unit 223

Operating CNC laser profiling machines

Outcome 2

Know how to operate CNC laser profiling machines

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be observed when operating CNC laser profiling machines (care when working with high power laser beams, machine guards; ventilation and fume extraction; machine safety devices)
- 2 explain how to stop the CNC laser cutting machines in both normal and emergency situations, and the procedure for restarting after an emergency
- 3 describe the hazards associated with laser profiling machines (dangers from the high power laser beam; live electrical components; moving parts of machinery), and how to minimise them and reduce any risks
- 4 describe the personal protective equipment to be worn, and where this can be obtained
- 5 describe the importance of keeping the work area clean and tidy
- 6 describe the main features of the CNC laser cutting, and the accessories that can be used
- 7 describe the various CNC machining operations that can be performed, and the methods and equipment used
- 8 describe the operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons)
- 9 explain how to use the visual display and understand the various messages displayed
- 10 describe the function of error messages, and what to do when an error message is displayed
- 11 explain how to find the correct restart point in the program when the machine has been stopped before completion of the program
- 12 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 13 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 14 explain how to use imperial and metric systems of measurement
- 15 describe the effects of clamping the workpiece in a workholding device, and how this can cause distortion in the finished components
- 16 explain how to recognise CNC laser cutting faults, and how to identify when actions need to be taken
- 17 describe the quality control procedures that are used, inspection checks to be carried out, and the equipment that will need to be used
- 18 describe the problems that can occur with the CNC laser cutting activities, and how these can be overcome
- 19 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Level: 2
Credit value: 39
UAN: F/600/6037

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to operate Computer Numerical Control (CNC) electro-discharge machines, such as spark erosion and wire erosion machines, in accordance with approved procedures. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. The learner will be expected to produce a range of components that cover a number of different features, such as flat, tapered and angled faces, internal and external profiles, parallel and tapered slots and steps, parallel and tapered holes which are linearly or radially pitched.

The learner will be required to operate the CNC machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the setter to make the required adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying procedures for electro-discharge machining. The learner will have an understanding of the CNC electro-discharge process and its application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate CNC electro-discharge machines
- 2 Know how to operate CNC electro-discharge machines

Guided learning hours

It is recommended that **130** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 24: Operating CNC Electro-Discharge Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 224

Outcome 1

Operating CNC electro-discharge machines

Be able to operate CNC electro-discharge machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the equipment is set up and ready for operation
- 3 confirm that the machine is ready for operation by checking all of the following:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without distortion
 - ensure that the dielectric fluid is at an appropriate level
 - check that the operating program is at the correct start point
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 4 follow the defined procedures for starting and running the operating system
- 5 operate one of the following CNC electro-discharge machines:
 - CNC spark erosion machine
 - CNC wire erosion machine
 - CNC electro-discharge machining centre
- 6 produce machined components which cover six of the following:
 - flat faces
 - parallel faces
 - tapered faces
 - angular faces
 - open-ended slots/recesses
 - internal profiles
 - external profiles
 - faces square to each other
 - enclosed slots/recesses

- tapered holes
 - holes on pitched circles
 - linear holes (rows, angles)
 - special profiles (eg, concave, convex)
 - parallel and tapered steps/slots/shoulders
 - circular/curved profiles (internal and external)
 - other special forms or features
- 7 machine components made from one of the following types of material:
- ferrous based
 - non-ferrous based
- 8 produce components with dimensional accuracy, form and surface texture within all of the following quality and accuracy standards as is applicable to the operations performed:
- dimensional tolerance equivalent to BS4500 or BS 1916 Grade 7
 - flatness and squareness within 0.001" per inch or 0.025mm per 25mm
 - components to be free from false starts, and sharp edges
 - angles within +/- 0.5 degree
 - machined holes within H 8
 - surface finish 32 μin ; 0.8 μm ; 18VDI
- 9 deal promptly and effectively with error messages or equipment faults that are within their control and report those that cannot be solved
- 10 monitor the computer process and ensure that the production output is to the required specification
- 11 use appropriate gauges or instruments to carry out the necessary checks, during production, for accuracy of three of the following:
- dimensions
 - position
 - parallelism
 - angle/taper
 - squareness
 - surface texture
 - profile
- 12 shut down the equipment to a safe condition on conclusion of the activities.

Unit 224

Outcome 2

Operating CNC electro-discharge machines

Know how to operate CNC electro-discharge machines

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed whilst operating CNC electro-discharge machines
- 2 describe the safety mechanisms on the CNC electro-discharge machine, and the procedure for checking that they function correctly
- 3 explain how to stop the CNC electro-discharge machine in both normal and emergency situations, and the procedure for restarting after an emergency
- 4 describe the hazards associated with the electro-discharge machining operations (such as moving machine parts, electrical components, handling dielectrics, fumes), and how to minimise them and reduce any risks
- 5 describe the personal protective equipment to be worn, and where this can be obtained
- 6 describe the importance of keeping the work area clean and tidy
- 7 describe the main features of the CNC electro-discharge machines, and the accessories that can be used
- 8 describe the various CNC electro-discharge operations that can be performed, and the methods and equipment used
- 9 describe the operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons)
- 10 explain how to use the visual display and understand the various messages displayed
- 11 describe the function of error messages, and what to do when an error message is displayed
- 12 explain how to find the correct restart point in the program when the machine has been stopped before completion of the program
- 13 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 14 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 15 explain how to use imperial and metric systems of measurement
- 16 describe the application of dielectric and ionised fluids with regard to a range of different materials
- 17 describe the effects of clamping the workpiece in a chuck/workholding device, and how this can cause distortion in the finished components
- 18 explain how to recognise CNC electro-discharge machining faults, and when actions need to be taken
- 19 describe the quality control procedures used, inspection checks to be carried out, and the equipment that will need to be used
- 20 describe the problems that can occur with the CNC electro-discharge machining activities, and how these can be overcome
- 21 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Level: 2
Credit value: 39
UAN: J/600/6038

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out gear cutting operations, in accordance with approved procedures, using Computer Numerical Control (CNC) machines. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. In operating the machine, the learner will be expected to follow the correct procedures for calling up the operating program, dealing with any error messages and executing the program activities safely and correctly.

The learner will be expected to produce a range of components that combine a number of different features, such as internal and external spur gears, helical gears, involute splines, straight splines, serrations, racks and bevel gears.

The learner will be required to operate the CNC machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the setter to make the required adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying machining procedures. The learner will have an understanding of the CNC gear cutting process and its application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate CNC gear cutting machines
- 2 Know how to operate CNC gear cutting machines

Guided learning hours

It is recommended that **130** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 25: Operating CNC Gear Cutting Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 225

Operating CNC gear cutting machines

Outcome 1

Be able to operate CNC gear cutting machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the equipment is set up and ready for operation
- 3 confirm that the machine is ready for operation by checking all of the following:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without distortion
 - check that the operating program is at the correct start point and the workpiece is clear of the machine spindle
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 4 follow the defined procedures for starting and running the operating system
- 5 operate one of the following CNC gear cutting machines:
 - CNC gear cutting machine
 - CNC gear hobbing machine
 - CNC gear shaving machine
- 6 produce machined components which cover four of the following, as applicable to the machine type used:
 - external spur gears
 - internal spur gears
 - external helical gears
 - internal helical gears
 - straight splines
 - involute splines
 - serrations
 - bevel gears
 - racks

- 7 machine one of the following types of material:
 - ferrous
 - non-ferrous
 - non-metallic
- 8 produce components with dimensional accuracy, form and surface texture within all the relevant quality and accuracy standards as is applicable to the operations performed:
 - components to be free from false tool cuts, burrs and sharp edges
 - straight splines and serrations to BS 2059 or BS1953 Class 1
 - spur and helical gears to BS 436 Pt 1 or BS1967
 - involute splines to BS 3550 1963 Class 1
 - tolerance to BS 4500 or BS1916 Grade 9
 - surface texture 63 μin or 1.6 μm
- 9 deal promptly and effectively with error messages or equipment faults that are within their control and report those that cannot be solved
- 10 monitor the computer process and ensure that the production output is to the required specification
- 11 use appropriate gauges or instruments to carry out the necessary checks, during production, for accuracy of three of the following:
 - gear blanks
 - lead and helix angle
 - gear tooth thickness
 - involute form
 - composite error rolling test
 - surface texture
- 12 shut down the equipment to a safe condition on conclusion of the activities.

Unit 225

Outcome 2

Operating CNC gear cutting machines

Know how to operate CNC gear cutting machines

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed whilst operating CNC gear cutting machines
- 2 describe the safety mechanisms on the machine, and the procedures for checking that they are operating correctly
- 3 explain how to stop the CNC gear cutting machine in both normal and emergency situations, and the procedure for restarting after an emergency
- 4 describe the hazards associated with working on CNC gear cutting machines (such as using moving machinery, automatic machine operation, handling cutting tools, hot and airborne metal particles), and how to minimise them and reduce any risks
- 5 describe the personal protective equipment to be worn, and where this can be obtained
- 6 describe the importance of keeping the work area clean and tidy
- 7 describe the main features of the CNC gear cutting machine, and the accessories that can be used
- 8 describe the various CNC gear cutting operations that can be performed, and the methods and equipment used
- 9 describe the operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons)
- 10 explain how to use the visual display and understand the various messages displayed
- 11 describe the function of error messages, and what to do when an error message is displayed
- 12 explain how to find the correct restart point in the program when the machine has been stopped before completion of the program
- 13 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 14 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 15 explain how to use imperial and metric systems of measurement
- 16 describe the application of roughing and finishing cuts, and the effect on cutter life, surface finish and dimensional accuracy
- 17 describe the application of cutting fluids with regard to a range of different materials
- 18 describe the effects of clamping the workpiece in a chuck/workholding device, and how this can cause distortion in the finished components
- 19 explain how to recognise CNC gear cutting faults, and how to identify when tools need re-sharpening/replacing
- 20 describe the quality control procedures used, inspection checks to be carried out, and the equipment that will need to be used
- 21 describe the problems that can occur with the CNC gear cutting activities, and how these can be overcome
- 22 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Level: 2
Credit value: 39
UAN: L/600/6039

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out machining operations, in accordance with approved procedures, using Computer Numerical Control (CNC) machining centres. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. In operating the machine, the learner will be expected to follow the correct procedures for calling up the operating program, dealing with any error messages and executing the program activities safely and correctly.

The learner will be expected to produce a range of components that cover a number of different features, such as bored holes, tapered holes, external diameters, flat faces, square and parallel faces, angular faces, slots, indexed and rotated forms, internal and external forms, grooves, drilled, reamed and tapped holes.

The learner will be required to operate the CNC machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the setter to make the required adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the machining activities undertaken, and to report any problems with the machining activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying CNC machining procedures. The learner will have an understanding of the CNC machining centre process and its application, and will know about the equipment, materials and consumables in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate CNC machining centres
- 2 Know how to operate CNC machining centres

Guided learning hours

It is recommended that **130** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 26: Operating CNC Machining Centres (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 226

Operating CNC machining centres

Outcome 1

Be able to operate CNC machining centres

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the equipment is set up and ready for operation
- 3 confirm that the machine is ready for operation by checking all of the following:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without distortion
 - check that the operating program is at the correct start point and the workpiece is clear of the machine spindle
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 4 follow the defined procedures for starting and running the operating system
- 5 produce components which cover six of the following:
 - external diameters
 - tapered diameters
 - shoulders and steps
 - bored holes
 - tapered holes
 - flat faces
 - tapped holes
 - square and parallel faces
 - angular faces
 - slots
 - indexed or rotated forms
 - internal profiles
 - external profiles

- internal threads
 - external threads
 - grooves
 - undercuts
 - drilled holes
 - reamed holes
- 6 machine one of the following types of material:
- ferrous
 - non-ferrous
 - non-metallic
- 7 produce component with dimensional accuracy, form and surface texture within all of the following quality and accuracy standards as is applicable to the operations performed:
- dimensional tolerance equivalent to BS4500 or BS 1916 Grade 9
 - components to be free from false tool cuts, burrs and sharp edges
 - flatness and squareness within 0.001" per inch or 0.025mm per 25mm
 - reamed/bored holes within H 8
 - angles within +/- 0.5 degree
 - screw threads BS medium fit
 - surface finish 63µin or 1.6µm
- 8 deal promptly and effectively with error messages or equipment faults that are within their control and report those that cannot be solved
- 9 monitor the computer process and ensure that the production output is to the required specification
- 10 use appropriate gauges or instruments to carry out the necessary checks, during production, for accuracy of four of the following:
- external diameters
 - internal diameters
 - lengths/depths
 - reamed hole size/fit
 - taper/angles
 - thread fit
 - slot or recess width and position
 - surface finish
 - flatness of faces
 - squareness of faces
- 11 shut down the equipment to a safe condition on conclusion of the activities.

Unit 226

Outcome 2

Operating CNC machining centres

Know how to operate CNC machining centres

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed whilst operating CNC machining centres
- 2 describe the safety mechanisms on the machine, and the procedures for checking that they are operating correctly
- 3 explain how to stop the CNC machining centre in both normal and emergency situations, and the procedure for restarting after an emergency
- 4 describe the hazards associated with working on CNC machining centres (such as use of moving machinery, automatic machine operation, handling cutting tools, hot and airborne metal particles), and how to minimise them and reduce any risk
- 5 describe the personal protective equipment to be worn, and where this can be obtained
- 6 describe the importance of keeping the work area clean and tidy
- 7 describe the main features of the CNC machining centre, and the accessories that can be used
- 8 describe the various CNC machining operations that can be performed, and the methods and equipment used
- 9 describe the operation of the various hand and automatic modes of machine control (such as hand wheels, joysticks, program operating and control buttons)
- 10 explain how to use the visual display and understand the various messages displayed
- 11 describe the function of error messages, and what to do when an error message is displayed
- 12 explain how to find the correct restart point in the program when the machine has been stopped before completion of the program
- 13 explain where to obtain the component drawings, specifications and/or job instructions required for the components to be machined
- 14 explain 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
- 15 explain how to use imperial and metric systems of measurement
- 16 explain how to handle and store tools and cutters safely and correctly
- 17 describe the application of roughing and finishing cuts, and the effect on tool life, surface finish and dimensional accuracy
- 18 describe the application of cutting fluids with regard to a range of different materials
- 19 describe the effects of clamping the workpiece in a chuck/workholding device, and how this can cause distortion in the finished components
- 20 explain how to recognise CNC machining faults, and how to identify when tools need re-sharpening/replacing
- 21 describe the quality control procedures used, inspection checks to be carried out, and the equipment that will need to be used
- 22 describe the problems that can occur with the CNC machining activities, and how these can be overcome
- 23 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Unit 227

Producing mechanical sub-assemblies/ assemblies

Level: 2
Credit value: 49
UAN: F/600/6040

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out assembly operations to produce mechanical assemblies, in accordance with approved procedures. The learner will be required to check that specified components are available and fit for purpose, to obtain all relevant and current documentation, to obtain the tools and equipment required for the assembly operations, and to check that they are in a safe and usable condition. In carrying out the assembly operations, the learner will be required to follow company procedures and specified assembly techniques, in order to produce the assembly.

The assembly activities will also include making all necessary checks and adjustments to ensure the components are correctly orientated, positioned and aligned, that moving parts have the correct working clearances, all fasteners are tightened to the correct torque and that the assembled parts are checked for completeness and function as per the specification.

The learner's responsibilities will require them to comply with organisational policy and procedures for the assembly activities undertaken, and to report any problems with the assembly activities, materials or equipment that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision taking, personal responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will be sufficient to provide a good understanding of their work, and will provide an informed approach to applying the assembly techniques and procedures. The learner will understand the mechanical product being assembled, and its application, and will know about the equipment, relevant components and joining techniques in adequate depth to provide a sound basis for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to produce mechanical sub-assemblies/assemblies
- 2 Know how to produce mechanical sub-assemblies/assemblies

Guided learning hours

It is recommended that **151** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 27: Producing Mechanical Sub-Assemblies/Assemblies (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 227

Producing mechanical sub-assemblies/ assemblies

Outcome 1

Be able to produce mechanical sub-assemblies/
assemblies

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 carry out all of the following during the assembly activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - check that tools and measuring instruments to be used are fit for service
 - use lifting and slinging equipment (where appropriate) in accordance with health and safety guidelines and procedures
 - use appropriate and approved assembly techniques at all times
 - ensure that the components used are free from damage, foreign objects, dirt or other contamination
 - leave the work area in a safe and appropriate condition on completion of the activities
- 3 follow the relevant instructions, assembly drawings and any other specifications
- 4 ensure that the specified components are available and that they are in a usable condition
- 5 use the appropriate methods and techniques to assemble the components in their correct positions
- 6 produce assemblies using four of the following methods and techniques:
 - assembly of components by expansion/contraction
 - fitting (such as filing, scraping, lapping or polishing)
 - securing using mechanical fasteners/threaded devices
 - applying sealants/adhesives
 - electrical bonding of components
 - assembly of products by pressure
 - setting working clearances
 - drilling
 - reaming
 - balancing components
 - applying bolt locking methods
 - shimming and packing
 - blue-bedding of components
 - aligning components
 - riveting
 - torque setting
 - soldering/brazing

- 7 produce assemblies constructed from two of the following:
 - sub-assemblies
 - support framework
 - component kits
 - fastener kits
 - casings, panels
 - single components
- 8 assemble products using one of the following assembly aids and equipment:
 - workholding devices
 - lifting and moving equipment
 - specialised assembly tools/equipment
 - jigs and fixtures
 - shims and packing
 - rollers or wedges
 - supporting equipment
- 9 secure the components using the specified connectors and securing devices
- 10 check the completed assembly to ensure that all operations have been completed and the finished assembly meets the required specification
- 11 carry out quality checks using appropriate equipment, to include four of the following:
 - positional accuracy
 - freedom of movement
 - component security
 - completeness
 - dimensions
 - orientation
 - alignment
 - function
 - bearing end float
 - operating/working clearances
 - free from damage or foreign objects
- 12 produce mechanical assemblies which comply with one of the following quality and accuracy standards:
 - BS, ISO or BSEN standards and procedures
 - customer standards and requirements
 - company standards and procedures
 - specific system requirements
- 13 deal promptly and effectively with problems within their control and report those that cannot be solved.

Unit 227

Producing mechanical sub-assemblies/ assemblies

Outcome 2

Know how to produce mechanical sub-assemblies/
assemblies

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the specific safety precautions to be taken whilst carrying out the mechanical assembly (including any specific legislation, regulations or codes of practice relating to the activities, equipment or materials)
- 2 describe the health and safety requirements of the work area in which they are carrying out the assembly activities, and the responsibility they place on them
- 3 describe the COSHH regulations with regard to the substances used in the assembly process
- 4 describe the hazards associated with producing mechanical assemblies, and how to minimise them and reduce any risks
- 5 describe the personal protective equipment and clothing to be worn during the assembly activities
- 6 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 7 describe the general principles of mechanical assembly, and the purpose and function of the components and materials used, including component identification systems (such as codes and component orientation indicators)
- 8 describe the preparations that need to be undertaken on the components prior to fitting them into the assembly
- 9 describe the assembly/joining methods, techniques and procedures to be used, and the importance of adhering to these
- 10 explain how the components are to be aligned, adjusted and positioned prior to securing, and the tools and equipment that is used
- 11 describe the importance of using the specified components and joining devices for the assembly, and why they must not use substitutes
- 12 explain where appropriate, the application of sealants and adhesives within the assembly activities, and the precautions that must be taken when working with them
- 13 describe the quality control procedures to be followed during the assembly operations
- 14 explain how to conduct any necessary checks to ensure the accuracy, position, security, function and completeness of the assembly
- 15 describe the methods and equipment used to transport, lift and handle components and assemblies
- 16 explain how to check that the tools and equipment to be used are in a safe and serviceable condition
- 17 describe the importance of ensuring that all tools are used correctly and within their permitted operating range
- 18 describe the things that can go wrong with the assembly operations, and what to do if they occur
- 19 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 228

Assembling fluid power components to mechanical equipment

Level: 2
Credit value: 49
UAN: L/600/6042

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to assemble and fit fluid power components (such as pneumatic, hydraulic, or vacuum) to mechanical equipment, in accordance with approved procedures. The learner will be required to check the specified components are available and fit for purpose, to obtain all relevant and current documentation, to obtain the tools and equipment required for the assembly operations and to check that they are in a safe and usable condition. In carrying out the fitting and assembly operations, they will be required to follow company procedures and specified assembly techniques, in order to assemble the required components.

The assembly activities will also include making all necessary checks and adjustments, to ensure the fluid power components are correctly positioned and aligned, that moving parts have the correct working clearances, all fasteners are tightened to the correct torque and that the assembled parts are checked for completeness.

The learner's responsibilities will require them to comply with organisational policy and procedures for the assembly activities undertaken, and to report any problems with the assembly activities, materials or equipment that they cannot personally resolve, or that are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will be sufficient to provide a good understanding of their work, and will provide an informed approach to applying fluid power assembly techniques and procedures. The learner will understand the mechanical product being assembled, and its application, and will know about the equipment, relevant components and joining techniques, in adequate depth to provide a sound basis for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to assemble fluid power components to mechanical equipment
- 2 Know how to assemble fluid power components to mechanical equipment

Guided learning hours

It is recommended that **151** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standards Mechanical Manufacturing Engineering Unit 28 (Suite 2)

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 228

Assembling fluid power components to mechanical equipment

Outcome 1

Be able to assemble fluid power components to mechanical equipment

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 carry out all of the following during the assembly activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - check that tools and measuring instruments to be used are fit for service
 - ensure that components and pipes used are free from damage, foreign objects, dirt or other contamination
 - use appropriate and approved fitting and assembly techniques at all times
 - leave the work area in a safe and appropriate condition on completion of the activities
- 3 follow the relevant instructions, assembly drawings and any other specifications
- 4 ensure that the specified components are available and that they are in a usable condition
- 5 use the appropriate methods and techniques to assemble the components in their correct positions
- 6 assemble and fit components for one of the following types of fluid power systems:
 - pneumatic
 - hydraulic
 - vacuum
 - electro-fluid power systems
- 7 prepare and fit four of the following fluid power components and materials to mechanical equipment:
 - power generation components (such as motors, pumps, compressors, intensifiers)
 - fluid conditioning components (such as filters, lubricators, separation units, heaters/driers, cooler units)
 - storage devices (such as reservoirs, accumulators)
 - monitoring components (such as sensors, meters, gauges and indicators)
 - pipework (such as rigid pipe, flexible pipe, hoses)
 - connection devices (such as manifolds, couplings, cables and wires)
 - control components (such as valves, actuators/cylinders, regulators)
- 8 secure the components using the specified connectors and securing devices
- 9 check the completed assembly to ensure that all operations have been completed and the finished assembly meets the required specification
- 10 carry out the quality checks using appropriate equipment, to include four of the following:
 - dimensions

- positional accuracy
 - alignment
 - correct direction and flow
 - leak or pressure tests
 - component security
 - electrical continuity
 - completeness
 - function
 - pipework (free from ripple and creases)
- 11 produce fluid power assemblies which comply with one of the following quality and accuracy standards:
- BS, ISO or BSEN standards and procedures
 - customer standards and requirements
 - company standards and procedures
 - specific system requirements
- 12 deal promptly and effectively with problems within their control and report those that cannot be solved.

Unit 228

Assembling fluid power components to mechanical equipment

Outcome 2

Know how to assemble fluid power components to mechanical equipment

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the specific safety precautions to be taken while carrying out the fluid power assembly (including any specific legislation, regulations or codes of practice relating to the activities, equipment or materials)
- 2 describe the health and safety requirements of the work area in which they are carrying out the assembly activities, and the responsibility these requirements place on them
- 3 describe the COSHH regulations with regard to the substances used in the fluid power assembly process
- 4 describe the hazards associated with assembling fluid power system components, and how to minimise them and reduce any risks
- 5 describe the personal protective equipment and clothing to be worn during the assembly activities
- 6 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 7 describe the general principles of fluid power, and the purpose and function of the components and materials used
- 8 describe the preparations to be undertaken on the components prior to fitting them onto the assembly
- 9 describe the fitting and assembly methods and procedures to be used, and the importance of adhering to these procedures
- 10 explain how the components are to be aligned, adjusted and positioned prior to securing, and the tools and equipment that are used
- 11 describe the importance of using the specified components for the assembly, and why they must not use substitutes
- 12 describe the quality control procedures to be followed during the assembly operations
- 13 explain how to detect assembly defects/faults (such as ineffective joining techniques, foreign objects, component damage), and what to do to rectify them
- 14 describe the methods and equipment used to transport, lift and handle components and assemblies
- 15 explain how to check that the tools and equipment to be used are in a safe and serviceable condition
- 16 describe the importance of ensuring that all tools are used correctly and within their permitted operating range
- 17 describe the things that can go wrong with the assembly operations, and what to do if they occur
- 18 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Unit 229

Assembling electrical or electronic components to mechanical equipment

Level: 2
Credit value: 49
UAN: R/600/6043

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to assemble electrical or electronic components to mechanical equipment, in accordance with approved procedures. The learner will be required to check that specified components are available and fit for purpose, to obtain all relevant and current documentation, to obtain the tools and equipment required for the assembly operations and to check that they are in a safe and usable condition. In carrying out the assembly operations, the learner will be required to follow company procedures and specified assembly techniques, in order to fit the electrical or electronic components to the mechanical assembly.

The assembly activities will also include making all necessary checks and adjustments, to ensure that the electrical or electronic components are correctly orientated, positioned and secured correctly. The learner must also check that any cables and wires are routed correctly and are tidy in appearance, and that connections are mechanically sound and checked for electrical continuity.

The learner's responsibilities will require them to comply with organisational policy and procedures for the assembly activities undertaken, and to report any problems with the assembly activities, materials or equipment that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will be sufficient to provide a good understanding of their work, and will provide an informed approach to applying electrical or electronic fitting and assembly techniques and procedures. The learner will have an understanding of the product being assembled and its application, and will know about the equipment, relevant components and joining techniques, in adequate depth to provide a sound basis for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to assemble electrical or electronic components to mechanical equipment
- 2 Know how to assemble electrical or electronic components to mechanical equipment

Guided learning hours

It is recommended that **151** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standards Mechanical Manufacturing Engineering Unit 29 (Suite 2)

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 229

Assembling electrical or electronic components to mechanical equipment

Outcome 1

Be able to assemble electrical or electronic components to mechanical equipment

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 carry out all of the following during the assembly activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - use lifting and slinging equipment (where appropriate) in accordance with health and safety guidelines and procedures
 - check that tools and measuring instruments to be used are fit for service
 - use appropriate and approved fitting and assembly techniques at all times
 - ensure that the components used are free from damage, foreign objects, dirt or other contamination
 - leave the work area in a safe and appropriate condition on completion of the activities
- 3 follow the relevant instructions, assembly drawings and any other specifications
- 4 ensure that the specified components are available and that they are in a usable condition
- 5 use the appropriate methods and techniques to assemble the components in their correct positions
- 6 fit electrical or electronic components using all of the following techniques:
 - routeing cables and wires
 - mounting/securing components
 - cable fixings and fasteners
- 7 terminate and join cables/wires to components using two of the following:
 - screwed connections
 - clamped connections
 - soldering
 - crimping
 - cable protection devices (such as sleeving or grommets)
- 8 fit four of the following electrical components on the mechanical equipment:
 - cable enclosures (such as conduit, trunking, tray work)
 - circuit connection devices (such as plugs, sockets)
 - monitoring components (such as sensors)
 - power generation components (such as motors, transformers)
 - control components (such as relays, solenoids, switches)
 - cables and wires
 - lamps/lighting

- electronic modules
 - instrumentation units
 - circuit protection devices
 - other specific components
- 9 secure the components using the specified connectors and securing devices
- 10 check the completed assembly to ensure that all operations have been completed and the finished assembly meets the required specification
- 11 carry out the required checks using the correct tools and equipment, to include four of the following:
- position
 - alignment
 - completeness
 - free from damage or foreign objects
 - electrical continuity
 - component security
- 12 produce mechanical assemblies which comply with one of the following standards:
- BS, ISO or BSEN standards and procedures
 - customer standards and requirements
 - company standards and procedures
 - specific system requirements
- 13 deal promptly and effectively with problems within their control and report those that cannot be solved.

Unit 229

Assembling electrical or electronic components to mechanical equipment

Outcome 2

Know how to assemble electrical or electronic components to mechanical equipment

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the specific safety precautions to be taken while carrying out the assembly (including any specific legislation, regulations or codes of practice relating to the activities, equipment or materials)
- 2 describe the health and safety requirements of the work area in which they are carrying out the assembly activities, and the responsibility these requirements place on them
- 3 describe the COSHH regulations with regard to the substances used in the assembly process
- 4 describe the hazards associated with assembling electrical or electronic components to mechanical equipment, and how to minimise them and reduce any risks
- 5 describe the personal protective equipment and clothing to be worn during the assembly activities
- 6 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 7 describe the general principles of electrical and electronic fitting techniques; the purpose and function of the components, including identification systems (such as colour codes, manufactures specification)
- 8 describe the preparations to be undertaken on the electrical or electronic components prior to fitting them into the assembly
- 9 describe the correct component handling procedures, including any relevant handling equipment
- 10 describe the assembly and securing methods and procedures to be used, and the importance of adhering to these
- 11 explain how the components are to be positioned, aligned and secured, and the tools and equipment that are used
- 12 describe the importance of using the specified electrical or electronic components and securing devices for the assembly, and why they must not use substitutes
- 13 describe the quality control procedures to be followed during the assembly operations
- 14 explain how to conduct any necessary checks to ensure the accuracy, position, security, function, completeness and electrical continuity of the assembly
- 15 explain how to detect assembly defects (such as ineffective joining techniques, component damage), and what to do to rectify them
- 16 explain how to check that the tools and equipment to be used are in a safe and serviceable condition
- 17 describe the importance of ensuring that all tools are used correctly and within their permitted operating range
- 18 describe the importance of ensuring all tools, equipment and components are accounted for and returned to their correct location on completion of the assembly activities
- 19 describe the things that can go wrong with the assembly operations, and what to do if they occur
- 20 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Unit 230

Assembling pipework components to mechanical equipment

Level: 2
Credit value: 49
UAN: D/600/6045

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to assemble and fit pipework components to mechanical equipment, in accordance with approved procedures. The learner will be required to check that specified components are available and fit for purpose, to obtain all relevant and current documentation, to obtain the tools and equipment required for the assembly operations and to check that they are in a safe and usable condition. In carrying out the assembly operations, the learner will be required to follow company procedures and specified assembly techniques, in order to assemble the pipework and components and to fit them to the mechanical equipment.

The assembly activities will also include making all necessary checks and adjustments to ensure that the pipework and components are correctly orientated, positioned and aligned and that all fasteners are tightened to the correct torque and the assembled parts are checked for completeness.

The learner's responsibilities will require them to comply with organisational policy and procedures for the assembly activities undertaken, and to report any problems with the assembly activities, materials or equipment that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will be sufficient to provide a good understanding of their work, and will provide an informed approach to applying pipework fitting and assembly techniques and procedures. The learner will have an understanding of the mechanical product being assembled, and its application, and will know about the equipment, relevant components and joining techniques, in adequate depth to provide a sound basis for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to assemble pipework components to mechanical equipment
- 2 Know how to assemble pipework components to mechanical equipment

Guided learning hours

It is recommended that **151** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standards Mechanical Manufacturing Engineering Unit 30 (Suite 2)

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 230

Assembling pipework components to mechanical equipment

Outcome 1

Be able to assemble pipework components to mechanical equipment

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 carry out all of the following during the assembly activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - check that tools and measuring instruments to be used are fit for service
 - ensure that components and pipes used are free from damage, foreign objects, dirt or other contamination
 - use appropriate and approved fitting and assembly techniques at all times
 - use lifting and slinging equipment (where appropriate) in accordance with health and safety guidelines and procedures
 - leave the work area in a safe and appropriate condition on completion of the activities
- 3 follow the relevant instructions, assembly drawings and any other specifications
- 4 ensure that the specified components are available and that they are in a usable condition
- 5 use the appropriate methods and techniques to assemble the components in their correct positions
- 6 use appropriate techniques to assemble two of the following types of pipework to the mechanical equipment:
 - steel pipe
 - copper pipe
 - plastic pipe
 - flexible hoses
- 7 connect pipework using two of the following methods:
 - compression
 - bolting
 - screwing
 - brazing
 - push fit
 - soldering
 - cementing/bonding
- 8 fit five of the following pipework components:
 - straight connectors
 - reduction pieces
 - straight sections

- tee pieces
- flanges
- elbows
- curved/profiled sections
- couplings
- angular sections

plus one more from the following:

- control components (such as valves, taps, regulators)
- storage devices (such as tanks, reservoirs)
- monitoring components (such as sensors, meters, gauges)
- fluid distribution components (such as motors, pumps)

- 9 secure the components using the specified connectors and securing devices
- 10 check the completed assembly to ensure that all operations have been completed and the finished assembly meets the required specification
- 11 carry out all of the following quality checks using appropriate equipment, to include:
 - alignment
 - completeness
 - positional accuracy
 - correct direction and flow
 - component security
 - component quality (such as free from ripple, creases, foreign objects)
- 12 produce pipework assemblies which comply with one of the following quality and accuracy standards:
 - BS, ISO or BSEN standards and procedures
 - customer standards and requirements
 - company standards and procedures
 - specific system requirements
- 13 deal promptly and effectively with problems within their control and report those that cannot be solved.

Unit 230

Assembling pipework components to mechanical equipment

Outcome 2

Know how to assemble pipework components to mechanical equipment

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the specific safety precautions to be taken while carrying out the fitting of pipework systems to mechanical assemblies (including any specific legislation, regulations or codes of practice relating to the activities, equipment or materials)
- 2 describe the health and safety requirements of the work area in which they are carrying out the assembly activities, and the responsibility these requirements place on them
- 3 describe the COSHH regulations with regard to the substances used in the assembly process
- 4 describe the hazards associated with assembling pipework and pipe components to mechanical equipment, and how to minimise them and reduce any risks
- 5 describe the personal protective equipment and clothing to be worn during the assembly activities
- 6 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 7 describe the general principles of producing pipework assemblies, and the purpose and function of the components and materials used, including identification systems (such as colour codes)
- 8 describe the application of different pipework assembly methods and techniques
- 9 describe the preparations to be undertaken on the pipework prior to fitting them to the assembly
- 10 describe the pipework assembly/joining methods and procedures to be used, and the importance of adhering to these
- 11 describe the importance of using the specified pipework and fittings for the assembly, and why they must not use substitutes
- 12 describe the quality control procedures to be followed during the assembly operations
- 13 explain how to conduct any necessary checks to ensure the safety, accuracy, position, security, function and completeness of the pipework assembly
- 14 explain how to identify pipework assembly defects (such as ineffective joining techniques, component damage), and what to do to rectify them
- 15 explain how to check that the tools and equipment to be used are in a safe and serviceable condition
- 16 describe the importance of ensuring that all tools are used correctly and within their permitted operating range
- 17 describe the things that can go wrong with the pipework assembly activities, and what to do if these occur
- 18 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Unit 231

Producing composite mouldings using wet lay-up techniques

Level: 2
Credit value: 42
UAN: H/600/6046

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to produce composite mouldings using wet lay-up techniques, in accordance with approved procedures. The learner will be required to follow the appropriate instructions, drawings, specifications and documentation to produce the composite mouldings, using the correct wet lay-up production techniques.

The learner will produce a range of composite mouldings, incorporating a variety of features and using a range of techniques and processes. Mouldings produced will include laminates and sandwich structures, using a range of resin, fibre and core materials.

The learner's responsibilities will require them to comply with organisational policy and procedures for the composite moulding activities undertaken, and to report any problems with the moulding activities, equipment or materials that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will be sufficient to provide a good understanding of their work, and will provide an informed approach to applying composite moulding wet lay-up techniques and procedures. The learner will have an understanding of the production techniques used, and their application, in adequate depth to provide a sound basis for carrying out the activities, recognising faults, and ensuring the work output is to the required specification.

The learner will understand the safety precautions required when carrying out the wet lay-up moulding activities and when using the associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to produce composite mouldings using wet lay-up techniques
- 2 Know how to produce composite mouldings using wet lay-up techniques

Guided learning hours

It is recommended that **151** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 31: Producing Composite Mouldings using Wet Lay-up Techniques (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 231 Producing composite mouldings using wet lay-up techniques

Outcome 1 Be able to produce composite mouldings using wet lay-up techniques

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 follow the correct component drawing or any other related specifications for the component to be produced
- 3 determine what has to be done and how this will be achieved
- 4 obtain and prepare the appropriate tools, equipment and materials
- 5 prepare moulds and materials for production activities, to include all of the following:
 - cleaning of tooling and removal of resin build-ups
 - checking of tooling for surface defects
 - correctly applying sealants/release agents
 - dispensing and applying the correct measure and mix of resin/catalyst
- 6 carry out the moulding or laying-up activities using the correct methods and techniques
- 7 carry out all of the following during the moulding activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation, material data sheets)
 - 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
 - obtain the correct tools and equipment for the activity and ensure they are safe to use
 - use the correct materials and consumables, as specified in the production documentation
 - apply safe and appropriate wet lay-up working practices and procedures at all times
 - keep the work area in a safe and suitable condition
- 8 produce components to the required specification
- 9 produce a range of mouldings, using two of the following application techniques:
 - spray application of fibre/resin
 - application of a gel coat
 - brush application of fibre/resin
 - roller application of fibre/resin
 - removal of voids and air pockets
 - use of vacuum bagging
 - use of bleed plies
- 10 produce a range of mouldings incorporating one of the following in the lay-up:
 - feathered joins
 - overlap joins
 - orientated plies
 - inserts
 - fixtures

- butt joins
- 11 produce a range of mouldings, incorporating two of the following shape features:
- internal corner
 - external corner
 - double curvature
 - concave surface
 - convex surface
 - vertical surface
- 12 produce a range of mouldings using all the following:
- resin (such as polyester, epoxy, phenolic, vinyl ester)
 - fibre (such as glass, carbon, polyethylene, aramid)
 - reinforcement (such as braids, roving, tapes, chopped strand, continuous filament, woven)
 - core material (such as wood, coremat, structural foam, honeycomb)
- 13 check that all the required operations have been completed to specification
- 14 produce a range of mouldings which comply with one of the following standards:
- BS, ISO or BSEN standards and procedures
 - customer standards and requirements
 - company standards and procedures
 - specific material/moulding requirements
- 15 deal promptly and effectively with problems within their control and report those that cannot be solved.

Unit 231 Producing composite mouldings using wet lay-up techniques

Outcome 2 Know how to produce composite mouldings using wet lay-up techniques

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the health and safety precautions to be taken, and procedures used in the specific work area, when working with composite materials, consumables, tools and equipment
- 2 describe the hazards associated with working with composite materials, consumables, tools and equipment, and how to minimise these and reduce any risks in the work area
- 3 describe the protective equipment that is needed for personal protection and, where required, the protection of others
- 4 describe the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables
- 5 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standard) in relation to work undertaken
- 6 explain how to interpret and use imperial and metric systems of measurement
- 7 describe the quality procedures used in the workplace to ensure production control (such as in relation to currency, issue, meeting specification)
- 8 describe the conventions and terminology used for wet lay-up techniques (such as resin and fibre weights/volumes, material orientation, material identification, material tailoring, mixing ratios, gel times, exotherm, bleed plies)
- 9 describe the type of resin, fibres and reinforcement used, and their applications
- 10 describe the visual identification of both raw and finished composite materials
- 11 describe the methods of preparation for patterns, moulds and tooling (including the correct use of surface sealers and release agents)
- 12 describe the mixing ratios for gel coats, resins and catalysts, and their associated working times
- 13 describe the methods used in the application of the resin/fibre during the lay-up activity
- 14 describe the tools and equipment used in the lay-up activities, and their care, preparation and control procedures
- 15 explain how to recognise faults that can occur during the lay-up process
- 16 describe the procedures and methods used for removing mouldings from production tooling
- 17 describe the identification of defects in the composite moulding (such as de-lamination, voids, contaminants)
- 18 describe the care and safe handling of production tooling and composite mouldings throughout the production cycle
- 19 describe the production controls used in the work area, and actions to be taken for unaccounted items
- 20 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Unit 232

Producing composite mouldings using pre-preg laminating techniques

Level: 2
Credit value: 42
UAN: M/600/6048

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to produce composite mouldings using pre-preg laminating techniques, in accordance with approved procedures. The learner will be required to follow the appropriate instructions, drawings, specifications and documentation to produce the various mouldings, using the correct pre-preg laminating production techniques.

The learner will produce a range of composite mouldings, incorporating a variety of features and using a range of techniques and processes. Mouldings produced will include laminates and sandwich structures, using a range of resin, fibre and core materials.

The learner's responsibilities will require them to comply with organisational policy and procedures for the pre-preg laminating activities undertaken, and to report any problems with the production activities, equipment or materials that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will be sufficient to provide a good understanding of their work, and will provide an informed approach to applying pre-preg laminating techniques and procedures. The learner will have an understanding of the pre-preg laminating production techniques used, and their application, in adequate depth to provide a sound basis for carrying out the activities, recognising faults, and ensuring the work output is to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to produce composite mouldings using pre-preg laminating techniques
- 2 Know how to produce composite mouldings using pre-preg laminating techniques

Guided learning hours

It is recommended that **151** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 32: Producing Composite Mouldings using Pre-Preg Laminating Techniques (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 232

Producing composite mouldings using pre-preg laminating techniques

Outcome 1

Be able to produce composite mouldings using pre-preg laminating techniques

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 follow the correct component drawing or any other related specifications for the component to be produced
- 3 determine what has to be done and how this will be achieved
- 4 obtain and prepare the appropriate tools, equipment and materials
- 5 prepare moulds and materials for production activities, to include carrying out all of the following:
 - cleaning of tooling and removal of resin build ups
 - checking of tooling for surface defects
 - correctly applying sealants/release agents
 - cutting materials to correct shape and orientation (where applicable)
- 6 carry out the moulding or laying-up activities using the correct methods and techniques
- 7 carry out all of the following during the moulding activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation, material data sheets)
 - 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
 - obtain the correct tools and equipment for the activity and ensure they are safe to use
 - use the correct materials and consumables, as specified in the production documentation
 - apply safe and appropriate pre-preg laminating working practices and procedures at all times
 - keep the work area in a safe and suitable condition
- 8 produce a range of mouldings, using techniques for two of the following types of production tools:
 - metal
 - wet lay-up
 - glass pre-preg
 - tooling block
 - carbon pre-preg
 - female tooling
 - male tooling
 - multi-part tools
 - matched tooling
 - closed tooling

- 9 produce composite mouldings incorporating one of the following in the lay-up:
 - butt joins
 - overlap joins
 - staggered joins
 - orientated plies
 - inverted plies
 - inserts
- 10 produce composite mouldings incorporating three of the following features:
 - internal corners
 - external corners
 - double curvature
 - concave surface
 - convex surfaces
 - return surfaces
 - joggle details
 - nett edges
- 11 use all of the following in the lay-up activities:
 - resin (such as epoxy, phenolic, bismaleimide, cyanate ester)
 - fibre (such as glass, polyethylene, aramid, carbon)
 - reinforcement (such as continuous, unidirectional, braids, woven, multi-axis, tapes)
 - core materials (such as wood, syntactic core, expanding core, foam, honeycomb)
- 12 use one of the following for applying temperature during the cure cycle:
 - oven
 - heated tools/moulds
 - autoclave
 - heated press
- 13 use one of the following for applying pressure during the cure cycle:
 - pressure bags
 - vacuum bags
 - thermal mould expansion
 - fibre tensioning
- 14 produce components to the required specification
- 15 produce a range of mouldings which comply with one of the following standards:
 - BS, ISO or BSEN standards and procedures
 - customer standards and requirements
 - company standards and procedures
 - specific material/moulding requirements
- 16 check that all the required operations have been completed to specification
- 17 deal promptly and effectively with problems within their control and report those that cannot be solved.

Unit 232

Producing composite mouldings using pre-preg laminating techniques

Outcome 2

Know how to produce composite mouldings using pre-preg laminating techniques

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the health and safety precautions to be taken, and procedures used in the specific work area, when working with composite materials, consumables, tools and equipment
- 2 describe the hazards associated with working with composite materials, consumables, tools and equipment, and how to minimise these and reduce any risks in the work area
- 3 describe the protective equipment that is needed for personal protection and, where required, the protection of others
- 4 describe the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables
- 5 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 6 explain how to interpret imperial and metric systems of measurement
- 7 describe the quality procedures used in the workplace to ensure production control (such as in relation to currency, issue, meeting specification)
- 8 describe the conventions and terminology used for pre-preg laminating techniques (such as material orientation, material identification, material templates, ply lay-up, pressure plates, vacuum bagging, cure cycles, exotherm)
- 9 describe the type of resin systems, fibres and reinforcements used, and their applications
- 10 describe the core, insert and filler materials used, and their applications
- 11 describe the visual identification of both raw and finished composite materials
- 12 describe the methods used in the application of pre-preg materials to tooling surfaces (including methods of tailoring and cutting)
- 13 describe the correct methods of storage and handling of ancillary and consumable materials
- 14 describe the tools and equipment used in the pre-preg laminating activities, and their care, preparation and control procedures
- 15 explain how to recognise faults that can occur during the moulding process
- 16 describe the importance of adhering to the cure cycle
- 17 describe the procedures and methods used for removing mouldings from production tooling
- 18 describe the care and safe handling of production tooling and composite mouldings throughout the production cycle
- 19 describe the production controls used in the work area, and actions to be taken for unaccounted items
- 20 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Level: 2
Credit value: 32
UAN: K/600/6050

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to produce components by acrylic moulding, in accordance with approved procedures. The learner will be required to follow the appropriate instructions, drawings, specifications and documentation to produce the various types of components. The learner will be expected to produce the acrylic components using the specified moulding process and techniques. This will involve using equipment such as air circulating ovens, presses, trimming and automated cutting equipment. The products produced will include deep drawn, double curvature, convex and concave shapes.

The learner's responsibilities will require them to comply with organisational policy and procedures for the acrylic moulding activities undertaken, and to report any problems with the moulding activities, equipment or materials that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will be sufficient to provide a good understanding of their work, and will provide an informed approach to applying acrylic moulding techniques and procedures. The learner will have an understanding of the production techniques used, and their application, in adequate depth to provide a sound basis for carrying out the activities, recognising faults, and ensuring the work output is to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to produce components by acrylic moulding
- 2 Know how to produce components by acrylic moulding

Guided learning hours

It is recommended that **130** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 33: Producing Components by Acrylic Moulding (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 233

Outcome 1

Producing components by acrylic moulding

Be able to produce components by acrylic moulding

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 follow the correct component drawing or any other related specifications for the component to be produced
- 3 determine what has to be done and how this will be achieved
- 4 obtain and prepare the appropriate tools, equipment and materials
- 5 carry out the moulding or laying-up activities using the correct methods and techniques
- 6 carry out all of the following during the moulding activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation, material data sheets)
 - 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
 - obtain the correct tools and equipment for the activity and ensure they are safe to use
 - use the correct materials and consumables, as specified in the production documentation
 - apply safe and appropriate acrylic moulding practices and procedures at all times
 - keep the work area in a safe and suitable condition
- 7 carry out one of the following moulding methods and techniques:
 - vacuum moulding
 - deep drawing
 - shape clamping
 - positive pressure shaping
 - stress relieving
- 8 carry out four of the following operations during the moulding process:
 - tool/equipment preparation
 - sheet preparation
 - trimming
 - setting and controlling temperatures
 - stress relieving
 - sheet forming
 - de-moulding
- 9 produce a range of components with two of the following features:
 - box sections
 - cylindrical section
 - convex shapes
 - concave shapes
 - single curvatures
 - double curvatures

- 10 produce components to the required specification
- 11 produce a range of mouldings which comply with one of the following standards:
 - BS, ISO or BSEN standards and procedures
 - customer standards and requirements
 - company standards and procedures
 - specific material/moulding requirements
- 12 check that all the required operations have been completed to specification
- 13 deal promptly and effectively with problems within their control and report those that cannot be solved.

Unit 233

Outcome 2

Producing components by acrylic moulding

Know how to produce components by acrylic moulding

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the specific safety practices and procedures that they need to observe when working with acrylics (including any specific legislation, regulations/codes of practice for the activities, equipment or materials used)
- 2 describe the health and safety requirements of the work area where they are carrying out the activities, and the responsibility these requirements place on them
- 3 describe the protective equipment that they need to use for both personal protection and, where appropriate, protection of others
- 4 describe the hazards associated with moulding acrylic materials, and with the tools and equipment used, and how to minimise them and reduce any risks in the workplace
- 5 describe the interpretation of drawings, standards, quality control procedures and specifications used for the moulding activity, and the currency/issue checks of the documents they are working with
- 6 describe the principles of deep drawing, concave/convex moulding, positive pressure moulding and stress relieving
- 7 describe the different methods of heating materials, and the temperature control methods
- 8 describe the sheet profiling procedures, and material trimming methods/procedures
- 9 describe the supply of acrylic sheet (such as colour, thickness, sheet size, surface texture, material protection)
- 10 describe the use of forming aids
- 11 describe the methods of sheet trimming and sheet cleaning prior to moulding
- 12 describe the preparation methods and procedures applied to the moulding surface
- 13 describe the material cleaning methods and procedures to be applied
- 14 describe the quality control procedures to be followed during the moulding operations
- 15 describe the methods and techniques for lifting, handling and supporting the components/equipment/materials during the moulding activities
- 16 describe the recognition of moulding defects (such as misalignment, distortion, damage, contamination and surface defects)
- 17 describe the tools and equipment used in the moulding activities, and their calibration, care, preparation and control procedures
- 18 describe the problems that can occur with the moulding operations, and how these can be overcome
- 19 describe the recording documentation to be completed for the moulding activities undertaken
- 20 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Level: 2
Credit value: 32
UAN: M/600/6051

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to vacuum form components, in accordance with approved procedures. The learner will be required to follow the appropriate instructions, drawings and specifications, to produce the various types of components from thermoplastic sheet, fibre reinforced thermoplastic sheet and structural foam. This will require the learner to use a range of air circulating ovens, vacuum forming machines, trimming equipment and various types of tooling. The components produced will have a range of features, including male shapes, female shapes, double curvatures and stiffened mouldings.

The learner's responsibilities will require them to comply with organisational policy and procedures for the vacuum forming activities undertaken, and to report any problems with the vacuum forming activities, equipment, materials or consumables that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will be sufficient to provide an understanding of their work, and will provide an informed approach to applying vacuum forming procedures. The learner will have an understanding of the vacuum forming procedures used, and their application, and will know about the vacuum forming techniques, materials, tooling and consumables used, in adequate depth to provide a sound basis for carrying out the activities, recognising faults and ensuring the work output is to the required specification.

The learner will understand the safety precautions required when carrying out the vacuum forming operations and when using the associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to vacuum form composite materials
- 2 Know how to vacuum form composite materials

Guided learning hours

It is recommended that **130** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 34: Vacuum Forming Composite Materials (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 234

Vacuum forming composite materials

Outcome 1

Be able to vacuum form composite materials

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the equipment is set up correctly and is ready for use
- 3 use two of the following types of equipment:
 - air circulating ovens
 - vacuum forming machines
 - Tufnol tooling
 - metal tooling
 - wood tooling
 - trimming equipment
 - composite tooling
- 4 manipulate the machine controls safely and correctly in line with operational procedures
- 5 produce components to the required specification
- 6 carry out all of the following during the vacuum forming activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation, material data sheets)
 - 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
 - obtain the correct tools and equipment for the activity and ensure they are safe to use
 - use the correct materials and consumables, as specified in the production documentation (such as colour, size, composition)
 - apply safe and appropriate vacuum forming techniques and working practices at all times
 - keep the work area in a safe and suitable condition
- 7 carry out three of the following operations:
 - bubble blowing to minimize webbing
 - positioning of robbers
 - cleaning tooling
 - temperature control
 - trimming techniques
 - drying of sheet
 - use of intensifiers
 - sheet cleaning
- 8 produce a range of components with two of the following features:
 - double curvatures
 - male shapes
 - female shapes
 - stiffened mouldings

- 9 produce a range of components using one the following materials:
 - thermoplastic sheet (such as polycarbonate, polysulphone, acrylic, polyvinyl chloride, ABS)
 - fibre-reinforced thermoplastic sheet
 - structural foams (such as polyvinyl chloride (PVC), polymethate (Rohacell), etc)
- 10 carry out quality sampling checks at suitable intervals
- 11 produce components which comply with one of the following standards:
 - BS, ISO or BSEN standards and procedures
 - customer standards and requirements
 - company standards and procedures
 - specific material/vacuum forming requirements
- 12 deal promptly and effectively with problems within their control and report those that cannot be solved
- 13 shut down the equipment to a safe condition on conclusion of the machining activities.

Unit 234

Outcome 2

Vacuum forming composite materials

Know how to vacuum form composite materials

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the specific safety practices and procedures that they need to observe when working with vacuum forming equipment (including any specific legislation, regulations/codes of practice for the activities, equipment or materials)
- 2 describe the health and safety requirements of the work area where they are carrying out the activities, and the responsibility these requirements place on them
- 3 describe the protective equipment that they need to use for both personal protection and, where appropriate, protection of others
- 4 describe the hazards associated with carrying out vacuum forming activities, and with the tools and equipment used, and how to minimise these and reduce any risks in the work area
- 5 describe the application of COSHH regulations in relation to the storage, use and disposal of materials and consumables used in the vacuum forming process
- 6 explain how to extract and use information from engineering drawings, and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to the work undertaken
- 7 explain how to interpret imperial and metric systems of measurement
- 8 describe the methods of sheet trimming and sheet cleaning, prior to forming
- 9 describe the preparation methods and procedures applied to the moulding surface
- 10 describe the identification of the correct male/female mould tooling
- 11 describe the methods and techniques of loading and aligning materials into the mould tooling
- 12 describe the methods and techniques for carrying out the de-moulding procedures
- 13 explain how to recognise vacuum forming defects (such as misalignment, distortion, damage, contamination and surface defects)
- 14 describe the importance of adhering to the vacuum forming cycle
- 15 describe the quality control procedures to followed during the vacuum forming operations
- 16 describe the tools and equipment used in the vacuum forming activities, and their care, preparation and control procedures
- 17 describe the problems that can occur with the vacuum forming operations, and how these can be overcome
- 18 describe the production documentation to be completed for the vacuum forming activities undertaken
- 19 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Unit 235

Trimming composite mouldings using hand tools

Level: 2
Credit value: 32
UAN: T/600/6052

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to trim composite mouldings using hand tools, in accordance with approved procedures. The learner will be required to follow the appropriate instructions, drawings, specifications and documentation to trim various composite mouldings, using the correct trimming techniques.

The learner will be expected to select and use the correct tools and equipment for the trimming activity. The learner will trim a range of composite mouldings, incorporating a variety of features, by using cutting, sanding, drilling and polishing techniques and processes. Mouldings to be trimmed will include a range of resin and fibre materials.

The learner's responsibilities will require them to comply with organisational policy and procedures for the trimming activities undertaken, and to report any problems with the trimming activities, equipment or materials that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will be sufficient to provide a good understanding of their work, and will provide an informed approach to applying composite moulding trimming techniques and procedures. The learner will have an understanding of the trimming techniques used, and their application, in adequate depth to provide a sound basis for carrying out the activities, recognising faults and ensuring the trimmed mouldings are to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to trim composite mouldings using hand tools
- 2 Know how to trim composite mouldings using hand tools

Guided learning hours

It is recommended that **130** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 35: Trimming Composite Mouldings using Hand Tools (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 235

Trimming composite mouldings using hand tools

Outcome 1

Be able to trim composite mouldings using hand tools

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 follow relevant specifications for the component to be produced
- 3 carry out all of the following during the trimming activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation, material data sheets)
 - 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
 - obtain the correct tools and equipment for the activity and ensure they are safe to use
 - apply safe and appropriate trimming techniques and working practices at all times
 - keep the work area in a safe and suitable condition
- 4 obtain the appropriate tools and equipment for the shaping operations and check they are in a safe and usable condition
- 5 shape the materials using appropriate methods and techniques
- 6 carry out all of the following when preparing for the trimming activity:
 - check the moulding is correct and complete
 - check for any defects in the moulding
 - identify and protect the moulding in the work area
- 7 mark out the mouldings using four of the following methods:
 - scribe
 - height gauge
 - moulded scribe lines
 - centre punch
 - trimming templates
- 8 cut mouldings using one the following methods:
 - cutting wheels/discs
 - saws
 - routers
 - trim jigs
- 9 sand mouldings using two of the following methods:
 - rubbing blocks
 - diamond files
 - pencil grinders
 - disc sanders
 - belt sanders

- 10 use a hand drill or pedestal drill to drill mouldings using two of the following methods:
 - drill jigs
 - hole saws
 - counterbores
 - countersinks
 - drill bits
- 11 polish mouldings using three of the following methods:
 - wet sanding
 - cutting compound
 - polishing compound
 - rubbing block
 - orbital sander
 - polisher
- 12 trim mouldings using appropriate techniques for both of the following:
 - resins (such as polyester, vinyl ester, epoxy, phenolic, bismaleimide, cyanate ester)
 - fibres (such as polyethylene, glass, aramid, carbon)
- 13 trim mouldings that require, or incorporate five of the following features:
 - straight edges
 - curved edges
 - flat surfaces
 - polished surfaces
 - shaped surfaces
 - radius corners
 - returns
 - nett edges
 - joggle details
 - removal of join lines
 - holes
 - multiple hole sizes
 - countersinks
 - counterbores
 - further lay-up stages
 - inserts to be drilled
 - inserts to be tapped
 - solid cores
 - honeycomb cores
 - edge filling
- 14 check that all the required shaping operations have been completed to the required specification
- 15 trim a range of mouldings in compliance with one of the following standards:
 - BS, ISO or BSEN standards and procedures
 - customer standards and requirements
 - company standards and procedures
 - specific material/moulding requirements
- 16 deal promptly and effectively with problems within their control and report those that cannot be solved.

Unit 235 Trimming composite mouldings using hand tools

Outcome 2 Know how to trim composite mouldings using hand tools

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the health and safety precautions to be taken and procedures used when working with composite materials, consumables, tools and equipment in the specific work area
- 2 describe the hazards associated with trimming composite materials, consumables, tools and equipment, and how to minimise these and reduce any risks in the work area
- 3 describe the protective equipment that is needed for personal protection and, where required, the protection of others
- 4 describe the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables
- 5 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 6 explain how to interpret drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
- 7 explain how to prepare for the trimming activities, and how to mark out the mouldings for the material that needs to be removed
- 8 describe the quality procedures used in the workplace to ensure production control (such as in relation to currency, issue, meeting specification, etc)
- 9 describe the conventions and terminology used for trimming activities (such as scribe lines, sanding grades, types of cutting tools, speeds)
- 10 describe the different types of manual and power tools used in composite trimming operations
- 11 describe the different types of cutting tools and abrasives used in trimming composite materials, and their application
- 12 describe the visual identification of cured composite materials
- 13 describe the identification of defects in composite mouldings
- 14 describe the methods used in the trimming of composite mouldings
- 15 describe the care and safe handling of composite mouldings throughout the trimming cycle
- 16 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Level: 2
Credit value: 23
UAN: F/600/6054

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to identify and deal with defects in composite mouldings (moulds, panels, components, jigs), in accordance with approved procedures. The learner will be required to follow appropriate drawings, specifications and documentation to identify and deal with defects in composites mouldings.

The learner will be able to identify a range of defects in composite mouldings, using various methods and techniques. Defects will be identified in a range of mouldings with a variety of resin and fibre materials.

The learner's responsibilities will require them to comply with organisational policy and procedures for the activities undertaken, and to report any problems with the activities that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work they carry out.

The learner's knowledge will be sufficient to provide a good understanding of their work, and will provide an informed approach to identifying defects in composite mouldings. The learner will have an understanding of composite materials, and their application, and will know about the associated defects, in adequate depth to provide a sound basis for identifying the defects in line with organisation practice and procedures.

The learner will understand the safety precautions required when working with the composite mouldings and when using associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to identify defects in composite mouldings
- 2 Know how to identify defects in composite mouldings

Guided learning hours

It is recommended that **95** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 36: Identifying Defects in Composite Mouldings (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 236

Outcome 1

Identifying defects in composite mouldings

Be able to identify defects in composite mouldings

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 inspect mouldings to one of the following standards:
 - BS, ISO or BSEN standards and procedures
 - customer standards and requirements
 - company standards and procedures
 - specific material/moulding requirements
- 3 identify defects with regard to the product or asset specification
- 4 carry out all of the following during the inspection activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation, material data sheets)
 - 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
 - obtain the correct tools and equipment for the activity and ensure they are safe to use
 - apply safe and appropriate inspection techniques and procedures at all times
 - keep the work area in a safe and suitable condition
- 5 identify defects in composite mouldings using four of the following methods:
 - touch
 - sound
 - visual
 - measurement
 - mechanical tests
 - co-ordinate measuring machines (CMM)
 - non-destructive testing (NDT)
 - stage inspection
- 6 identify defects in six of the following types of composite mouldings:
 - trim
 - closing panels
 - housings
 - body panels
 - tubes
 - sections
 - sandwich panels
 - structural
 - aerodynamic
 - moulds
 - jigs

- 7 identify defects applicable to two of the following resin types:
- polyester
 - vinyl ester
 - epoxy
 - phenolic
 - bismaleimide
 - cyanate ester
- 8 identify defects applicable to two of the following fibre types:
- polyethylene
 - glass
 - aramid
 - carbon
- 9 identify eight of the following types of defect in composite mouldings:
- incomplete curing
 - dimensional
 - tolerances
 - ply orientation
 - wrong join type
 - surface finish
 - distortion
 - blisters
 - bridging
 - de-lamination
 - wrinkles
 - broken fibres
 - splintering
 - voids
 - dents or 'dings'
 - dis-bonds
 - resin rich areas
 - incorrect material
 - excessive adhesive
 - damaged cores
 - wrong inserts
 - insert positions
 - impact damage
- 10 assess the defects and determine action required to return the products and assets to specified condition
- 11 report recommendations for action to the appropriate people promptly and in accordance with organisational procedures
- 12 record details of defects in accordance with quality assurance and control systems and procedures.

Unit 236

Outcome 2

Identifying defects in composite mouldings

Know how to identify defects in composite mouldings

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the health and safety precautions to be taken and procedures used when working with composite materials, consumables, tools and equipment in the specific work area
- 2 describe the hazards associated with working with composite materials, consumables, tools and equipment, and how to minimise these and reduce any risks in the work area
- 3 describe the protective equipment that is needed for personal protection and, where required, the protection of others
- 4 describe the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables
- 5 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 6 explain how to use imperial and metric systems of measurement, workpiece reference points and system of tolerancing
- 7 describe the quality procedures used in the workplace to ensure production control (such as in relation to currency, issue, meeting specification), and the completion of appropriate documents
- 8 describe the conventions and terminology used when identifying and rectifying defects (such as dis-bonds, de-lamination, resin injection, resin voids, core potting, repair patches)
- 9 describe the failure modes for various composite mouldings, and what can contribute to these
- 10 describe the correct methods of storage and handling of composite materials
- 11 describe the tools and equipment used for checking the various composite mouldings
- 12 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Unit 237

Carrying out repairs to composite mouldings

Level: 2
Credit value: 42
UAN: J/600/6055

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out repairs to composite mouldings (cured panels, moulds, components and jigs), in accordance with approved procedures. The learner will be required to use appropriate specifications and documentation to bond composite materials, using the correct techniques.

The learner will be required to obtain all relevant and current documentation relating to the repair, to obtain the tools and equipment required for the repair operations, and to check that they are in a safe and usable condition. In carrying out the repair, they will be required to follow company procedures and specified repair techniques. The learner 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.

The learner's 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. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will be sufficient to provide a good understanding of their work, and will provide an informed approach to applying composite moulding repair procedures. The learner 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.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to carry out repairs to composite mouldings
- 2 Know how to carry out repairs to composite mouldings

Guided learning hours

It is recommended that **151** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 37: Carrying Out Repairs to Composite Mouldings (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 237

Outcome 1

Carrying out repairs to composite mouldings

Be able to carry out repairs to composite mouldings

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 repair a range of composite mouldings which comply with one of the following standards:
 - BS, ISO or BSEN standards and procedures
 - customer standards and requirements
 - company standards and procedures
 - specific material/moulding requirements
- 3 follow the relevant specifications for the component to be repaired
- 4 prepare the component for repair
- 5 carry out the repairs within agreed timescale using approved materials and components and methods and procedures
- 6 carry out all of the following during the repair activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation, material data sheets, repair procedures)
 - 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
 - obtain the correct tools and equipment for the activity and ensure they are safe to use
 - identify what needs to be repaired and the method of repair to be used
 - use the correct materials and consumables, as specified in the repair/production documentation
 - apply appropriate and safe repair techniques and procedures at all times
 - keep the work area in a safe and suitable condition
- 7 repair defects in three of the following types of composite moulding:
 - trim
 - closing panels
 - housings
 - body panels
 - tubes
 - sections
 - sandwich panels
 - structural
 - aerodynamic
 - moulds
 - jigs

- 8 repair defects in composite mouldings using three of the following methods:
- localised curing
 - fettling
 - surface filling
 - relieving distortion
 - separation of bonds
 - bonding
 - resin injection
 - wet-lay patching
 - pre-preg patching
 - core patching
 - insert/core potting
 - repair patches/kits
- 9 repair defects in composite mouldings using techniques and materials applicable to both of the following:
- resins (such as polyester, vinyl ester, epoxy, phenolic, bismaleimide, cyanate ester)
 - fibres (such as polyethylene, glass, aramid, carbon)
- 10 repair five of the following types of defect in composite mouldings:
- incomplete curing
 - dimensional
 - surface finish
 - distortion
 - blisters
 - bridging
 - de-lamination
 - broken fibres
 - voids
 - dis-bonds
 - dents or 'dings'
 - excessive adhesive
 - damaged cores
 - wrong inserts
 - insert positions
 - impact damage
- 11 ensure that the repaired component meets the specified operating conditions
- 12 produce accurate and complete records of all repair work carried out.

Unit 237

Outcome 2

Carrying out repairs to composite mouldings

Know how to carry out repairs to composite mouldings

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the health and safety precautions to be taken and procedures used when working with composite materials, consumables, tools and equipment in the specific work area
- 2 describe the hazards associated with carrying out repairs to composite materials, consumables, tools and equipment, and how to minimise these and reduce any risks in the work area
- 3 describe the protective equipment that is needed for personal protection and, where required, the protection of others
- 4 describe the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables
- 5 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 6 describe the quality procedures used in the workplace to ensure that repairs are carried out satisfactorily
- 7 describe the conventions and terminology used when repairing composite mouldings (such as dis-bonds, de-lamination, resin injection, resin voids, core potting, repair patches)
- 8 describe the different types of composite resin systems, fibres and reinforcements, and the repair techniques that can be used
- 9 describe the various bonding agents and methods used
- 10 describe the correct methods of storage and handling of composite materials
- 11 describe the tools and equipment used for the various activities associated with repairing composite mouldings
- 12 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Unit 238

Applying surface finishes to composite mouldings

Level: 2
Credit value: 32
UAN: L/600/6056

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to apply finishes to composite mouldings (moulds, panels and components), in accordance with approved procedures. The learner will be required to use appropriate drawings, specifications and documentation to apply finishes, using the correct techniques.

The learner will apply finishes to composite mouldings using a range of techniques and processes. A variety of finishes will be applied to a range of resin and fibre materials.

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

The learner's knowledge will be sufficient to provide a good understanding of their work, and will provide an informed approach to applying finishing techniques and procedures to composite mouldings. The learner will have an understanding of the finishing techniques used, and their application, in adequate depth to provide a sound basis for carrying out the activities, recognising faults and ensuring the work output is to the required specification.

The learner will understand the safety precautions required when carrying out the finishing operations and when using the associated tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to apply surface finishes to composite mouldings
- 2 Know how to apply surface finishes to composite mouldings

Guided learning hours

It is recommended that **130** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 38: Applying Surface Finishes to Composite Mouldings (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 238

Applying surface finishes to composite mouldings

Outcome 1

Be able to apply surface finishes to composite mouldings

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 carry out all of the following during the finishing activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation, material data sheets)
 - 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
 - obtain the correct tools and equipment for the activity and ensure they are safe to use
 - use the correct materials and consumables, as specified in the finishing documentation
 - apply safe and appropriate finishing techniques and procedures at all times
 - keep the work area in a safe and suitable condition
- 3 ensure the material surfaces to be treated are suitably prepared for the finishing operations to be carried out
- 4 carry out all of the following activities when preparing for the finishing activity:
 - check that mouldings are correct and complete
 - check for any defects in the mouldings
 - check availability of ancillary materials required
 - select correct equipment for the activity
 - check that equipment is suitable for use
 - identify and protect the moulding in the work area
- 5 prepare surfaces of composite mouldings, using two of the following methods:
 - abrading
 - bead blasting
 - water cleaning
 - solvent cleaning
 - priming
- 6 check that the finishing equipment and treatment solutions are set up and maintained at satisfactory operating conditions and levels
- 7 carry out the treatment process in accordance with operating procedures and the component specification requirements
- 8 apply finishes to composite mouldings, using two of the following techniques:
 - cloth application
 - brush
 - spray
 - laying films
 - roller

- 9 apply two types of finish to composite mouldings from the following:
 - surface sealers
 - primers
 - top coats
 - adhesive films
 - UV coatings
 - heatproof coatings
 - speciality coatings
 - flexible coatings
- 10 apply finishes to composite mouldings, using three of the following:
 - one-part finishes
 - two-part finishes
 - multiple coatings
 - combination coats
 - solvent based
 - adhesive based
 - water based
 - single coatings
- 11 use four of the following consumable materials during the finishing operations:
 - abrasives
 - masking tapes
 - masking films
 - polishes
 - thinners
 - solvents
 - stoppers
 - fillers
 - sealers
 - primers
 - cutting compounds
 - cleaning agents
- 12 apply finishes to composite mouldings which are suitable for two of the following resin types:
 - polyester
 - vinyl ester
 - epoxy
 - phenolic
 - bismaleimide
 - cyanate ester
- 13 ensure that the treated workpiece achieves the required characteristics and meets the finishing specification
- 14 apply finishes to composite mouldings suitable for two of the following fibre types:
 - polyethylene
 - glass
 - aramid
 - carbon
- 15 apply finishes to a range of mouldings, which comply with one of the following standards:
 - meet company standards and procedures

- meet customer standards and requirements
 - have an appropriate surface finish and are free from defects or surface blemishes
- 16 deal promptly and effectively with problems within their control and report those that cannot be solved
- 17 dispose of waste and excess materials in line with agreed organisational procedures
- 18 shut down the finishing equipment to a safe condition on completion of the processing activities.

Unit 238

Applying surface finishes to composite mouldings

Outcome 2

Know how to apply surface finishes to composite mouldings

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the health and safety precautions to be taken and procedures used when working with composite materials, consumables, tools and equipment in the specific work area
- 2 describe the hazards associated with composite materials, consumables, tools and equipment, and how to minimise these and reduce any risks in the work area
- 3 describe the protective equipment that is needed for personal protection and, where required, the protection of others
- 4 describe the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables
- 5 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 6 describe the quality procedures used in the workplace to ensure production control (such as in relation to currency, issue, meeting specification), and the completion of appropriate documents
- 7 describe the conventions and terminology used for applying finishes (such as surface keying, finish thickness, matt finish, gloss finish, treatment reactions)
- 8 describe the different types of composite resin systems, fibres and reinforcements, and their merits
- 9 describe the different finishes applied to composites, and their merits
- 10 describe the correct methods of storage, handling and disposal of finishing materials
- 11 describe the methods of preparation for applying different finishes
- 12 describe the mixing ratios for two-part finishes, and the associated working times
- 13 describe the methods of application for different finishes
- 14 describe the problems that can occur during the finishing process, including defects such as contamination
- 15 explain how defects can be overcome during the finishing activity
- 16 describe the tools and equipment used in finishing activities, and their care, preparation and control procedures
- 17 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Unit 239

Bonding composite mouldings

Level: 2
Credit value: 23
UAN: Y/600/6058

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to bond composite mouldings, in accordance with approved procedures. The learner will be required to follow the appropriate instructions, drawings, specifications and documentation to bond composite materials, using the correct production techniques.

The learner will produce a range of bonded composite mouldings, incorporating a variety of features and using a range of techniques and processes. Bonded mouldings produced will include a range of resin, fibre and adhesive materials.

The learner's responsibilities will require them to comply with organisational policy and procedures for the composite bonding activities undertaken, and to report any problems with the bonding activities, equipment or materials that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will be sufficient to provide a good understanding of their work, and will provide an informed approach to applying composite bonding techniques and procedures. The learner will have an understanding of the bonding techniques used, and their application, in adequate depth to provide a sound basis for carrying out the activities, recognising faults, and ensuring the work output is to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to bond composite mouldings
- 2 Know how to bond composite mouldings

Guided learning hours

It is recommended that **95** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 39: Bonding Composite Mouldings (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 239

Bonding composite mouldings

Outcome 1

Be able to bond composite mouldings

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 follow the relevant bonding procedure specification and job instructions
- 3 check that the materials to be bonded and bonding agents comply with the specification
- 4 correctly prepare the parent materials and bonding agents in line with the bonding specification
- 5 carry out all of the following when preparing for the bonding activity:
 - check that mouldings are correct and complete
 - check for any defects in the mouldings
 - identify and protect the moulding and bonding materials in the work area
 - check that bonding materials are correct and complete
- 6 prepare bonding surfaces, using three of the following methods:
 - peel plies
 - templates
 - abrading
 - bead blasting
 - water cleaning
 - solvent cleaning
 - dry fitting
 - acid etching
 - priming
 - surface masks
- 7 carry out the bonding operations using the specified processes and techniques to position and bond the materials in their correct locations
- 8 carry out all of the following during the bonding activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation, material data sheets)
 - 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
 - obtain the correct tools and equipment for the activity and ensure they are safe to use
 - use the correct materials and consumables, as specified in the production documentation
 - apply safe and appropriate bonding techniques at all times
 - keep the work area in a safe and suitable condition
- 9 bond composite mouldings, using techniques for one of the following:
 - one-part pastes
 - two-part pastes
 - film adhesives
 - syntactic films

- 10 use two of the following methods when bonding the composite mouldings:
 - dry fitting
 - bonding sequences
 - shimming materials
 - mixing adhesives
 - wetting-out by brush
 - applicator gun
 - laying film adhesives
 - oven curing
 - heated press
- 11 bond composite mouldings using techniques for one of the following:
 - sandwich panels
 - butt joints
 - overlap joints
 - joggle joints
 - return joints
- 12 bond composite mouldings using techniques for two of the following:
 - flat surfaces
 - shaped surfaces
 - internal surfaces
 - external surfaces
- 13 use appropriate techniques for bonding one of the following materials to the composite moulding:
 - other composites
 - metals
 - ceramics
 - plastics
 - wood-based materials
- 14 bond composite mouldings using adhesives suitable for both of the following:
 - resins (such as polyester, epoxy, phenolic, bismaleimide, cyanate ester, vinyl ester)
 - fibres (such as polyethylene, glass, aramid, carbon, other specific types)
- 15 ensure that any equipment used to maintain surface contact during the bonding activities is set up and used correctly
- 16 use one of the following to retain the bond during the curing process:
 - weighting down
 - bonding jigs
 - pinning joints
 - clamping
 - press
 - vacuum bagging
- 17 achieve bonds of the required quality and within the specified dimensional accuracy
- 18 bond a range of mouldings which comply with one of the following standards:
 - BS, ISO or BSEN standards and procedures
 - customer standards and requirements
 - company standards and procedures
 - specific material/moulding requirements
- 19 deal promptly and effectively with problems within their control and report those that cannot be solved.

Unit 239

Outcome 2

Bonding composite mouldings

Know how to bond composite mouldings

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the health and safety precautions to be taken and procedures used when working with composite materials, consumables, tools and equipment in the specific work area
- 2 describe the hazards associated with bonding composite materials, consumables, tools and equipment, and how to minimise these and reduce any risks in the work area
- 3 describe the protective equipment that is needed for personal protection and, where required, the protection of others
- 4 describe the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables
- 5 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 6 explain how to use imperial and metric systems of measurement, workpiece reference points and system of tolerancing
- 7 describe the quality procedures used in the workplace to ensure production control (such as in relation to currency, issue, meeting specification)
- 8 describe the conventions and terminology used for bonding (such as gel points, cure times, bond thickness, bond strength, peel strength)
- 9 describe the correct methods of storage and handling of bonding agents
- 10 describe the methods of preparation for bonding different materials
- 11 describe the methods of application for different bonding agents
- 12 describe the methods of retaining the bond during the curing process, and their merits
- 13 describe the tools and equipment used in bonding activities, and their care, preparation and control procedures
- 14 describe the identification of bonding defects
- 15 describe the problems that can occur during the bonding process
- 16 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Unit 240

Producing composite assemblies

Level: 2
Credit value: 42
UAN: D/600/6059

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to produce composite assemblies from composite components and non-composite components, in accordance with approved procedures. The learner will be required to work to instructions, specifications and documentation to produce the composite assemblies, using the correct techniques. The learner will produce a variety of composite assemblies, incorporating a range of features and using a number of techniques and processes.

The learner's responsibilities will require them to comply with organisational policy and procedures for the composite assembly activities undertaken, and to report any problems with the assembly activities, equipment or materials that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will be sufficient to provide a good understanding of their work, and will provide an informed approach to applying composite assembly techniques and procedures. The learner will have an understanding of the composite assembly techniques used, and their application, in adequate depth to provide a sound basis for carrying out the activities, recognising faults, and ensuring the finished assembly is to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to produce composite assemblies
- 2 Know how to produce composite assemblies

Guided learning hours

It is recommended that **151** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 40: Producing Composite Assemblies (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 240

Producing composite assemblies

Outcome 1

Be able to produce composite assemblies

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 follow the relevant instructions, assembly drawings and any other specifications
- 3 carry out all of the following during the assembly activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation, material data sheets)
 - 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
 - obtain the correct tools and equipment for the activity and ensure they are safe to use
 - ensure that components to be used are of the correct type, and that all mouldings are free from defects
 - apply safe and appropriate assembly techniques and procedures at all times
 - keep the work area in a safe and suitable condition
- 4 ensure that the specified components are available and that they are in a usable condition
- 5 use the appropriate methods and techniques to assemble the components in their correct positions
- 6 produce one of the following types of composite assembly:
 - one-off assemblies
 - batch assemblies
 - assembly line
- 7 produce assemblies that incorporate two of the following features:
 - loose fit tolerances
 - close fit tolerances
 - non-permanent fixing
 - shape location
 - joggle joints
 - permanent fixing
 - return joints
 - overlap joints
- 8 produce composite assemblies that require two of the following methods to be used:
 - fettling
 - pinning
 - clamping
 - trial fitting
 - aligning
 - assembly jigs

- 9 produce composite assemblies that use one of the following joining methods:
 - thread inserts
 - quick-release fasteners
 - rivets
 - mechanical fasteners
 - anchor nuts
- 10 assemble composite components which include two of the following:
 - trim
 - closing panels
 - body panels
 - tubes
 - structural
 - aerodynamic
 - core materials
 - sections
 - inserts
 - housings
- 11 produce assemblies which include one of the following non-composite components:
 - brackets
 - fixtures
 - fittings
 - trim
 - tapes
 - memory foam
 - films
- 12 secure the components using the specified connectors and securing devices
- 13 check the completed assembly to ensure that all operations have been completed and the finished assembly meets the required specification
- 14 produce assemblies which comply with one of the following standards:
 - BS, ISO or BSEN standards and procedures
 - customer standards and requirements
 - company standards and procedures
 - specific material/moulding assembly requirements
- 15 deal promptly and effectively with problems within their control and report those that cannot be solved.

Unit 240

Producing composite assemblies

Outcome 2

Know how to produce composite assemblies

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the health and safety precautions to be taken and procedures used in the specific work area, when working with composite materials, consumables, tools and equipment
- 2 describe the hazards associated with assembling composite materials, and with the consumables, tools and equipment used, and how to minimise these and reduce any risks in the work area
- 3 describe the protective equipment that is needed for personal protection and, where required, the protection of others
- 4 describe the application of COSHH regulations in relation to the storage, use and disposal of composite materials and consumables
- 5 explain how to extract and use information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 6 explain how to use imperial and metric systems of measurement, workpiece reference points and system of tolerancing
- 7 describe the quality procedures used in the workplace to ensure production control
- 8 describe the methods of assembling composite components using mechanical methods (such as screw fasteners, rivets, special purpose fittings)
- 9 describe the methods for handling composite assemblies throughout the assembly activities
- 10 describe the tools and equipment used in assembly activities, and their care, preparation and control procedures
- 11 describe the things that can go wrong with the assembly activities, and how they can be avoided
- 12 describe the extent of their own authority and to whom they should report if they have problems that they cannot resolve.

Unit 241

Carrying out inspection activities on optical components

Level: 2
Credit value: 42
UAN: R/600/6060

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out optical inspection operations, in accordance with approved procedures, using optical inspection techniques and equipment. The learner will be expected to check components made from a range of optical materials, using a mixture of inspection equipment, as appropriate. The learner will be required to inspect a range of components that combine a number of different features, such as centre-thickness, diameters, generated blanks, optical lens form and power, angles, profiles, and with cosmetic defects.

The learner will be required to operate the equipment in line with safe working practices and approved procedures, and to continuously monitor the equipment operations, making any necessary minor adjustments or seek help in making the adjustments, in order to ensure that the work output is to the required quality and accuracy.

The learner's responsibilities will require them to comply with organisational policy and procedures for the optical inspection activities undertaken, and to report any problems with the optical inspection activities, equipment or materials that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will be sufficient to provide a good understanding of their work, and will enable them to adopt an informed approach to applying optical inspection procedures. The learner will understand the optical inspection procedures used, and their application, and know about the equipment, materials and consumables, in adequate depth to provide a sound basis for carrying out the activities, identifying out-of-specification components, and ensuring accepted components meet the required specification.

The learner will understand the safety precautions required when working with the inspection equipment. The learner will be required to demonstrate safe working practices throughout, and will understand the responsibility they owe to themselves and others in the workplace.

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to carry out inspection activities on optical components
- 2 Know how to carry out inspection activities on optical components

Guided learning hours

It is recommended that **151** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 41: Carrying Out Inspection Activities on Optical Components (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 241 **Carrying out inspection activities on optical components**

Outcome 1 Be able to carry out inspection activities on optical components

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 follow the correct specification for the product or equipment being inspected
- 3 inspect optical components to one of the following:
 - BS, ISO or BSEN standards and procedures
 - other accepted international standards
 - customer (contractual) standards and requirements
 - company standards and procedures
- 4 use the correct equipment to carry out the inspection
- 5 operate four types of optical inspection equipment from the following:
 - lens centring rig
 - centre thickness gauge
 - microscopes
 - micrometers
 - optical measuring equipment
 - focometer test equipment
 - auto collimators
 - optical spheres
 - optical flats
 - dial test indicators
 - slip gauges
 - Vernier equipment
 - interferometry and phase analysis equipment
 - shadowgraph test equipment
- 6 identify and confirm the inspection checks to be made and acceptance criteria to be used
- 7 carry out all required inspections as specified
- 8 carry out all of the following during the inspection activity:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation, material data sheets)
 - 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
 - obtain and check that the required inspection equipment is within current calibration dates
 - use appropriate inspection techniques to check the components
 - determine any out-of-specification components

- complete all relevant inspection documentation, accurately and legibly
 - apply safe working practices at all times
- 9 inspect three types of optical component from the following:
- infra-red lens
 - combiners
 - infra-red glass flats
 - infra-red glass domes
 - cylinders
 - glass prisms
 - infra-red prisms
 - plastic lens components
 - glass lens
 - optical mirrors
 - profiled optical components
- 10 inspect six features of machined optical components from the following:
- prism angles
 - concentricity
 - profiles
 - focal length
 - flats power error
 - lens diameter
 - lens form error
 - sag depth
 - lens centring
 - cosmetic defect
 - cap height
 - flats form error
 - centre thickness
 - refractive index
 - other features
 - truncation
 - lens wedge
 - flat/parallelism
 - lens power (radius)
- 11 use inspection methods and techniques suitable for components made from three different types of material:
- germanium
 - barium crowns
 - dense flints
 - flints/light flints
 - infra-red glass 4,5,6
 - barium dense flints
 - zinc selenide
 - zinc sulphide
 - silicon
 - plastics
 - lanthanum crowns

- anomalous dispersion flint crowns
- optical neutral density glass
- optical orange filter glass
- optical blue filter glass
- thallium iodobromide
- borosilicate crowns
- other

12 identify any defects or variations from the specification

13 record the results of the inspection in the appropriate format

14 deal promptly and effectively with problems within their control and report those that cannot be solved.

Unit 241

Carrying out inspection activities on optical components

Outcome 2

Know how to carry out inspection activities on optical components

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed while using optical inspection equipment
- 2 describe the safety mechanisms on the equipment, and the procedure for checking that they function correctly
- 3 describe the personal protective equipment to be worn, and where this can be obtained
- 4 describe the hazards associated with carrying out optical inspection operations, and how to minimise them and reduce any risks
- 5 describe the importance of keeping the work area clean and tidy
- 6 explain how to extract and use information from optical engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 7 explain how to use imperial and metric systems of measurement, workpiece reference points and system of tolerancing
- 8 describe the various optical inspection operations to be performed, and types of equipment used
- 9 explain how to set or check the calibration of the equipment before inspection operations are carried out
- 10 explain how to recognise the various cosmetic defects
- 11 explain how to handle and store all inspection equipment, safely and correctly
- 12 explain how the various types of material will affect the way the inspection operation is performed
- 13 describe the effect of clamping the workpiece, and how this can cause distortion in the finished component
- 14 explain how to recognise inspection equipment faults, and identify when inspection equipment needs refurbishment
- 15 describe the problems that can occur with optical inspection activities, and how they can be overcome
- 16 describe the quality control procedures used, inspection checks to be carried out, and the equipment used
- 17 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 242

Operating infra-red/special material lens process machines

Level: 2
Credit value: 42
UAN: Y/600/6061

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out machining operations on optical infra-red and special materials, in accordance with approved procedures, using optical infra-red process machines. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components, materials and consumables are available. The learner will be required to operate a range of machines, in order to produce the components that combine a mixture of processes identified for infra-red and special materials, using a selection of specified optical lens and flat materials. The learner will be expected to produce a range of components that combine a number of different features, such as centre thickness, diameters, generated blanks, optical lens form and power.

The learner will be required to operate the machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the machine setter to make the adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

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

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying optical machining procedures. The learner will have an understanding of the optical lens and flat infra-red and special materials processes used, and their application, and will know about the optical procedures, equipment, materials and consumables, in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate infra-red/special material lens process machines
- 2 Know how to operate infra-red/special material lens process machines

Guided learning hours

It is recommended that **151** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 42: Operating Infra-Red/Special Material Lens Process Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 242

Operating infra-red/special material lens process machines

Outcome 1

Be able to operate infra-red/special material lens process machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 apply all of the following during the machine activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without damage or distortion
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 3 confirm that the machine is set up and ready for the machining activities to be carried out
- 4 manipulate the machine tool controls safely and correctly in line with operational procedures
- 5 produce components to the required quality and within the specified dimensional accuracy
- 6 operate two types of optical lens process machines from the following:
 - conventional pitch
 - lens silk polishing
 - flat silk polishing
 - special materials
 - automated
 - generating
 - lens edging
- 7 produce machined optical components that combine different operations and cover four of the following:
 - centre thickness
 - lens diameter
 - lens concentricity

- flat parallelism
 - lens form analysis
 - lens power analysis
 - lens surface generation
 - lens cosmetic defects
 - lens truncation and cap height
- 8 machine two different types of materials from the following:
- zinc selenide
 - zinc sulphide
 - optical silicon
 - other optical grade
 - optical infra-red glass 4
 - optical infra-red glass 5
 - optical infra-red glass 6
 - optical cleartran
 - optical grade germanium
 - optical thallium ideobromide
 - other appropriate optical material
- 9 carry out quality sampling checks at suitable intervals
- 10 produce components with dimensional accuracy, form and surface quality, which comply to one of the following standards:
- BS, ISO or BSEN standards and procedures
 - other accepted international standards
 - customer (contractual) standards and requirements
 - company standards and procedures
- 11 carry out the necessary checks for accuracy during production of three of the following:
- optical bevels
 - lens chamfers
 - lens diameters
 - lens surface finish
 - lens cap height
 - optical parallelism
 - optical truncations
 - lens centre thickness
 - lens surface form error
 - lens surface power error
- 12 deal promptly and effectively with problems within their control and report those that cannot be solved
- 13 shut down the equipment to a safe condition on conclusion of the machining activities.

Unit 242

Operating infra-red/special material lens process machines

Outcome 2

Know how to operate infra-red/special material lens process machines

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed while operating optical lens generating, smoothing and polishing equipment
- 2 describe the safety mechanisms on the machine, and the procedure for checking that they function correctly
- 3 describe the operation of the machine controls in both set-up and run modes, and how to stop the machine in an emergency
- 4 describe the personal protective equipment to be worn, and where this can be obtained
- 5 describe the hazards associated with carrying out optical lens process operations, and how to minimise them and reduce any risks
- 6 describe the importance of keeping the work area clean and tidy
- 7 explain where to obtain the component drawing, specifications and/or job instructions required for the components to be machined
- 8 explain how to interpret optical engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 9 explain how to use imperial and metric systems of measurement
- 10 describe the various optical lens operations that can be performed
- 11 describe the effects of backlash in machine slides, dials and screws, and how this can be overcome
- 12 explain how to handle and store all cutting tools and kit required, safely and correctly
- 13 describe the application of roughing and finishing cuts and the effect on tool life, surface finish and dimensional accuracy
- 14 explain how tool wear affects surface finish and dimensional accuracy
- 15 explain how the various types of material will affect the way the operation is performed
- 16 describe the application of cutting fluids with regard to the range of material being produced
- 17 describe the effect of clamping the workpiece, and how this can cause distortion in the finished component
- 18 explain how to recognise machine faults and identify when tooling needs refurbishment
- 19 describe the problems that can occur with optical lens infra-red and special material machining activities, and how they can be overcome
- 20 describe the quality control procedures used, inspection checks to be carried out, and the equipment used
- 21 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Level: 2
Credit value: 42
UAN: D/600/6062

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out machining operations on optical glass lens material, in accordance with approved procedures, using optical glass lens process machines. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components/materials and consumables are available. The learner will be required to operate a range of machines, in order to produce components that combine a mixture of processes identified for optical glass lens machining, using a selection of specified optical glass materials. The learner will be expected to produce a range of components that combine a number of different features such as centre thickness, diameters, generated blanks, optical lens form and power.

The learner will be required to operate the machines in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the machine setter to make the adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the optical glass machining activities undertaken, and to report any problems with the machining activities, materials or equipment that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying optical machining procedures. The learner will have an understanding of the optical glass lens processes used, and their application, and will know about the equipment, materials and consumables, in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate optical glass lens process machines
- 2 Know how to operate optical glass lens process machines

Guided learning hours

It is recommended that **151** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 43: Operating Optical Glass Lens Process Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 243

Operating optical glass lens process machines

Outcome 1

Be able to operate optical glass lens process machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the machine is set up and ready for the machining activities to be carried out
- 3 apply all of the following during the machine activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without damage or distortion
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 4 manipulate the machine tool controls safely and correctly in line with operational procedures
- 5 produce components to the required quality and within the specified dimensional accuracy
- 6 operate two types of optical lens process machine from the following:
 - lens edging
 - automated small lens
 - conventional large lens pitch
 - generating
 - automated large lens
 - conventional small lens pitch
- 7 produce optical machined components which combine different operations and cover four of the following:
 - centre thickness
 - lens diameter
 - lens concentricity
 - lens wedge
 - lens form analysis

- lens power analysis
 - lens surface generation
 - lens cosmetic defects
 - lens truncation and cap height
- 8 machine two different types of material from the following:
- barium crowns
 - borosilicate crowns
 - flints/light flints
 - optical orange filter glass
 - optical blue filter glass
 - optical neutral density glass
 - anomalous dispersion flint crowns
 - other optical grades
 - dense flints
 - barium dense flints
 - lanthanum crowns
- 9 carry out quality sampling checks at suitable intervals
- 10 produce components with dimensional accuracy, form and surface quality which complies to one of the following standards:
- BS, ISO or BSEN standards and procedures
 - other accepted international standards
 - customer (contractual) standards and requirements
 - company standards and procedures
- 11 carry out the necessary checks for accuracy during production of three of the following:
- optical bevels
 - optical lens wedge
 - optical parallelism
 - optical truncations
 - lens cap height
 - lens chamfers
 - lens diameters
 - lens surface finish
 - lens surface power error
 - lens centre thickness
 - lens surface form error
- 12 deal promptly and effectively with problems within their control and report those that cannot be solved
- 13 shut down the equipment to a safe condition on conclusion of the machining activities.

Unit 243

Outcome 2

Operating optical glass lens process machines

Know how to operate optical glass lens process machines

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed while operating optical lens generating, smoothing and polishing equipment
- 2 describe the safety mechanisms on the machine, and the procedure for checking that they function correctly
- 3 describe the operation of the machine controls in both set-up and run modes, and how to stop the machine in an emergency
- 4 describe the personal protective equipment to be worn, and where this can be obtained
- 5 describe the hazards associated with carrying out optical lens process operations, and how to minimise them and reduce any risks
- 6 describe the importance of keeping the work area clean and tidy
- 7 explain where to obtain the component drawing, specifications and/or job instructions required for the components to be machined
- 8 explain how to extract and use information from optical engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 9 explain how to use imperial and metric systems of measurement
- 10 describe the various optical lens operations that can be performed
- 11 describe the effect of backlash in machines slides, dials and screws, and how this can be overcome
- 12 explain how to handle and store all cutting tools and kit required, safely and correctly
- 13 describe the application of roughing and finishing cuts and pressures, and the effects on tool life, surface finish and dimensional accuracy
- 14 explain how tool wear affects surface finish and dimensional accuracy
- 15 explain how the various types of material will affect the way the operation is performed
- 16 describe the application of cutting fluids/rouges, with regard to the range of material being produced
- 17 describe the effect of clamping the workpiece, and how this can cause distortion in the finished component
- 18 explain how to recognise machine faults, and how to identify when tooling needs refurbishment
- 19 describe the problems that can occur with optical lens glass machining activities, and how they can be overcome
- 20 describe the quality control procedures used, inspection checks to be carried out, and the equipment used
- 21 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 244

Operating optical prism and flat process machines

Level: 2
Credit value: 42
UAN: K/600/6064

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out machining operations on optical prisms and flat components, in accordance with approved procedures, using a range of optical prism and flat process machines. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components, materials and consumables are available. In operating the machine, the learner will be expected to produce a range of components that combine a number of different features such as angles, flats, parallelism, wedge shapes, chamfers and bevels, using a selection of specified optical prism and flat materials. The learner will also be required to check the finished components for accuracy and quality.

The learner will be required to operate the machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary, make minor adjustments or seek the help of the machine setter to make the adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the optical machining activities undertaken, and to report any problems with the machining activities, materials, tooling or consumables that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying optical machining procedures. The learner will have an understanding of the optical prism and flat machining processes, and their application, and will know about the equipment, materials and consumables, in adequate depth to provide a sound background for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate optical prism and flat process machines
- 2 Know how to operate optical prism and flat process machines

Guided learning hours

It is recommended that **151** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 44: Operating Optical Prism and Flat Process Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 244

Operating optical prism and flat process machines

Outcome 1

Be able to operate optical prism and flat process machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the machine is set up and ready for the machining activities to be carried out
- 3 apply all of the following during the machining activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without damage or distortion
 - follow the defined operating procedures and apply safe working practices and procedures at all times
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 4 manipulate the machine tool controls safely and correctly in line with operational procedures
- 5 produce components to the required quality and within the specified dimensional accuracy
- 6 operate two of the following types of optical prism and flat process machine:
 - preparation and smoothing
 - twin lap flat polishing
 - lap-master flat and prism
 - hard lap flat and prism polishing
- 7 produce machined optical components which combine different operations and cover four of the following:
 - flat centre thickness
 - angular tolerances
 - flatness tolerances
 - parallelism tolerances
 - cosmetic tolerances
 - transmission tolerances

- finished size tolerances
 - prism chamfers/bevels tolerances
- 8 machine two different types of materials from the following:
- optical grade germanium
 - zinc selenide prisms and flats
 - zinc sulphide prisms and flats
 - borosilicate crowns
 - barium crowns
 - dense flints
 - optical orange filter glass
 - optical blue filter glass
 - optical neutral density glass
 - flint/light flints
 - barium dense flints
 - lanthanum crowns
 - anomalous dispersion flint crowns
 - other appropriate optical material
- 9 carry out quality sampling checks at suitable intervals
- 10 produce components with dimensional accuracy, form and surface quality, which comply to one of the following standards:
- BS, ISO or BSEN standards and procedures
 - other accepted international standards
 - customer (contractual) standards and requirements
 - company standards and procedures
- 11 carry out the necessary checks for optical accuracy during production of four of the following:
- flatness
 - prism chamfers and bevels
 - flat centre thickness
 - prism surface cosmetics
 - prism flatness measurement
 - flat surface cosmetics
 - flat chamfers and bevels
 - prism angular measurement
 - flat parallelism
 - prism baffle height measurement
 - flatness transmission
- 12 deal promptly and effectively with problems within their control and report those that cannot be solved
- 13 shut down the equipment to a safe condition on conclusion of the machining activities.

Unit 244

Operating optical prism and flat process machines

Outcome 2

Know how to operate optical prism and flat process machines

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed while operating optical prism preparation, smoothing and polishing equipment
- 2 describe the safety mechanisms on the machines, and the procedure for checking that they function correctly
- 3 describe the operation of the machine controls in both set-up and run modes, and how to stop the machine in an emergency
- 4 describe the personal protective equipment to be worn, and where this can be obtained
- 5 describe the hazards associated with carrying out optical prism process operations, and how to minimise them and reduce any risks
- 6 describe the importance of keeping the work area clean and tidy
- 7 explain how to extract and use information from optical engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 8 explain how to use imperial and metric systems of measurement
- 9 describe the various optical prism operations that can be performed
- 10 describe the effects of backlash in machine slides, dials and screws, and how this can be overcome
- 11 describe the methods that can be used to set up the workpiece prior to the operation, to minimise optical wedge and parallelism in relation to the cutting tool (such as alloy jigs, plaster blocks, pitch pads)
- 12 explain how to handle and store all tools and kit required, safely and correctly
- 13 the application of roughing and finishing cuts and pressures, and their effects on tool life, surface finish and dimensional accuracy
- 14 explain how tool wear affects surface finish and dimensional accuracy
- 15 explain how the various types of material will affect the way the operation is performed
- 16 describe the application of cutting fluids with regard to the range of material being produced
- 17 describe the effect of clamping the workpiece, and how this can cause distortion in the finished component
- 18 describe the problems that can occur with optical prism machining activities, and how they can be overcome
- 19 describe the quality control procedures used, inspection checks to be carried out, and the equipment used to achieve required component
- 20 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Unit 245

Operating CNC aspheric optical and diamond turning machines

Level: 2
Credit value: 32
UAN: A/600/6067

Unit aim

This unit covers the skills and knowledge needed to prove the competences required to carry out the machining of aspheric glass and diamond turned components, using Computer Numerical Control (CNC) machines or CNC machining centres, in accordance with approved procedures. The learner will confirm with the machine setter that the machine is ready for the operations to be performed and that all the required components, materials and consumables are available. The learner will be required to produce a range of aspheric components of various infra-red and/or visible materials, which combine a range of different features, such as aspheric form, power, surface roughness, cap height, etc. The learner will also be required to check and verify the finished components, using a variety of equipment, to ensure they meet the required specifications.

The learner will be required to operate the machine in line with safe working practices and approved procedures, to continuously monitor the machining operations and, where necessary make minor adjustments or seek the help of the machine setter to make the adjustments, in order to ensure that the work output is to the required quality and accuracy. Meeting production targets will be an important issue, and their production records must show consistent and satisfactory performance.

The learner's responsibilities will require them to comply with organisational policy and procedures for the CNC optical machining activities undertaken, and to report any problems with the machining activities, materials or equipment used that they cannot personally resolve, or are outside their permitted authority, to the relevant people. The learner will be expected to work to instructions, with a minimum of supervision, taking personal responsibility for their own actions and for the quality and accuracy of the work that they produce.

The learner's knowledge will be sufficient to provide a sound basis for their work, and will enable them to adopt an informed approach to applying CNC optical machining procedures. The learner will have an understanding of the CNC aspheric glass and diamond turning processes used, and their application, and will know about the equipment, materials and consumables, in adequate depth to provide a sound basis for carrying out the activities to the required specification.

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

Learning outcomes

There are **two** learning outcomes to this unit. The learner will:

- 1 Be able to operate CNC aspheric optical and diamond turning machines
- 2 Know how to operate CNC aspheric optical and diamond turning machines

Guided learning hours

It is recommended that **130** hours should be allocated for this unit, although patterns of delivery are likely to vary.

Details of the relationship between the unit and relevant national standards

This unit has been derived from Semta National Occupational Standard Mechanical Manufacturing Engineering Unit 45: Operating CNC Aspheric Optical and Diamond Turning Machines (Suite 2).

Support of the unit by a sector or other appropriate body

This unit is endorsed by Semta, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Assessment

This unit must be assessed in a work environment and in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF', which can be downloaded from the **Semta** website.

Additional assessment requirements have also been published by **Semta** and are included in the Mechanical Manufacturing Engineering Suite 2 Unit Assessment Strategy, which can also be downloaded from the **Semta** website.

Unit 245

Operating CNC aspheric optical and diamond turning machines

Outcome 1

Be able to operate CNC aspheric optical and diamond turning machines

Assessment criteria

Practical skills

The learner can:

- 1 work safely at all times, complying with health and safety and other relevant regulations and guidelines
- 2 confirm that the equipment is set up and ready for operation
- 3 follow the defined procedures for starting and running the operating system
- 4 apply all of the following during the machining activities:
 - obtain and use the appropriate documentation (such as job instructions, drawings, quality control documentation)
 - 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
 - confirm with the machine setter that the machine is ready for production
 - where appropriate, seek any necessary instruction/training on the operation of the machine
 - ensure that machine guards are in place and are correctly adjusted
 - hold components securely, without damage or distortion
 - maintain the cutting tools in a suitable condition
 - ensure that the operating program is at the correct start point before starting the machine
 - ensure that the workpiece is clear of the machine spindle
 - ensure that safe working practices and start-up procedures are observed
 - ensure that machine settings are adjusted as and when required (either by themselves or the setter) to maintain the required accuracy
 - ensure that the components produced meet the required specification for quality and accuracy
 - leave the work area and machine in a safe and appropriate condition on completion of the activities
- 5 operate one of the following aspheric lens processes:
 - glass aspheric generating process
 - glass aspheric polishing process
 - diamond turning aspheric process
 - diamond turning diffractive/hybrid process
- 6 produce machined optical components that combine different operations and cover four of the following:
 - centre thickness
 - lens cosmetic defects
 - lens concentricity
 - lens cap height

- lens diameter/step feature, angle
 - lens aspheric form analysis
 - lens surface roughness
 - lens power analysis/radius
 - lens diffractive step height
- 7 machine three different types of material from the following:
- zinc selenide
 - zinc sulphide
 - optical silicon
 - optical cleartran
 - optical infra-red glass 4
 - optical infra-red glass 5
 - optical infra-red glass 6
 - gallium arsenide
 - acrylic
 - optical glass
 - optical grade germanium
 - optical thallium ideobromide
 - aluminium
 - other appropriate optical material
- 8 deal promptly and effectively with error messages or equipment faults that are within their control and report those that cannot be solved
- 9 monitor the computer process and ensure that the production output is to the required specification
- 10 produce components with dimensional accuracy, form and surface quality, which comply to one of the following standards:
- BS, ISO or BSEN standards and procedures
 - other accepted international standards
 - customer (contractual) standards and requirements
 - company standards and procedures
- 11 carry out the necessary checks for accuracy during production of four of the following:
- lens chamfers
 - lens surface finish
 - lens diameter
 - lens cap height
 - lens centre thickness
 - lens power error
- 12 lens surface power error
- 13 shut down the equipment to a safe condition on conclusion of the activities.

Unit 245 Operating CNC aspheric optical and diamond turning machines

Outcome 2 Know how to operate CNC aspheric optical and diamond turning machines

Assessment criteria

Underpinning knowledge

The learner can:

- 1 describe the safe working practices and procedures to be followed while operating CNC aspheric lens generating, and polishing equipment and diamond turning equipment
- 2 describe the safety mechanisms on the machine, and the procedure for checking that they function correctly
- 3 describe the operation of the machine controls in both set-up and run modes, and how to stop the machine in an emergency
- 4 describe the personal protective equipment to be worn, and where this can be obtained
- 5 describe the hazards associated with carrying out aspheric lens process operations, and how to minimise them and reduce any risk
- 6 describe the importance of keeping the work area clean and tidy
- 7 explain how to extract and use information from optical engineering drawings and related specifications (to include symbols and conventions to appropriate BS, ISO or BSEN standards) in relation to work undertaken
- 8 explain how to use imperial and metric systems of measurement and system of tolerancing
- 9 describe the process methods of aspheric manufacture, and the use of a variety of tools (such as diamond tip tools, diamond abrasive wheels and polishing tools)
- 10 describe the lens mounting methods used to set up the workpiece prior to operation, to minimise wedge error, concentricity and astigmatism
- 11 explain how to handle and store all cutting tools and kit required, safe and correctly
- 12 describe the factors which affect the selection of cutting feeds, pressures and speeds required, and the depth of cut that can be taken (such as workpiece rigidity, machine condition, types of tooling, material, finish and tolerance required)
- 13 explain how tool wear affects surface finish and dimensional accuracy
- 14 explain how the various types of material will affect the way the operation is performed
- 15 describe the application of cutting fluids with regard to the range of material being produced
- 16 explain how to recognise machine faults, and how to identify when tooling needs refurbishment
- 17 describe the problems that can occur with CNC optical lens infra-red and special material machining activities, and how they can be overcome
- 18 describe the quality control procedures used, inspection checks to be carried out, and the equipment used
- 19 describe the extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Appendix 1 Relationships to other qualifications

Links to other qualifications and frameworks

Centres are responsible for checking the different requirements of all qualifications they are delivering and ensuring that candidates meet requirements of all units/qualifications. For example, units within a QCF qualification may be similar in content to units in the NQF qualification which the candidate may have already undertaken and this may present opportunities for APL.

These qualifications have connections to the:

- Level 3 NVQ Extended Diploma and Diploma in Mechanical Manufacturing Engineering

Literacy, language, numeracy and ICT skills development

These qualifications include opportunities to develop and practise many of the skills and techniques required for success in the following qualifications:

- Functional Skills (England) – see www.cityandguilds.com/functionalskills
- Essential Skills (Northern Ireland) – see www.cityandguilds.com/essentialskillsni
- Essential Skills Wales – see www.cityandguilds.com/esw

There might also be opportunities to develop skills and/or portfolio evidence if candidates are completing any Key/Functional Skills alongside these qualifications.

Appendix 2 Sources of general information

The following documents contain essential information for centres delivering City & Guilds qualifications. They should be referred to in conjunction with this handbook. To download the documents and to find other useful documents, go to the **Centres and Training Providers homepage** on www.cityandguilds.com.

Centre Manual - Supporting Customer Excellence contains detailed information about the processes which must be followed and requirements which must be met for a centre to achieve 'approved centre' status, or to offer a particular qualification, as well as updates and good practice exemplars for City & Guilds assessment and policy issues. Specifically, the document includes sections on:

- The centre and qualification approval process
- Assessment, internal quality assurance and examination roles at the centre
- Registration and certification of candidates
- Non-compliance
- Complaints and appeals
- Equal opportunities
- Data protection
- Management systems
- Maintaining records
- Assessment
- Internal quality assurance
- External quality assurance.

Our Quality Assurance Requirements encompasses all of the relevant requirements of key regulatory documents such as:

- Regulatory Arrangements for the Qualifications and Credit Framework (2008)
- SQA Awarding Body Criteria (2007)
- NVQ Code of Practice (2006)

and sets out the criteria that centres should adhere to pre and post centre and qualification approval.

Access to Assessment & Qualifications provides full details of the arrangements that may be made to facilitate access to assessments and qualifications for candidates who are eligible for adjustments in assessment.

The **centre homepage** section of the City & Guilds website also contains useful information such on such things as:

- **Walled Garden:** how to register and certificate candidates on line
- **Qualifications and Credit Framework (QCF):** general guidance about the QCF and how qualifications will change, as well as information on the IT systems needed and FAQs
- **Events:** dates and information on the latest Centre events
- **Online assessment:** how to register for e-assessments.

Useful contacts

UK learners

General qualification information

T: +44 (0)844 543 0033

E: learnersupport@cityandguilds.com

International learners

General qualification information

T: +44 (0)844 543 0033

F: +44 (0)20 7294 2413

E: intcg@cityandguilds.com

Centres

Exam entries, Certificates, Registrations/enrolment, Invoices, Missing or late exam materials, Nominal roll reports, Results

T: +44 (0)844 543 0000

F: +44 (0)20 7294 2413

E: centresupport@cityandguilds.com

Single subject qualifications

Exam entries, Results, Certification, Missing or late exam materials, Incorrect exam papers, Forms request (BB, results entry), Exam date and time change

T: +44 (0)844 543 0000

F: +44 (0)20 7294 2413

F: +44 (0)20 7294 2404 (BB forms)

E: singlesubjects@cityandguilds.com

International awards

Results, Entries, Enrolments, Invoices, Missing or late exam materials, Nominal roll reports

T: +44 (0)844 543 0000

F: +44 (0)20 7294 2413

E: intops@cityandguilds.com

Walled Garden

Re-issue of password or username, Technical problems, Entries, Results, e-assessment, Navigation, User/menu option, Problems

T: +44 (0)844 543 0000

F: +44 (0)20 7294 2413

E: walledgarden@cityandguilds.com

Employer

Employer solutions, Mapping, Accreditation, Development Skills, Consultancy

T: +44 (0)121 503 8993

E: business@cityandguilds.com

Publications

Logbooks, Centre documents, Forms, Free literature

T: +44 (0)844 543 0000

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If you have a complaint, or any suggestions for improvement about any of the services that City & Guilds provides, email: feedbackandcomplaints@cityandguilds.com

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